June 17, 1969 J. H. FRANCIS 3,449,840

CONTINUOUS GRAIN DRYING APPARATUS

Filed Oct. 18, 1967 Sheet 1 of 4

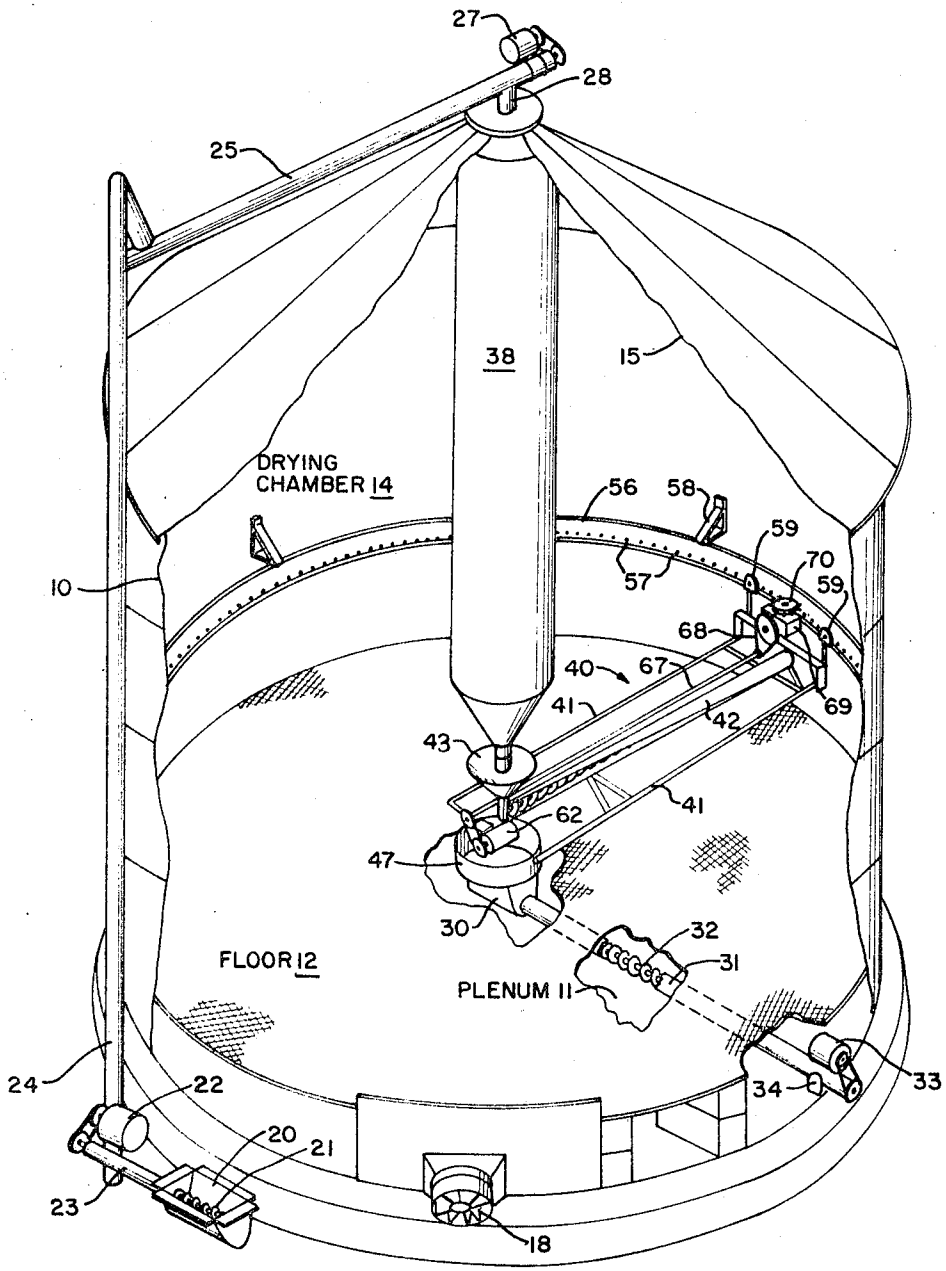



FIG. 1

INVENTOR.
JAMES H. FRANCIS

BY Arthur Robert

ATTORNEY

June 17, 1969 J. H. FRANCIS 3,449,840

CONTINUOUS GRAIN DRYING APPARATUS

Filed Oct. 18, 1967 Sheet 2 of 4

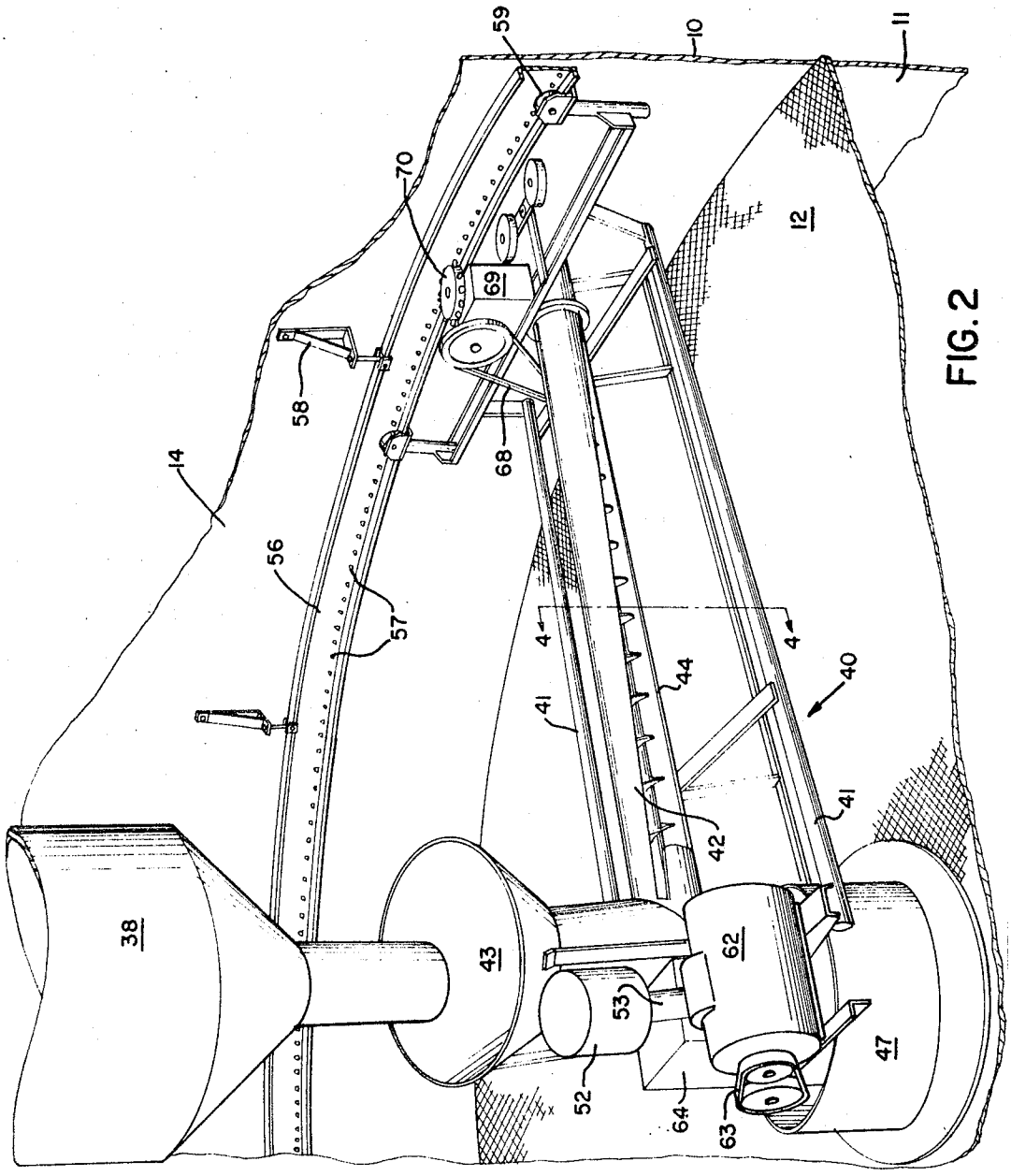



FIG. 2

INVENTOR.
JAMES H. FRANCIS

BY Arthur J. Robert
ATTORNEY

June 17, 1969 J. H. FRANCIS 3,449,840

CONTINUOUS GRAIN DRYING APPARATUS

Filed Oct. 18, 1967 Sheet 3 of 4

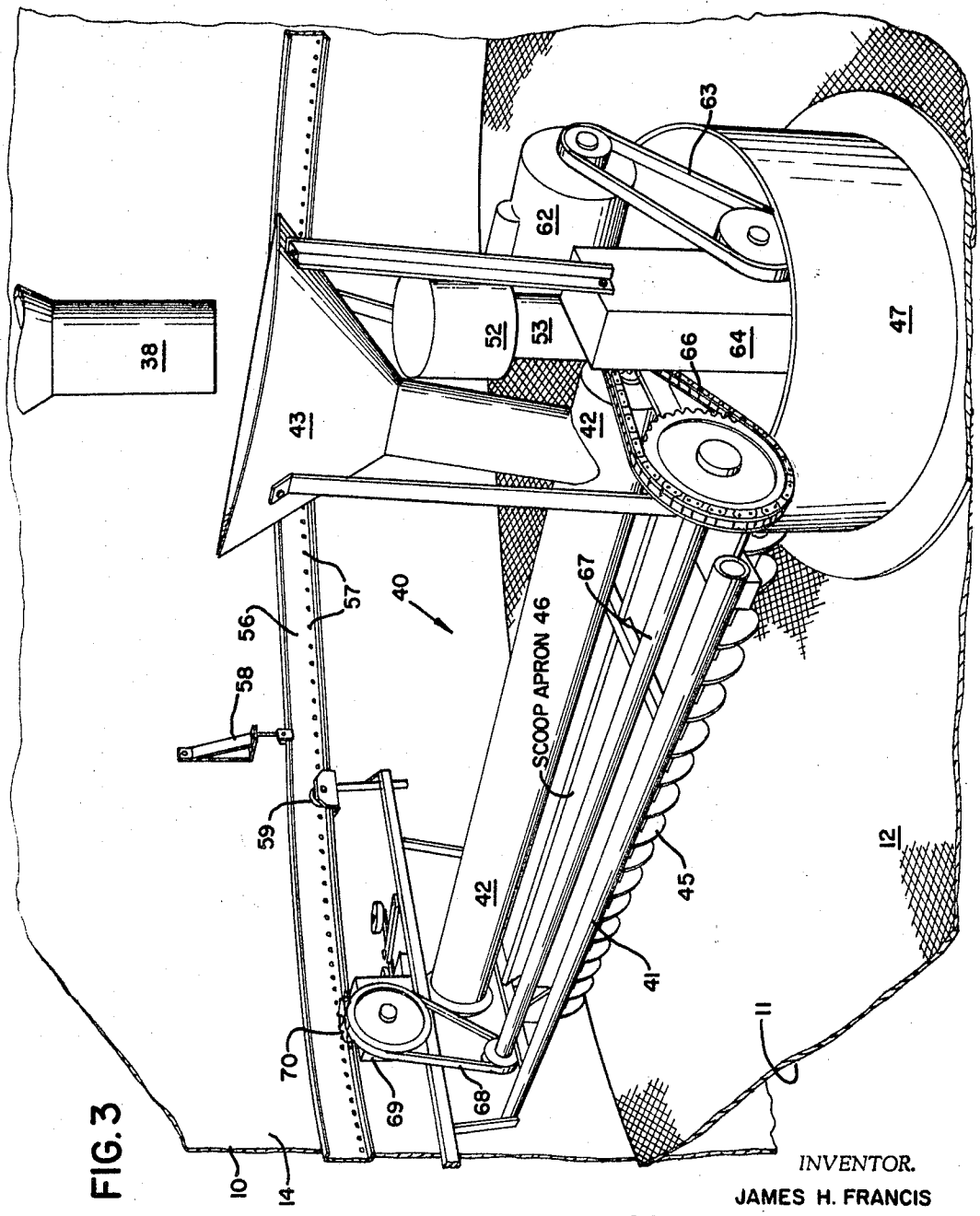



FIG. 3

INVENTOR.
JAMES H. FRANCIS
BY Arthur Robert
ATTORNEY

June 17, 1969 J. H. FRANCIS 3,449,840

CONTINUOUS GRAIN DRYING APPARATUS

Filed Oct. 18, 1967 Sheet 4 of 4

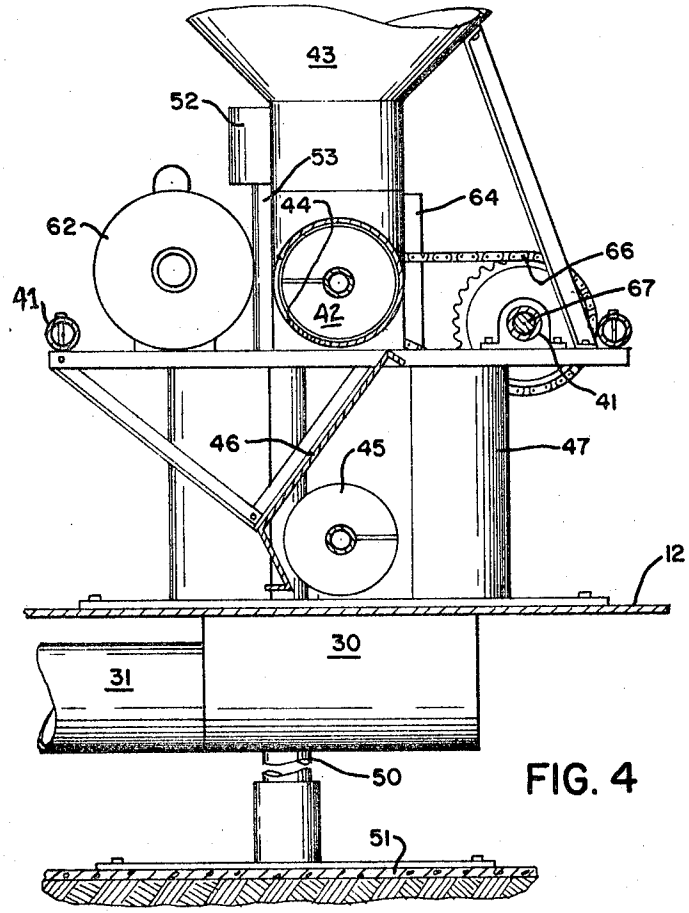



FIG. 4

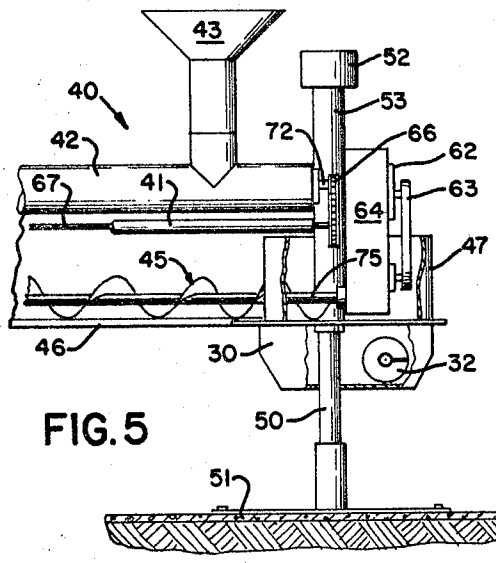



FIG. 5

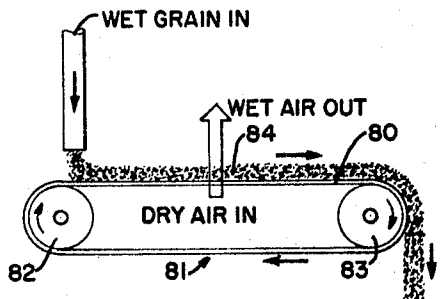



FIG. 6

INVENTOR.
JAMES H. FRANCIS

BY Arthur Robert

ATTORNEY

United States Patent Office 3,449,840 Patented June 17, 1969



3,449,840

# CONTINUOUS GRAIN DRYING APPARATUS

James H. Francis, Louisville, Ky., assignor to Clayton and Lambert Manufacturing Company, Buckner, Ky., a corporation of Delaware

Filed Oct. 18, 1967, Ser. No. 676,126
Int. Cl. F26b 15/02
U.S. Cl. 34—187 9 Claims

## ABSTRACT OF THE DISCLOSURE

A radially-extending grain handler is mounted in a grain drying bin for rotary sweep movement about the vertical axis of a centrally-open disc-like floor which is perforated to accommodate the upward passage of a drying gas therethrough. As the handler sweeps rotationally forward, it operates, on its lag side, through one auger, to feed a stream of incoming wet grain to said floor and, on its lead side, through another auger, to retrieve and remove dry grain from said floor. The grain feeding auger receives an incoming stream of wet grain at its inner end adjacent the central opening of the floor and directs that stream horizontally outward along a radially-extending overflow dam on its lag side in a manner causing the dam to overflow rearwardly along its length and thereby deposit, during each rotation of the handler, a radially wide band or layer of wet grain progressively extending circularly about said vertical axis of the bin. The grain retrieving auger has a radially-extending grain scoop on its lead side which, during each rotation of the handler, progressively scoops up the circular layer of grain deposited during the preceding rotation while the feed auger contemporaneously deposits a new circular layer of wet grain.

## BACKGROUND OF THE INVENTION

*Field of the invention*

This invention relates to grain drying apparatus of the continuous type. More particularly, the invention is concerned with an apparatus for receiving wet grain in a continuous stream, progressively drying that grain and then discharging the dried grain in a continuous stream.

*Description of the prior art*

The Ellis U.S. Patent No. 3,309,782 points out: (1) that is is desirable to harvest and dry ripe grain promptly; and (2) that such grains are usually dried either (a) by a batch-drying method, wherein small quantities of grain are placed and dried in a drier and then removed for storage, or, (b) by an in-storage drying method, wherein large quantities of grain are placed in the storage bin and slowly dried. Continuous grain driers are shown in the Ullgren and Denison et al U.S. Patents No. 1,779,571 and No. 3,256,615 wherein a stream of wet grain is continuously fed to the axial center of a drying bin and then subjected to a drying action as the layer is progressively forced to move over that surface along a path extending from the center of the surface "spirally" outward to a peripheral discharge opening.

## SUMMARY OF THE INVENTION

*Objects of the invention*

The principal objects of the present invention are: to provide a continuous grain drier which has a simple design that enables the drier to be easily, quickly and sturdily constructed; to provide one which can be readily installed in bins of the conventional perforated-floor type described in the Ellis patent as having a plenum chamber under an elevated perforated floor, a covered roof containing a central grain-inlet, air-outlet opening and a heated (or unheated) air supply unit for forcing drying air upwardly from the plenum chamber successively through the perforated floor, the stored grain and the roof of the bin; and to provide one which, in use, maintains a continuous stream of grain flowing into and out of the drier while providing, within the drier, from the time the stream enters the drier as wet grain to the time it leaves the drier as dry grain, operating conditions which facilitate the uniform drying of the grain over a substantial range of grain flow rates.



*Statement of the invention*

All of the important objects of the present invention can be achieved in a grain drier constructed in accordance with my preferred embodiment wherein a radially-extending grain handler, having grain feeding and retrieving augers, is installed in a grain drying bin, of the conventional perforated floor type, for rotary sweep movement about the vertical axis of the bin. The feeding auger provides, on the lag side of the handler, a radially extending overflow dam for feeding grain along its radial length at a controlled rate and thereby depositing on the floor, during each revolution, the wet lead end of desired layer of grain. The retrieving auger provides, on the lead side of the handler, a radially extending means for picking or scooping up grain along its radial length and thereby removing from the floor, during each revolution, the dry lag end of that layer of grain which was deposited during the preceding revolution.

With this arrangement, the rate of grain feed can be coordinated to the speed of the relative movement to provide a uniform layer of desired thickness while the drying action can be coordinated with the speed, thickness and length of this layer to reduce the grain to a desired and uniform degree of dryness.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated in the accompanying drawings wherein:

FIG. 1 is a partly broken perspective view of a grain drying installation constructed in accordance with the present invention;

FIGS. 2 and 3 are enlarged fragmentary views showing the lag side and lead side, respectively, of the grain handler shown in FIG. 1;

FIG. 4 is a vertical section corresponding to one taken along line 4—4 of FIG. 2;

FIG. 5 is a partly broken side elevation showing the inner end of the grain handler as seen in FIG. 3; and

FIG. 6 is a schematic illustration of a modified form of drier.

## DESCRIPTION OF THE PREFERRED FIGS. 1–5 EMBODIMENT

The preferred embodiment illustrated in FIGS. 1–5 may be described as comprising four more or less conventional elements together with one element, which is constructed in accordance with the present invention, these five elements being as follows: A. a perforated-floor type of grain bin; B. grain drying means; C. means for conducting incoming wet grain; D. means for conducting outgoing dry grain; and E. static layer-forming means.

*The grain bin*

The conventional perforated-floor type of cylindrical metal bin **10** illustrated in FIG. 1 has: a bottom plenum chamber **11**; an elevated perforated floor **12** containing a central opening concentric to the vertical axis of the bin **10**; a drying chamber **14** above the floor; and a conical roof **15** covering the drying chamber **14** and containing a central opening to accommodate the inflow of wet grain and the outflow of spent moisture-laden air.

*Grain drying means*

Any suitable means for drying the grain may be employed. In the arrangement shown, a blower **18** is conventionally mounted to blow heated or unheated air into the bottom plenum chamber **11** and, in so doing, maintain a continuous flow of drying air from the plenum chamber upwardly successively through the floor **12**, any grain layer on the floor, the drying chamber **14** and the central air-outlet opening in the roof **15**.

Needless to say, the central opening of the floor **12** is blocked off from plenum **11** in any conventionally suitable way (which is later described) to prevent the flow of drying air from the plenum chamber **11** to the drying chamber **14**.

*Means for conducting incoming wet grain*

The conveying or conducting means for the incoming wet grain comprises: a hopper **20** into which the incoming wet grain may be dumped; a conveyor screw **21** driven by motor **22**; a horizontal conveyer pipe **23**; an upright side wall pipe **24**; and a slanted roof pipe **25**, which contains a conveyer screw driven by motor **27** and which is arranged to discharge wet grain downwardly into and along the vertical axis of bin **10** through down-pipe **28**. This brings the incoming wet feed into and drops it down along the vertical axis of bin **10**.

*Means for conducting outgoing dried grain*

The conveying or conducting means for the outgoing dried grain comprises: an upwardly open stationary hopper **30** which is positioned on the under side of the central opening of the floor **12** (to receive dry grain which falls along the vertical axis at that point) and arranged to block the flow of drying air upwardly through the central floor opening; and a horizontal pipe **31**, which contains conveyer screw **32** driven by motor **33** and which is arranged to discharge dry grain downwardly into outlet pipe **34**.

*Static layer-forming means*

The static layer-forming means, which is interposed between the conducting means for incoming wet grain and the outgoing dry grain, operates to form and maintain a relatively stationary static layer of grain within the grain bin **10**. This static layer, which has a lead end, lag end and a given or predetermined length therebetween, essentially includes three (3) elements comprising: (1) means for forming the lead end of said layer on said surface, including means for feeding grain to the perforated surface of the floor **12** at the lead end of said static layer, said grain feeding means preferably but not necessarily including an accumulator for leveling out variations in the rate of flow of the incoming wet grain; (2) means for contemporaneously removing the lag end of said static layer of dry grain from said surface; and (3) means for creating relative movement, between said surface and said conducting means at the opposite ends of said static layer, and for contraining that relative movement in a direction such as to lengthen the static layer at the lead end and shorten it at the lag end.

The accumulator and the aforesaid three (3) essential elements may be best described as comprising: an accumulator; a grain handler; handler mounting means; and a handler drive means.

*The accumulator*

The accumulator **38** of the feed means is in the form of a large vertical open-ended cylinder, also designated **38**, positioned along the axis of the grain bin **10** to receive the incoming wet grain from the top outlet pipe **34** and hold back any excess wet grain while feeding a continuous stream of wet grain from its bottom opening at a desired rate into the grain handler. In place of the accumulator, the flow of incoming grain may be suitably metered during its passage between hopper **20** and down pipe **28** at the center of the roof **15**.

The *grain handler*

The grain handler **40** comprises: a horizontally elongate frame **41** composed of spaced longitudinal and transverse frame members suitably secured together; a horizontally elongate screw conveyer or feed auger **42** of the overflow type, which is mounted on the frame to extend longitudinally along the frame, which is provided at its inner end with a funnel **43** for channeling the incoming feed to the feed auger **42** and which is arranged to provide, on the lag side of the handler, a radially-extending overflow dam **44** which, by lag-side overflow action along its radial extent, deposits grain on the floor to form the wet progressively advancing lead-end of a desired layer of grain; a horizontally elongate screw conveyer or retrieving auger **45**, which is mounted on the frame to extend longitudinally along the frame and which is provided along its length, with a parallel "scoop-apron" **46** positioned alongside the retrieving auger **45** to provide two things, namely, 1st, a radially-wide forwardly-extending lead-side scoop, which scoops up the dry grain from the floor at all points along the radial width of the scoop, and which directs that grain rearwardly to the retrieving auger **45**, and, 2nd, an apron which is located behind the retrieving auger **45** and which cooperates therewith to force the scooped up dry grain to flow inwardly along the auger toward the center opening **13** of the floor **12**. The inner end of the retrieving auger **45** extends inwardly through the cylindrical wall of a rotating baffle **47**, which forms a part of the frame of the grain handler **40**. The auger **45** discharges the retrieved grain within the confines of the rotating baffle **47** where the grain falls into the open hopper **30** of the outgoing grain conducting means.

*Handler mounting means*

The grain handler **40** is mounted at its opposite ends for rotary sweep movement about the vertical axis of the grain bin **10**. The inner end mounting means comprises: a stationary upright (preferably hollow) post **50** centered on the long axis of the bin with its lower end fixed to the base **51** of the bin; a collector ring having a stationary part (not shown) fixedly mounted on the upper end of the post **50** and a cup-like rotary part **52** inverted over and rotationally mounted on the stationary part of the collector ring; a rotary sleeve **53** mounted to depend from and rotate with the rotary part **52** of the collector ring. The inner end of the handler frame **41** is rigidly secured to the sleeve **53**. Thus the handler **40** is rotationally supported on the collector ring center post **50** through the rotary collector-ring part **52** and its depending sleeve **53**.

The means for rotationally supporting the outer end of the grain handler **40** comprises: a stationary traction ring **56**, of the type conventionally having an endless series of spaced sprocket wheel openings **57**, mounted on the wall of the bin **10** through spaced brackets **58**; and a pair of transversely spaced wheels **59** carried by the outer end of the handler frame **41** in position to ride upon the lower flange of the traction ring **56** and thereby suspend the outer end of the handler rotationally therefrom.

*Handler drive means*

The handler drive means comprises: a main drive unit; and means for driving the handler and both of its augers from that unit.

The main drive unit comprises: a variable speed drive motor **62** suitably carried on the inner end of the handler frame **41**; a motor driven belt **63**; and a belt-driven reduction gear mechanism **64** (not shown) but housed in a gear box, which is also designated by the numeral **64**.

The handler drive means, which operates to rotate the grain handler **40** in sweep hand fashion about the vertical axis of the bin, comprises a drive train interconnect-

ing the traction ring **56** with the main drive unit in a manner such as to rotate the handler **40** when the main drive unit is energized. This drive train includes: a reduction gear-driven belt **66** at the inner end of the handler; a belt-driven radial shaft **67** rotationally mounted on the handler frame **41**; a shaft-driven belt **68** located at the outer end of the radial shaft **66**; a belt-driven gear mechanism **69** (not shown) but housed in a gear box, which is also designated by the numeral **69**; and a gear-driven sprocket **70** which is mounted to engage in the openings **57** of traction ring **56** and thereby track along that ring when rotated, so as to pull the outer end of the handler **40** with it. Alternatively, the handler may be driven by connecting sprocket **70** to a suitable variable speed driven motor mounted on the handler frame at its outer end.

The auger drive means on the handler **40** comprises: a direct connection **72** between the reduction gear mechanism **64** at the upper end of gear box **64** and the shaft of the feeding auger **42**; and another direct connection **75** between the rotary end of reduction gear mechanism **64** and the shaft of the retrieving auger **45**.

*Operation*

In operation, the main drive unit is energized to impart rotary sweep movement to the grain handler **40** and to the drive the grain-feeding and grain-retrieving augers **42** and **45**. At the same time, the motors **22** and **27** of the conveying or conducting means for the wet grain are energized so that grain fed into the wet grain hopper **20** will pass as a continuous stream through the conducting means **20–27** for wet grain and be discharged into the upper end of the accumulator **38** of the static layer-forming means.

A continuous stream of wet grain will flow from the accumulator **38** through the receiving hopper or funnel **43** into the inner end of the feed auger or conveyer **42**, which forces the grain to flow radially outward along the conveyer and causes it to overflow dam **44** of the conveyer and thereby fall upon the floor **12** where it forms the lead end of the 1st static layer of grain. During the 1st revolution of the handler, we assume that the drying fan **18** is not operated; hence, near the end of the 1st revolution, a static layer of wet grain will extend circularly from the feeding auger **42** at the lead end of the 1st static layer clockwise to the retrieving auger **45** at the lag end of the static layer.

At the end of the 1st and the beginning of the 2nd revolution, the operation of the drying fan **18** and associated drying equipment may be instituted to direct a stream of heated or unheated drying air, as the case may be, upwardly through the perforations of the floor, the static layer and the wet air outlet of the bin. During the 2nd revolution, the scoop or retrieving auger **45** on the the lead side of the handler will remove wet grain from the lag end of the first static circular layer while the feeding auger **42** on the lag side of the handler will contemporaneously form the lead end of the second circular layer as a continuation of the first circular layer.

As the 1st circular layer is scooped up by the scoop apron **46**, it is forced to move inwardly along that apron by the screw of the retrieving auger **45**, the inner end of which passes through the rotating baffle **47** to discharge the grain downwardly into the upwardly-open hopper **30** on the underside of the floor **12** at its central opening. This particular layer of grain may be recycled through the bin in any suitable fashion since it is largely composed of wet grain. At the end of the 2nd revolution, the scoop or retrieving auger will be located at the lag end of the 2nd static layer but, since this end is now dry, regular operation may be instituted with the scoop auger **45** on the lead side of the handler removing the dry grain constituting the lag end of the 2nd circular layer and with the feed auger **42** on the lag side of the handler contemporaneously forming the wet lead end of the third circular static layer, etc.



*FIG. 6 modification*

In FIG. 6, a continuous stream of wet grain is fed onto one end of the upper run **80** of a horizontally elongate endless perforated belt **81**, having a feed end and a discharge end. The belt **81** is rotationally supported on drums **82**, **83** and rotated to move the upper run **80** toward the discharge end. As a result, the static layer **84**, formed on the upper run, is progressively carried by that run toward the discharge end and thus correspondingly lengthened until it reaches the discharge end.

The flow of grain may now be continued as before, the flow of drying air instituted, and the discharged grain recycled until the discharge of suitably dry grain begins. On the other hand, when the upper run **80** is covered by a full length layer of grain, the flow of drying air may be instituted and the flow of grain stopped until all of the grain on the upper run **80** is suitably dry. Again, that part of the upper run, which is not covered by the first layer, may be blocked off to restrict the flow of drying air to the covered part, the blockage being removed when a full length of drying grain is first achieved and the discharge of dry grain begins or is about to begin.

Finally, the flow of drying air may be instituted at the very beginning of the flow of incoming grain and the flow of incoming grain regulated to provide a progressively thickening layer, beginning with a thin layer of low gas-flow resistance and ultimately ending with a layer of desired thickness. For example, a perforated floor provides a resistance to air flow approximating the resistance of a 6″ layer of grain. Consequently, if a 1″ layer of grain is initially formed on the floor **12**, the resistance which it affords to the air flow will be 7 units as against the 6 units afforded by the uncovered portion of the floor; hence, an adequate drying rate can be maintained in that grain despite the fact that the entire floor is not covered. Furthermore, this 1″ thickness can be progressively increased at a desired rate beginning before, during or after the completion of the first circular layer. At the tail end of the operation, the thickness of the last layer can be progressively reduced to insure adequate drying.

In any such event, drying air, drawn from a suitable source of supply, is forced into the space between the upper and lower runs of the belt **81** and thence forced upwardly successively through the upper run **80** of the belt **81** and static layer **84**. By appropriately co-ordinating the rate of wet grain flow to the speed of the belt, a grain layer of a desired and uniform thickness can be built up and maintained on the belt. By co-ordinating the drying action (the volume, velocity, temperature and moisture content of the drying air) to the speed, thickness and length of the static grain layer, the incoming wet grain can be reduced to a desired and uniform degree of dryness by the time it reaches the discharge end of the belt where it will be directed into any suitable receiver or dry grain conveying means.

The present invention has many advantages. First it can be readily installed in existing cylindrical drying bin installations. This enables the farmer to use existing equipment and thus effect important economies. Another important advantage is that, after all of the grain has been dried, it my be returned to and stored in bin **10** to be removed as needed through the bottom auger **31–32**. In this connection, the handler **40** may be operated until it lays the last circular layer. Thereupon it can be removed and the last layer dried entirely by the heat stored in the bin or by a continuing use of the drying apparatus. With the last layer in a suitably dry condition, the previously dried grain may now be fed back into the bin and stored. This again enables the farmer to effect important economies.

Having described my invention, I claim

**1.** An improvement in a grain drying apparatus of the type having a grain-supporting circular surface, which is stationarily mounted within a housing to extend circu-

larly about a vertical axis and perforated to accommodate a stream of grain-drying gas flowing upwardly therethrough, comprising:

(A) a pair of grain moving means for continuously maintaining, on said stationary surface, a relatively stationary static layer of grain having a radial width and a predetermined circular length between ends, said pair of means including

(1) one for forming one end of said layer on said surface by feeding incoming grain to and depositing it across said surface along a line corresponding to the radial width of said one end of said static layer, and

(2) the other for removing the other end of said layer from said surface by contemporaneously removing grain from said surface along a line corresponding to the radial width of said other end of said static layer,

(3) one of said pair being in the form of an elongate grain-handler of the rotary sweep type mounted to extend radially over said surface and arranged for rotation about said vertical axis, said handler having mechanism for moving grain radially along its length from a receiving point to a discharging point; and

(B) means for rotating said grain moving means horizontally over said surface in a direction tending to lengthen the static layer at said one end and shorten it at said other end.

2. The apparatus of claim 1 wherein:

(A) said grain handler includes

(1) a frame and

(2) a radially extending grain feeder of the rotary sweep type mounted on said frame to receive incoming grain in the vicinity of said axis, to direct the flow of said grain radially outward and to discharge said outwardly flowing grain along its length to form a radially wide layer of grain on said surface at the lag side of said rotary feeder.

3. The apparatus of claim 2 wherein:

(A) said grain feeder is in the form of an auger conveyer having an overflow dam over which the discharging grain flows.

4. The apparatus of claim 1 wherein:

(A) said grain handler includes

(1) a frame and

(2) a radially-extending grain retriever of the rotary sweep type mounted on said frame to pick up grain forming the radial width of the lag end of said layer, to flow said picked up grain radially inward and to discharge said inwardly flowing grain in the vicinity of said axis.

5. The apparatus of claim 4 wherein:

(A) said grain retriever is in the form of a radially-extending auger having a radially-wide scoop along its length to pick up said grain.

6. The apparatus of claim 1 wherein:



(A) said grain moving means comprises a pair of adjacent elongate grain handlers of the rotary sweep type mounted to extend radially over said surface and arranged for rotation about said vertical axis, each handler having mechanism for moving grain radially along its length from a receiving point to a discharging point,

(1) one rotary sweep grain handler including

(a) a frame, and

(b) a radially-extending grain feeder mounted on said frame to receive incoming grain in the vicinity of said axis to direct the flow of said grain radially outward and to discharge said outwardly flowing grain along its length to form a radially wide layer of grain on said surface on the lag side of said rotary feeder,

(2) the other rotary sweep grain handler including

(a) a frame, and

(b) a a radially-extending grain retriever mounted on said frame to pick up grain forming the radial width of the lag end of said layer, to flow said picked up grain radially inward and to discharge said inwardly flowing grain in the vicinity of said axis.

7. The apparatus of claim 6 wherein:

(A) said grain feeder is in the form of an auger conveyer having an overflow dam over which the discharging grain flows; and

(B) said grain retriever is in the form of a radially-extending auger having a radially-wide scoop along its length to pick up said grain.

8. The improvement of claim 7 in combination with:

(A) means providing said perforated grain-supporting surface; and

(B) means for drying grain along the length of a static layer of grain on said surface.

9. The improvement of claim 7 in combination with:

(A) an upright cylindrical bin providing said perforated grain-supporting surface and a plenum chamber under said surface; and

(B) means for flowing a drying gas from said plenum chamber upwardly through said surface.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 410,085 | 8/1889 | Gent | 34—173 XR |
| 1,515,103 | 11/1924 | Gage. | |
| 2,132,984 | 10/1938 | Chaney | 34—173 XR |
| 3,256,615 | 6/1966 | Dennison | 34—68 |



FREDERICK L. MATTESON, JR., *Primary Examiner.*

HARRY B. RAMEY, *Assistant Examiner.*

U.S. Cl. X.R.

34—236