United States Patent

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[73] Assignee **said Gerald D. Arnold, by said John B. Arnold**

[54] **AGRICULTURAL DEHYDRATING AND COOLING SYSTEM**
1 Claim, 8 Drawing Figs.

[52] **U.S. Cl.** **34/136,** 222/368, 55/432
[51] **Int. Cl.** **F26b 17/00**
[50] **Field of Search** ..... 34/109, 128, 136, 135, 79, 57, 57 D; 55/267, 430, 459; 222/368

[56] **References Cited**

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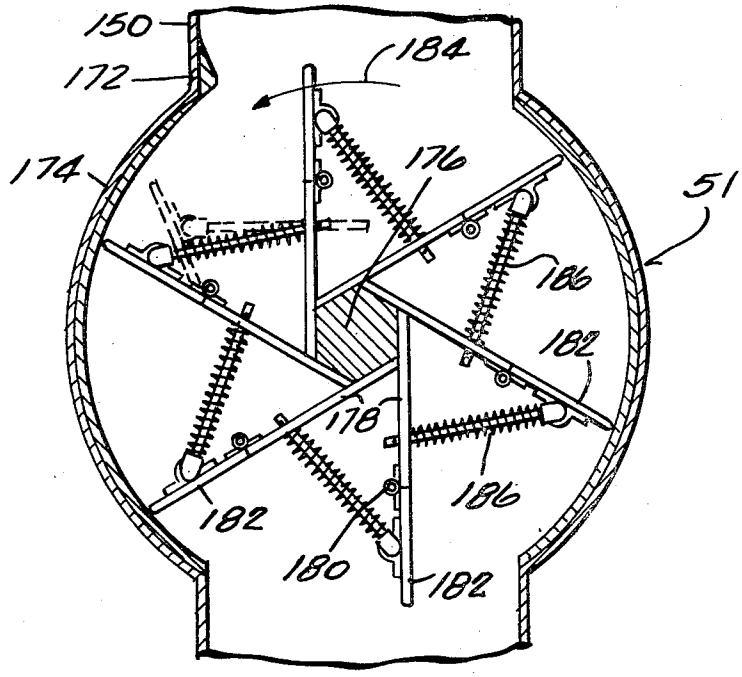
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ABSTRACT: A furnace for providing dehydrating gases has its flue connected in series with a multiple-pass dehydrating drum compartment by longitudinal radial partitions to promote efficient intimate exposure of material to dehydrated gas by subdividing both the gas and the material into narrow streams while still providing the tumbling which results from drum rotation. The light output of the drum is delivered through a settling chamber into a cyclone separator which has its gas discharge port connected to a blower that subjects the chamber and drum and furnace to vacuum. The light solids are then recombined with heavy solids before discharge. Discharge of solids without access of air is controlled by a rotary valve which has generally radial vanes protected from breakage by provision of angularly yieldable end portions.



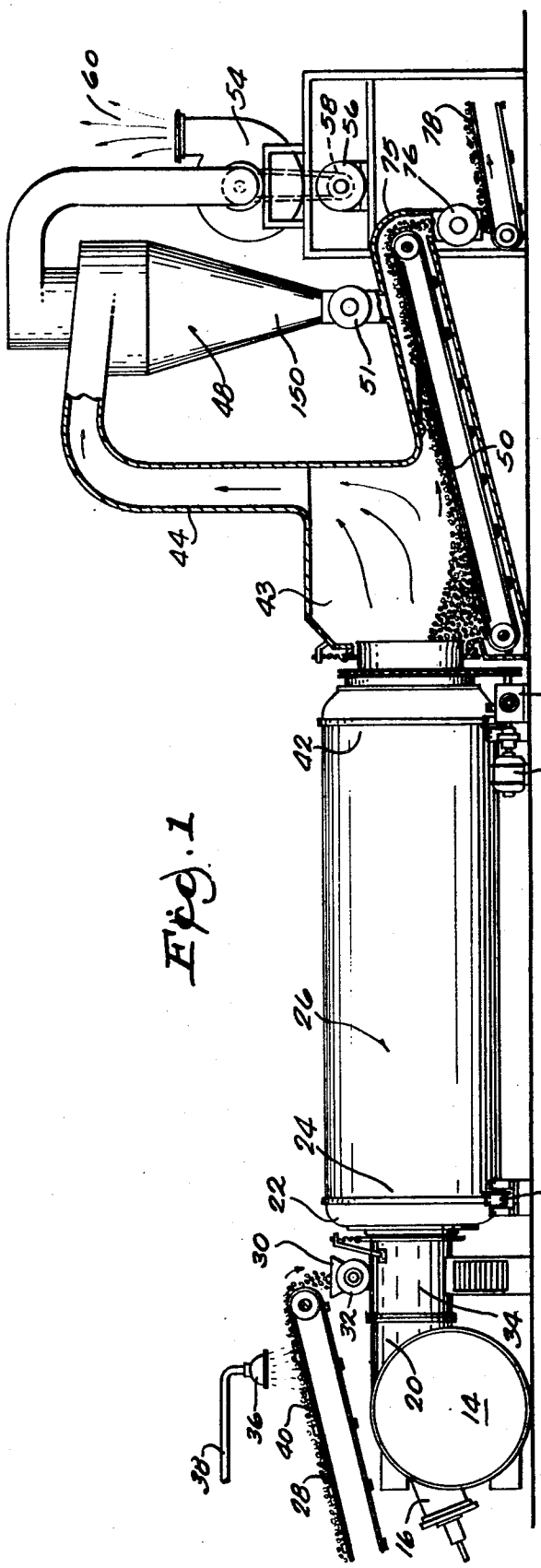


Fig. 1

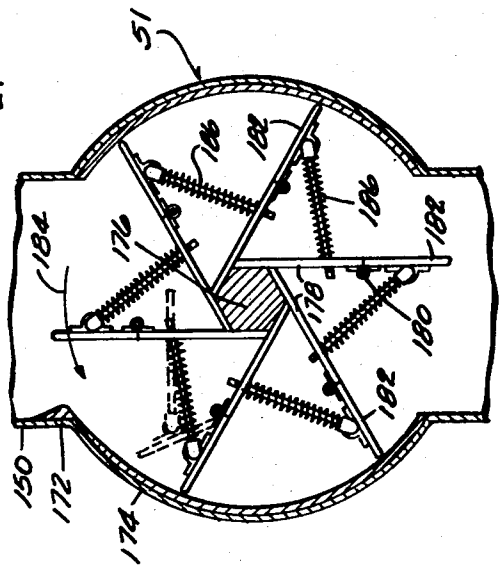


Fig. 2

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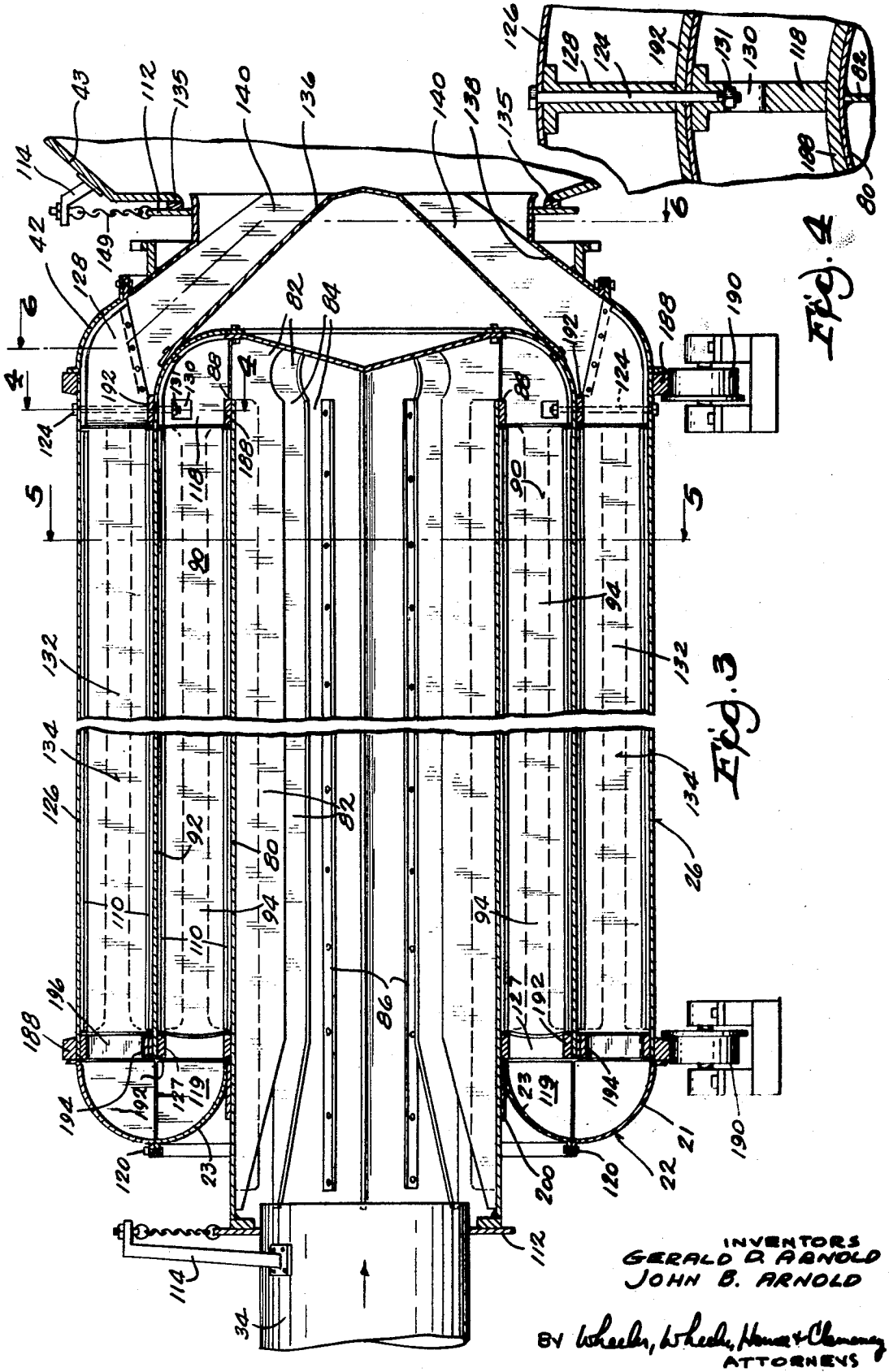


Fig. 3

Fig. 4

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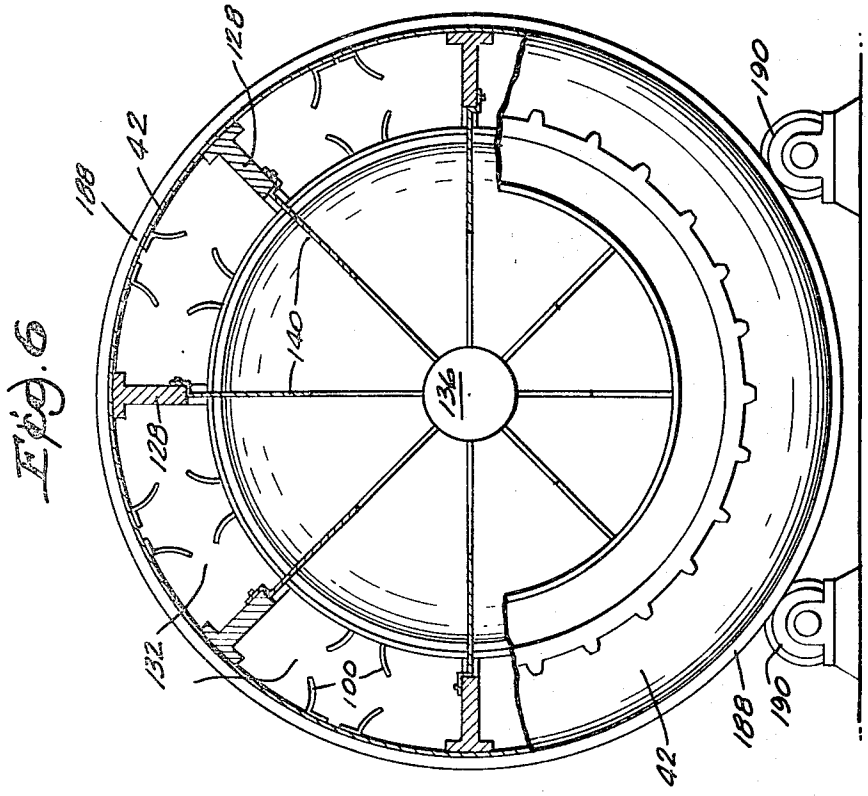


Fig. 6

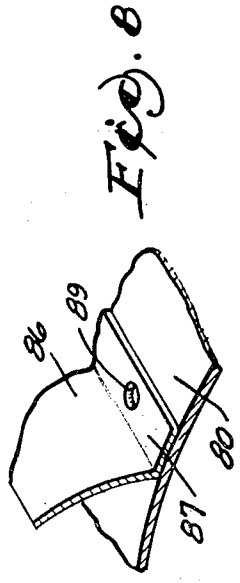


Fig. 8

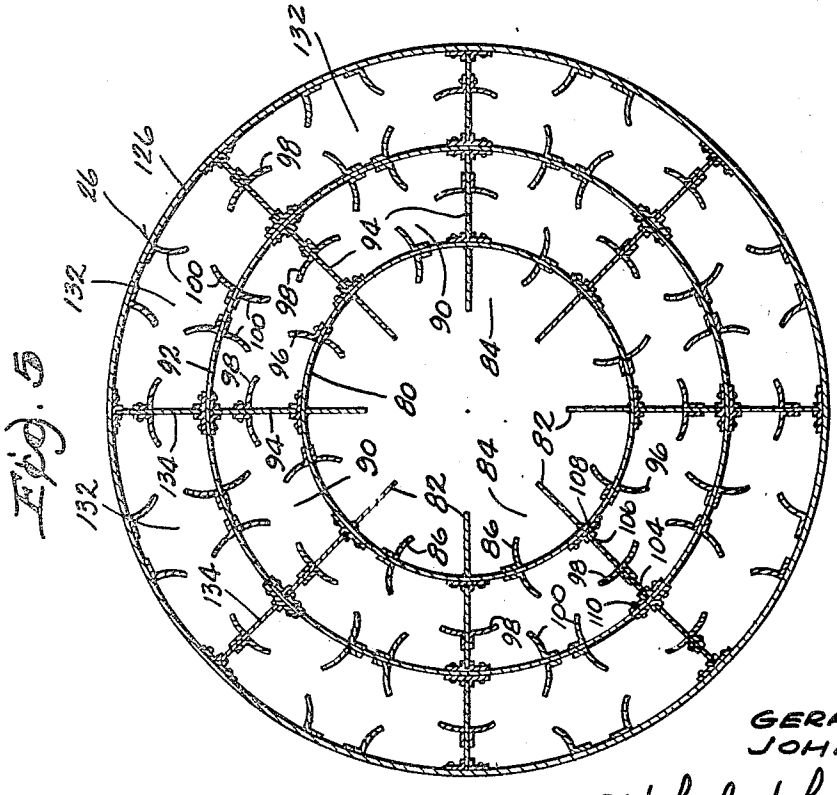


Fig. 5

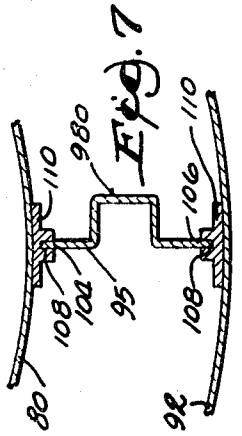


Fig. 7

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AGRICULTURAL DEHYDRATING AND COOLING SYSTEM

BACKGROUND OF THE INVENTION

Systems on the general order of that herein disclosed are old but the material being dried in a multiple-pass drum tends to concentrate at one side and both ends of the drum as the result of rotation thereof, the other side of the drum being thereby left open for the passage of dehydrating gas which has not fully acted upon the material.

It is also known to draw the dehydrating gas and the solids through the drum under partial vacuum, the convection current being created by a fan at the discharge end of the system.

SUMMARY OF THE INVENTION

The invention herein disclosed makes improved use of the dehydrating gas by dividing both the solids and the gas into components which traverse segmental axial passages between longitudinal partitions in the drum and about the end. These assure that substantially all portions of the dehydrating gas will be tumbled while fully exposed to the produce or grain or other solids to be dried.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a general view in side elevation of a dehydrating system embodying the invention.

FIG. 2 is an enlarged detail view in transverse section through the valve which controls the discharge of solids from the separator.

FIG. 3 is a fragmentary view in axial section through the drum on a considerably enlarged scale.

FIG. 4 is a further enlarged detail view taken in section on the line 4—4 of FIG. 3.

FIG. 5 is a view taken in section on the line 5—5 of FIG. 3.

FIG. 6 is a detail view taken in section on the line 6—6 of FIG. 3.

FIG. 7 is a fragmentary detail view showing a modified partition and baffle arrangement.

FIG. 8 is a fragmentary detail view partially in section and partially in perspective showing a modified flight arrangement.

DETAILED DESCRIPTION

The nonrotatable furnace drum **14** has a generally tangential fuel and air inlet at **16**.

A flue pipe **20** leads toward the dehydrator drum head **22** at the inlet end **24** of the rotatable mounted drum **26**. A motor **25** rotates the drum on supporting rollers **190**. A rate changer **27** preferably intervenes in the drive from the motor to the drum to enable the operator to control the speed of drum rotation. The material to be dehydrated is elevated by conveyor **28** and delivered into a hopper **30** which communicates through a rotary valve **32** with a throat **34** through which the dehydrating gas from furnace **14** enters drum **26**. The entire system is preferably maintained under partial vacuum by an exhaust fan **54**.

A spray nozzle **36** has a water supply connection **38** which delivers water directly onto the produce **40** on conveyor **28**. The amount of water is controlled with discharged gas temperature as explained in Arnold U.S. Pat. No. 3,360,868 to prevent scorching of the material in the drum while assuring complete dehydration thereof. In addition to preventing scorching, the moisture and heat together are effective in degradating pesticides and antibiotics on the produce, whereby to protect animals and milk from contamination.

Details of the drum construction will be explained later.

Dehydrated material issues from the outlet end **42** into settling chamber **43** from which the pipe **44** carries the dehydrating gas and the lighter entrained dehydrated solids upwardly to the tangential inlet **46** of a centrifugal separator **48**. In its upward movement, the dehydrating gas will tend to drop out not only the heavier dehydrated material but also any foreign matter such as stones or iron. All such material will be received by conveyor **50**, recombined with light material from the separator **48** and discharged downwardly by gravity through the rotary discharge valve **51** onto discharge conveyor **50**.

The gases are withdrawn from the cyclone separator **48** by means of said exhaust fan or blower **54** operated from motor **56** through a speed controlling rate changer **58**. The gases discharge into the atmosphere at **60**. The solids pass through a rotary valve **51** onto conveyor **50** (as previously described). This conveyor is sealed from the atmosphere by housing **75** from which solids are delivered through rotary valve **76**. Discharge is effected on conveyor **78**.

THE DRUM CONSTRUCTION

The drum **26** as shown is a rotatable triple-pass drum. There is an inner shell **80**, an intermediate sleeve **92**, and an outer shell **126**. The clearance between the inner shell **80** and the throat **34** is sealed against the admission of atmospheric air by a floating sealing ring **112** bearing on throat **34** and guided by suspension from brackets **114** as best shown in FIG. **3**. The seal ring **112** is held by partial vacuum against the end of inner shell **80**.

The dehydrating gas and the entrained material **40** to be dehydrated enter through the throat **34** into the inner tubular shell **80** which is divided by short radial partitions **82** into arcuate segmental passages **84**. These passages are further divided by flights **86** riveted or welded to the inner shell **80**. During drum rotation the partitions **82** and the flights **86** lift the materials to be dehydrated and drop it across the path of dehydrating gases traversing the narrow segmental passage **84** longitudinally of the drum. Some of the material drops repeatedly across the center portion of the drum where it is exposed to the gases passing through the center. However, it will be noted that practically none of the dehydrating gases will escape exposure of the material thereto. This exposure of the gases and the material to each other continues in successive drum traverses.

Once the material enters one of the passages **84** it is segregated from other material all the way through the intermediate and outer drums.

The central tube or shell **80** has its end **88** sleeved in a ring **188** supported by the gussets **118**, one of which is shown in FIG. 4. Similarly the intermediate drum or shell **92** is supported by gussets **127** and ring **192** from the outer shell **126** (FIGS. 3 and 4). The dehydrating gas and the material sweep around the end **88** into the passages **90** between the inner shell **80** and the intermediate shell **92** (FIGS. 3 and 5). Generally radial partitions **94** delineate arcuately segmental passages **90** which extend longitudinally of the drum between sleeve **92** and the inner shell **80**. Into each of the passages **90** extend flights **96** from the inner shell **80**, flights **98** from the partitions **94** and flights **100** from the intermediate sleeve **92**. The flights preferably are backwardly pitched as shown in FIG. **8** and have flanges **87** riveted or welded at **89** to the respective shell or sleeve.

Radial partitions **94** have outer margins **104** and inner margins **106**, respectively slidable in channels **108** provided by the fittings **110** attached to respective shells. The ends of these partitions line up with the gusset plates **118** which, in turn, are in the same plane as the partitions or flanges **82** in the interior of the inner shell **80**. They also line up with partitions **119** which subdivide the inner section **23** of the end **22** of the dehydrator. Bolts **120** connect the inner section **23** with the outer section **21** of the end member **22**. When these bolts are removed, the central cylinder **80** with the partitions **82** on the interior thereof and the partitions **94** on the exterior thereof may be axially removed unitarily from the rest of the dehydrator. However, the bolts **124** extending through gusset plates **128** in a radial direction are provided with nuts **131** in the apertures **130** of gusset plate **118** to prevent withdrawal.

Instead of attaching flights **98** to the partitions **94** as shown in FIG. **5**, it is possible to form these partitions as shown at **95** in FIG. **7** with bodily offset portions **980** which perform the function of flights **98**. In any case, the outer and inner margins **104** and **106** of the partitions are preferably slidable in channels **108** provided by the fittings **110** attached to the respective shells as best shown in FIG. **7**. (See, also, FIG. **5**)

Partitions **134** circumferentially spaced from each other and disposed radially between the intermediate sleeve **92** and the outer shell **126** provide segmental passages **132** into which flights project in the same manner as between the inner shell **80** and the intermediate sleeve **92**. Material which has traversed the intermediate passages **90** is guided by the curved end to enter the external passages **132**, these being traversed from left to right as viewed in FIG. **3**.

Aligned with the partitions **134** between passages **132** are the gusset plates **128** referred to above. These are aligned, in turn, with partitions **140** between the conical end wall **138** and the conical interior baffle **136** (FIG. **3**). This baffle guides the material and dehydrating gas to throat **139** which is loosely telescoped over the delivery pipe **44** above mentioned. Encircling this pipe is a sealing ring **112** identical with the sealing ring at the inlet. Ring **112** is seated against flange **135** on the end of pipe **44**. The ring **112** is held to the flange **135** by partial vacuum produced within the system by the suction of the blower **54**. The ring floats under guidance of the chains **149** which may be connected, for example, with the brackets **114** on throat **139**.

In practice, the solids pass downwardly through the cone **150** because of the fact that the discharge pipe **172** is normally closed against air admission, being equipped with a rotary valve **51**. As will be noted in FIG. **2**, the liner for the valve housing **51** is eccentric with the housing where it has a lip portion at the point where it connects to a throat or discharge pipe **172**. Elsewhere the valve vanes **182** are in close proximity to the liner but they have increased clearance from the liner at the lip where the material enters the housing so that such material will not be sheared by the vanes at this point. This is of particular importance when the material consists of grain such as corn. But for the described construction, the corn might be cracked by the vanes.

THE ROTARY VALVE

A power driven shaft **176** carries fixed vanes **178** which are not radial but rearwardly inclined and which extend only part way outwardly from the shaft. At corresponding points, each of these vanes is provided with a hinge **180** for a yieldable vane extension **182** which is normally biased into alignment with the vane **178** but is yieldable backward. The direction of rotation is indicated by arrow **184**. The spring **186** holds each of these vane extensions in its retracted position as shown but each is yieldable in a clockwise direction as viewed in FIG. **2**, against the bias of spring **186** if the blade is impacted by iron or other hard material which may reach this point in the apparatus, the object being to avoid damaging the valve. As shown in FIG. **2** one of the vane extensions is shown in dotted lines in a position to which it has yielded against the bias of its spring **186**.

In accordance with routine practice, the outer shell **126** carries peripheral riding rings **188** which are supported on rollers **190** to facilitate rotation of the drum **26**. The gussets **128** at the outlet end of the drum carry rings **192** which support the intermediate sleeve **92**, similar support being provided at the inlet end of the drum by rings **194** supported by gussets **196** from the outer shell **126**. The intermediate sleeve **92** is axially slidable telescopically into and from the ring **192**, being held in position during normal use by the bolts **124** already described. The mounting of the inner shell **80** which supports its weight from the riding rings **188** is similar, the gusset **118** between the inner shell and the intermediate sleeve providing support for the rings **188** as already described. The ring **200** into which the inlet end of the inner shell **80** is sleeved is carried by the head **22** which supports it directly from the riding ring **188** which is closest to the inlet of the dehydrating drum.

The parts are readily assembly by telescopically sleeving them together as already described. It is equally easy to disassemble them simply by removing the inner shell **80** from the internally projecting partitions **28** and disconnecting the bolts **124** so that the intermediate sleeve can be withdrawn through the previously disassembled section **23** of the head **22** at the inlet end of the drum.

In practice, the dehydrating gases include products of combustion and additional air. They are very hot when they issue from the furnace and traverse the throat **34** in which the material **28** to be dehydrated is introduced through the valve **32** with its surfaces thoroughly wet by the water directed upon them through the spray nozzle **36**. This water is immediately evaporated and turned into steam at temperatures above 212°, at which temperatures the moisture contained in the material **28** is also evaporated.

It is a basic feature of the present invention to subdivide the interior of the drum into longitudinally extending passages which are quite narrow circumferentially so that the material to be dehydrated is tumbled during drum rotation while confined quite closely in the path of the gases traversing the particular passage in which the material is being tumbled. It is to be noted that in the preferred structure shown each passage is continuous and distinct from all other passages about the curved heads from one cylinder to the next. This maintains a much more intimate contact between the dehydrating gases and the material upon which the gases are acting and the result is to achieve more quickly the very effective dehydration of such material. Various baffles which project from the tubular shells and sleeve and the generally radial longitudinal partitions serve to distribute the finely divided material throughout the cross section of the drum in the course of drum rotation.

The rate of evaporation is fast enough so that notwithstanding the initial high temperature of the gases, the material is kept cool by evaporation and never rises high enough to become oxidized. Accordingly, the dehydrated material discharged will have substantially natural color notwithstanding that it is sufficiently dry to keep indefinitely.

We claim:

1. A dehydrator comprising a rotatable drum having an inlet at one end and an outlet at the other, a suction fan for effecting flow of dehydrating gases and material through the drum, a cyclone separator connected in series between the drum and the fan for segregating dehydrated material from the gases which have acted thereon, said separator including a tapered separating chamber and a discharge port for solids opening from the smaller end thereof, a normally closed rotary discharge valve controlling flow through said discharge port, said valve comprising a rotatably mounted shaft and outwardly projecting vanes mounted thereon, each such vane having a vane extension in hinged connection therewith, means for biasing said extension to project outwardly from the vane to which it is hinged, and a valve chamber substantially closed by the several extensions when they are in the normal position to which they are biased, each such extension being yieldable upon its hinged connection to pass objects foreign to the material being dehydrated.