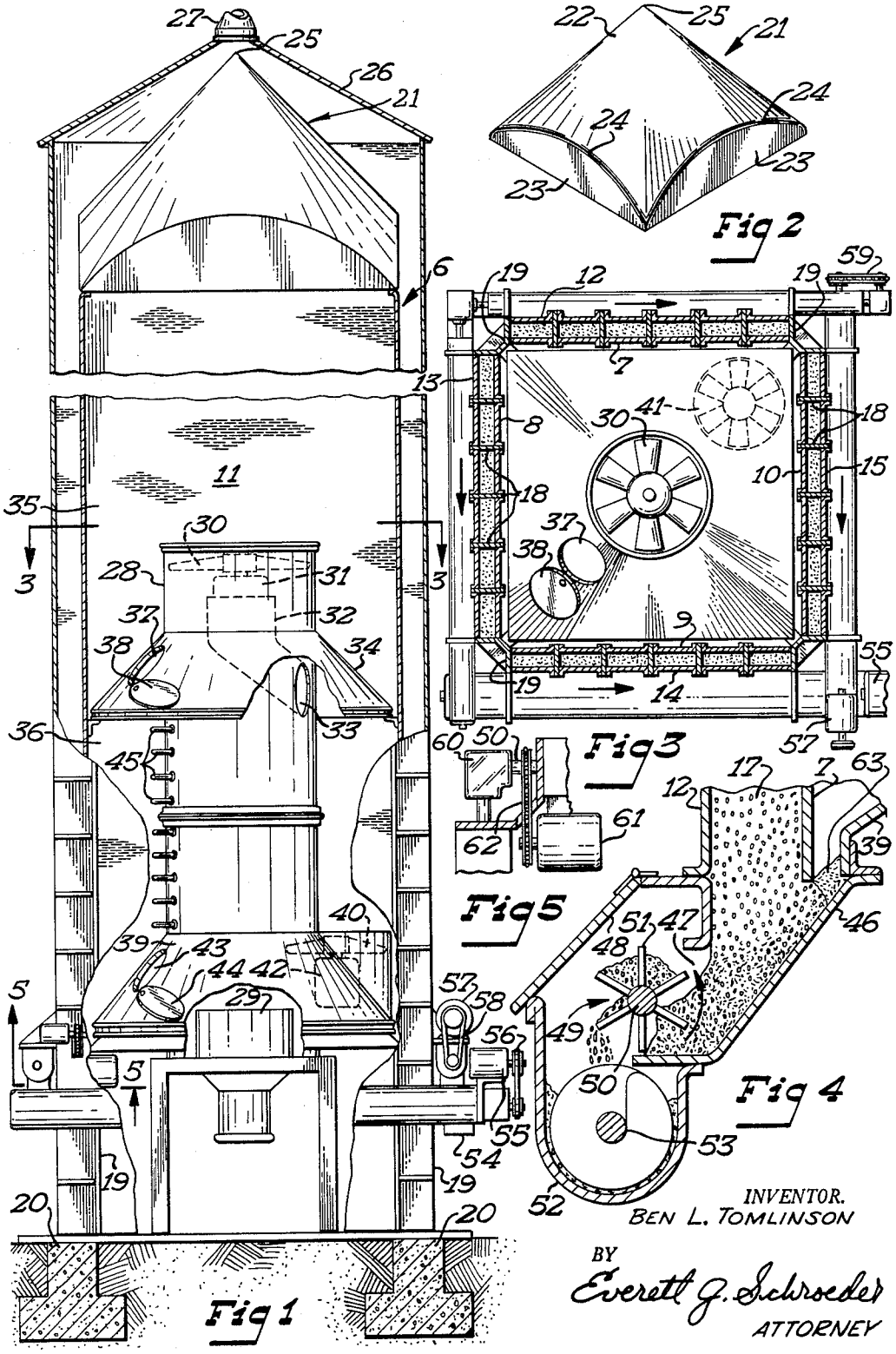
Feb. 8, 1966 B. L. TOMLINSON 3,233,337

TERMINAL GRAIN DRYER

Filed March 30, 1961



INVENTOR.
BEN L. TOMLINSON

BY
Everett J. Schroeder
ATTORNEY

United States Patent Office

3,233,337

Patented Feb. 8, 1966

3,233,337

TERMINAL GRAIN DRYER

Ben L. Tomlinson, Hopkins, Minn., assignor, by mesne assignments, to Hart-Carter Company, Chicago, Ill., a corporation of Delaware

Filed Mar. 30, 1961, Ser. No. 99,489
5 Claims. (Cl. 34—65)

This invention relates to grain dryers. More particularly, it relates to grain dryers of the type designed for use at grain terminals to dry grain continuously and rapidly in large capacities in order to handle the large volumes of grain which must be accommodated by grain terminals.

Various types of terminal grain dryers have been designed previously in an effort to provide a dryer having adequate capacity and satisfactorily performing the necessary drying function at a grain terminal. To the best of my knowledge none of these have been satisfactory for a number of reasons. It has always been difficult to obtain a terminal dryer having adequate capacity which will perform the necessary drying function in a satisfactory manner. In addition, most such dryers require structure which cover relatively large areas and since realty adjacent grain terminals is generally held at a premium price, such grain dryers prove very costly to maintain and operate. Many of these grain dryers attempt to recirculate the air with the consequent result, of course, that the drying function suffers. Many of these devices do not heat evenly throughout and there is a very substantial heat loss in most of them because they require considerable duct work in order to transfer the heat from its source to the point of application. One of the most serious drawbacks of grain dryers known is their very distinct danger of fire for in these dryers dust tends to collect and soon constitutes a very substantial fire hazard. In recent years the grain which is reaching the grain terminals has become increasingly less clean in that modern large scale harvesting methods frequently results in the harvested grain having increasingly larger proportions of dust, dirt, debris, etc. Many of such grain dryers, in an effort to obtain the desired capacity have reached almost prohibitive heights with consequent increase in cost of manufacture, assembly, etc. Most such grain dryers have blind spots in which dust, chaff, etc. collect and which are inaccessible for cleaning, thus constituting a very real fire hazard. My invention is directed toward overcoming these disadvantages and I have found that my terminal grain dryer functions in a highly improved manner over any grain dryer heretofore known.

It is a general object of my invention to provide a novel and improved terminal grain dryer of relatively simple and inexpensive construction and improved efficiency.

A more specific object is to provide a novel and improved terminal grain dryer having much greater capacity than heretofore known and constructed and arranged to substantially reduce fire hazards.

Another object is to provide a novel and improved terminal grain dryer which will heat evenly throughout the drying area.

Another object is to provide a novel and improved terminal grain dryer in which all of the air which is heated is forced to pass through the grain being dried within the dryer.

Another object is to provide a novel and improved terminal grain dryer which eliminates blind spots in which dirt, chaff, etc. may collect in inaccessible areas with consequent increased fire hazards.

Another object is to provide a novel and improved terminal grain dryer constructed and arranged to facilitate maintenance and servicing of the dryer after it has been placed in operation and to simplify the entire structure

for maintenance, inspection, observation, and repair while yielding an increased capacity, improved function and substantial reduction in fire hazards.

Another object is to provide a novel and improved grain dryer which can be constructed upon a minimum area without extending to prohibitive heights while providing an increased capacity over other dryers heretofore known when mounted upon a given restricted ground area.

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

FIG. 1 is a side elevational view of one embodiment of my invention with the upper portion thereof shown in vertical section and portions broken away to show the heat generating apparatus in elevation.

FIG. 2 is a perspective view of the divider cover member carried by the inner wall structure of my dryer at the upper end thereof to uniformly divide the grain between the four sides of the dryer.

FIG. 3 is a horizontal sectional view taken along approximately line 3—3 of FIG. 1.

FIG. 4 is a fragmentary detailed vertical sectional view on an enlarged scale through the discharge and conveying portion of one of the sides of my dryer; and

FIG. 5 is a horizontal sectional view taken along line 5—5 of FIG. 1.

One embodiment of my invention, as shown in FIGS. 1–5, includes an upright shaft indicated generally by the numeral **6** and defined by a plurality of perforated inner walls **7**, **8**, **9**, and **10**. As best shown in FIGS. 1 and 3 these walls are arranged to define an open interior indicated by the numeral **11** which is rectangular in horizontal section as clearly shown in FIG. 3. The vertical walls **7–10** inclusive are enclosed by a second set of vertical walls which are also perforated. These outer walls **12**, **13**, **14**, and **15** are spaced outwardly from the inner walls and are each disposed parallel to one of the inner walls so as to enclose the inner walls and defining an area which is also rectangular in horizontal section. Reference to FIG. 3 shows that these perforated outer walls **12–15** are spaced outwardly from the inner walls and cooperatively define a four-sided grain drying column indicated in FIG. 4 by the numeral **17**. Vertically extending panels **18** serve to connect the associated inner and outer walls and divide each side of the drying column into a plurality of separate vertical chutes through which the grain descends.

The weight of the upright shaft **6** is supported by a plurality of posts **19** which are angled in cross-section and supported by footings **20**. These angled posts **19** are connected to the inner and outer walls at each of the corners as best shown in FIG. 3.

Secured to the upper ends of each of the inner walls **8–10** inclusive is a divider member indicated generally by the numeral **21**. This divider member **21** is comprised of a hood or cover the upper portions **22** of which are truly conical in configuration. This cover member **21** has a plurality of vertically extending side walls such as is indicated by the numeral **23** and each extends in the vertical plane of its associated perforated inner wall and is fixedly connected thereto. The upper edge **24** of each of the vertically extending walls **23** is arcuately shaped and connected along its length to the conical portion **22** of the divider member so that when grain is deposited from directly above upon the apex **25** of the divider **21**, the grain will be evenly divided and distributed to each of the four sides of the drying column **17** in such a manner that the

"fines" will not be separated from the "heavies." In other words, by utilizing a divider member constructed as shown herein I have eliminated a normal tendency of the "heavies" to collect in areas where there is the greatest angle of inclination and the "lights" to collect in the areas of lesser inclination with the consequent adverse effect of unequal drying and loss of the heat and pressure.

A roof member 26 covers the entire shaft and is secured, as best shown in FIG. 1, to the outer walls of the structure. A grain chute 37 is connected to the apex of the roof 26 directly above the apex 25 of the divider member 21 and deposits grain as needed upon the divider member. The capacity of the area surrounding the divide 21 is approximately 350 bushels.

Mounted within the open interior 11 of the shaft 6 is a firing tube 28 which, as shown in FIG. 1, is directed upwardly. It will be noted that the entire firing tube 28 is disposed within the vertical confines of the inner wall members 7–10 inclusive and that its open upper end is directed upwardly so that the hot air emanating therefrom will be discharged in an upward direction. A burner 29 is mounted directly below the firing tube 28 and within the lower end portions thereof, this burner also being directed upwardly so that the heat generated thereby will move upwardly through the firing tube and be discharged through the open upper end. A blower 30 is mounted in the open upper end of the firing tube 28 to draw the hot air upwardly through the tube and discharge it under pressure into the open interior 11 of the shaft. This blower 30 is driven by an electrical motor 31 which is surrounded by a conduit 32 extending downwardly within the firing tube and then outwardly through an opening 33 formed in the wall of the firing tube.

Surrounding the firing tube 28 is a separator panel 34 which extends outwardly and downwardly from the firing tube with its lower peripheral portions being disposed immediately adjacent to but slightly spaced from the inner surfaces of the side walls 7, 8, 9, and 10. This separator 34 separates the interior 11 of the shaft 6 into an upper hot air chamber 35 and a lower cool air chamber 36. A man hole opening 37 is formed through the panel 34 and a cover member 38 is hinged immediately below the opening to permit the same to swing between a position covering the opening and a second position at which it hangs downwardly from the hinge to permit a service man to pass upwardly through the opening.

The lower end of the cool air chamber 36 is substantially closed off by a closure panel 39 which surrounds the firing tube 28 and extends downwardly and outwardly therefrom as best shown in FIG. 1 with its lower peripheral portions immediately adjacent the lower ends of the inner walls 7, 8, 9, and 10 but in slightly spaced relation thereto, as best shown in FIG. 4. A cool air fan 40 is mounted beneath the walls of the closure panel 39 and is directed upwardly to throw the cool air through an opening 41 formed therein. An electric motor 42 drives the blower 40 which draws the cool air from beneath the shaft 6, as best seen in FIG. 1. A man hole opening 43 and a cover member 44 therefor is also provided for the closure panel 39 to enable a service man to climb upwardly into the interior of the cool air chamber 36 for servicing and repairing the blower 40 or into the hot air chamber (via the man hole opening 37) to service or repair the blower 30 as desired. To this end a ladder 45 is mounted on the exterior of the firing tube 30.

At each side of the shaft 6 directly below the column of grain 17 is an elongated panel 46 which, as best shown in FIG. 4, has its upper edge portions fixedly secured to the peripheral portions of the closure panel 39. The panel 46 is vertically spaced from the lower edge of the inner walls such as the wall 7 and extends outwardly with its lower portions disposed in vertically spaced relation to the lower ends of the outer walls such as the wall 12. Thus, as shown in FIG. 4, the panels 46 cooperatively define a chute 47 in cooperation with the associated inner and outer walls and a hinged cover member 48 which is carried by the lower end of the outer side wall such as 12. Thus, the column of grain 17 as it moves downwardly between the inner and outer wall will be directed outwardly against a variable speed rotary feed control 49. As shown this feed control 49 is comprised of a shaft 50 and a plurality of radially outwardly extending vanes 51 mounted thereon and rotating therewith about the longitudinal axis of the shaft. The shaft 50 extends across the entire width of its associated side of the drying structure and is driven, in a manner which will be hereinafter described, to rotate in the direction indicated by the arrow in FIG. 4.

Carried by the lower end portions of the panel 46 in receiving relation thereto is a trough member 52 which, like the shaft 50, extends along the full width of its associated side of the drying structure. It will be understood that each side of the structure is provided with a similar panel 46, control means 49 and trough 52 as well as an auger conveyor 53 one each of which is mounted within each of the troughs 52. The auger conveyors 53 move the grain longitudinally of the trough 52 to a discharge 54 as shown in FIG. 1.

The auger conveyors 53 vary in size as best seen in FIG. 3. The conveyors at the top and at the left hand side of FIG. 3 are six inch conveyors while the conveyor at the right hand side is a nine inch conveyor and the conveyor at the lower side of the drawing is a twelve inch conveyor. The conveyors, as best shown in FIG. 1, are disposed at different elevations so that the six inch conveyor at the left hand side of FIG. 3 will move the grain therein in the direction of the arrow and empty from above into the twelve inch conveyor shown at the lower portion of that figure. The twelve inch conveyor moves the material in the direction of the arrow to the discharge 54 which is disposed at the lower right hand corner of FIG. 3. The six inch conveyor shown at the top of FIG. 3 moves the grain in the direction by the arrow to the right and discharges from above into the nine inch conveyor which in turn moves the grain in the direction of the arrow toward the discharge at the lower right hand corner of FIG. 3. The twelve inch conveyor is driven by an electric motor 55 and a belt 56. The nine inch conveyor is driven by an electric motor 57 and a belt 58. A chain 59 drives the six inch conveyor, as shown at the upper right hand corner of FIG. 3, the chain in turn being driven by the shaft and pulley arrangement connected to the shaft of the nine inch conveyor. The six inch conveyor shown at the top of FIG. 3 in turn drives the six inch conveyor at the left hand side of that figure by means of gearing which is not shown.

Each of the feed controls 49 are connected together at their ends by means of gearing 60 which is best shown in FIG. 5 so that one drives the other, each at the same rate of speed. The power is supplied by a motor 61 which is mounted below the closure panel 39 and is connected in driving relation, as best shown in FIG. 5, by means of a chain 62 to one of the shafts 50 of one of the feed controls 49, the chain 62 passing through one of the plates 19 through a slot provided for that purpose. Means for varying the speed (not shown) is provided so that the rate of rotation of the feed controls 49 may be controlled and hence the rate of descent of the grain column 17 may be varied in accordance with the drying requirements.

The operation of my terminal grain dryer is initiated by controls (not shown), these controls being arranged so that the blower 30 commences a brief period before the blower 40 is started. This causes pressure to be built up initially within the hot air chamber 35 and force any dust, etc. which may have collected in the hot air chamber downwardly into the cool air chamber 36 through the slight space provided between the lower peripheral portions of the panel 34 and the inner walls of the dryer. Thus each time the drying operation commences the hot

air chamber 35 is emptied of the material which normally creates serious fire hazards and is transferred to the cool air chamber where such fire hazards are greatly reduced.

During the grain drying operation, the grain being considerably heavier than the dust (which is indicated by the numeral 63), the grain extends from the lower end of the wall 7 across to the panel 46 as seen in FIG. 4. Most of the dust 63 is transferred back into the grain during the drying operation at this point for it is absorbed into the flow of grain. Thus it can be seen that may dryer is constructed so as to continuously reduce and remove fire hazards during the actual drying operation and to permit further substantial reduction of the fire hazards when the drying operation is not in progress.

After the blower 30 has created pressure within the drying chamber 35, the blower 40 is also actuated to create an internal pressure within the cool air chamber 36. Thus hot dry air is forced outwardly through the grain held between the perforated inner walls and the perforated outer walls with the result that the moisture is withdrawn from the grain as it descends between these walls and is carried outwardly with the hot dry air. The temperature of the grain is increased substantially while descending from the top of the shaft to an elevation opposite the cool air chamber 36. While passing downwardly between the inner and outer wall opposite the cool air chamber 36, cool air is forced outwardly through the perforated inner and outer walls and through the grain column to effectively cool the same and complete the drying operation. As pointed out above, the rate of descent of the grain column 17 is controlled by varying the rate of rotation of the control members 49.

It should be noted that I have completely eliminated the normal tendency of grain in dryers of this type to rearrange itself in such a manner that the lighter kernels or "lights" collect in one portion of the dryer while the heavier kernels or "heavies" collect in another portion. Such a situation causes uneven drying and an inefficient operation in addition to increasing fire hazards for the "lights" dry quickly and, when subjected to the necessary heating required to dry the "heavies," a serious fire hazard results. The grain deposited upon the conical portion of the divider 21 completely eliminates this tendency so that the "heavies" and "lights" will remain mixed in their original proportions and will be distributed between the four sides of the dryer evenly.

It should also be noted that the structure of my grain dryer while being extremely simple lends itself to a highly efficient operation. Moreover, this simplicity facilitates maintenance, inspection, observation, and repair while giving increased capacity and reducing fire hazards. Maintenance and repair of the blowers is greatly simplified by the use of the two man holes 37 and 43 and the fire hazards are very substantially reduced through the spacing of the separator 34 and the inner walls and the closure 39 and the inner walls.

From the above it can be seen that my terminal grain dryer will heat evenly throughout while causing all of the air which has been heated to be driven through the dryer and the grain itself. It will be noted that there is no exterior duct work required and consequently no heat loss thereby. Moreover, my terminal grain dryer can be erected upon a minimum of ground area and yet provides substantially increased capacity in that grain is being continuously dried at all four sides of the dryer. It should be noted that there is no recirculation of air involved in the drying operation in that none of the air after having once been passed through the grain is subsequently again passed through the grain in a further attempt to perform a drying function.

It should also be noted that my grain dryer, because of its unique design, will provide the same capacity as other dryers while requiring superstructure of a lower height or, in the alternative, greatly increased capacity when utilizing superstructure of the same height. In addition, all of the heat generated by the burning of the fuel is applied directly to the grain and is conserved and utilized so that the dryer will operate at maximum efficiency.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of my invention which consists of the matter shown and described herein and set forth in the appended claims.

What is claimed is:

1. A non-recirculating directly-fired terminal grain dryer comprising an upright shaft having perforated inner wall structure rectangular in horizontal section and defining an open interior and having perforated outer wall structure spaced outwardly from said inner wall structure and also rectangular in horizontal section and cooperatively defining with said inner wall structure a four sided grain drying column therebetween, said grain drying column discharging at the lower ends of said wall structures, means for continuously filling said column with grain to be dried as it descends between said wall structures, separator means extending transversely across the open interior of said inner wall structure to prevent the free passage of air thereby and separating the same into an upper hot air chamber and a lower cool air chamber, said upper hot air chamber having means for substantially closing off its upper end to prevent free escape of air therethrough, means disposed entirely within the vertical confines of said inner wall structure for heating air and introducing the same under pressure into said upper hot air chamber and forcing the same without recirculation outwardly through said inner and outer wall structures and through the column of grain to the exterior of said shaft, said lower cool air chamber being substantially closed off at its lower end to prevent the free escape of air therethrough, means disposed entirely within the vertical confines of said inner wall structure for creating pressure upon cool air and introducing the same into said lower cool air chamber and forcing the same without recirculation outwardly through said inner and outer wall structures and through the column of grain therebetween to the exterior of said shaft, said shaft having an open bottom and said air heating means being comprised of a burner extending upwardly from a point at said open bottom below and exterior of said cool air chamber into a firing tube mounted within said inner wall structure and extending upwardly through said cooler air chamber and into said upper hot air chamber and discharging into the latter, a blower directed upwardly and disposed within the discharge of said firing tube, a motor connected to said blower and driving the same, and conduit means extending round said motor from said cooler air chamber to a point adjacent said fan and introducing cool air from said cooler air chamber into said firing tube around said motor.

2. A non-recirculating directly-fired terminal grain dryer comprising an upright shaft having perforated inner wall structure rectangular in horizontal section and defining an open interior and having perforated outer wall structure spaced outwardly from said inner wall structure and also rectangular in horizontal section and cooperatively defining with said inner wall structure a four sided grain drying column therebetween, said grain drying column discharging at the lower ends of said wall structures, means for continuously filling said column with grain to be dried as it descends between said wall structures, separator means extending transversely across the open interior of said inner wall structure to prevent the free passage of air thereby and separating the same into an upper hot air chamber and a lower cool air chamber, said upper hot air chamber having means for substantially closing off its upper end to prevent free escape of air therethrough, means disposed entirely within the vertical confines of said inner wall structure for heating air and introducing the same under pressure into said upper

hot air chamber and forcing the same without recirculation outwardly through said inner and outer wall structures and through the column of grain to the exterior of said shaft, said lower cool air chamber being substantially closed off at its lower end to prevent the free escape of air therethrough, means disposed entirely within the vertical confines of said inner wall structure for creating pressure upon cool air and introducing the same into said lower cool air chamber and forcing the same without recirculation outwardly through said inner and outer wall structures and through the column of grain therebetween to the exterior of said shaft, said shaft having an open bottom and said air heating means being comprised of a burner extending upwardly from a point at said open bottom below and exterior of said cool air chamber into a firing tube mounted within said inner wall structure and extending upwardly through said cooler air chamber and into said upper hot air chamber and discharging into the latter, a blower directed upwardly and disposed within the discharge of said firing tube, a motor connected to said blower and driving the same, conduit means extending around said motor from said cooler air chamber to a point adjacent said fan and introducing cool air from said cooler air chamber into said firing tube around said motor, the lower end of said lower cool air chamber also having a closable opening formed therethrough adapted to enable a man to pass therethrough, and ladder means mounted on the exterior surface of said firing tube and extending between the opening in said lower end and said separator means.

3. A non-recirculating directly-fired terminal grain dryer comprising:

(a) an upright shaft having an upper hot air chamber and a lower cool air chamber and having perforated inner wall structure rectangular in horizontal section and defining an open interior and having perforated outer wall structure spaced outwardly from said inner wall structure and also rectangular in horizontal section and cooperatively defining with said inner wall structure a four sided grain drying column therebetween, said grain drying column discharging at the lower ends of said wall structures,

(b) divider means connected to the upper end of said inner wall structures and closing off said upper hot air chamber and being comprised of a cover having a plurality of flat vertically extending walls one each of which is connected to the upper end of one side of said inner wall structure and extends upwardly therefrom and substantially as a continuation thereof, each of said walls having a convex upper edge and the remainder of said cover member being truly conical in shape and connected to the upper edges of said walls and extending downwardly from its apex at the same angle of inclination in all directions to said vertically extending walls whereby grain when deposited from above upon the apex of said cover member will flow in such a manner so as to avoid separating the light and heavy particles in the grain and will distribute the same in an evenly divided flow of uniform composition into each of the four sides of said grain drying column,

(c) means for introducing grain into said shaft and depositing the same from above upon said divider means at its apex,

(d) separator means extending transversely across the open interior of said inner wall structure to prevent the free passage of air thereby and separating the same into said upper hot air chamber and said lower cool air chamber,

(e) said lower cool air chamber having means to substantially close off its lower end to prevent the free escape of air therefrom,

(f) means disposed entirely within the vertical confines of said inner wall structure for heating air and introducing the same under pressure into said upper hot air chamber and forcing the same outwardly through said inner and outer wall structures and adapted to pass such air through a column of grain to the exterior of said shaft,

(g) means disposed entirely within the vertical confines of said inner wall structure for creating pressure upon cool air and introducing the same into said lower cool air chamber and forcing the same outwardly through said inner and outer wall structures and adapted to pass such air through a column of grain therebetween to the exterior of said shaft, and

(h) means for controlling the rate of flow of grain downwardly between said wall structures.

4. A non-recirculating directly-fired terminal grain dryer comprising:

(a) an upright shaft having perforated inner wall structure rectangular in horizontal section and defining an open interior and having perforated outer wall structure spaced outwardly from said inner wall structure and also rectangular in horizontal section and cooperatively defining with said inner wall structure a four sided grain drying column therebetween, said grain drying column discharging at the lower end of said wall structures,

(b) means for continuously filling said column with grain to be dried as it descends between said wall structures,

(c) separator means extending transversely across the open interior of said inner wall structure to prevent the free passage of air thereby and separating the same into an upper hot air chamber and a lower cool air chamber, said upper hot air chamber being substantially closed off at its lower end to prevent free escape of air therethrough,

(d) said separator means terminating slightly inwardly of said inner wall structure and providing a small passage therebetween to permit dust to pass therethrough directly from said upper hot air chamber into said lower cool air chamber,

(e) means disposed entirely within the vertical confines of said inner wall structure for heating air and having a discharge introducing such air under pressure into said upper hot air chamber and forcing the same outwardly through said inner and outer wall structures and through the column of grain to the exterior of said shaft,

(f) panel means substantially closing off said lower cool air chamber at its lower end to prevent the free escape of air therefrom and terminating slightly inwardly of said inner wall structure to permit dust to pass therethrough into the flow of cool dried grain,

(g) means disposed entirely within the vertical confines of said inner wall structure for creating pressure upon cool air and introducing the same into said lower cool air chamber and forcing the same outwardly through said inner and outer wall structures and through the column of grain therebetween to the exterior of said shaft,

(h) said shaft having an open bottom and said air heating means being comprised of a burner extending upwardly within said shaft and having its air intake in direct air-flow communication with the free atmosphere,

(i) a firing tube having an upper discharge end mounted within said inner wall structure and surrounding the discharge of said air heating means in air-receiving relation and extending upwardly through said cool air chamber and into said upper hot air chamber and discharging into the latter,

(j) a blower directed upwardly and disposed within the said discharge end of said firing tube,

(k) and a motor connected to said blower for driving the same.

5. A non-recirculating directly-fired terminal grain dryer comprising:

(a) an upright shaft having perforated inner wall structure rectangular in horizontal section and defining an open interior and having perforated outer wall structure spaced outwardly from said inner wall structure and also rectangular in horizontal section and cooperatively defining with said inner wall structure a four sided grain drying column therebetween, said grain drying column discharging at the lower ends of said wall structures,

(b) means for continuously filling said column with grain to be dried as it descends between said wall structures,

(c) separator means extending transversely across the open interior of said inner wall structure to prevent the free passage of air thereby and separating the same into an upper hot air chamber and a lower cool air chamber, said upper hot air chamber being substantially closed off at its upper end to prevent free escape of air therethrough,

(d) means disposed entirely within the vertical confines of said inner wall structure for heating air and introducing the same under pressure into said upper hot air chamber and forcing all of the same outwardly through said inner and outer wall structures and adapted to pass such air through a column of grain to the exterior of said shaft,

(e) said air heating means having an air inlet means connected in direct air-flow communication with the free atmosphere so as to receive air therefrom without being drawn through the said perforated inner and outer walls,

(f) said lower cool air chamber having means for substantially closing off its lower end to prevent the free escape of air therethrough,

(g) means disposed entirely within the vertical confines of said inner wall structure for creating pressure upon cool air and introducing the same into said lower cool air chamber and forcing the same outwardly through said inner and outer wall structures and adapted to pass such air through a column of grain therebetween to the exterior of said shaft,

(h) said shaft having an open bottom and said air heating means being comprised of a burner extending upwardly within said shaft with its air inlet means connected in direct air-flow communicating relation with the free atmosphere through said open bottom.

References Cited by the Examiner

UNITED STATES PATENTS

51,169	11/1865	Gecmen	34—174
865,546	9/1907	Uhlhorn	34—174
1,711,574	5/1929	Miller	34—174 X
2,227,634	1/1941	Dalin	34—165
2,245,664	6/1941	Gronert	34—174
2,602,498	7/1952	Overton	159—12
2,627,670	2/1953	Hurst et al.	34—174
2,654,590	10/1953	Molenaar	34—65
2,706,345	4/1955	Arndt	34—174
2,799,097	7/1957	Williams	34—174 X
2,858,620	11/1958	Naylor	34—174 X
2,991,559	7/1961	Pierpoint	34—174 X
3,053,522	9/1962	Applegate	34—174 X
3,092,472	6/1963	Figley	34—174 X

FOREIGN PATENTS

529,901	11/1940	Great Britain.

WILLIAM F. O'DEA, *Acting Primary Examiner.*

CHARLES O'CONNELL, NORMAN YUDKOFF, *Examiners.*