United States Patent [19]

Neville

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[45] **May 20, 1975**

[54] **GAS HEATED ROTARY DRIER**

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[73] Assignee: **AMF Incorporated**, White Plains, N.Y.

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[21] Appl. No.: **488,617**

Related U.S. Application Data

[62] Division of Ser. No. 379,743, July 16, 1973.

[52] **U.S. Cl.** **34/48;** 34/133; 34/134; 432/107; 432/113

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

[58] **Field of Search** 34/133, 134, 139, 136, 34/137, 48; 432/107, 112, 113; 165/89; 259/89, 90

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[57] **ABSTRACT**

A gas drier for tobacco and the like having a rotatable drum with internally disposed axially extending V-shaped vanes each open to the gas burners disposed along the bottom of the drier.

6 Claims, 7 Drawing Figures

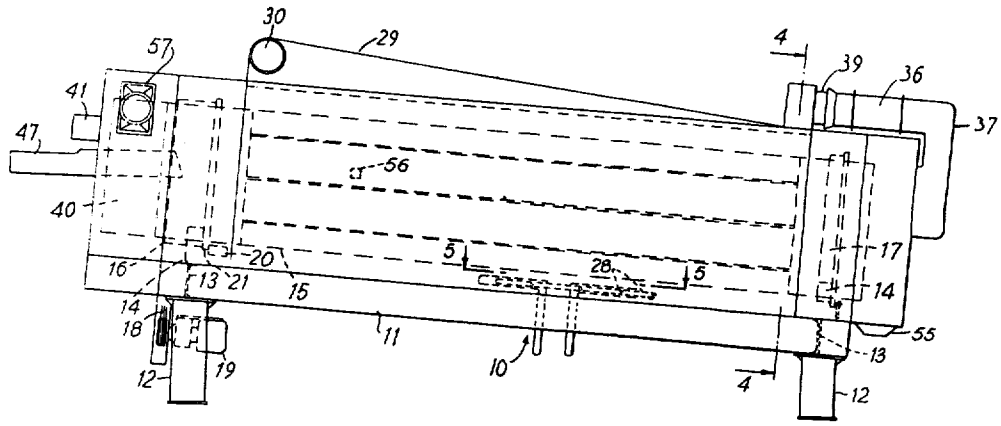
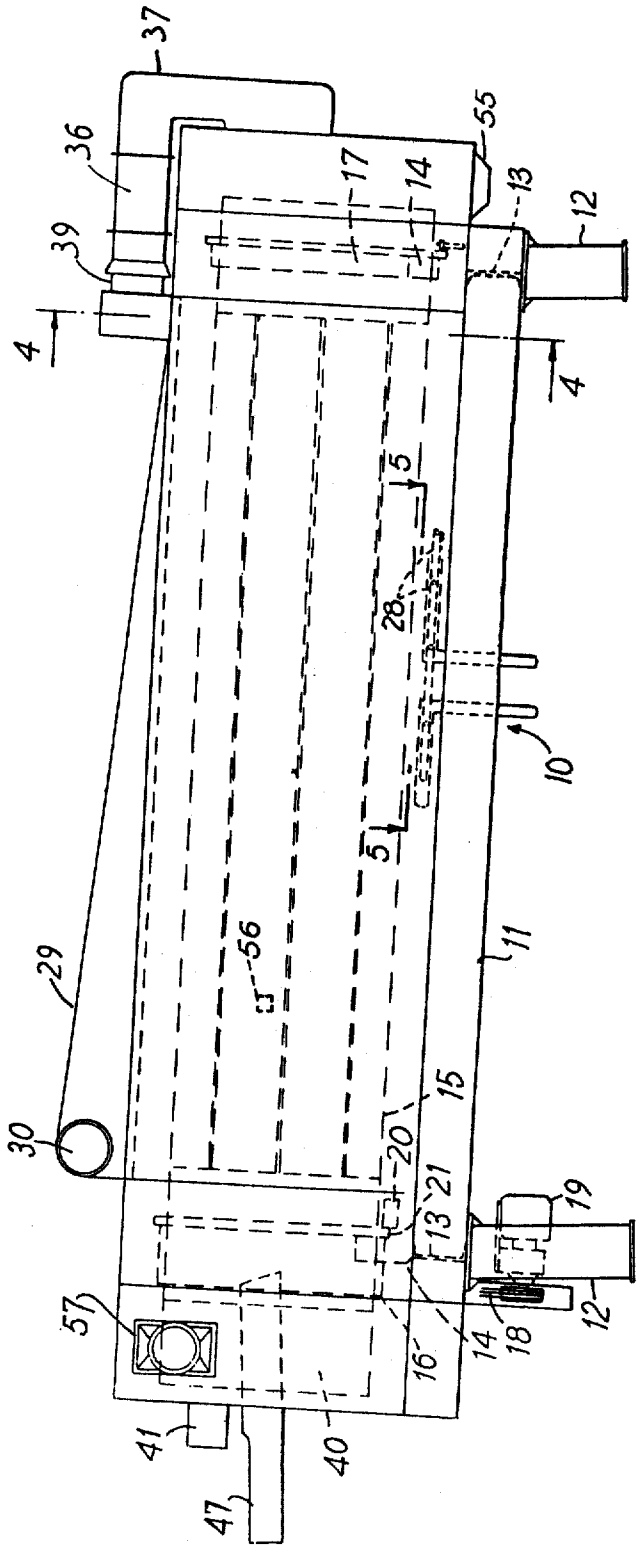


FIG. 1.


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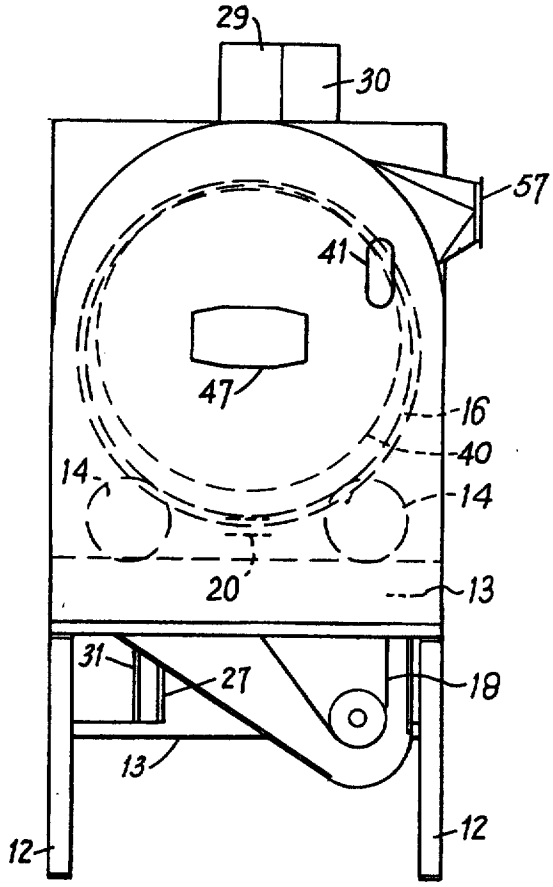

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FIG. 2.

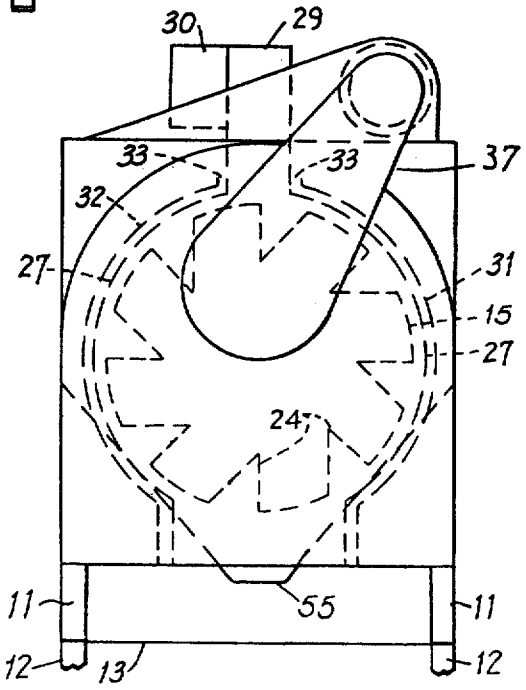

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FIG. 3.

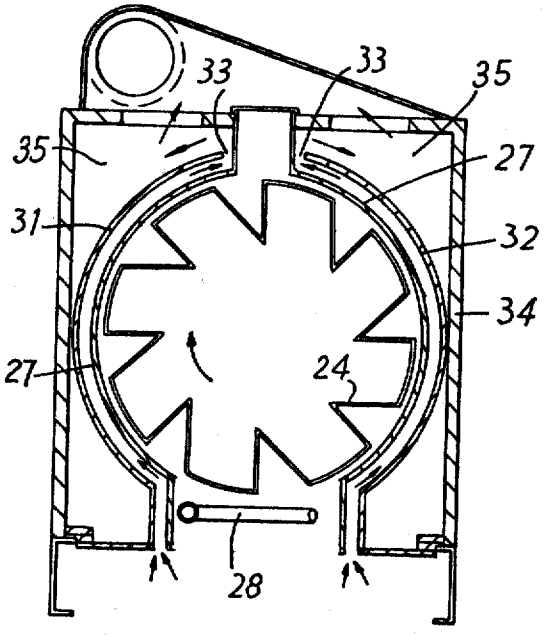


FIG. 4.

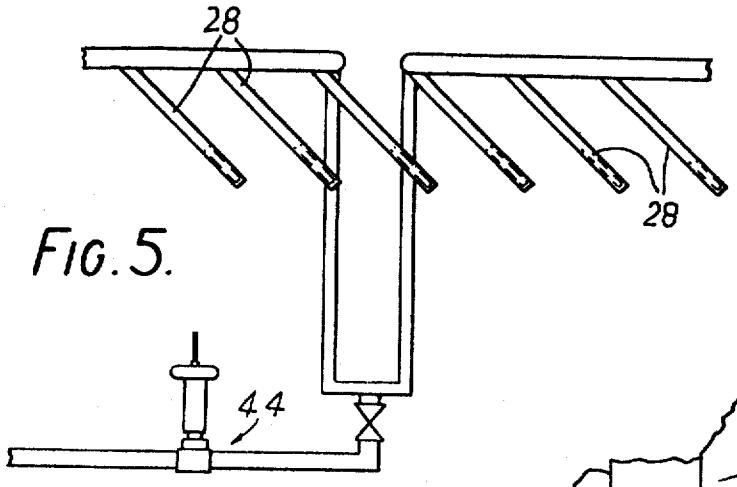


FIG. 5.

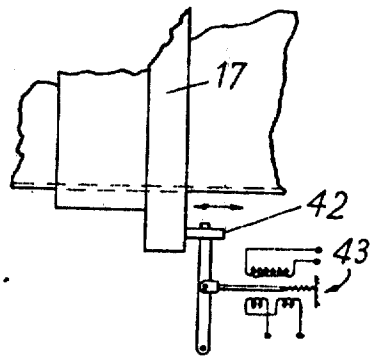
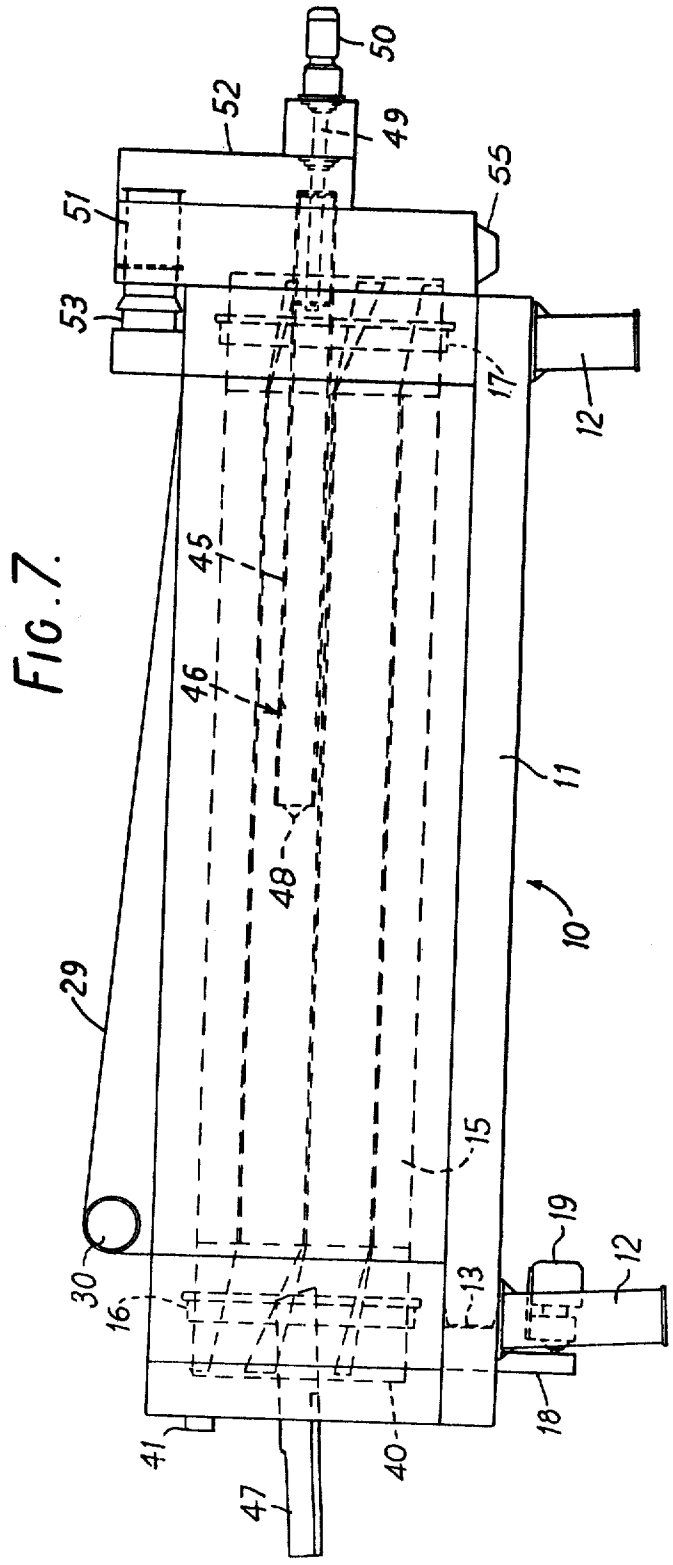


FIG. 6.

FIG. 7.



GAS HEATED ROTARY DRIER

This is a division of application Ser. No. 379,743, filed July 16, 1973.

This invention relates to driers for particulate or loose material such as rag or stem tobacco.

With the general availability of natural or propane gas, the gas drier is a relatively inexpensive and attractive alternative to the steam drier for rag or stem drying. With a low thermal capacity and rapid response it is particularly suitable for automatic moisture control.

A known drier traditionally used for stem drying comprises a rotatably mounted cylinder having radially inwardly extending paddles. The cylinder is heated by strip type burners arranged below and parallel to the cylinder axis to throw flame at the cylinder along its entire length at the same moment. Its short paddles and high cylinder temperature suit the low flow/high moisture removal stem application. The heat conduction along the paddles is negligible and size is based on the cylinder heating surface only.

For rag drying, larger paddles are required to match the larger volume flow. To keep the size and dwell time of the drier comparable to that of a steam drier for the same working temperatures (or smaller for higher working temperatures) the paddles must supply heat to the tobacco.

Conducting paddles are not practicable. Using the best practical conductor, copper, a 1 inch base triangular section only barely conducts sufficient heat; combined with an ½ inch cylinder thickness the thermal capacity of the whole would be totally unacceptable. The conduction of steel is about 8 times worse and stainless 24 times worse.

According to the invention there is provided a rotary drier for particulate or loose material comprising a cylinder arranged to rotate about its axis disposed horizontally or inclined to the horizontal and having formed along its cylindrical surface a plurality of hollow paddles extending axially along said cylinder and inwardly thereof. The interior of said paddles communicate with the exterior of the cylinder and at least one gas burner arranged below the cylinder to direct flame into the interior of the hollow paddles.

In the present drier the paddles are heated directly by gas flame, giving the maximum heat transfer and ensuring a high thermal efficiency. The paddles are preferably of a V-shape or hollow triangular sections each with an open base exposed to the combustion space. If strip burners parallel to the cylinder axis are used there would be no room for the cooled gases in the paddle to escape, whwich would consequently prevent the flame entering the hollow paddle. The present construction avoids this problem by, in effect, dividing the normal strip type burner into short lengths which are inclined to the cylinder axis. Accordingly, at any one moment the flame only enters the paddle at the intersections of the open paddle base and the inclined burners. This arrangement allows the flame to enter the hollow paddle by leaving space either side of the scouring out of cooled gases, and insures uniform heating of the cylinder throughout its length.

Further features of the present invention are cylinder temperature control by cylinder expansion measurement, or differential or zonal cylinder temperature control by thermistor, and combined casing cooler and air pre-heater.

The foregoing and other objects and advantages will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein several embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration purposes only and are not to be construed as defining the limits of the invention.

FIG. **1** is a side view of the rotary drier,

FIG. **2** is a view of the drier at the feed end thereof,

FIG. **3** is a view on the delivery end of the drier

FIG. **4** is a section taken along the line **4—4** in FIG. **1**,

FIG. **5** is a plan view of the burners taken in the direction of the arrows **5—5** in FIG. **1**.

FIG. **6** is a scrap view of an expansion follower for temperature measurement, and

FIG. **7** is a side view of a rotary drier which includes an air inlet probe for suppressing exhaust air ventilation.

Referring now to the drawings, a drier in accordance with the invention is provided with a chasis **10** comprising longitudinal side channels **11** supported on legs **12** and having cross channels **13**. On the cross channels **13** are mounted pairs of support rollers **14**, preferably of a reinforced phenolic resin which carry a cylinder **15** by way of track rings **16** and **17** attached by spacers. The cylinder **15** is driven by belts **18** passing around a belt ring, formed as part of the track ring **16**, and driven by a geared motor **19** or the like. The cylinder has its axis of rotation disposed at an angle of 1¾° or 3½° according to the desired flow rate and drying capacity. Generally, the inclination is preferably between 1° and 5°. A thrust roller **20** is mounted on the cross channel **13** at the feed end for engagement with a rim **21** provided on the cylinder **15**. A feed conveyor **47** which may be of the vibratory type is provided at one end of the driver with a discharge chute **55** being provided at the other end.

As is seen from FIG. **4**, the cylinder **15** is formed with a series of inwardly projecting paddles **24** which are generally V-shaped or of an open base triangular cross section all extending axially of the cylinder. One side of each paddle **24** is positioned radially and the other obliquely relative to the rotation axis of the cylinder **15**. This is to insure that the radial sides of paddles **24** which when the cylinder **15** rotates clockwise or in the direction shown by the arrow will carry the tobacco up to the top of the cylinder and the enlarged opening will provide maximum exposure to the combustion space to a greater extent than the oblique side.

Burner Equipment

Normally forced draught ribbon type gas burners are fitted, with pilot burners, flame failure control and pneumatically operated modulating valve giving a 20:1 turn down range. The burner assembly (see FIG. **5**) is pivotably mounted on an axis adjacent and parallel to a chassis side member so that it can be swung down for access to the burners. Heating by diagonal strip burners has the following advantages compared with other known methods, viz.

1. It is simple and avoids the use of a fan found in other driers which has to handle very hot gasses,
2. The cylinder and especially its open paddles can be uniformly heated from end to end, or

3. The cylinder and especially its open paddles can be heated differentially to reduce the overdried tobacco at start-up and shut-down and to give quick response control during normal running.
4. Direct flame exposure of the open paddles gives a more efficient heat transfer from gas to cylinder.

The hot combustion gases are kept in close proximity to the cylinder by a cylindrical combustion space casing **27**, (see FIG. **4**) which is concentric with the cylinder **15** and surrounds it at a few inches distance. The bottom of the casing **27** is open for the burners **28** and the top includes a tapered flue gas collection manifold **29** which connects to a flue duct **30.**

A few inches outside the combustion space casing **27** are two further concentric curved sheets **31** and **32**, one on each side of the cylinder **15**, forming a narrow curved air passage way. The passage way finishes either side of corner space **35** formed by the outer insulation boards **34.**

Both corner spaces **35** are connected to a fan **36** (see FIG. **1**) which enables air to be drawn up through the curved passage way, heated and delivered to the cylinder via a ducting **37.** This method of pre-heating the cylinder drying air has the double purpose of improving the overall thermal efficiency of the drier and considerably reducing the heat conducted to the outer insulation. As a result the outside surface of the insulation is below 100°F. and typically only 20°F. above ambient. The outer casing is of conventional asbestos board construction.

Alternatively, where pre-heating of the drying air is not required, the corner spaces are connected to the combustion gas flue **29** and a flow of casing cooling air induced by convection.

EXHAUST AIR

For high duty application the drying air is contra flow and the cylinder is provided with a cylindrical feed end sieve **40** as an extension of the cylinder **15**, and a sieve cleaner **41.** Contra flow is essential for applications with high input moisture content where the exhaust air is saturated. Additional air is fed via fan inlet **57** to the feed hood from a preheater in such applications to prevent condensation.

For lesser duties a lower volume air flow is used without a sieve.

Proposed Range of sizes			
Cylinder diameter in feed	3	4	6
Number of paddles	4	8	16
cylinder rotational speed in r.p.m.	21	18	15
Maximum rag flow rate at:			
3½° cylinder inclination in lb/hr	5,000	10,000	20,000
1¾° cylinder inclination in lb/hr	2,500	5,000	10,000
Heated cylinder lengths in feed:	8		
	12	12	
	16	16	16
		20	20
			24

The volume of the hollow paddle is sufficient to contain a high proportion of the hot products of combustion which continue to conduct to the paddles **24** while they are rotated to the top of the cylinder **15.** The flame jets also can be inclined to the vertical so that they are directed toward the working radial surfaces of the paddles **24.**

This direct heating of the paddles **24** permits a thin cylinder and paddle wall to be used, giving a lower thermal capacity than the corresponding size of steam drier. Typical heating and cooling rates for a ⅛ inch thick cylinder being 50°F/min under normal working conditions. At 15 r.p.m. this is a fluctuation of only 3⅓°F per revolution.

CYLINDER TEMPERATURE CONTROL

The traditional gas control from the cylinder exhaust air temperature is not satisfactory for use with automatic moisture control system or for good manual control. The exhaust air temperature is only a poor reflection of the cylinder temperature as it is effected by exhaust air flow, tobacco temperature and moisture removal and it furthermore lags behind the cylinder temperature.

For manula control and the simpler automatic control systems, the gas drier of the present invention is fitted with average cylinder temperature control by measurement of cylinder expansion using followers **42** (see FIG. **6**) on one but preferably on both runner track rings **16** (not shown) and **17.** The position of a follower **42** is converted by a transducer **43** into an electric signal and the difference between the signals from the transducers **43**, after smoothing, gives a measure of cylinder expansion and hence cylinder temperature.

The resulting signal is fed to a temperature indicating process controller (not shown) which controls a modulating valve **44** in the gas supply to maintain a set temperature. With automatic moisture control the set point of the temperature is adjusted automatically by cascade control.

THE CYLINDER TEMPERATURE IS SET MANUALLY

The virtually instantaneous reaction to cylinder temperature results in a very tight control of cylinder temperature. The burners are sized to give double the normal working heat. This, combined with the low thermal capacity of the cylinder, enables the cylinder temperature to be increased or reduced rapidly and accurately within the normal working range of 150° to 400°F.

An over-riding safety control is fitted based on the conventional exhaust air temperature measurement.

ZONAL CYLINDER TEMPERATURE CONTROL

For applications with fully automatic feed forward and feed back control from moisture meters with automatic start-up and shut down the burner **28** is divided into two or more sections (see FIG. **5**) depending on the length of the drier. Each section has an independent gas control valve (not shown).

The temperature of each zone of the drier corresponding to each burner section is measured by a number of thermistors **56** (of which only one is shown in FIG. **1**) fixed to the cylinder surface and connected in parallel to give an average temperature for each zone. This replaces the overall cylinder expansion measurement used for manual and simpler automatic control systems.

One side of each thermistor is connected to the cylinder and connection is made to the rotating cylinder by a sprung metal roller on the track ring.

The other connection from the thermistors in each zone is brought to a slip ring mounted on an insulated extension of the track ring. Thermistors are used for the temperature measurement as their very high resistance change with temperature makes them insensitive to variation in slip ring resistance. Instead of arranging slip rings on the outside of the cylinder the connections may extend to one end of the cylinder where longitudinally extending arms are provided with a connected arm diametrically positioned, at the centre of which arm is mounted a slip ring of considerably less diameter than that of the cylinder. Since a small diameter slip ring can be used in such a construction a proprietory slip ring and brush enclosed in a dustproof housing can be used.

A separate temperature controller for each zone enables the temperature of each zone to be controlled independently of its neighbor. This zonal or differential temperature control is used at start up and shut down and also during normal running.

At start up as the tobacco runs in from the infeed **47** to the discharge **55**, the down stream zones are heated up successively after the upstream zones using a programmed start. Similarly at shut down as the tobacco runs out the upstream zones are turned off successively before the down stream zones. This avoids over-dried tobacco during run-in and run-out.

During normal working the feed end zone only is used to control short term variations in output moisture control and the delivery end zone is correct short term output variations in moisture content. This is achieved by a system of duel control which ensures that short term fluctuations are corrected by the appropriate end zone and long term variations are corrected by the general temperature level of all zones.

This arrangement of zonal cylinder temperature control enables quick response corrections to be made which are not possible with a cylinder of a uniform temperature throughout its length. The paddles are divided between zones to allow for any differential expansion.

To improve the ability of the tobacco to fill cigarettes using a minimum amount of tobacco, it is often required to 'stew' the tobacco in the drier, i.e., suppress the exhaust air ventilation and raise the tobacco to around 170°F. The heat for drying is supplied by the drier and though the majority of the moisture removal still takes place in the drier, a greater proportion is removed in the cooler by evaporative cooling.

A weakness of this method of operation is the uneven moisture loss that can occur at this high temperature both between the drier and cooler and in the cooler. To overcome this there is provided a preheated air inlet probe **45** as shown in FIGURE 7.

This probe **45** is introduced at the delivery-end of the drier and discharges air via an air diffuser **46** about one-third of the heat length from the delivery end. The feed-end of the cylinder is carefully sealed and the tunnel of the vibrating feed conveyor **47** is sealed by a succession of curtain seals (not shown). A small controlled amount of air (approximately 250 c.f.m. in a 4 ft. diameter drier) is exhausted from the feed hood. Adjustment of this air flow determines the temperature achieved by the tobacco in the first two-thirds of the cylinder heated length. The tobacco temperature at this point is sensed by a thermistor **48** attached to the end of the probe and so arranged that it is always covered with a fresh fall of tobacco.

The majority of the air (approximately 1,250 c.f.m. in a 4 ft. diameter drier) is exhausted from the delivery end hood so that the ventilation which takes place in the last one-third of the cylinder heated length cools the tobacco to normal drier outlet temperature of around 100°/120°F.

The air inlet probe **45** is cantilevered from the delivery end and arranged to rotate to keep it clear of falling tobacco. The probe is rotated through a shaft **49** driven by a motor **50.** The hot air from the curved air space and the slots **33** is fed to the probe by a fan **51** and ducting **52.** Ambient air enters through an adjustable entry **53.** The thermistor connections are brought out via a small slip ring (not shown). The air diffuser has sufficient pressure drop across it to prevent tobacco settling on it.

The drying capacity of the first two-thirds of the drier length is reduced due to the suppressed ventilation. In a 4 inch dia. ×16 inch heated length cylinder of the kind (shown in FIG. 7) up to 5% moisture from 5,000 lbs/hr. of rag can be removed. This removal figure includes the removal in the cooler, the heat for which is supplied in the drier.

Although several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

I claim:

1. A rotary drier for particulate or loose material comprising a cylinder arranged to rotate about its axis inclinded to the horizontal, said cylinder having formed along its cylindrical surface a plurality of hollow paddles extending axially along said cylinder and inwardly thereof, the interior of said paddles communicating with the exterior of the cylinder, at least one gas burner arranged below the cylinder to direct flame into the interior of the hollow paddles, said cylinder being surrounded along its length by a cylindrical wall defining a combustion space between said cylinder adn said wall communicating with the interior of said paddles and the bottom therof being open to said burner, the top of the combustion space including a tapered flue gas collection manifold which communicates with a flue duct for removing waste combustion gases, means for introducing air into said cylinder, said means comprising a passageway for conducting ambient air around said cylinder to preheat the air and for separating the ambient air from combustion gases, a fan for drawing air theough said passageway and ducting for the preheated air to the interior of said cylinder, an inlet probe for introducing preheated air into said cylinder at a position intermediate its ends, and means for measuring and controlling the temperature of tobacco within said cylinder.

2. A rotary drier as claimed in claim **1** in which said temperature measurement and control means includes means for controlling the flow of gas to said burner.

3. A rotary drier as claimed in claim **1** in which said temperature measurement and control means, further includes means for controlling the flow of gas to said burner in accordance with sensed cylinder temperature.

4. A rotary drier as claimed in claim **3** in which said temperature measurement and control means includes

means for measuring cylinder expansion and a transducer means for converting such measurements into signals indicative of cylinder temperature.

5. A rotary drier as claimed in claim 3 in which said temperature measurement and control means includes at least one thermistor connected to the cylinder.

6. A rotary drier as claimed in claim 1 having at least one additional burner, and said measuring and control means including a plurality of sensing means each controlling the flow of gas to a different one of said burners in accordance with the temperature sensed by said sensing means.

* * * * *