

Sept. 11, 1962

R. D. APPELGATE

3,053,522

CONTINUOUS DRIER

Filed Oct. 11, 1957

2 Sheets-Sheet 1

FIG. 1

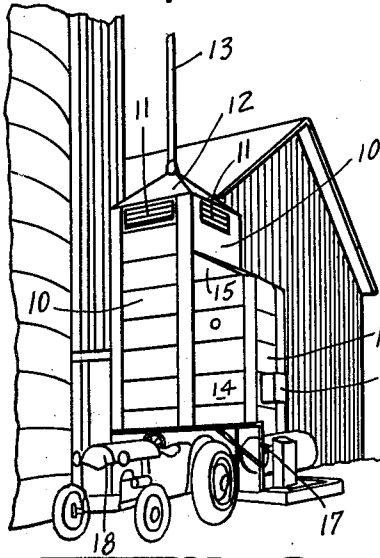


FIG. 2

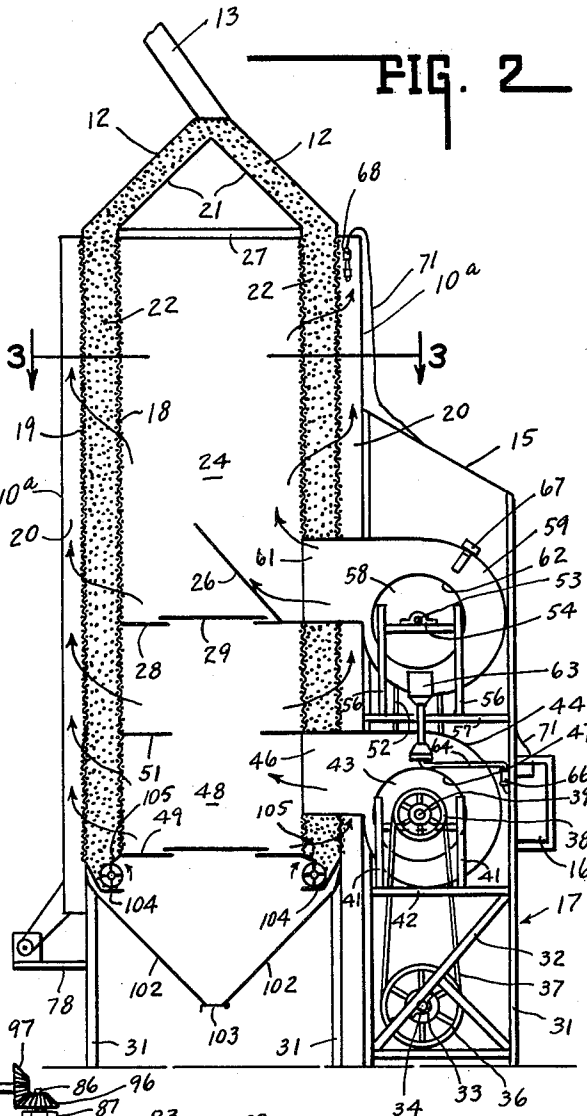


FIG. 3

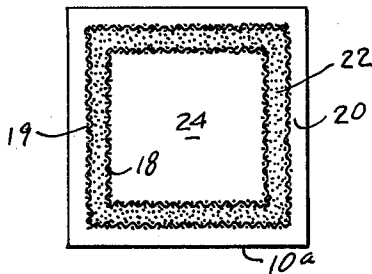
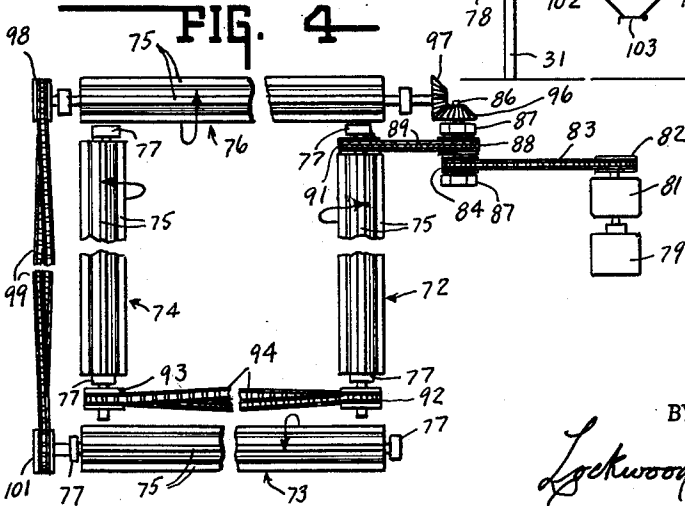


FIG. 4



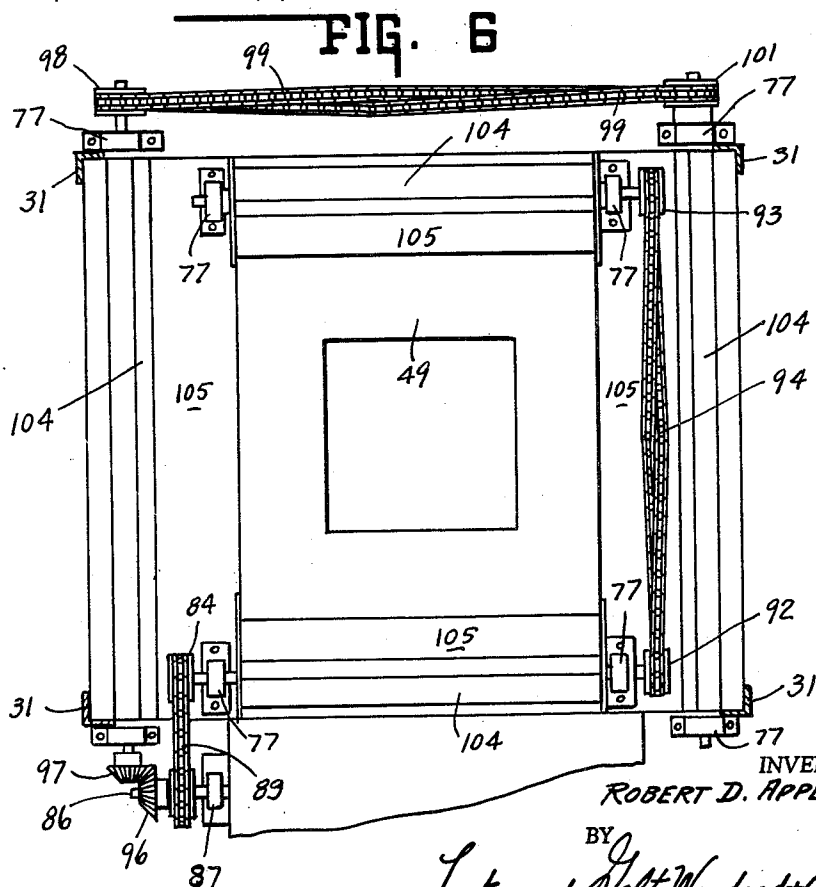
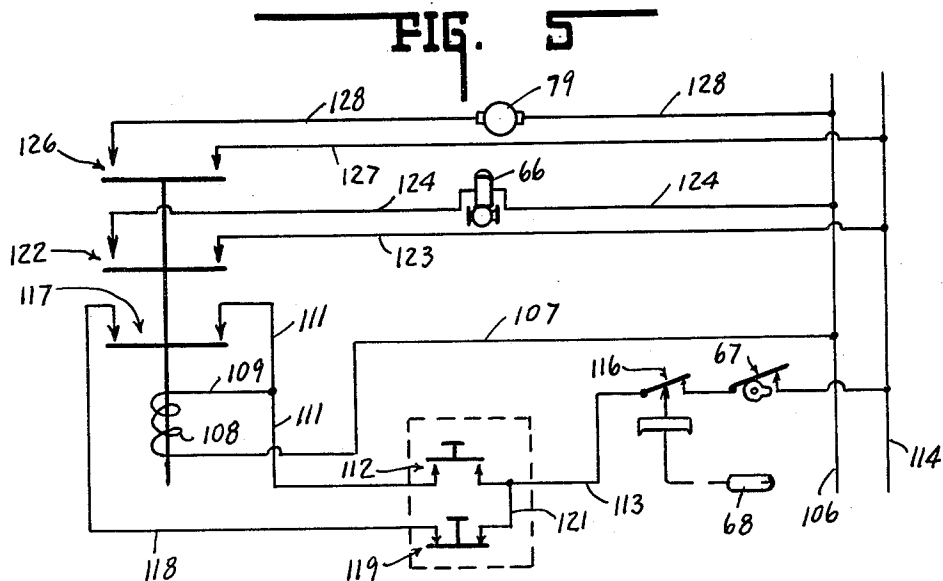
Sept. 11, 1962

R. D. APPELGATE  
CONTINUOUS DRIER

3,053,522

Filed Oct. 11, 1957

2 Sheets-Sheet 2



INVENTOR.  
ROBERT D. APPELGATE.

BY  
*Lockwood, Salt, Woodard & Smith.*  
ATTORNEYS.

1

3,053,522

## CONTINUOUS DRIER

Robert D. Applegate, R.R. 1, Attica, Ind.

Filed Oct. 11, 1957, Ser. No. 689,679

5 Claims. (Cl. 263—30)

This invention relates generally to drying apparatus, and in particular to a continuous drier for processing grain.

In the construction of driers of the type referred to above, it is customary to provide a grain chamber formed by two concentric perforate tubes. A casing surrounds the upright perforate tubes and has side walls spaced somewhat from the outer one of the concentric tubes. This space forms a discharge air duct and the upper end of the annual space thus formed is open to permit the discharge of air from the duct. Means are provided for conventionally introducing grain having a high moisture content into the space between the perforate tubes at the top thereof. Means are further provided for removing grain from the drier at its base. Thus, the grain chamber is loaded at the top thereof and grain fills the space between the perforate tubes. As the unloading means at the base of the drier is operated, the grain is lowered through the grain chamber until it has traversed the entire length of the concentric tubes.

During its passage through the grain chamber, the grain is dried by means of heated air admitted to the central space enclosed by the inner tube, the heated air passing through the perforate tubes and the grain chamber bounded thereby and discharging through the air discharge duct. Although the drying air is admitted to the central area at temperatures of the order of 200° F., since it loses considerable heat by supplying the latent heat of vaporization required to lower the moisture content of the grain, it is delivered to the discharge duct at temperatures of the order of 60° F. Cooling air is similarly passed through the grain just prior to its removal from the grain chamber by the unloading means to reduce the temperature of the grain to permit handling thereof.

The principal object of the present invention is to provide a continuous drier of the type referred to above in which the perforate tubes or columns are rectilinear in cross sectional configuration and in which a novel unloading means removes processed grain uniformly and simultaneously from each of the margins of the grain chamber.

A further object of the present invention is to provide a drier of the type referred to above in which a switch responsive to the temperature of the air in the air discharge duct shuts down the unloading means and the air heating means whenever the temperature of the discharge air indicates that a gap has occurred in the column of grain moving through the grain chamber.

A further object of the present invention is to provide a drier of the type referred to above, in which a switch operable in response to the flow of drying air into the drier shuts down the unloading means and air heating means upon failure of the flow of heated air into the drier.

A further object of the present invention is to provide a grain drier characterized by a low spread or variation in moisture content of the processed grain.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a perspective view of a drier embodying the present invention having its protective enclosure in place and showing a tractor positioned so that its power take-off shaft may serve as one of the driving means for the drier.

2

FIG. 2 is a diagrammatic sectional view of a drier embodying the present invention.

FIG. 3 is a sectional view taken generally along the line 3—3 of FIG. 2.

FIG. 4 is a top plan view of the grain chamber unloading means.

FIG. 5 is a schematic circuit diagram for the drier control circuit.

FIG. 6 is a bottom plan view of the grain chamber unloading means with the depending hopper removed.

Referring initially to FIG. 1, it may be seen that the drier includes a major column which is generally square in cross sectional configuration and is provided with side walls 10 which, at their upper ends, provide louvered openings 11. The louvered openings communicate with an air discharge duct to be subsequently described. A pyramid-shaped cupola, having inclined walls 12, tops the structure, and by means of the tube 13 serves to direct grain to be dried into the grain chamber as will subsequently be described.

The adjoining minor column structure, generally rectangular in configuration, abuts one of the side walls of the major column. This structure includes side walls 14 and an inclined metal shield or cap 15 which closes its upper end. A control box 16 is mounted upon one of the side walls 14 and both columnar structures are supported by the metal framework indicated generally at 17. The tractor 18 is shown positioned so that its conventional power take-off may be employed for driving certain of the drier components, as will subsequently be described.

Referring now to FIG. 2, it may be seen that the side walls of the major column enclose a drier casing or liner 10a, formed of sheet metal, which enclose inner and outer concentric columns 18 and 19. Both of these columns are formed of perforated metal screen and are generally coextensive with the drier casing. The outer column is spaced inwardly from the casing 10a so as to provide an exhaust air duct or passage 20.

The cupola, whose outer walls 12 have previously been referred to, is formed to include inner walls 21, the cupola being mounted upon the columns 18 and 19 so that the space between the walls 12 and 21 communicates with the space 22 between the columns, this space being referred to as the grain chamber. It will be understood that by means of the introduction of unprocessed grain to the garner bin formed by the adjacent walls of the cupola, the grain chamber may be filled throughout its length.

Upright members 31, forming a part of the supporting structure 17, are spanned by diagonal members 32 which support bearings 33 rotatably mounting a shaft 34. The shaft is adapted to be coupled to a driving device such as the power take-off drive of a conventional tractor. Between its bearings the shaft has keyed thereto a pulley 36, which by means of a belt 37 transmits rotary motion of the shaft to a driven pulley 38. The pulley 38 is keyed to a shaft 39 which is rotatably supported by uprights 41 extending from a transverse platform 42. The shaft 39 serves to drive the rotor 43 of a centrifugal blower or fan having a conventional volute casing 44 provided with an outlet passage 46 and an intake passage 47 conventionally disposed at the eye of the volute casing. The outlet passage communicates with the cooling air space 48 which is bounded on its sides by the inner perforated column 18, at its upper end by the plate 28 and at its lower end by a plate 49. The plate 51 extends intermediately across the space 48 and has a central opening therein which may be closed by a closure member similar to closure member 29 under certain conditions of operation of the drier, as will subsequently be explained.

At the end of shaft 39 opposite pulley 38 there is keyed a further pulley (not visible in FIG. 2) which by means

of a belt 52 drives an additional pulley (not shown) which is keyed to a shaft 53 supported by means of bearings 54 upon uprights 56 carried by a transverse platform 57. The shaft 53 drives the rotor 58 of a centrifugal blower or fan having a volute casing 59 provided with an outlet passage 61 and an inlet 62. The outlet passage communicates with the heating air space 24 which is bounded on its sides by the upper portion of the inner perforated column 18, at its upper end by the top closure 27, and at its lower end by the plate 28. A removable closure 29 seals a central opening in the plate 28 and may be removed therefrom under certain conditions of operation of the drier as will subsequently be explained. A baffle 26, carried by plate 28, serves to direct the heated air generally upwardly through the space 24.

The platform 57 further supports a gas burner diagrammatically shown at 63. The burner is connected by means of a gas conduit 64 to the outlet side of a solenoid control valve 66. The inlet side of the solenoid valve may be connected by suitable tubing (not shown) to a source of fuel gas, such as propane. The function of the burner is to heat the air passing into the centrifugal blower so that the air discharged therefrom is at an elevated drying temperature. It will be understood that the burner could be located other than as shown, it being required only that the thermal output of the burner be transferred to the air entering the upper centrifugal blower by suitable duct work or heat exchange surfaces.

A conventional sail-switch 67 extends within the casing of the fan and is actuated by the discharge of air therefrom for a purpose which will be subsequently explained. The air discharge passage 20, which borders the outer perforated column, communicates with atmosphere through the louvered openings 11. In this passage and adjacent these openings there is positioned the remote bulb 68 of a conventional thermally responsive switch which may be located in the control box 16. This switch is of a common type having a capillary tube 71 adjoining its bulb to a diaphragm type operator (not shown), and may be set so that its contacts are closed for all bulb temperatures below 100° F. The purpose of this switch will be subsequently explained.

Referring now to FIGS. 2, 4 and 6, the unloading means for the grain chamber will now be described. This unloading means includes longitudinally fluted rolls 72, 73, 74 and 76, each carrying a series of parallel bosses or blades 75. The rolls are disposed so as to rotate on an axis which is parallel to and spaced somewhat below the adjacent lower edges of the perforated columns. Bearing 77 supporting the rolls may be appropriately mounted upon the supporting framework 17. A platform 78 (FIG. 2) extending sidewardly from the supporting structure serves as a mounting base for the roll driving means.

This driving means may include an electric motor 79 (FIG. 4) which operates through a variable speed mechanism 81 to rotate a sprocket 82 which in turn drives a chain 83. The chain 83 drives a sprocket 84 which is keyed to a shaft 86 supported by bearings 87. The shaft 86 has further keyed thereto a sprocket 88 which drives a chain 89 serving to rotate a sprocket 91. The sprocket 91 serves to rotate the roll 72 and this rotary movement of the roll 72 is transmitted to roll 74 by means of sprocket 92 and 93 and crossed chain 94.

The drive for the rolls 73 and 76 includes the miter gear 96 carried on the end of shaft 86 which meshes with the miter gear 97 which serves to rotate the roll 76. Rotation of roll 76 serves to rotate the sprocket 98 and its rotary motion is transmitted to the roll 73 by the crossed chain 99 and the sprocket 101. It will be noted that the driving means rotates the roll 72 in the direction indicated by the arrow in FIG. 4, and that the crossed chain 94 rotates roll 74 oppositely as indicated by the arrow placed adjacent roll 74. The roll 76 and the roll 73 are

oppositely rotated in similar fashion as indicated by the arrows adjacent the respective rolls.

Referring again to FIG. 2, it may be seen that the lower portion of the outer column 19 is formed so as to provide a pyramid or funnel-shaped hopper having inclined sides 102 and an outlet opening 103 at its downwardly directed apex. It will be understood that the portion of the column forming inclined sides 102 is imperforate and serves to direct grain toward the outlet 103. Appropriately shaped flanges 104 and 105 extend from each lower margin of the perforated columns 18 and 19 and serve to direct grain into the adjacent rolls. Rotation of the rolls thus serves to impel grain laterally away from the lower edges of the perforated columns 18 and 19.

The control circuit for the drier will now be described with reference to the schematic diagram of FIG. 5. The power line 106 is connected by means of a wire 107 to a relay coil 108. Wires 109 and 111 connect the relay coil to one side of the normally open push button switch 112. The outer side of switch 112 is connected by means of a wire 113 to the other power line 114. Serially interposed in the wire 113 are the temperature responsive switch, diagrammatically indicated at 116, and the sail-switch 67. As previously mentioned, the switch 116 is operated by response of the bulb 68 to the temperature of the air in the air discharge passage 20 and may be set so that its contacts are closed until the temperature of the air in the passage exceeds 100° F. The sail-switch has been previously referred to as being mounted in the casing of the centrifugal fan which transmits heated air to the space 24.

The switches operated by the relay coil include a hold-in switch 117, one of whose contacts is connected to the wire 111. The other contact of the hold-in switch is connected by means of a wire 118 to one side of a push button switch 119, the other side of this switch being connected by a wire 121 to the wire 113. A further relay operated switch 122, by means of wires 123 and 124 connects the burner controlling solenoid valve 66 across the power lines 106 and 114. A third relay operated switch 126 connects the drive motor 79 for the unloading rolls across the power lines 106 and 114, this connection being made by means of wires 127 and 128. It will be understood that although the burner 63 is controlled by the solenoid valve 66, further circuit components which provide for ignition, safety shut-down, and thermostatic operation would also be required in the control circuit of the burner. Since they form no part of the present invention, these components have been omitted from the schematic diagram of FIG. 5. It should be further noted that the on-off push button switch assembly, which includes switches 112 and 119 together with relay coil 108 and the switches operated thereby, are conventional push button starter components located in the control box 16.

In operation, the drive means for the shaft 34 is started, causing both of the centrifugal blowers to operate to deliver air into the spaces 24 and 48. Under these conditions sail-switch 67 will be closed, as will switch 116. Manual depression of the appropriate push button serves to close the switch 112, thereby energizing relay coil 108. Energization of the relay coil closes the hold-in switch 117 to make continued energization of the relay coil dependent upon the push button switch 119, the thermally responsive switch 116 and the sail-switch 67. Energization of the relay coil further closes switches 122 and 126 which place the gas burner 63 and the drive motor 79 for the unloading rolls in operation.

Under these conditions with the filling tube 13 providing a reservoir of high moisture content grain in the garner bin, grain will fill the grain chamber formed between the perforate columns 18 and 19. As the unloading rolls are rotated, this grain will move downwardly through the

5

grain chamber and will be dispatched uniformly from each side of the chamber by the unloading rolls. As previously mentioned, the rotation of the rolls causes the dried grain to be directed laterally away from the lower edges of the perforated columns to fall in line with the outlet opening 103 in the hopper formed by the inclined surfaces 102.

As will be apparent from FIG. 2, the hot, drying air directed into the space 24 passes through the perforate columns and the grain enclosed thereby and is exhausted through the air passage 20. In passing through the relatively moist grain, this heated air evaporates moisture therefrom, and consequently reaches the passage 20 at a considerably lowered temperature. The temperature of this exhaust air will, as an example, be approximately 60° F., well below that required to heat the bulb 68 sufficiently to open the switch 116. As the grain moves through the grain chamber past the space 24, its moisture content will be appreciably lowered, and as the grain moves past the space 48 the cooling air introduced through the passage 46 will lower the temperature of the grain sufficiently to permit handling thereof as it leaves the outlet 103.

Should the grain delivery through the tube 13 be halted during operation of the drier, as for example by slugging of the elevator supplying the tube 13, the grain "seal" between the space 24 and the air passage 20 will be broken. The hot drying air will thereupon by-pass the moist grain and will pass through the perforate columns into the passage 20, retaining its elevated temperature. This abnormally hot air in the passage 20 will raise the temperature of bulb 68 sufficiently to cause switch 116 to open.

As may be seen in FIG. 5, opening of switch 116 de-energizes the relay coil 108, valve 66, and the drive motor for the unloading rolls. The burner 63 is thus shut down and the operation of the unloading rolls is terminated. When the gap or by-pass opening in the grain chamber has been eliminated, the drier may again be placed in operation by depressing the starter button, closing the switch 112. The switch 116 thus prevents the unloading of the undried column of grain subsequent to occurrence of a gap or break in the grain column.

Should there be a failure of the drive provided for the fan shaft 62, the resulting cessation of the air flow through the passage 61 will cause the sail-switch 67 to open. As may be seen in FIG. 5, opening of the sail-switch shuts down the burner and the unloading means as previously described in reference to the opening of switch 116.

The relative sizing of the spaces 24 and 48 as shown in FIG. 2 is suitable for drying corn or other small grain which has a moisture content below approximately 22 percent when introduced into the grain chamber. For drying corn having a moisture content of approximately 22 percent or higher, the drier is modified to increase the size of the space 24 as compared to the size of the space 48. This may be conveniently done by removing the closure 29 from the plate 28 and installing a similar closure across the central opening in the plate 51. This modified arrangement increases the drying area of the grain chamber and shortens the cooling area.

From the foregoing it will be evident that the present invention provides a continuous grain drier having unloading means which removes grain uniformly from all sides of the grain chamber. Further, the circuit connection of the switch 116 and the placement of its bulb 68 within the exhaust air passage 20 provides for shut down of the air heating means and the unloading means should an abnormal gap appear in the mass of grain passing through the grain chamber.

While the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as other modifications may readily

6

suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. A continuous grain drier comprising an elongated upright casing, concentric spaced tubular columns disposed within said casing and generally coextensive therewith, said spaced columns being rectilinear in cross-sectional configuration and having perforate walls, the space between said columns defining a grain chamber, the outer one of said concentric columns being spaced inwardly from said casing to provide an exhaust air duct therebetween, means for introducing grain to be dried between said columns at the upper ends thereof, a fuel burner, electrically energizable means controlling operation of said burner, air moving means for introducing drying air heated by said burner into the upper portion of the space enclosed by the inner one of said concentric columns and for introducing unheated cooling air into the lower portion of said space, whereby the drying and cooling air passes through said column walls and through the grain in said chamber to enter said exhaust duct, electrically energized unloading means for said grain chamber operable to remove dried grain at the base of said concentric columns, and a control circuit for said burner controlling means and said unloading means, said control circuit including means responsive to the temperature of the air in said exhaust duct operable to shut down said burner and said unloading means at an exhaust air temperature indicating heated air has entered said exhaust duct without passing through the grain in said grain chamber, and a switch responsive to operation of said air moving means operable to shut down said burner and said unloading means upon failure of the air moving means.

2. A continuous grain drier comprising an elongated upright casing, concentric spaced tubular columns disposed within said casing and generally coextensive therewith, said spaced columns being rectilinear in cross-sectional configuration and having perforate walls, the space between said columns defining a grain chamber, the outer one of said concentric columns being spaced inwardly from said casing to provide an exhaust air duct therebetween, means for introducing grain to be dried between said columns at the upper ends thereof, a fuel burner, electrically energizable means controlling operation of said burner, air moving means for introducing drying air heated by said burner into the upper portion of the space enclosed by the inner one of said concentric columns and for introducing unheated cooling air into the lower portion of said space, whereby the drying and cooling air passes through said column walls and through the grain in said chamber to enter said exhaust duct, electrically energized unloading means for said grain chamber operable to remove dried grain at the base of said concentric columns, and a control circuit for said burner controlling means and said unloading means, said control circuit including a switch responsive to the temperature of the air in said exhaust duct operable to shut down said burner and said unloading means at an exhaust air temperature indicating heated air has entered said exhaust duct without passing through the grain in said grain chamber.

3. A continuous grain drier comprising an elongated upright casing, concentric spaced tubular columns disposed within said casing and generally coextensive therewith, said spaced columns and said casing being square in cross-sectional configuration and having perforate walls, the space between said columns defining a grain chamber, the outer one of said concentric columns being spaced inwardly from said casing to provide an exhaust air duct therebetween, means for introducing grain to be dried between said columns at the upper ends thereof, a fuel burner, electrically energizable means controlling opera-

tion of said burner, air moving means for introducing drying air heated by said burner into the upper portion of the space enclosed by the inner one of said concentric columns, whereby the drying air passes through said column walls and through the grain in said chamber to enter said exhaust duct, electrically energized unloading means for said grain chamber operable to remove dried grain at the base of said concentric columns, and a control circuit for said burner controlling means and said unloading means, said control circuit including a switch responsive to the temperature of the air in said exhaust duct operable to shut down said burner and said unloading means at an exhaust air temperature indicating heated air has entered said exhaust duct without passing through the grain in said grain chamber.

4. A grain drier comprising an elongated upright casing, concentric spaced tubular columns disposed within said casing and generally coextensive therewith, said spaced columns having perforate walls, the space between said columns defining a grain chamber, the outer one of said concentric columns being spaced inwardly from said casing to provide an exhaust air duct therebetween, means for introducing grain to be dried between said columns at the upper ends thereof, a fuel burner, electrically energizable means controlling operation of said burner, air moving means for introducing drying air heated by said burner into the upper portion of the space enclosed by the inner one of said concentric columns and for introducing unheated cooling air into the lower portion of said space, whereby the drying and cooling air passes through said column walls and through the grain in said chamber to enter said exhaust duct, electrically energized unloading means for said grain chamber operable to remove dried grain at the base of said concentric columns, and a control circuit for said burner controlling means and said unloading means, said con-

trol circuit including a switch responsive to the temperature of the air in said exhaust duct operable to shut down said burner and said unloading means at an exhaust air temperature indicating heated air has entered said exhaust duct without passing through the grain in said grain chamber.

5. A grain drier comprising an elongated upright casing, concentric spaced tubular columns disposed within said casing and generally coextensive therewith, said spaced columns having perforate walls, the space between said columns defining a grain chamber, the outer one of said concentric columns being spaced inwardly from said casing to provide an exhaust air duct therebetween, means for introducing grain to be dried between said columns at the upper ends thereof, a fuel burner, electrically energizable means controlling operation of said burner, air moving means for introducing drying air heated by said burner into the upper portion of the space enclosed by the inner one of said concentric columns, whereby the drying air passes through said column walls and through the grain in said chamber to enter said exhaust duct, electrically energized unloading means for said grain chamber operable to remove dried grain at the base of said concentric columns, and a control circuit for said burner controlling means and said unloading means, said control circuit including a switch responsive to the temperature of the air in said exhaust duct operable to shut down said burner and said unloading means at an exhaust air temperature indicating heated air has entered said exhaust duct without passing through the grain in said grain chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

|           |              |               |
|-----------|--------------|---------------|
| 2,245,664 | Gronert      | June 17, 1941 |
| 2,627,670 | Hurst et al. | Feb. 10, 1953 |
| 2,706,345 | Arndt        | Apr. 19, 1955 |