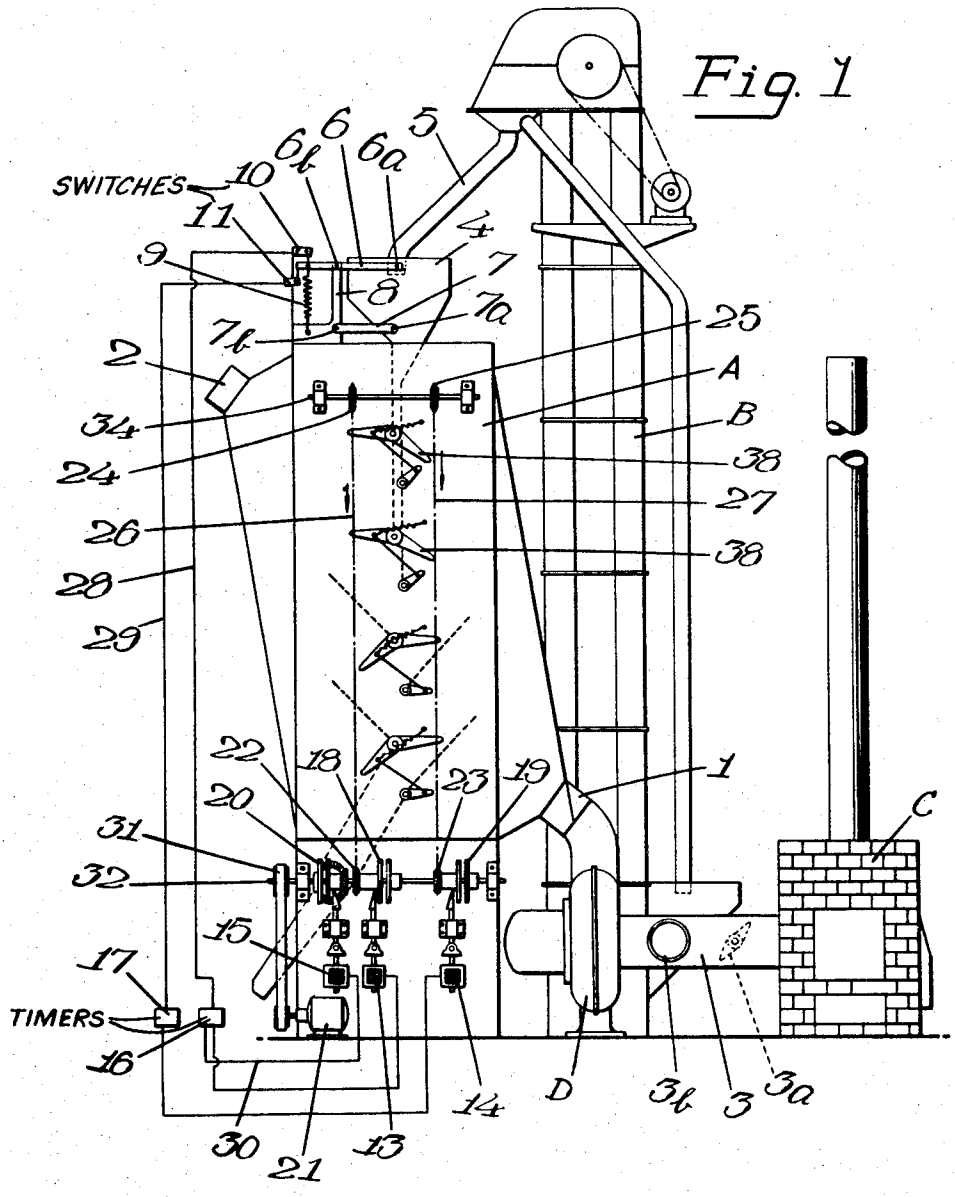
Nov. 26, 1968 TOSHIHIKO SATAKE 3,412,478

GRAIN DRIER

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Fig. 1



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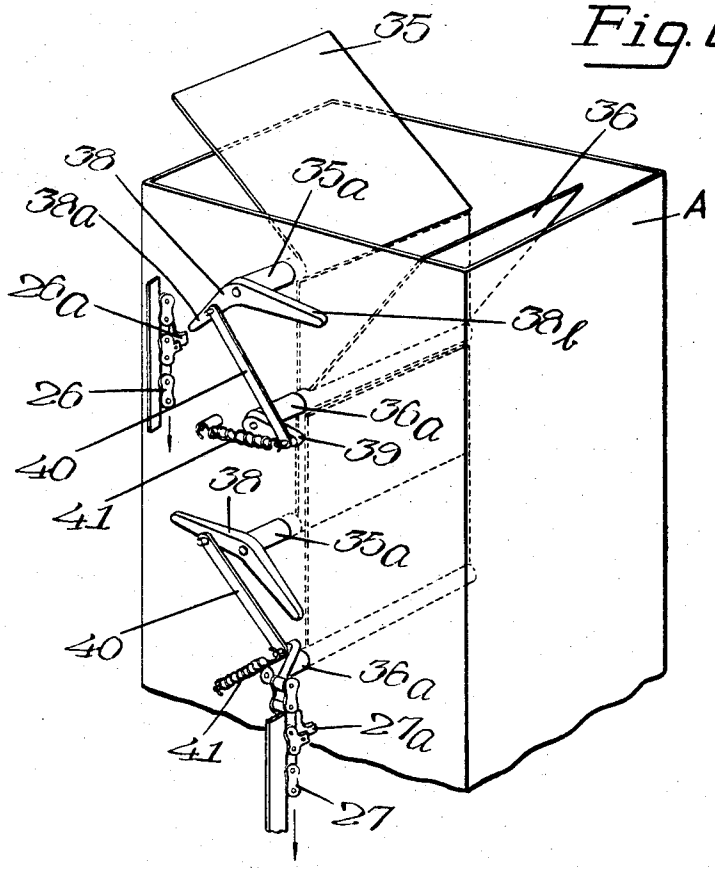
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GRAIN DRIER

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Fig. 2



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GRAIN DRIER

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Fig. 3

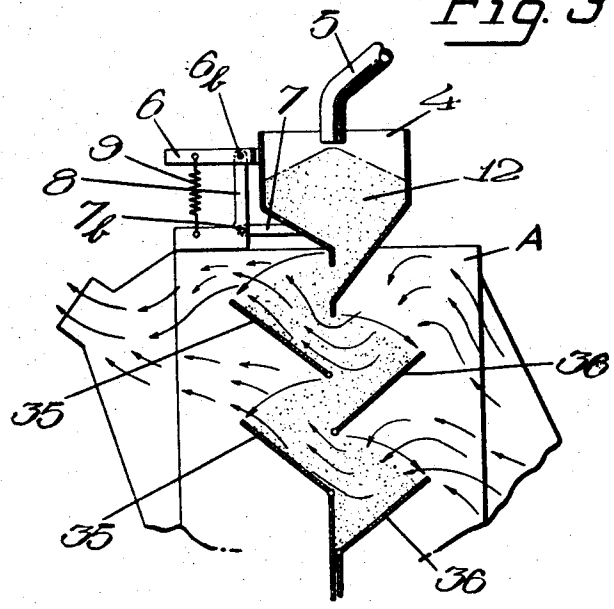
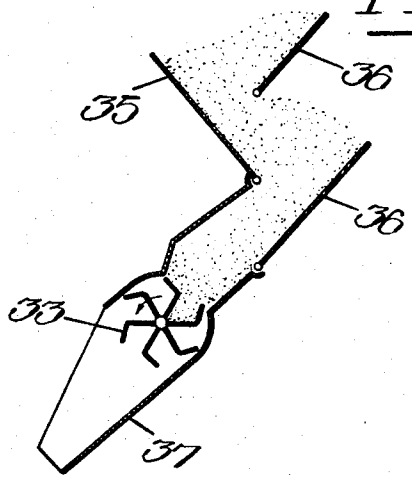


Fig. 4



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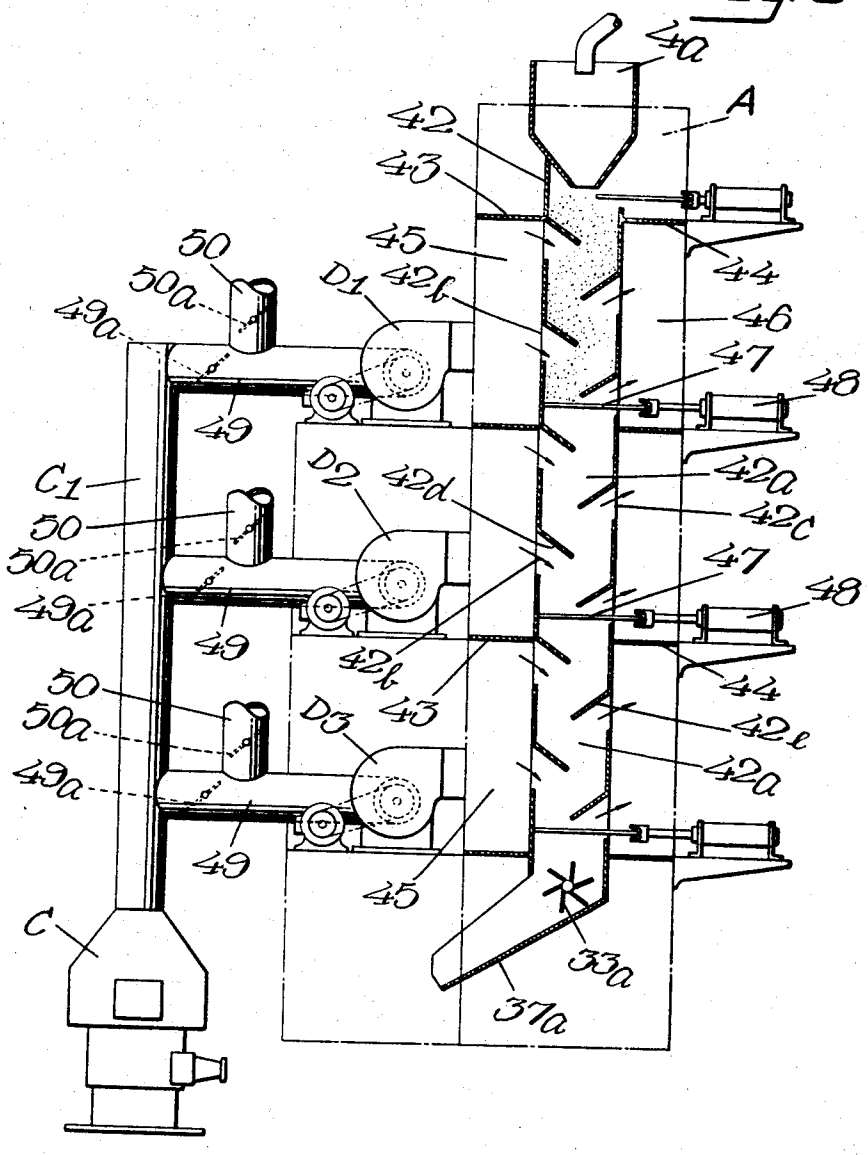
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GRAIN DRIER

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Fig. 5



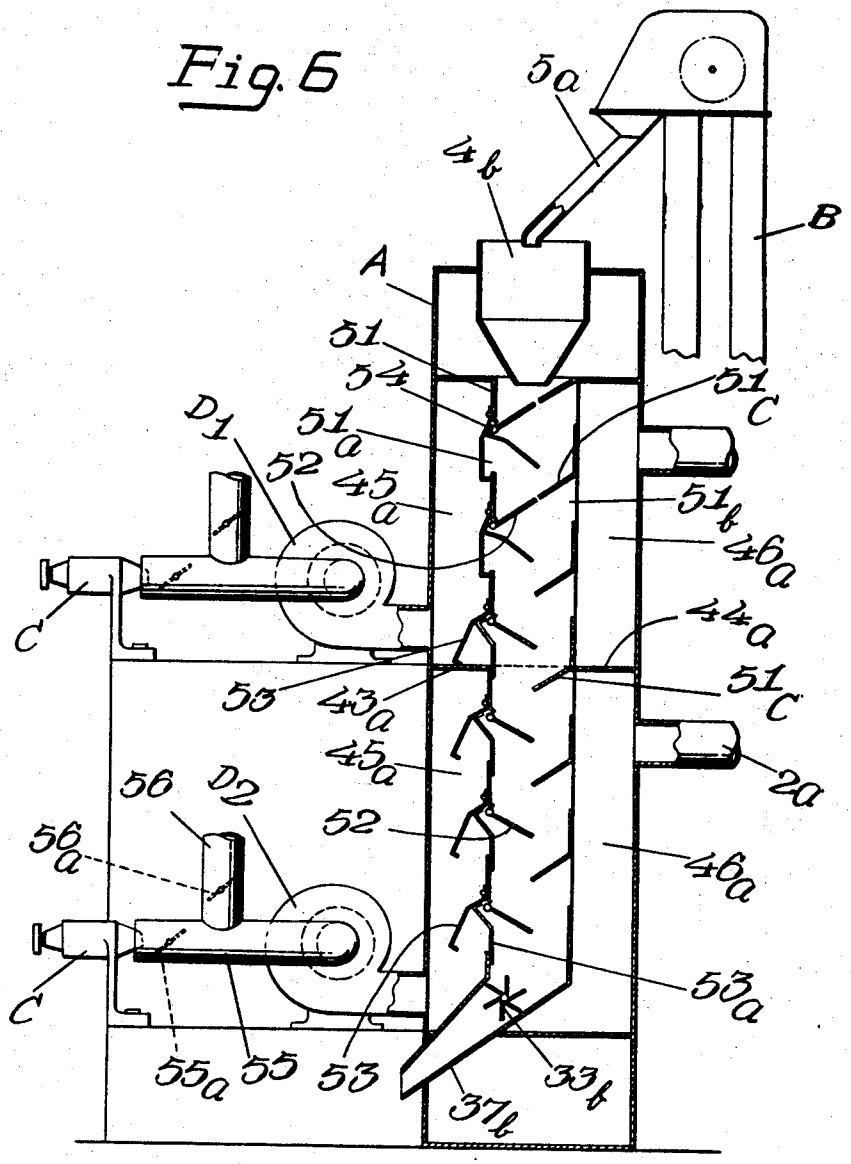
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GRAIN DRIER

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Fig. 6



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3,412,478

GRAIN DRIER

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9 Claims. (Cl. 34—172)

ABSTRACT OF THE DISCLOSURE

A grain drier is comprised of a vertically arranged chamber for passing the grain downwardly in contact with an upwardly flowing drying medium such as hot air. At its upper end the drying chamber receives grain from a hopper which is pivotally mounted on the drying chamber. A number of shutters are disposed within the drying chamber and are rotatably movable between opened and closed positions. Each of the shutters is mounted on a rotatable shaft extending transversely of the drying chamber and the shafts are arranged in pairs. As the hopper is filled to a predetermined level due to its pivotal mounting it closes switch means which activates driving means for disposing the shutters from the closed to the opened positions. Similarly, the hopper is arranged to close a second switch means when it is empty to activate other means for moving the shutters from the opened into the closed positions. Interconnected level means are provided on each pair of shafts by means of which the shafts are rotated and the shutters displaced between the opened and the closed positions. A rotatable outlet valve is provided at the lower end of the chamber and is placed in operation as the shutters are moved into their opened positions for positively discharging the grain from the drying chamber.

This invention relates to a grain drier.

An object of the present invention is to provide a grain drier so adjusted that the grain supplied from the hopper sequentially to the drier may be dried out evenly and continuously from the outset until the end of the supply.

Another object of the present invention is to provide a grain drier wherein a plurality of drying chambers are connected in a series vertically and drying may be effected continuously by the draft of air.

Another object is to provide a grain drier so adjusted that the greatest drying efficiency may be attained with the minimum of floor space.

A further object is to provide a grain drier wherein the drying time may be determined suitably and drying may be performed at all times in an optimum state in relation to the kind of grain to be dried, the quantity of water contained therein, and the like.

A further object is to provide a grain drier so adjusted as to prevent the hot air passing uselessly through the vacant area that may be produced towards the upper part of the drying chamber where the quantity of grain to be dried is decreased, i.e. the grain inside the drying chamber is decreased in quantity at the latter stages of the consecutive feeding process of the grain to be dried, or where a small quantity of grain is to be dried.

A further object of the present invention is to provide a grain drier wherein the drying chambers are provided in rows and these may either be used independently or communicated to each other and also the temperature as well as the quantity of the hot air may be regulated, or the hot air may be screened out completely, so that the drying of grain may be operated at all times in an optimum state in relation to the kind of grain to be dried, the quantity of water contained therein, and the like.

A further object of the present invention is to provide a grain drier wherein the circulation of hot air may take place only when the grain is flowing down the vertical barrel but not when the grain is not flowing down, thereby to prevent the redundant loss of heat.

In consideration of these objects and other objects that will be set forth hereinafter, the arrangement and construction of each part of the present invention will be described in the following specification and the claims appended thereto.

In the drawings:

FIG. 1 is a view in side elevation showing an embodiment of the grain drier according to the present invention;

FIG. 2 is a perspective view, shown in part, of the drying apparatus thereof;

FIG. 3 is a sectional side elevation showing the upper part thereof;

FIG. 4 is a sectional side elevation showing the lower part thereof; and

FIGS. 5 and 6 are side elevations showing other embodiments according to the invention.

Now, describing the present invention in detail with reference to the accompanying drawings, in FIGS. 1 to 4 the referential mark A indicates a drying apparatus, B a lift means, C a furnace, and D a ventilator. To one side of the drying apparatus A is connected a ventilator D through an inlet **1**, and to the other side thereof is fitted an outlet **2**.

The ventilator D is coordinated by way of a connecting pipe **3** to the furnace C, and the connecting pipe **3** is fitted with an adjustment plate **3***a* and an air intake **3***b*. Referential numeral **4** indicates a hopper mounted on the upper part of the drying apparatus A and grain is fed to the hopper **4** by way of the pipe **5** installed at the upper part of the lift device B.

The hopper **4** is pivoted at the upper and lower parts thereof to the ends of the levers **6** and **7** by means of the shafts **6***a* and **7***a*, and the lever **6** is pivoted halfway to the support plate **8** of the drying apparatus A by the shaft **6***b* while the base of the lever **7** is pivoted to the support plate **8** by the shaft **7***b*.

A torsion spring **9** is extended between the base of the lever **6** and the support plate **8**, and thereby the hopper is carried. Referential numerals **10**, **11** indicate limit switches that may be turned on cooperatively with the motion of the lever **6**. The arrangement is such that the hopper **4** is depressed under the weight of the grain when the grain is supplied inside the hopper **4** in a certain amount as desired to turn on the limit switch **10** by way of the lever **6**, and when the grain **12** is exhausted from inside the hopper **4** the limit switch **11** is conected in turn by way of the lever **6**.

Referential numerals **13**, **14** and **15** indicate solenoids, **16** and **17** indicate timers, **18**, **19** and **20** indicate clutches, **21** indicates a motor, **22**, **23** and **24**, **25** indicate sprocket wheels, and **26** and **27** indicate chains. The solenoid **13** is connected to the limit switch **10** by way of the timer **16** and conductive wires **28** while the solenoid **14** is connected to the limit switch **11** by way of the timer **17** and conductive wire **29**, and the solenoid **15** to the timer **16** by way of the conductive wire **30**.

Chain sprocket wheels **22**, **23** are mounted on the rotary shaft **32** rotated by the motor **21** through a gearing **31**. These sprocket wheels **22**, **23** are rotated by way of the clutches **18**, **19** respectively, while the clutch **20** acts on the rotary valve **33** to be described later. The solenoids **13**, **14** and **15** cooperate with the clutches **18**, **19** and **20** respectively to engage or disengage these clutches.

Sprocket wheels **24** and **25** are secured to the axis **34**,

the sprocket wheel **24** being connected to the sprocket wheel **22** by chain **26** and the sprocket wheel **25** to the sprocket wheel **23** by chain **27**.

Referential numerals **35** and **36** indicate shutters, for controlling the flow of grain, secured to the rotary shafts **35***a* and **36***a*. The shutters **35** and **36** are provided in a number of rows beneath the center of the hopper **4** on the side of the outlet **2** and on the side of the inlet **1**, respectively, and to the lowermost part thereof is fitted an outlet pipe **37** equipped with a horizontal outlet valve **33**.

As shown in FIG. 2 a bifurcate lever **38** is attached to one end of the rotary shaft **35***a* and a lever **39** secured to one end of the rotary shaft **36***a*. The one end of the bifurcate lever **38** is coupled to the lever **39** through a rod **40** to which is installed a torsion spring **41**.

Lugs **26***a*, **27***a* are provided to the chains **26**, **27** and the lug **26***a* abuts on the one end **38***a* of the bifurcate lever **38** while the lug **27***a* abuts on the other end **38***b* of the bifurcate lever **38**.

In accordance with the construction of the grain drier as hereinabove described, the grain conveyed sequentially by the lift device B is fed to the inside of the hopper **4** through the pipe **5** (at this time, each of the shutters **35**, **36** for controlling the flow of grain is in a closed state). If more than a certain amount of grain **12** is supplied inside the hopper **4**, as desired, the latter is depressed to some measure against the force of the torsion spring **9**, to make the microswitch **10** by way of the lever **6**. Solenoid **13** is energized by way of the timer **16** through the action of the microswitch **10**, and the clutches **18** and **20** are engaged. With the clutch **18** engaged, the sprocket wheels **22** start to be rotated, and the chain **26** is rotated in the direction indicated by the arrow mark. With the rotation of chain **26**, the lug **26***a* thereof firstly engages with the end **38***a* of the topmost bifurcate lever **38**. Thus the end **38***a* of the bifurcate lever **38** is pressed down and along with it the rotary shaft **35***a* is turned axially to open the shutter **35** as shown in FIG. 2. At the same time that the end **38***a* of the bifurcate lever **38** is pressed down, the lever **39** and the rotary shaft **36***a* are rotated by the medium of the rod **40**, and the shutter **36** is opened as shown in FIG. 3.

With the topmost shutters **35**, **36** opened in this way, the grain **12** contained in the hopper **4** may be passed onto the said shutters **35**, **36**. Simultaneously, the hot air circulated from the furnace C is circulated by the ventilator D by way of the inlet **1** in the direction as indicated by the arrow mark of FIG. 3 and forced through the outlet **2**.

The lug **26***a* on the chain **26**, when disengaged from the end **38***a* of the topmost bifurcate lever **38**, engages with the bifurcate lever **38** directly below said lever **38**, and bears the same downwardly. The shutters **35**, **36** are opened in the manner as described, and the grain is passed down onto these shutters **35**, **36**. The grain is conveyed in the similar manner onto the lowermost shutters **35**, **36** in order, while being dried, and the outlet valve is rotated with the clutch **20** engaged, as described in the foregoing. The periods of time in which these members are operated may be determined by the timer **16**.

When the grain is exhausted, and the hopper **4** elevated by the torsion spring **9** to resume its former position, the limit switch **11** is turned on and clutch **19** engaged by the solenoid **14** by way of the timer **17**, so that the sprocket wheel **23** begins to rotate and the chain **27** is rotated in the direction as indicated by the arrow mark. With the rotation of chain **27**, the lug **27***a* attached thereto sequentially engages with and bears down the other ends **38***b* of the bifurcate levers **38** arranged in rows, so that the rotary shafts **35***a* are rotated with the downward movements of the ends **38***b* of the bifurcate levers **38**, and the shutters **35** are closed. At the same time that the ends **38***b* of the bifurcate levers **38** are pressed down, the levers **39** are rotated along with the rotary shafts **36***a* and the shutters **36** are also closed.

Referring to FIG. 5, referential mark A indicates a drying apparatus, C indicates a furnace, D_1, D_2 and D_3 indicate ventilators, and referential numeral **42** indicates a vertical barrel. The vertical barrel **42** is mounted centrally inside the drying apparatus A, and to the upper part of the barrel **42** is fitted to hopper **4***a* while to the lower part thereof is fitted an outlet pipe **37***a* provided with a free rotatory valve **33***a*.

A number of partition walls **43**, **44** are provided in rows at the front and back of the vertical barrel **42** to divide the latter into several ventilating chambers **45** and exhaust chambers **46**.

Referential numeral **47** indicates flow controlling shutters mounted in the vicinity of the partition walls **43**, **44** to divide the vertical barrel into several upper and lower drying chambers **42***a* and operated by the suitable prime movers **48**. A number of vents **42***b*, **42***c* with their respective guide panels **42***d*, **42***e* are provided to the upper and lower parts of each drying chamber so as to face the front and back of the vertical barrel, and the interior of each drying chamber **42***a* is formed into a tortuous passage for grain by the guide panels **42***d*, **42***e*.

The duct C_1 for hot air is erected upright on the furnace C and to the duct C_1 are coupled a number of connecting pipes **49** fitted with ventilators D_1, D_2 and D_3 etc. each vented to the associated ventilating chamber **45**.

Each connecting pipe **49** is provided with an air intake **50** each having an adjustment plate **50***a*, and each connecting pipe **49** is also provided with an adjustment plate **49***a*.

In accordance with the setup so far described, the grain supplied to the hopper **4***a* is conveyed down the interior of the vertical barrel alongside the guide panels **42***d* and exhausted through the outlet pipe **37***a* by way of the free rotatory valve **33***a*, but the flow of grain down the vertical barrel is impeded by the flow controlling shutters **47** and caused to remain in the inside of each drying chamber **42***a*. During the time that the grain is caused to remain inside the drying chamber **42***a* it is dried through by the draft of hot air from the ventilators D_1, D_2 and D_3.

Referring to FIG. 6, referential mark A indicates a drying apparatus, B indicates lift device, C indicates a furnace, D_1 and D_2 indicate ventilators and reference numeral **51** indicates a vertical barrel. The vertical barrel **51** is mounted centrally in the inside of the drying apparatus A and to the upper part thereof is fitted a hopper **4***b* while to the lower part thereof is fitted an outlet pipe **37***b* provided with a free rotatory valve **33***b*.

To the front and back of the vertical barrel **51** are fitted partition walls **43***a*, **44***a*, in a number of rows to divide the vertical barrel into several ventilating chambers **45***a* and exhaust chambers **46***a*.

Reference numerals **51***a*, **51***b* indicate a number of vents provided towards the front and back of the vertical barrel **51**, numeral **51***c* indicates a number of guide panels provided inside the vertical barrel **51**, numeral **52** indicates flow controlling shutters, numeral **53** indicates shutters for vents **51***a* and numeral **53***a* indicates stoppers secured to the shutters **53**. Each flow controlling shutter **52** is fitted integral with shutter **53** for vent **51***a* by a hinge **54**.

To each furnace C is fitted an air inlet pipe **55** each having an adjustment plate **55***a* and connected to the ventilators D_1, D_2 each vented to the ventilating chamber **45***a*. Each inlet pipe **55** is fitted with an air intake **56** each having an adjustment plate **56***a*. Reference mark **2***a* indicates an air outlet pipe, and reference mark **5***a* indicates a conduit for supplying the grain into the hopper **4***b* from the lift device B.

In accordance with the setup as described hereinabove the shutter **52** is opened under the weight of the corn flowing down from the hopper **4***b* and as soon as the shutter **52** is opened the shutter **53** for vent **51***a* is opened to let the hot air into the vertical barrel **51**. The hot air is then let into the air exhaust chamber **46***a* by way of the vent **51***b* and drawn out of the vertical barrel through an

air outlet pipe 2*a*. The drying of grain is effected while the grain flows down the vertical barrel **51**, causing a number of flow controlling shutters **52** mounted in rows to be opened sequentially.

Heretofore, a corn drier of the gravity feed type is well known. However, the machine of this kind has had many deficiencies that the grain to be dried is passed at a time onto the bottom of the drying chamber at the initial stages of the feeding process, and the grain supplied to the drying chamber at the earlier stages is passed uselessly without being dried throughout the periods of time that may be needed for the drying process, thus causing an unequal degree of dryness compared with the grain being supplied successively to the drying chamber in a normal operation, and moreover, since the grain is conveyed successively in layers during the drying process, the grain cannot be dried separately by lots of minor quantity of different kinds, and in case the quantity of grain to be dried is decreased and a vacant spot produced in the drying chamber, the drying air is circulated uselessly, and an overmuch heat loss has been caused. These deficiencies are eliminated in accordance with the present invention, and the objects in view may be attained satisfactorily.

Though the description of a few embodiments of the present invention has been made, it is to be noted that the present invention is not restricted to the embodiments as hereinabove described but comprises all other structures coming under the purview of the invention as defined in the appended claims.

What is claimed is:

1. A grain drier comprising walls forming a generally vertically extending drying chamber, means for feeding grain into the upper end of said drying chamber, a plurality of pairs of rotatable shafts, each pair of shafts comprising a first shaft and a second shaft both extending across said drying chamber transverse to the vertical axis thereof, said first shaft in each pair of shafts is vertically spaced above said second shaft, a first shutter is attached to each said first shaft and is rotatable therewith between a closed position and an opened position, a second shutter is attached to each said second shaft and is rotatable therewith between a closed position and an opened position, a first lever is mounted at its midpoint on one end of each of said first shafts and it has oppositely disposed sections extending transversely of the vertical axis of said drying chamber, a second lever mounted on one end of each of said second shafts and extending transversely to the vertical axis of said drying chamber, a connecting arm is secured between each of said first and second levers attached to a pair of said shafts, each said connecting arm is secured at one end to one of said first levers at a point spaced from said first shaft and is secured at its other end to one of said second levers at a point spaced from said second shaft, and first means arranged to move downwardly through said drying chamber for seriously pivoting said first levers starting with the uppermost one thereof and rotating said first shafts and said first shutters attached thereto whereby said first shutters are moved from the closed position into the opened position and as said first levers are pivoted said connecting arms pivot said second levers which rotate said second shafts and said second shutters attached thereto whereby said second shutters are moved from the closed position into the opened position, said first and second shutters are arranged in the opened position to provide a continuous tortuous flow path for grain passing downwardly through said drying chambers.

2. A grain drier as set forth in claim **1**, wherein said first and second shafts are arranged to rotate said first and second shutters in opposite directions relative to the plane of the closed positions of said shutters whereby in the opened positions said first and second shutters are angularly disposed on opposite sides of the plane of said first and second shutters in the closed position.

3. A grain drier as set forth in claim **1**, wherein second means are arranged to move downwardly through said drying chamber for serially pivoting said second levers starting with the uppermost one thereof and rotating said second shafts and said second shutters attached thereto whereby said second shutters are moved from the opened position into the closed position and as said second levers are pivoted said connecting arm pivots said first levers which rotates said first shaft and said first shutter attached thereto whereby said first shutters are moved from the opened into the closed position.

4. A grain drier as set forth in claim **1**, wherein the uppermost of said first shutters in the closed position forms a closure for preventing grain from passing from said means for feeding grain into the upper end of said drying chamber downwardly into said drying chamber.

5. A grain drier as set forth in claim **3**, wherein said first means and said second means arranged for pivoting said first lever and said second levers respectively each comprises a chain, means for driving said chain, and a lug attached to said chain and arranged to contact the adjacent one of said first and second levers for rotating said lever about said shaft to which it is connected.

6. A grain drier as set forth in claim **3**, wherein said means for feeding grain comprises a hopper pivotally mounted on the upper end of said drying chamber, a first switch means and a second switch means disposed in operative relationship with said hopper whereby as said hopper is filled and reaches a selected level the hopper pivots and closes said first switch means and activates said first means for pivoting said first levers and as said hopper is emptied said second switch means is closed and activates said second means for pivoting said second levers.

7. A grain drier as set forth in claim **6**, wherein timer means are arranged in cooperating relationship with said switch means for timing the period of operation of the grain drier.

8. A grain drier as set forth in claim **1**, wherein a drying medium inlet is positioned at the lower end of said drying chamber, and a drying medium outlet in positioned at the upper end of said drying chamber, and means for supplying the drying medium to said inlet whereby said drying medium flows upwardly through said drying chamber in counterflow relationship with the grain passing downwardly over the first and second shutters in their opened positions.

9. A grain drier as set forth in claim **1**, wherein a rotatable outlet valve is positioned at the lower end of said drying chamber, and means for rotating said outlet valve arranged to be placed in operation as said first shutters and said second shutters are displaced into their opened positions.

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