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2,657,031

GRAIN DRIER

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FIG. 1

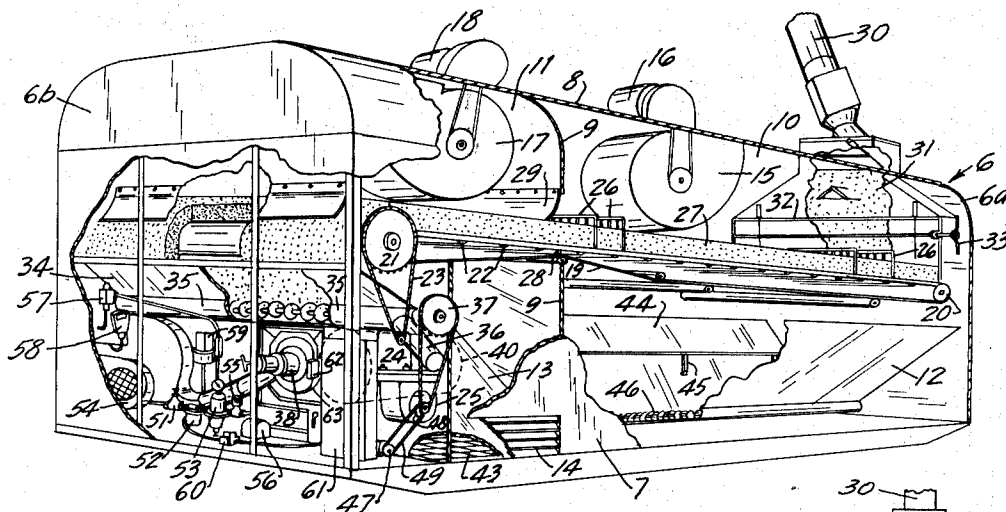


FIG. 2

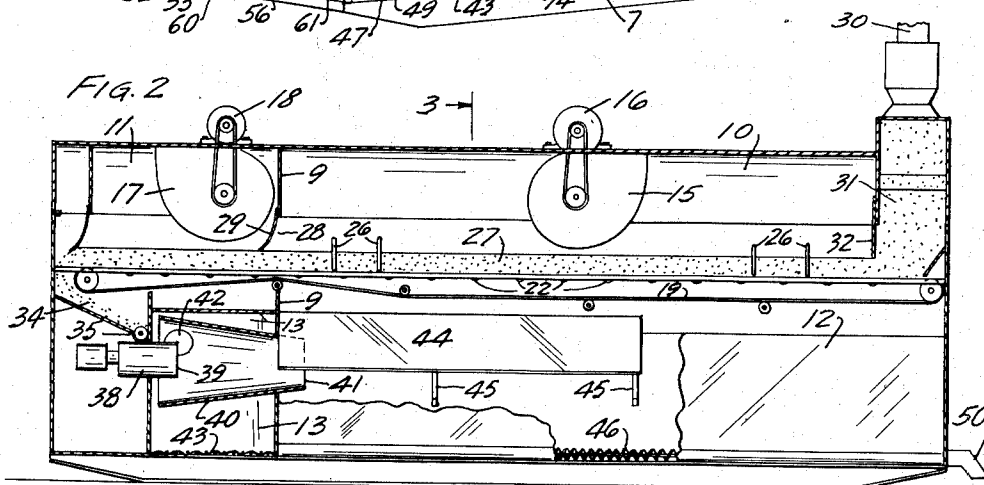


FIG. 3

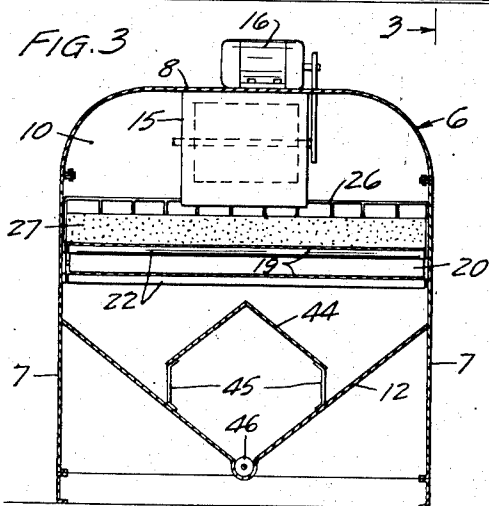
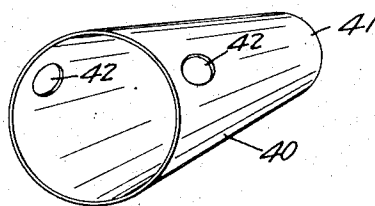


FIG. 4



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GRAIN DRIER

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Application September 4, 1951, Serial No. 244,972

6 Claims. (Cl. 263—8)

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This invention relates to dryers and dehydrators for drying grain and other products. More particularly, it relates to grain dryers of the type wherein a source of relatively hot air is utilized to dry the grain during its continuous passage through the dryer.

This invention constitutes improvements over the invention as disclosed and claimed in U. S. Letters Patent No. 2,490,176, dated December 6, 1949, and entitled Grain Drier, filed by William E. Tomlinson and Ben L. Tomlinson on September 5, 1947.

Although the invention disclosed and claimed in the patent referred to in the preceding paragraph provides a grain dryer of high operating efficiency, we have found that by making certain improvements thereto it is possible to increase the efficiency of the drying unit and practically eliminate fire hazards normally attendant therewith.

It is a general object of our invention to provide a novel and improved grain dryer of simple and improved construction and having increased efficiency, compactability and safety during operation.

A more specific object is to provide an improved grain dryer constructed to distribute the hot air relatively uniformly throughout the length of the drying chamber to accomplish more uniform and effective drying of the grain passing there-through.

Another object is to provide an improved grain dryer constructed to effectively and continuously remove the dust and dirt which normally collects within the interior of a grain dryer and thereby substantially reduce the danger of fire resulting therefrom.

Another object is to provide an improved grain dryer constructed to prevent substantially all of the hot air, when released within the drying chamber, from rising and passing through only the portions of the conveyor which are immediately adjacent the discharge of such hot air to the neglect of the portions of the conveyor more removed.

Another object is to provide an improved grain dryer constructed to effectively collect along a central area the dust and dirt which works its way through the grain and the conveyor and to thereafter efficiently remove the same.

Another object is to provide a grain dryer having inherent means for retaining a substantial portion of the hot air beneath a retaining hood to release the same at points substantially removed from the discharge area.

Another object is to provide a novel and improved grain dryer having improved structure for accomplishing complete and thorough mixing of the hot air discharged by the burner with cool air prior to its release within the drying chamber of the dryer.

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These and other objects and advantages of my invention will be more apparent from the following description made in connection with the accompanying drawings, wherein like reference characters refer to similar parts throughout the several views and in which

Fig. 1 is a perspective view of one embodiment of our invention with portions of the walls broken away to reveal the interior thereof;

Fig. 2 is a vertical sectional view taken longitudinally of the dryer.

Fig. 3 is a transverse vertical sectional view taken along approximately line 3—3 of Fig. 2.

Fig. 4 is a perspective view of the tubular member utilized to effect a more thorough mixing of the hot and cool air adjacent the burner.

One embodiment of our invention may include as shown in Figs. 1-4, an elongated housing indicated generally as 5 and having side walls 7, a top wall 8, a receiving end 6A, and a delivery end 6B. The walls of the housing 5 are insulated to prevent the escape of hot air therefrom and the interior of the housing is divided by a partition 9 into a hot chamber 10 and a cooling chamber 11. The hot chamber 10 has a generally V-shaped bottom 12 while the cooling chamber 11 has a generally inverted V-shaped bottom 13. The cooling chamber 11 communicates with the exterior by means of a louvered cooling air intake 14 arranged adjacent the lower portion of the housing and within the opposite side walls thereof as best shown in Fig. 1. Secured to the top wall 8 of the housing within the hot chamber 10 is a drying blower 15 which is driven by a motor 16. Also secured to the top wall 8 of the housing within the cooling chamber 11 is a cooling blower 17 driven by a motor 18.

Mounted within the interior of the housing to extend longitudinally thereof throughout the major portion of its length and medially disposed relative to the height of the housing is an endless porous conveyor 19. This porous conveyor 19 is formed of material which will readily permit air to pass therethrough but the openings thereof are sufficiently small to prevent small grains from working downwardly therethrough. It has been found that a type of wire mesh belting is best adapted for this type of conveyor. As shown, the conveyor is provided with a rear alignment sprocket 20 and with a main drive sprocket 21 which positively drives the endless conveyor continuously around its mounting. The conveyor is provided with a plurality of apron support rollers 22 to facilitate its movement throughout the length of the housing.

The conveyor is driven by means of a drive chain 23 which is connected with a speed reducer 24 which in turn is driven by a variable speed drive motor 25. Rakes or agitator bars 26 are mounted between the opposite side walls of the housing directly above the conveyor 19

and extend downwardly toward the conveyor in position so that the grain 27 must pass therebetween. The partition 9 is provided with a transverse aperture 28 to permit the conveyor to pass therethrough. A flexible flap 29 depends from the upper portion of the partition 9 a sufficient distance so that the lower edge thereof will drag along the upper surface of the grain being dried.

At the receiving end 6a of the housing 6 there is provided a wet grain intake spout 30 which empties into the intake hopper 31. The intake spout and the hopper act as a conduit for the incoming wet grain and the flow therethrough is controlled by a control gate 32. The control gate 32 may be regulated by an adjustment handle 33.

At the delivery end 6b of the housing and at the delivery end of the conveyor 19 and slightly therebelow is positioned a hopper 34 which extends transversely of the housing. The floor of this hopper 34 is disposed at an angle so that the grain which has been dried and discharged over the adjacent end of the conveyor will drop into the hopper and slide to its lowest point within which a dry grain discharge screw conveyor 35 is mounted for rotation on a horizontal axis. This screw conveyor 35 discharges into a discharge spout 36 and is driven by a second drive sprocket 37 which is connected as shown to the variable speed drive motor 25.

Mounted in the lower portion of the housing 6 adjacent its delivery end 6b is a blast type oil burner indicated generally as 38 which has a discharge 39 which terminates beneath the inverted V-shaped bottom 13 of the cooling chamber 11. The discharge end 39 is surrounded by a tubular member 40 which tapers throughout its length toward the receiving end of the housing. The larger end of the tubular member is disposed so that the discharge 39 of the burner extends well within the interior of the tubular member 40. The smaller end 41 of the tubular member extends through the partition 9 and into the interior of the hot chamber 10 as best shown in Fig. 2. This tubular member 40 has a pair of ports 42 formed therethrough and disposed directly opposite the discharge 39 of the burner. These ports cause the interior of the tubular member 40 to communicate with the area exterior of that member to permit air to pass therethrough. A supply of cold air is available through the screening 43 which is disposed at the bottom of the housing directly below the discharge of the burner. Thus cool air is permitted to rise through this screen and enter the larger end of the tubular member 40 as well as the ports 42 to mix with the extremely hot air discharged at 39 by the burner 38.

Mounted within the interior of the hot chamber 10 and extending longitudinally thereof beneath the conveyor 19 but at a level above the discharge of hot air through the smaller end 41 of the tubular member 40 is a hood or air distributor 44. As best shown in Fig. 3 this hood is mounted upon a plurality of upstanding arms 45 which extend upwardly from the V-shaped bottom 12 of the hot chamber 10. This hood 44 is preferably of an inverted V-shape when viewed cross-sectionally, as shown in Fig. 3, and extends a substantial distance through the length of the hot chamber 10, preferably to a point beyond the middle thereof. The sides of the hood 44 are spaced from the side walls of the housing and from the walls 5 forming the bottom 12 so

that warm air may readily pass laterally therebetween to rise upwardly through the conveyor 19. A portion of the hot air will be confined within the confines of the hood and driven longitudinally thereof to be discharged beyond the end of the hood adjacent the receiving end of the housing.

The V-shaped bottom of the hot chamber 10 is provided with an auger type clean-out conveyor 46 which extends longitudinally of the cooling chamber and the housing. This is best shown in Figs. 2 and 3. This conveyor 46 is rotatably mounted and driven by the clean-out auger drive 47 which is connected to the variable speed drive motor 25 by a pulley 48 and a belt 49. This screw type conveyor discharges at the receiving end of the housing to the exterior of the housing as at 50.

The controls for the entire unit are mounted adjacent the delivery end of the housing. These controls are not considered to be part of the invention but they will be briefly enumerated and identified herein for the purpose of clarity. In conjunction with the oil burner 10, there is provided a manual oil valve 51, an oil filter 52, an oil pressure regulator 53, an oil pump 54, a solenoid oil valve 55 and an oil burner control motor 56. Also provided is a low limit control 57, a high limit control and thermometer 58 and a vaporstat 59. A foot switch 60, an electric control panel 61, an electric eye 62 and a control 63 for the electric eye complete the controls.

Operations

In operation the conveyor 19 is first started. The combustion blower then starts and opens the solenoid valve which controls the oil feed. This oil feed is connected in series with the valve and the valve is opened only when at full pressure to prevent smoking and/or improper fuel and air mixture. The oil is under pressure approximating 10 pounds and is forced through the spray nozzle of the burner for combustion. Air comes around the nozzle from the rear to provide the oxygen for combustion.

The electric eye, in case the fire of the burner goes out, is electrically connected to cut off all of the mechanisms within the burner and to automatically sound a warning horn. The low limit control does the same when the temperature within the chamber above the material being dried reaches a level above 160 degrees Fahrenheit and the high limit control does the same if the temperature in the hot air chamber should reach a level above 260 degrees Fahrenheit.

The grain is fed into the wet grain intake spout 30 from the source of grain to be dried. This grain passes into the hopper 31, through the gate 32 and is deposited thereby upon the receiving end of the conveyor 19 in an even stratum. As the endless conveyor 19 moves around its mounting, the stratum of grain 27 passes slowly toward the delivery end 6b of the housing at a steady rate. As it passes through the rakes 26 the grain is slightly agitated and disturbed to facilitate the passing of the hot air upwardly therethrough. The blower 15 draws the hot air upwardly through the stratum of grain and discharges it by its tangential discharge to the exterior of the housing.

By the time the grain has reached the panel 9 to pass beneath the flap 29 it has been substantially dried but is at a temperature too high for storage. The blower 17, however, draws cool

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air upwardly through the cooling chamber and through the stratum of warm grain to cool the same while it is within the cooling chamber. This cool air, which of course will be warmed by the grain, is discharged to the exterior of the housing. The cooled grain is thereafter discharged over the end of the conveyor 19 into the hopper 34 and passes downwardly into the dry grain discharge auger 35 which in turn carries the same laterally of the housing and into the discharge spout 36.

As the grain passes through the hot chamber dust, dirt and other foreign materials, ordinarily found mixed with grain which has not been cleaned, will gradually work downwardly through the stratum of grain and through the porous conveyor 19. This downward progression of foreign matter is facilitated to the disturbing action of the rakers 26 as the grain passes therebetween. Such dirt and dust, once it has worked its way through the the stratum of grain and conveyor, falls downwardly to the V-shaped bottom 12 of the hot chamber and slides to the apex thereof to be engaged by the discharge conveyor 46. This discharge conveyor 46 rotates very slowly but it is amply sufficient to constantly remove such foreign matter which would otherwise collect within the interior of the housing to cause a substantial fire hazard. The continuous elimination of this dirt and dust and its discharge to a point exterior of the housing eliminates this fire hazard.

The hot air which is discharged by the burner 38 is at such a high temperature that cool air is mixed therewith prior to its release beneath the conveyor for drying purposes to prevent injury to the grain. This is accomplished through the use of the tubular member 40 which permits cool air to enter its larger end in surrounding relation to the discharge 39 of the burner. The arrows in Fig. 2 indicate the direction of flow of such cool air. We have found, however, that it is important that means be provided for uniformly mixing this cool air with the hot air discharged by the burner. To accomplish this, we have tapered the tubular member 40 to facilitate the mixing of the warm and hot air. In addition we have found it to be advantageous to provide a pair of ports 42 positioned as shown so that additional cool air will be drawn therethrough to mix with the hot air discharged from the burner at 39. The introduction of cool air from this lateral point of vantage and having a cross-directional movement induces or creates a vorticity within the interior of the tubular member 40 which substantially increases the mixing action of the warm and cool air. Thus by the time the hot air has reached the discharge 41 of the tubular member 40, it has been thoroughly mixed so as to have an even temperature throughout its mass.

The hot air discharged by the tubular member 40 is released at a point beneath the hood 44 as best shown in Fig. 2. This hot air of course tends to rise immediately upon its release. We have found however that if such rising action is permitted uninhibited, uneven drying may result within the stratum of grain at its passes along with the conveyor. In other words, we have found that a greater efficiency may be obtained by distributing the discharge of hot air over a major portion of the hot chamber 10 so that the hot air will be released more uniformly throughout the various points of the hot chamber. The inverted V-shaped hood 44 permits a substantial

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portion of this hot air to move laterally and upwardly between its sides and the bottom 12 to dry the grain immediately thereabove. At the same time, a substantial portion of the hot air remains within the confine of the hood and is driven longitudinally of the housing and of the hood to be released adjacent the end of the hood which is adjacent the receiving end of the housing. Thus it can be readily seen that a relatively uniform distribution of the hot air is provided so that the grain deposited upon the conveyor will be dried substantially equally as rapidly adjacent the receiving end as it will adjacent the partition 9. We have found that such a hood produces a substantially uniform distribution of the hot air within the hot chamber 10 and effects a substantially more uniform drying action.

It should be noted also that by mounting the blowers 15 and 17 within the confines of the housing we have substantially increased the compactability of the unit.

Thus it can be seen that we have provided an improved grain drying unit constructed to effectively and continuously remove the dust and dirt which normally collects within such a unit and which normally constitutes a serious fire hazard thereto. At the same time we have provided structure which substantially increases the efficiency of the unit as a result of accomplishing improved mixing of the hot and cold air and uniform distribution of the mixed air throughout the interior of the hot chamber.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the various parts without departing from the scope of our invention.

What we hereby claim is:

1. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and a bottom, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to be dried to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby, hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, a panel-like air distributor member mounted below said conveyor and at a level above the discharge of said hot air conduit means and extending from a point adjacent the point of discharge of said hot air conduit means longitudinally of said housing toward the receiving end thereof to effective-

ly distribute the warm air more uniformly throughout said hot chamber than would otherwise take place, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain thereon and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulated in said cooling chamber.

2. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and a bottom, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to be dried to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, a clean-out conveyor mounted in the lower portion of said housing below said endless porous conveyor and extending longitudinally thereof in position to receive whatever dust and dirt may pass through said porous conveyor and fall downwardly and to discharge its thusly acquired load exteriorly of said housing, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain therein and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulated in said cooling chamber.

3. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and an imperforate V-shaped bottom, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to be dried to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the

delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, a clean-out conveyor extending longitudinally of said housing and mounted in the lower portion thereof below said endless porous conveyor and at the apex of said V-shaped bottom in position to receive whatever dust, dirt and other foreign materials which may pass through said porous conveyor and fall downwardly and to discharge its thusly acquired load exteriorly of said housing, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain thereon and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulated in said cooling chamber.

4. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and a generally V-shaped bottom when viewed cross-sectionally, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby, hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, a power-driven auger-type clean-out conveyor extending longitudinally of said housing and mounted for rotation about its longitudinal axis within the apex of said V-shaped bottom and discharging exteriorly of said housing whereby dust, dirt and other foreign materials which pass through said porous con-

veyor and fall downwardly to constitute fire hazards may be continuously and effectively eliminated and thereby prevented from accumulating within said housing, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain thereon and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulate within said cooling chamber.

5. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and a bottom and side walls, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to be dried to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, an elongated hood member mounted below said conveyor at a level above the discharge of said hot air conduit means and extending from a point adjacent the point of discharge of said hot air conduit means longitudinally of and in spaced relation to the side walls of said housing toward the receiving end thereof to effectively distribute the warm air more uniformly throughout said hot chamber than would otherwise take place, said hood member having side portions extending at a lower level than its medial portion when viewed cross-sectionally, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain thereon and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulated in said cooling chamber, said tubular element having at least one port formed in its walls opposite the discharge of said burner to provide increased communication between the interior of said element and the exterior and to thereby induce increased mixing of the hot air with the cool air drawn into said tubular element from its exterior as a result of the vorticity set up within the interior of said tubular element by the flow of cool air through said port into said element.

6. A continuous grain dryer having in combination a housing having a delivery end and a receiving end and a top and bottom, an endless porous conveyor extending substantially horizontally throughout the major portion of the length of said housing and medially disposed relative to

the height thereof, conduit means in the receiving end of said housing adapted when connected to a source of grain to be dried to deliver continuously a stratum of such grain upon the receiving end of said conveyor, means for delivering dry grain from the delivery end of said housing to a point exterior thereof, a blast type burner mounted within said housing adjacent its delivery end and having a hot air discharge, a transverse partition dividing the interior of said housing into a larger hot chamber extending from a point inwardly of said burner to the receiving end of said housing and a cooling chamber extending from said partition to the delivery end of said housing, said cooling chamber communicating with the exterior at points below said conveyor, said partition having an aperture in the central portion thereof for accommodating said conveyor and the stratum of grain carried thereby, hot air conduit means receiving from the discharge of said burner and discharging hot air into said hot chamber of said housing below said conveyor and directed longitudinally and centrally of said housing toward the receiving end thereof, said hot air conduit means comprising a tubular element having a receiving end surrounding the discharge of said burner in spaced relation and a discharge end extending into said hot chamber, said tubular element being tapered inwardly throughout its length away from its receiving end whereby increased mixing of the hot air discharged by said burner and the cold air drawn into said element around the discharge of said burner may be accomplished prior to its discharge into said hot chamber, and an expeller-type blower mounted in the upper portion of said housing above said conveyor and having an intake and a discharge communicating with the interior and the exterior of said housing respectively whereby hot air and products of combustion will be drawn and circulated upwardly through said porous conveyor and the stratum of grain thereon and then discharged from the dryer and whereby cool air will be drawn and circulated upwardly through the delivery portion of said conveyor and circulated in said cooling chamber, said tubular element having at least one port formed in its walls opposite the discharge of said burner to provide increased communication between the interior of said element and the exterior and to thereby induce increased mixing of the hot air with the cool air drawn into said tubular element from its exterior as a result of the vorticity set up within the interior of said tubular element by the flow of cool air through said port into said element.

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