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Keirn

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[54] **CONTINUOUS FLOW GRAIN DRYING APPARATUS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 230,857, March 1, 1972, abandoned.

[52] **U.S. Cl.** **34/174,** 34/65, 34/171

[51] **Int. Cl.** **F26b 19/00**

[58] **Field of Search** 34/56, 64–66, 34/165–174

[56] **References Cited**

UNITED STATES PATENTS

1,558,119	10/1925	Sherban	34/174
2,740,204	4/1956	Seltzer et al.	34/174
3,053,522	9/1962	Applegate	34/174
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3,313,040	4/1967	Mathews	34/174
3,406,463	10/1968	Andersen	34/174
3,526,969	9/1970	Alms et al.	34/174

FOREIGN PATENTS OR APPLICATIONS

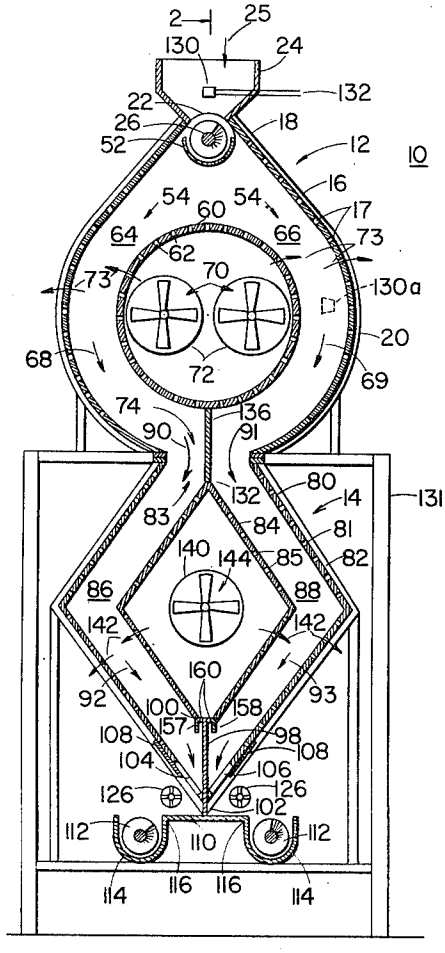
326,871	3/1930	Great Britain	34/171

Primary Examiner—John J. Camby
Assistant Examiner—James C. Yeung

[57] **ABSTRACT**

Continuous flow grain drying apparatus having an upper, foraminous drying enclosure into which grain to be dried is introduced and which communicates with a lower, foraminous cooling enclosure. A first enclosed, foraminous duct in the upper enclosure defines therewith a first pair of passages which divide the downward flow of grain into two separate parallel streams, a blower and burner combination communicating with the first duct causing outward flow of heated air simultaneously through the first passages. A second, enclosed, foraminous duct is provided in the lower enclosure defining therewith a second pair of passages and a divider connects the first and second ducts and extends through the open ends of the upper and lower enclosures thereby coupling respective ones of the first and second passages so that the two streams respectively continue separate, downward, parallel flow through the second passages. A blower communicates with the second duct causing an outward flow of cooling air simultaneously through the second passages. The two streams of grain are discharged, separately, from the bottom of the lower enclosure.

3 Claims, 2 Drawing Figures



SHEET 1 OF 2

FIG. 1

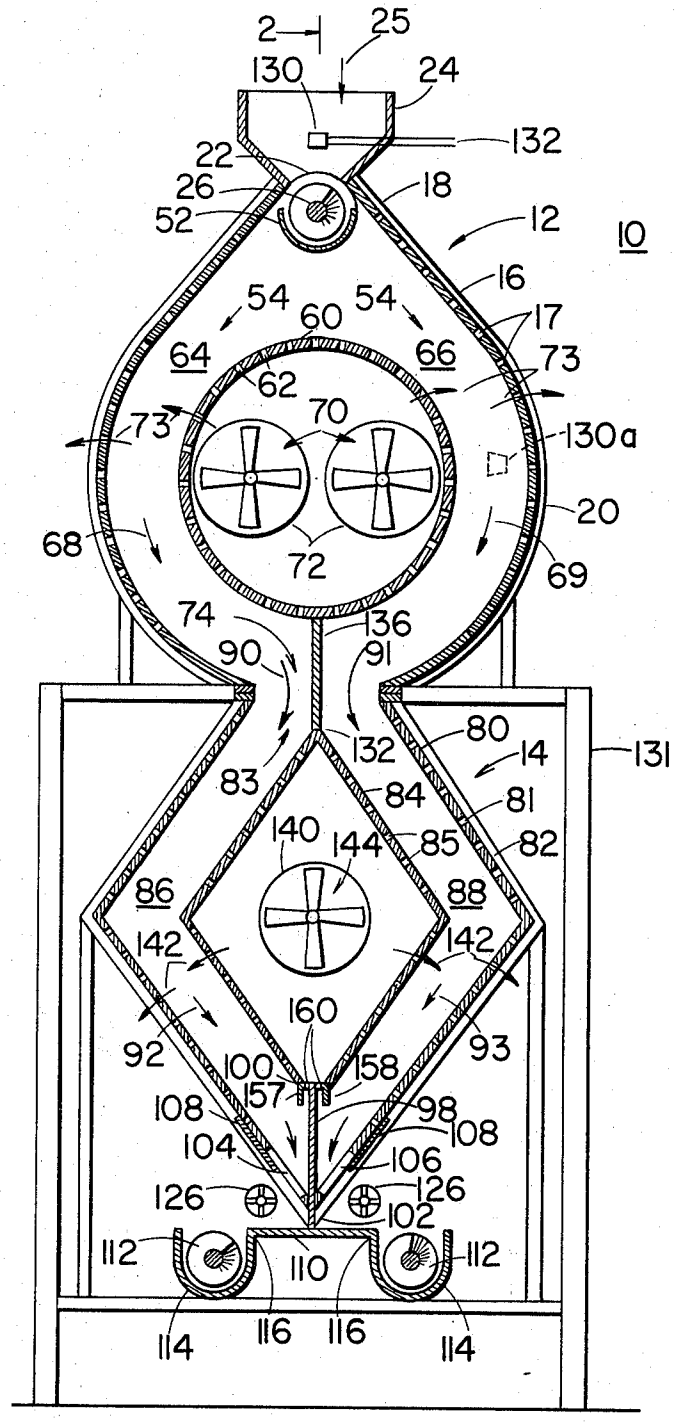
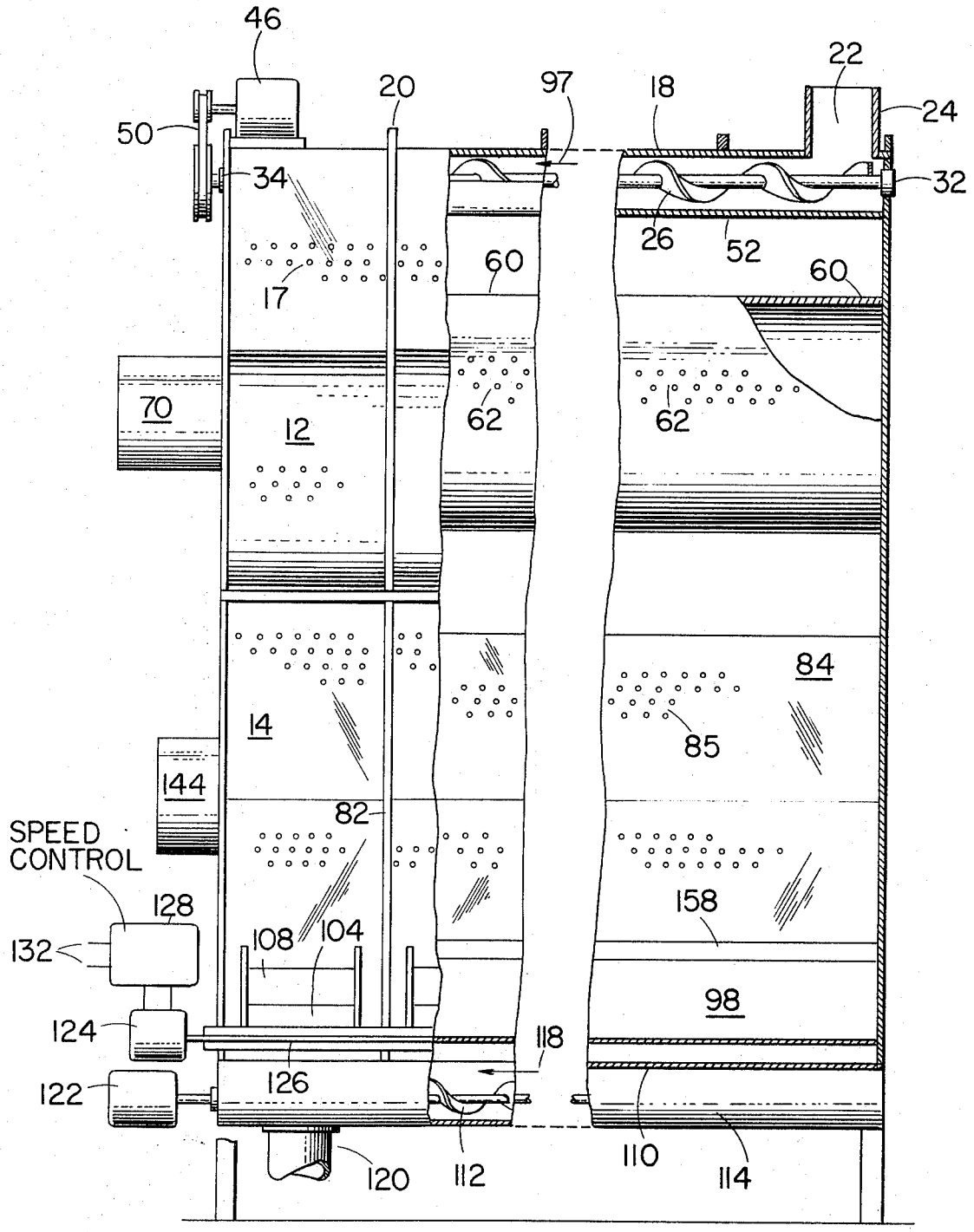


Fig. 2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SPEED CONTROL
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CONTINUOUS FLOW GRAIN DRYING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

A present invention relates generally to continuous flow grain drying apparatus. This application is a continuation-in-part of application Ser. No. 230,857, filed Mar. 1, 1972 now abandoned.

2. DESCRIPTION OF THE PRIOR ART

In the storage of grain such as corn, it is a common practice to dry the grain to remove a portion of the moisture content thereof. Many types of batch-type and continuous flow grain drying apparatus have been proposed and used. Typically, such prior grain drying apparatus included one or more chambers arranged to permit a flow of grain to gravitate downwardly therethrough, the grain being first subjected to a flow of heated, dry air which removes moisture and thereafter is subjected to a flow of cool air so as to cool the grain.

In one type of prior grain drying apparatus, the grain is passed through the apparatus in a single, relatively large column thus requiring the use of a multiplicity of air inlet and outlet ducts in order to minimize the length of the air flow paths through the grain. Further, passing the grain through the drying apparatus in a single column results in some portion of the grain be subjected to more or less heating and cooling than other portions.

U.S. Pat. No. 3,526,969 to Erhard E. Alms and James E. Mitchell discloses batch-type grain drying apparatus having separate drying and cooling chambers. Batch-type grain drying apparatus of the type shown in the aforesaid Alms et al patent for employing only a drying chamber is has also been used.

British Pat. No. 326,871 discloses continuous flow grain drying apparatus employing counter-flow of drying air.

In certain installations, by reason of its increased capacity, continuous flow grain drying apparatus is preferred to the batch-type apparatus. Since there are many existent installations of batch-type drying apparatus of the type shown in the aforesaid Alms et al patent, it is desirable to convert such batch-type apparatus to continuous flow apparatus.

SUMMARY OF THE INVENTION

The apparatus of the present invention employs the drying chamber portion of batch-type drying apparatus, such as that shown in the aforesaid Alms et al patent, eliminating the holding bin and cooling chamber, if any, and adding thereto a new cooling chamber with flow dividing means in the drying and cooling chambers providing a pair of passages therethrough thus dividing the downward flow of grain into two separate, parallel streams.

In its broader aspects, the continuous flow grain drying apparatus of the invention comprises an upper, foraminous drying enclosure having an top end and an open bottom end with means for introducing grain to be dried to the upper enclosure adjacent its top end for downward gravity flow therethrough. First, enclosed, foraminous duct means is provided in the upper enclosure for defining therewith a first pair of passages therein which divide the downward flow into two separate, parallel streams, and means are provided communicating with the first duct means for causing an outward flow of heated air simultaneously through the first passages. A lower, foraminous cooling enclosure is provided having an open top end connected to the bottom end of the upper enclosure and having a bottom end, and second enclosed, foraminous duct means is provided in the lower enclosure for defining therewith a second pair of passages therein. Divider means is provided connecting the first and second duct means and extending through the open ends of the enclosures for coupling respective ones of the first and second passages so that the two streams respectively continue separate, downward, parallel flow through the second passages. Means are provided communicating with the second duct means for causing an outward flow of cooling air simultaneously through the second passages, and means are also provided adjacent the bottom end of the lower enclosure for respectively, separately discharging the streams from the second passages whereby the two streams are maintained separate without co-mingling throughout their downward flow through the apparatus.

It is therefore an object of the invention to provide improved continuous flow grain drying apparatus.

Another object of the invention is to provide improved continuous flow grain drying apparatus wherein two separate, parallel streams of grain flow therethrough.

The above-mentioned and other features and object of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of the improved continuous flow grain drying apparatus of the invention; and

FIG. 2 is a fragmentary side view of the continuous flow grain drying apparatus of FIG. 1, partly in cross section and partly broken away, taken generally along the line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, the improved continuous flow grain drying apparatus of the invention, generally indicated at **10**, comprises an upper, drying enclosure, generally indicated at **12** and a lower, cooling enclosure generally indicated at **14**. Upper enclosure **12** includes a generally cylinderical side wall **16** fabricated from foraminous sheet material, such a perforated steel, having a multiplicity of openings **17** therein. The top end portion of side wall **16** has a longitudinally extending protuberance portion **18**, and the entire side wall **16** is reinforced with a plurality of peripherally extending, longitudinally spaced-apart ribs **20**. End walls **28, 30** join side wall **16** and complete enclosure **12**. Inlet opening **22** is formed in protuberance **18** adjacent end wall **28** and accumulator hopper or storage bin **24** communicates therewith, grain being introduced to upper enclosure **12** through hopper **24** and inlet opening **22**, as shown by arrow **25**.

Helical loading auger **26** extends longitudinally within protuberance portion **18** being rotatably mounted by bearings **32, 34** in end walls **28, 30**. Motor **46** drives auger **26** as by belt drive **50**. Distribution

trough **52** is mounted vertically beneath and closely adjacent auger **26.** The direction of auger **26** is such that grain introduced thereto through inlet opening **22** is moved from right to left as viewed in FIG. **2,** as shown by arrow **97,** and is distributed into upper enclosure **28** throughout the length thereof, as shown by arrows **54.**

A first cylindrical duct **60** is mounted coaxially within upper enclosure **12** extending between end walls **28,** 30, duct **60** also being fabricated of foraminous sheet material and having a multiplicity of openings **62** therein. Duct **60** defines two passages **64, 66** with side wall **16** of enclosure **12** thereby dividing the downward flow of grain into two separate, parallel streams, as shown by arrows **68.**

Conventional blower-heater units **70** are mounted on end wall **30** communicating with the interior of duct **60** through openings **72** in end wall **30.** Blower-heater units **70** thus force heated air into duct **70** and outwardly through opening **62** therein, across passages **64,** and outwardly through openings **17** in side wall **16** of enclosure **12,** as shown by arrows **73,** the flow of heated air simultaneously through passages **64, 66** thus heating and drying the parallel streams of downwardly flowing grain therein.

The bottom end of side wall **16** of upper enclosure **12** has longitudinally extending opening **74** formed therein. Lower, cooling enclosure **14** has a generally diamond-shaped cross-section and includes outer side wall **80** fabricated from foraminous sheet material having a multiplicity of openings **81** therein. End walls **28,** 30 are common to upper and lower enclosures **12, 14.** Side wall **80** is supported by a plurality of peripherally extending, longitudinally spaced-apart ribs **82.** Lower enclosure **14** has longitudinally extending inlet opening **83** formed therein communicating with discharge opening **74** of upper enclosure **12.**

A second duct **84** also having a diamond-shaped cross-section is provided within lower enclosure **14** extending between side walls **28, 30** and is formed of foraminous sheet material having a multiplicity of openings **85** therein. Duct **84** defines passages **86, 88** with side wall **80** of lower enclosure **14.**

Vertically extending, imperforate divider plate **136** extends between top apex **132** of duct **84** and the bottom portion of duct **60,** divider plate **136** extending vertically through openings **74, 83** and extending longitudinally between end walls **28, 30.** Divider plate **136** thus bisects openings **74, 83** so as directly to connect passages **64, 86** and **66, 88** so that the two, parallel streams of grain **68, 69** in passages **64, 66** of upper enclosure **12** are maintained separate and continue downward gravity flow as separate parallel streams in passages **86, 88** of lower enclosure **14,** as indicated by arrows **90, 91** and **92, 93.**

Conventional blower assembly **144** is mounted on end wall **30** and communicates with the interior of duct **84** through opening **140** and end wall **30.** Blower assembly **144** forces cool, ambient air into the interior of duct **84,** outwardly through openings **85,** across passages **86, 88,** and outwardly through openings **81,** as shown by arrows **142,** the simultaneous flow of air through passages **86** cooling the parallel streams of grain flowing therethrough.

Another vertically extending, imperforate divider plate **98** extends between lower apex **100** of duct **84** and lower apex **102** of side wall **80** of lower enclosure **14,** divider plate **98** extending longitudinally between end walls **28, 30.** Discharge openings **104, 106** are formed in side wall **80** of lower enclosure **14** adjacent bottom apex **102** respectively on opposite sides of divider plate **98** and respectively communicating with passages **86, 88,** the separate, downwardly flowing, parallel streams of grain in passages **86, 88** of lower enclosure **14** being separately discharged through openings **104, 106.** Flow control gates **108** are provided for respectively selectively adjusting the size of discharge openings **104, 106.**

A pair of skirt elements **157, 159** depend from bottom apex **100** of duct **84** in spaced parallel relationship with divider plate **98** and extending longitudinally between end walls **28, 30.** The width of skirts **157, 159** is substantially less than the width of divider plate **98.** Openings **160** in duct **84** communicate with the spaces between skirts **157, 159** and divider plate **98.** Upper and lower enclosures **12, 14** are supported by frame work indicated generally at **131.**

Flat plate member **110** extends longitudinally beneath discharge openings **104, 106** on either side of divider plate **98.** Metering rolls **126** are positioned beneath discharge openings **104, 106,** above plate **110,** and on either side of divider plate **98** for respectively metering the grain discharged through openings **104,** 106. A pair of discharge augers **112** are respectively located in troughs **114** which are respectively attached to the side edges **116** of plate **110,** discharge augers **112** receive grain respectively metered by metering rolls **126** from discharge openings **104, 106** and are rotated in a direction to move the grain from right to left as viewed in FIG. **2,** as shown by arrow **118,** for ultimate discharge through conduit **120.** Discharge augers **112** are driven by a suitable drive motor **122.**

Metering rolls **126** are driven by a suitable variable speed motor **124,** the speed of which is controlled by conventional speed control apparatus **128.**

A moisture sensing device **130,** such as a humidistat, is positioned in hopper **24** for sensing the moisture content of the grain entering the apparatus. Moisture sensing device **130** is electrically coupled to speed control device **128** by suitable electrical leads **132,** speed control device **128** controlling the speed of metering rolls **128** in inverse proportional to the moisture content of the entering grain, i.e., as the moisture content of the entering grain increases, the speed of the metering rolls is decreased. Moisture sensing device **130** may alternatively be located in one of the passages **64, 66** of upper enclosure **12,** as shown in dashed lines at **130a.**

In converting batch-type grain drying apparatus of the type shown in the aforesaid Alms et al patent to the continuous flow apparatus described above, the holding bin of the batch-type apparatus, if present, is eliminated, small hopper **24** installed, and distributing auger **26** installed. The lower cooling chamber, if present, is removed (and may be used as the drying chamber for another continuous flow dryer) and the drying chamber is elevated as need be. Divider plate **136** is then installed followed by installation of lower enclosure **80** having duct **84** and divider plate **98** therein, together with metering rolls **126,** unloading augers **112,** and the associated drive and control apparatus.

In the operation of continuous flow grain drying apparatus **10,** grain is continuously fed into the upper drying enclosure **12** through hopper **24** and inlet opening **22,** the grain being longitudinally moved and discharged into upper enclosure **12** by loading auger **26**

which substantially and uniformly distributes the grain over the longitudinal length of upper enclosure **12.** The grain then passes downwardly by gravity and is divided into two separate and substantially equal streams in passages **64, 66,** as shown by arrows **68, 69.** Heated drying air is forced by blower-heater assemblies **70** simultaneously outwardly through passages **64, 66** thereby heating and drying the two separate, downwardly flowing streams of grain therein, as indicated by arrows **73.** It will be observed that the grain travels a substantial distance as it follows the parallel paths **64,** 66 and that the path the drying air must traverse in passing through the grain is relatively short and thus, a relatively small drop in temperature occurs in the heated air as it passes through the parallel streams of grain flowing downwardly in passages **64, 66.** There will be some cooling and moisture accumulation in the drying air as it passes radially outwardly through the parallel streams of grain, however, it will be observed that the grain traveling along paths **68, 69** adjacent side wall **16** will travel a longer path than the grain traveling closer to duct **60.** Thus, the portions of grain subjected to relatively higher temperature, dryer air will pass through upper enclosure **12** in a shorter period of time than the portions of grain subjected to the relatively cooler and wetter air will be subjected thereto for a longer period of time thereby tending to equalize the overall drying effect on all the grain passing through the apparatus. As the grain reaches the lower extremities of upper drying enclosure **12** and enters discharge opening **74,** the two streams of grain following paths **68, 69** are maintained in separate, segregated paths and mixing or co-mingling is prevented by divider plate **136.**

As the grain progresses downwardly through discharge opening **74** in upper enclosure **12** and enters inlet opening **83** in lower enclosure **80,** the two separate, parallel streams of grain are maintained in passages **86, 88** by duct **84,** as shown by arrows **92, 93.** Simultaneously, cool air is forced into duct **84** by blower **144** and is forced outwardly through passages **86, 88** and through the parallel streams of grain flowing downwardly therein, the radial distance which the cooling air must traverse passing through the two, parallel streams of grain **92, 93** being relatively short. Further, it will be apparent that as the cooling air passes readially outwardly through the grain, it will accumulate moisture and heat from the warm grain. Again, the grain in the separate, parallel streams **92, 93** moving adjacent duct **84** will follow a shorter path than the grain moving adjacent side wall **80** thus tending to equalize the drying and cooling effect of the cooling air on the grain passing through passages **86, 88.** The dried grain in the two parallel streams **92, 93** is maintained in a completely separate state by divider plate **98.**

As the grain in the two, separate, parallel streams **92,** 93 approaches discharge openings **104, 106,** it is subjected to a final flow of cooling air which passes downwardly through openings **160** in duct **84** between skirts **157, 159** and divider plate **98.**

The two, parallel, separate streams of dried grain **92,** 93 are separately discharged through discharge openings **104, 106** under the control of metering rolls **126** and separately discharged to unloading augers **112.**

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What is claimed is:

1. Continuous flow grain drying apparatus comprising: an upper, foraminous drying enclosure having a top end and an open bottom end, means for introducing grain to be dried to said upper enclosure adjacent said top end for downward gravity flow therethrough, first, enclosed, foraminous duct means in said upper enclosure for defining therewith a first pair of passages therein thereby dividing said downward flow into two separate, parallel streams, means communicating with said first duct means for causing an outward flow of heated air simultaneously through said first passages, a lower foraminous cooling enclosure having an open top end connected to said bottom end of said upper enclosure and having a bottom end, second, enclosed foraminous duct means in said lower enclosure for defining therewith a second pair of passages therein, divider means connecting said first and second duct means and extending through said open ends of said enclosures for coupling respective ones of said first and second passages whereby said two streams respectively continue separate, downward, parallel flow through said second passages, means communicating with said second duct means for causing an outward flow of cooling air simultaneously through said second passages, said cooling air flow being discharged to the atmosphere, said heating and cooling air flows being in parallel, first and second discharge openings in the side wall of said second duct means for respectively separately discharging said streams from said second passages, an imperforate divider plate extending downwardly from said second duct means between said discharge openings for separately discharging said streams from said second passages whereby said two streams are maintained separate without co-mingling throughout their downward flow through said apparatus, a pair of skirt elements depending from said second duct means wall in spaced parallel relationship with said divider plate, said last-named openings respectively communicating with the spaces between said skirt elements and divider plate, said skirt elements being shorter than said divider plate whereby said second streams are respectively subjected to a final flow of cooling air as they are discharged.

2. Continuous flow grain drying apparatus comprising: an upper, foraminous drying enclosure having a top and an open bottom end, means for introducing grain to be dried to said upper enclosure adjacent said top end for downward gravity flow therethrough, first, enclosed, foraminous duct means in said upper enclosure for defining therewith a first pair of passages therein thereby dividing said downward flow into two separate, parallel streams, said upper enclosure and said first duct means being generally cylinderical in cross-section, means communicating with said first duct means for causing an outward flow of heated air simultaneously through said first passages, a lower foraminous cooling enclosure having an open top end connected to said bottom end of said upper enclosure and having a bottom end, second, enclosed, foraminous duct means in said lower enclosure for defining therewith a second pair of passages therein, said lower enclosure being generally diamond-shaped in cross-section and having an apex at its bottom end, said second duct means being generally diamond-shaped in cross-section and having apices at its top and bottom

ends, a first imperforate divider plate extending between the top apex of said second duct and said first duct and extending through said open ends of said enclosures for coupling respective ones of said first and second passages whereby said two streams respectively continue separate, downward, parallel flow through said second passages, means communicating with said second duct means for causing an outward flow of cooling air simultaneously through said second passages, said cooling air flow being discharged to the atmosphere, said heating and cooling air flows being in parallel, a second imperforate divider plate extending between the bottom apices of said second duct and lower enclosure, discharge openings respectively formed in the side walls of said lower enclosure adjacent its bottom apex and on opposite sides of said second divider plate for respectively separately discharging said streams from said second passages whereby said two streams are maintained separate without co-mingling throughout their downward flow through said apparatus, a horizontal plate member connected to the bottom apex of said lower enclosure and having sid edges respectively spaced on opposite sides thereof, metering rolls respectively disposed adjacent said discharge openings on opposite sides of said bottom apex and over said plate member for respectively metering grain discharged through said discharge openings from said second passages, trough elements respectively connected to said opposite sides of said plate member and respectively having first and second unloading augers therein for respectively receiving grain from said first and second metering rolls, and flow control gates for respectively selectively adjusting the size of said discharge openings.

3. Continuous flow grain drying apparatus comprising: an upper, foraminous drying enclosure having a top end and an open bottom end, means including a hopper communicating with said top end for introducing grain to be dried to said upper enclosure for downward gravity flow therethrough, first, enclosed, foraminous duct means in said upper enclosure for defining therewith a first pair of passages therein thereby dividing said downward flow into two separate, parallel streams, means communicating with said first duct means for causing an outward flow of heated air simultaneously through said first passages, a lower foraminous cooling enclosure having an open top end connected to said bottom end of said upper enclosure and having a bottom end, second, enclosed, foraminous duct means in said lower enclosure for defining therewith a second pair of passages therein, first divider means connecting said first and second duct means and extending through said open ends of said enclosures for coupling respective ones of said first and second passages whereby said two streams respectively continue separate, downward, parallel flow through said second passages, means communicating with said second duct means for causing an outward flow of cooling air simultaneously through said second passages, said cooling air flow being discharged to the atmosphere, said heating and cooling air flows being in parallel, first and second discharge openings in the side wall of said lower enclosure respectively communicating with said second passages for separately discharging said streams therefrom, second divider means extending downwardly from said second duct means between said first and second openings for completing separation of said second passages whereby said two streams are maintained separate without co-mingling throughout their downward flow through said apparatus, first and second metering rolls respectively disposed on opposite sides of said second divider means for respectively metering grain discharged through said openings from said second passages, variable speed drive means operatively connected to said metering rolls, and moisture sensing means positioned in one of said first passages and hopper and coupled to said variable speed drive means for controlling the speed of said metering rolls inversely proportional to the moisture content of the grain therein.

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