United States Patent

Buffington

[15] **3,673,699**

[45] **July 4, 1972**

[54] GRAIN DRYING APPARATUS

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[22] Filed: **Jan. 29, 1970**

[21] Appl. No.: **6,771**

[52] **U.S. Cl.** **34/66,** 34/86, 34/236

[51] **Int. Cl.** **F26b 17/04**

[58] **Field of Search** 34/66, 67, 236, 86; 263/8

[56] **References Cited**

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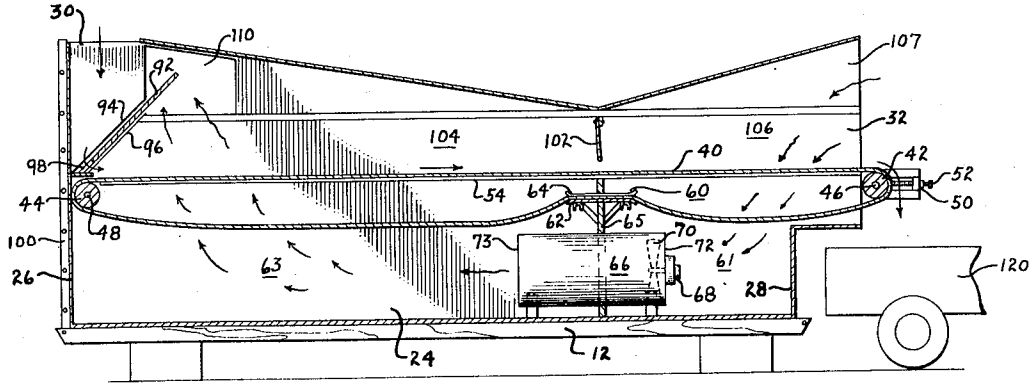
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Assistant Examiner—Harry B. Ramey
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[57] **ABSTRACT**

A grain drying apparatus having a housing and horizontally disposed porous conveyor. The housing is divided into a cool air compartment and a hot air compartment with a heating unit therebetween. A blower draws cool air through the grain on the conveyor in the cool air compartment and discharges it through the grain on the conveyor in the hot air compartment after the air has passed through the heating unit.

9 Claims, 7 Drawing Figures



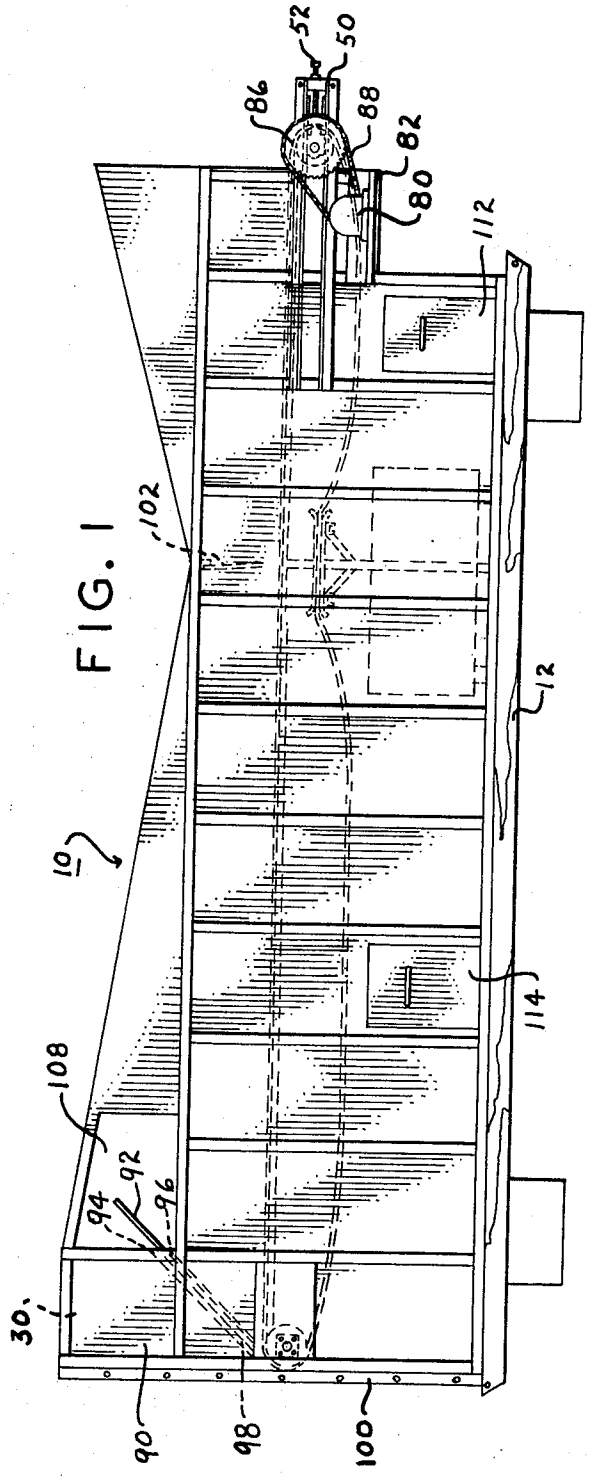


FIG. 1

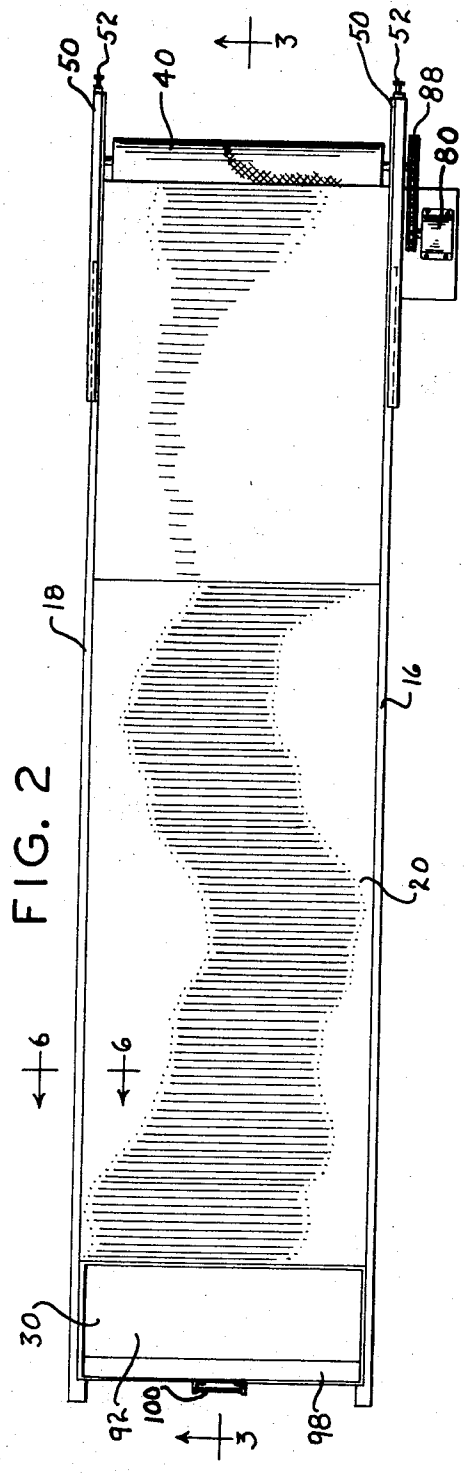


FIG. 2

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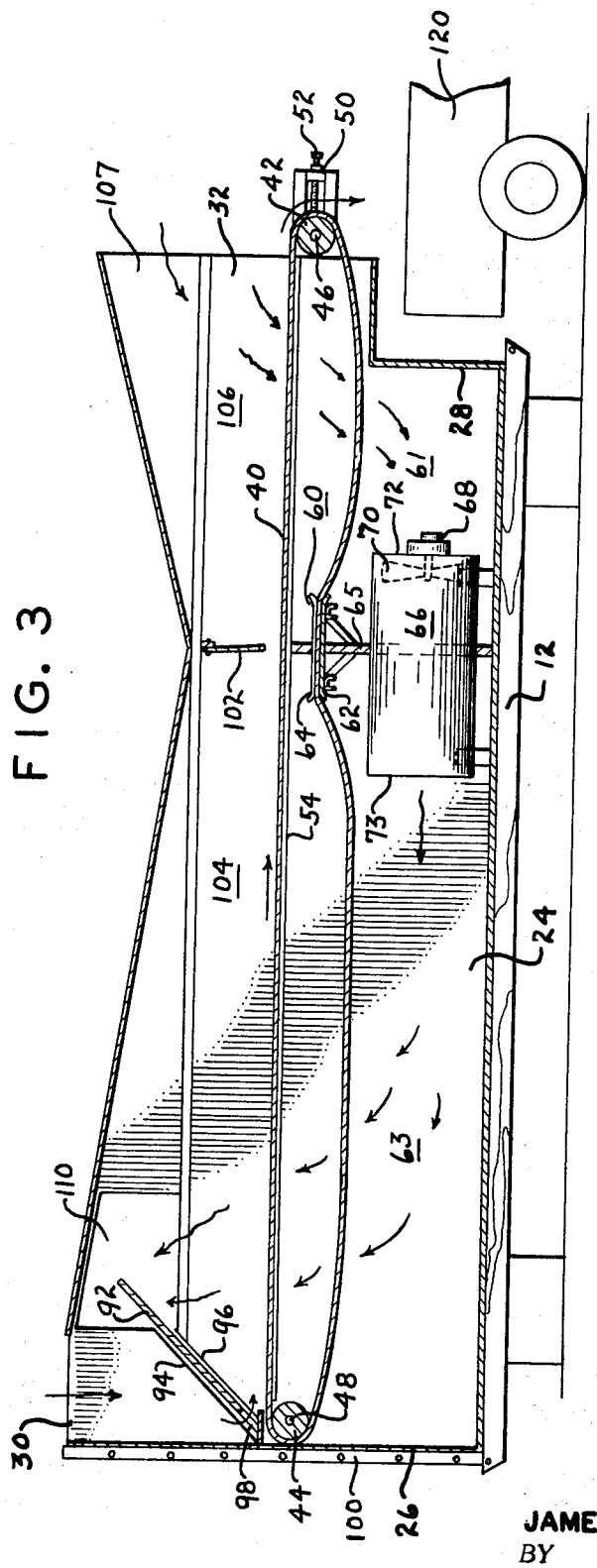
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FIG. 3



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FIG. 4

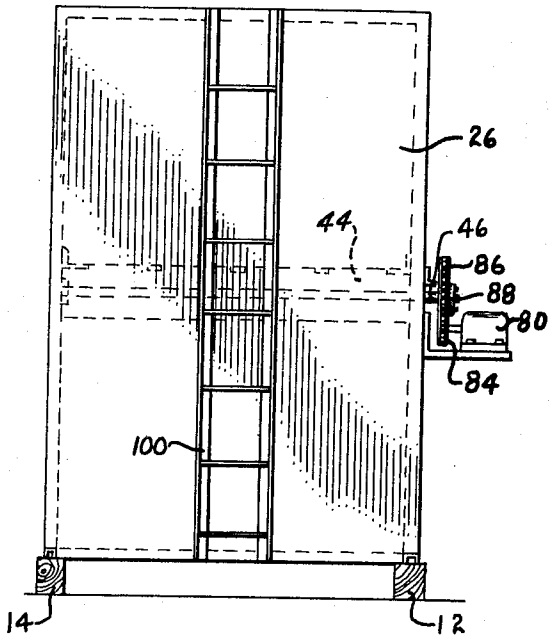
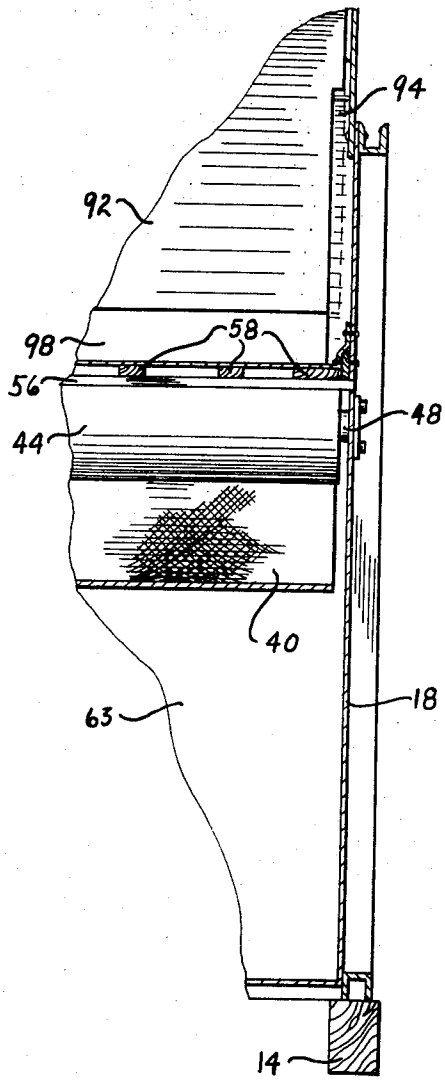


FIG. 6



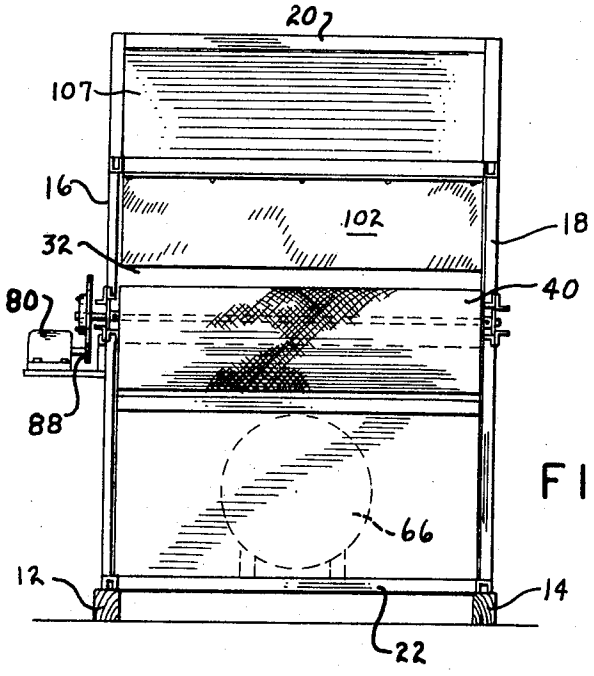


FIG. 5

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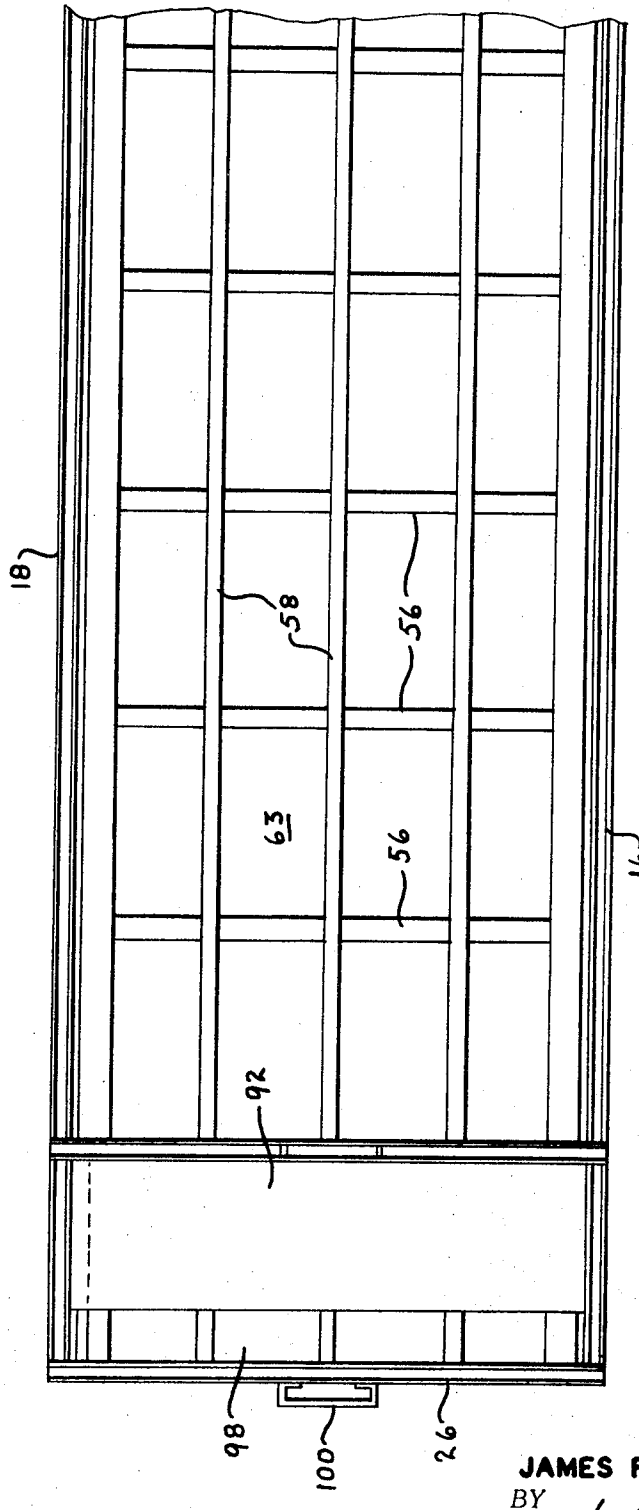


FIG. 7

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GRAIN DRYING APPARATUS

Grain drying apparatus in the past have had a number of inherent disadvantages, including damage to the grain through compression and abrasion of the grain, inefficiency of operation through ineffective utilization of the heat required for drying the grain, and inability to handle and dry grain which has not been carefully cleaned prior to the grain drying operation. Further, prior grain drying apparatus have often been relatively bulky and difficult to transport and install and have required excessive space to use and operate properly, and have involved the use of high speed augers or other conveyors for loading and unloading which not only often damaged the grain but also made the apparatus initially expensive and thereafter costly to service and maintain. It is, therefore, one of the principal objects of the present invention to provide a grain drying apparatus which gently handles the grain in a relatively thin layer without the use of high columns of grain or lift conveyors, and which increases the efficiency of the drying operation by utilizing the incoming circulating air to cool the dried grain and thereafter utilizing the heat absorbed in the cooling step to assist in the grain drying step.

Another object of the invention is to provide an apparatus for drying grain in which the drying operation is performed with a continuous and horizontal flow of grain from the inlet to the outlet in a relatively thin layer, permitting the heated air to readily pass therethrough, and in which the intake and discharge openings are so positioned with respect to the loading and unloading vehicle that the apparatus can easily be fed and emptied without the use of conveyors or other mechanisms which place the grain under substantial compressive loads.

Still another object of the invention is to provide a relatively simple, easily operated grain dryer which has a low profile for easy transportation and installation, yet which is high enough that the apparatus can be loaded and unloaded without the use of pits or conveyors.

A further object is to provide a grain drying apparatus of the aforesaid type which can effectively be controlled by varying the flow rate of the grain through the apparatus and which can easily be so controlled that it gives optimum drying performance for a variety of different grains, such as for example soybeans and shelled or corn on the ear.

Another object of the invention is to provide a grain drying apparatus in which air pollution is positively controlled and in which the principal moving parts are a horizontal belt conveyor for the grain during the drying operation and a fan for circulating the air through the belt and grain, both of which are enclosed within the housing, thus providing a quiet, clean and efficient operation.

Additional objects and advantages of the invention will become apparent from the following description and accompanying drawings, wherein:

FIG. 1 is a side elevational view of the present grain drying apparatus;

FIG. 2 is a top plan view of the apparatus shown in FIG. 1;

FIG. 3 is a longitudinal vertical cross sectional view of the present apparatus, the section being taken on line 3—3 of FIG. 2;

FIG. 4 is an elevational view of one end of the apparatus shown in the preceding figures;

FIG. 5 is an elevational view of the other end of the present apparatus;

FIG. 6 is an enlarged fragmentary cross sectional view of the present apparatus, the section being taken on line 6—6 of FIG. 2; and

FIG. 7 is a fragmentary plan view of a portion of the conveyor system and hopper.

Referring more specifically to the drawings and to FIG. 1 in particular, numeral 10 indicates generally the present grain drying apparatus, showing it mounted on skids 12 and 14 extending substantially the full length of the apparatus for the purpose of assisting in moving the apparatus from one place to another and assisting in installing it in operating position. The apparatus may be of various sizes to satisfy requirements; however, the preferred embodiment is of a size which can be easily transported on a semi-trailer, on standard state highways, thus permitting transporting of the fully assembled apparatus from the plant to a location in the farming area where it is to be installed and used.

The grain drying apparatus consists of a housing formed by side walls 16 and 18, top 20, and bottom 22. The two side walls and top and bottom are joined together to form a rigid structure defining a chamber 24 closed at one end by panel 26 and at the other end by a panel 28. The grain intake or feeding opening of the apparatus is indicated by numeral 30 and the outlet or discharge end is indicated by numeral 32. The feeding and discharge openings 30 and 32 normally remain open, and the feeding end may be connected to a larger hopper or bin which permits continuous feeding of the apparatus over extended periods of time. The housing is preferably constructed principally of sheet metal and angle iron; however, other types of material may be used if desired.

Chamber 24 contains a conveyor belt 40 mounted at one end on drive pulley 42 and at the other end on pulley 44, the two pulleys being mounted on shafts 46 and 48, respectively, journalled in bearings mounted on the frame of the side walls 16 and 18. The conveyor belt is preferably constructed of relatively porous flexible metal wire mesh, and is adapted to move from the intake end to the outlet end in the clockwise direction as viewed in FIGS. 1 and 3, the upper half thereof moving from the intake end to the discharge end as indicated by the arrows in chamber 24. The tension on the belt is regulated by takeup assembly 50, which has an adjustable mechanism 52 at each end of roller 42. The upper half of belt 40 is supported by a frame structure 54 consisting of a plurality of spaced metal angle iron cross members 56 and longitudinally arranged hard wood members 58 extending substantially the full length of chamber 24 between pulleys 42 and 44. The members 58 are supported by and secured to cross members 56, and longitudinal members 58 are spaced, respectively, from one another sufficiently to permit the free flow of air therebetween and through the belt supported thereon. The lower half of belt 40 is supported at a point between the two pulleys by a support structure indicated generally by numeral 60 having lower and upper plates 62 and 64 extending transversely across chamber 24 from one side wall to the other side wall at a vertical partition 65.

Chamber 24 is divided into a cool air compartment 61 and a hot air compartment 63, the two compartments being separated by partition 65 extending transversely across the housing from one side wall to another. Mounted in an opening through wall 65 is air heating unit 66 having a burner (not shown) in the left hand end of the heating unit and a fan or blower in the right hand end of the heating unit, the fan being driven by a motor 68 disposed in the air intake end of the heating unit. The burner may be one using either natural or bottle gas or fuel oil, or it may be electric. In the form shown, the heating unit includes a housing 70 of a generally cylindrical shape with the air intake end 72 in compartment 61 and the heated air discharge end 73 in compartment 63.

The belt is driven by an electric motor 80 mounted on a support structure 82 and connected to pulley 42 by a sprocket 84 on the motor, a sprocket 86 on shaft 46 and a chain 88 trained on the two sprockets. A gear reduction unit is normally included in the electric motor structure, preferably of the variable speed type so that the speed of the conveyor can be controlled to provide the required time for drying grain having different moisture content. The variable speed reducer and motor are of well known construction and are only shown schematically in the drawings and are not described herein in detail. A hopper 90 is provided at the intake end, the hopper structure being formed by the adjacent side walls 16 and 18 and end wall 26 and an adjustable sliding door 92, the door being supported by guide members 94 and 96 above and below and at opposite ends of the door, the guides and support members being rigidly secured to the inner side of the two side walls 16 and 18. The door is adjusted to provide a variable

space 98 at the bottom of the door and, as the door is moved upwardly or downwardly to vary the space, the amount of grain flowing from hopper 90 onto the upper surface of conveyor belt 40 is varied and controlled. The grain is fed into hopper 90 through inlet 30 and rests on door 92 while it is fed onto the conveyor belt through the slot or space 98 between the bottom edge of the door and the upper surface of the conveyor belt adjacent pulley 44. A ladder 100 is preferably installed at end wall 26 to provide the operator with easy access to the hopper opening.

In order to prevent back flow of the heated air along the conveyor, a partition 102 of flexible material such as canvas is provided in chamber 24 directly above partition 65, thus dividing the upper part of chamber 24 above the conveyor belt into compartments 104 for heated air and 106 for cool air. The flexible partition permits the grain to pass from one compartment to the other without having to adjust the partition as the thickness of the layer of grain is varied in accordance with drying requirements. Air is drawn by the fan in the air heating unit inwardly through air intake opening 107 and discharge opening 32, heated by the burner in unit 66 and the heated air, which is discharged by the air heating unit, passes upwardly through the porous endless wire conveyor belt and through the grain on the upper surface thereof and passes outwardly from compartment 104 through exhaust ports 108 and 110 in housing side walls 16 and 18. Compartments 61 and 63 are provided with doors 112 and 114 for cleaning out refuse which accumulates during the operation from foreign material in the grain and from broken grain falling through the belt into the respective compartments.

The conveyor extends outwardly beyond the discharge end 32, and end wall 28 is recessed inwardly to provide space for a truck 120 or other grain receiving vehicle or apparatus to be positioned directly beneath pulley 42. Thus, as the grain is discharged it falls into the vehicle or apparatus without the necessity of having a second conveyor.

In the operation of the present grain drying apparatus, grain such as shelled corn is placed in hopper 90 and the burner in air heating unit 66 is ignited and the fan driven by motor 68 is started. Motor and gear reduction unit 80 is also placed in operation for driving conveyor 40. With the apparatus in operation in the foregoing manner, grain is fed onto the upper surface of the conveyor as the conveyor is driven in the direction of the arrows shown in FIG. 3. The grain, as it is discharged from the hopper, is spread evenly in a relatively thin layer on the conveyor. The operation of the fan draws cool air through the discharge opening 32 downwardly through the porous wire mesh conveyor belt through the heating unit where it is heated and thence discharged into compartment 63. The air under pressure flows upwardly through the conveyor and through the grain on the upper surface of the conveyor and is discharged through discharge ports 108 and 110 into the atmosphere. As the grain moves along the conveyor it passes into compartment 106 in a heated and dried condition, and as it moves through compartment 106, it is cooled rapidly by the incoming air passing downwardly through the mass of grain on the conveyor as the air passes inwardly from openings 32 and 107 and through the conveyor to the air heating unit. This cools the dried grain within a relatively short time, and before it is discharged into the vehicle 120 or other conveyor or transporting mechanism.

The thickness of the layer on the conveyor and the speed of the conveyors are varied in accordance with the drying requirements, the thickness of the layer being controlled by the vertical position of door 92 and the speed of the conveyor being controlled by motor and speed reducer 80. The grain drying capacity of the apparatus may also be varied by varying the heat output of the air heating unit 66 and the speed of the fan in the heating unit circulating the air from compartments 106 and 61 to and through compartments 63 and 104 to the discharge openings 108 and 110. The regulation of these factors to give a relatively slow rise and a relatively slow cooling in the temperature of the grain as it passes through compartments 104 and 106, respectively, results in effective drying without cracking the grain. The vacuum created by blower 68 in compartment 106 effectively completes the drying operation.

While only one embodiment of the present invention has been described in detail herein, various changes and modifications may be made without departing from the scope of the invention.

I claim:

1. A grain drying apparatus comprising a housing having an elongated chamber therein with a grain feed opening at one end and a grain discharge opening at the other end, a porous belt conveyor extending substantially the full length of said chamber, means for driving said conveyor to move grain from the feed end of the chamber to the discharge end thereof, a partition dividing said chamber into a cool air compartment and a hot air compartment, a heating unit between said compartments beneath said conveyor, an air inlet in said cool air compartment above said conveyor, an air outlet in said hot air compartment above said conveyor, and a blower beneath said conveyor and on the air intake side of said heating unit for circulating air from said inlet downwardly through the grain on the conveyor in said cool air compartment to cool the dried grain, through the blower and the heating unit, and thence upwardly through the grain on the conveyor in the hot air compartment to said air outlet to heat and dry the grain.

2. A grain drying apparatus as defined in claim 1 in which said porous belt conveyor includes an endless wire belt and a pulley at each end of said chamber on which said belt is trained.

3. A grain drying apparatus as defined in claim 2 in which said belt and pulleys are positioned on horizontal axes and the grain to be dried is fed thereon by gravity and the dried grain is discharged therefrom by gravity.

4. A grain drying apparatus as defined in claim 2 in which a hopper is disposed adjacent said feed opening and an opening near the bottom of said hopper extends substantially the full width of said belt.

5. A grain drying apparatus as defined in claim 4 in which a door is provided for the opening near the bottom of said hopper and is adjustable to vary the discharge of grain from the hopper onto the belt to vary the thickness of the layer transported thereon.

6. A grain drying apparatus as defined in claim 1 in which a hopper is disposed adjacent said feed opening and an opening near the bottom of said hopper extends substantially the full width of said conveyor.

7. A grain drying apparatus as defined in claim 6 in which a door is provided for the opening near the bottom of said hopper and is adjustable to vary the discharge of grain from the hopper onto the belt to vary the thickness of the layer transported thereon.

8. A grain drying apparatus as defined in claim 1 in which said air heating unit extends through said partition and includes a burner and said blower.

9. A grain drying apparatus as defined in claim 1 in which a flexible member forms a partition above said conveyor belt and can be deflected by the grain passing on the conveyor from the hot air compartment to the cool air compartment.

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