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Driscoll et al.

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[54] **DRYING APPARATUS WITH FEED AND HUMIDITY CONTROL**

[75] Inventors: **Gerald Jon Driscoll,** Crozet; **James Larkin Wellborn,** Waynesboro, both of Va.

[73] Assignee: **E.I. du Pont de Nemours and Company,** Wilmington, Del.

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[58] **Field of Search** 34/56, 52, 54, 50, 34/44, 45, 51

[56] **References Cited**

UNITED STATES PATENTS

3,186,102	6/1965	Brociner et al.	34/56 X
3,259,995	7/1966	Powischill	34/54 X
3,396,476	7/1968	Eves	34/52 X
3,599,343	8/1971	Nielson	34/52
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FOREIGN PATENTS OR APPLICATIONS

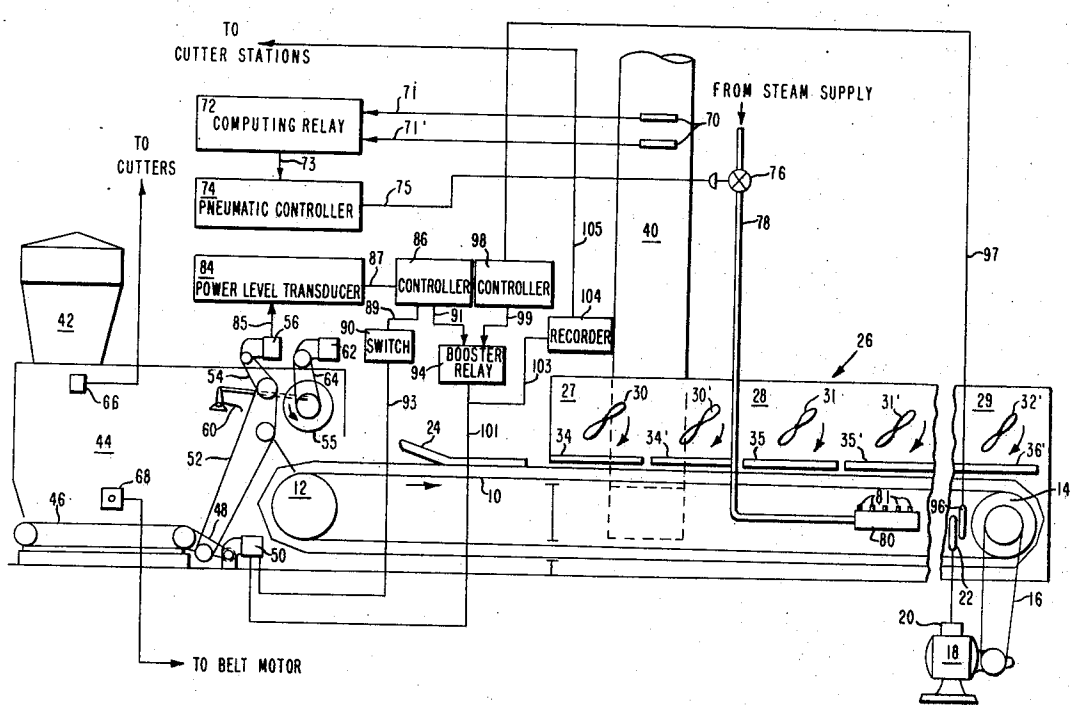
480,355	1/1952	Canada	34/44

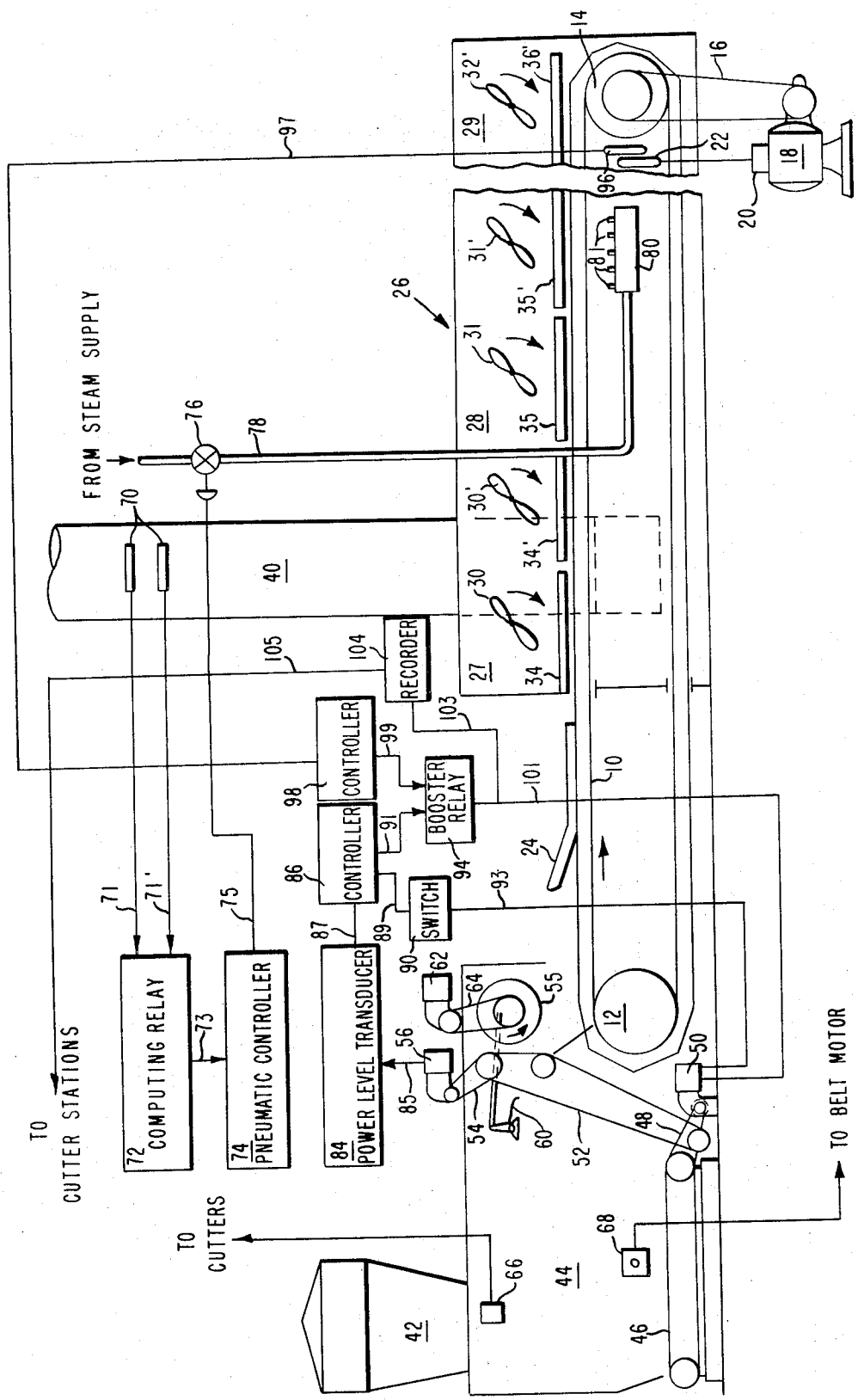
Primary Examiner—William F. O'Dea
Assistant Examiner—Paul Devinsky
Attorney—Howard P. West, Jr.

[57] **ABSTRACT**

An improved dryer for bulk material of the type employing a feed apron, a pin elevator and an endless, foraminous belt moved through a series of air drying zones, the improvement comprising (A) a humidity transducer in the air exhaust stack arranged to regulate flow of steam to a sparger under the belt in a zone and (B) a power level transducer attached to the pin elevator drive motor, a temperature transducer located under the belt in the final zone, each transducer connected through a separate controller to a booster relay arranged to select the lower of the two control signals and apply this to regulate feed apron drive motor speed.

2 Claims, 1 Drawing Figure




FROM STEAM SUPPLY
TO CUTTER STATIONS
TO CUTTERS
TO BELT MOTOR
COMPUTING RELAY
PNEUMATIC CONTROLLER
POWER LEVEL TRANSDUCER
CONTROLLER
CONTROLLER
BOOSTER RELAY
SWITCH
RECORDER

DRYING APPARATUS WITH FEED AND HUMIDITY CONTROL

BACKGROUND OF THE INVENTION

This invention concerns apparatus for improved drying of loose bulky material such as textile staple fibers in bulk. More specifically, it relates to auxiliary control apparatus appended to a continuous dryer which employs an enclosed endless foraminous belt and circulating air.

Uniform rate of drying and final level of moisture content are important to product quality. Color, dyeability and openness of synthetic fiber staple products are often adversely affected by variable or poorly regulated drying conditions.

A significant improvement in controlling dryers of this type has been realized by the apparatus of Powischill in U.S. Pat. No. 3,259,995. However, further improvement was required for certain drying systems such as, for example, a system where the dryer is supplied from a hopper that has an intermittent input. A case in point is a dryer of the type for textile staple wherein the feed hopper is supplied from tow cutters, one or more of which must be interrupted for splices, knife change, etc. In these cases, the hopper fill level may vary sharply and the rate of feeding of staple to the dryer as well as dryer conditions require special regulation.

SUMMARY OF THE INVENTION

This invention provides apparatus attached to an enclosed endless belt dryer chamber that is supplied with bulk material in a hopper by a feed apron in the bottom of the hopper and a pin elevator extending from the apron to deposit material on the belt. Both the apron and the pin elevator are independently driven by variable speed motors. Improved regulation of the extent of drying is provided by the novel auxiliary control apparatuses of this invention. These comprise in combination wet and dry bulb temperature transducers in the exhaust duct. These transducers are connected to a computing relay. The resulting difference signal is fed to a controller arranged to regulate the flow of steam to a steam sparger located under the belt at a position along the belt which is near the latter stages of drying. The belt enclosure is separated into three zones along its length by transverse partitions. Circulating fans bring air in from the room outside the enclosure and pass it over control conditioning elements, then through the belt from above to below and finally exhaust through a duct.

In addition to sparger control effects, further improvement is provided by a temperature transducer located under the belt in the last zone of drying. This transducer is connected to a first of two companion controllers. A power level transducer is attached to the motor of the pin elevator and the output signal of this transducer is connected to the second controller. The outputs of these controllers are connected to a booster relay which selects the lower signal. The output of this relay is connected to the speed controller of feed apron motor of the supply hopper. Thus, the speed of the feed apron is regulated in response to either pin elevator power drop below set point or below belt temperature dropping too low.

These improvements may be used in conjunction with or as a replacement for one or more of the known

arrangements, e.g., those of Powischill. These known methods include: (A) control of the dryer belt speed; (B) control of fan motors; (C) control of an exhaust damper; (D) adjustment of a unit to humidify incoming air; and (E) regulation of steam supply to heaters employed in conditioning the air used for drying, all in response to the below belt temperature measurement.

BRIEF DESCRIPTION OF THE DRAWING

The Drawing is a schematic plan view of an endless belt enclosed dryer and a circuit diagram showing the novel control features of this invention attached thereto.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An understanding of the apparatus of this invention can best be achieved by reference to the attached drawing. The preferred apparatus is described in connection with the drying of synthetic textile staple fibers in bulk which are received from textile tow cutters, not shown, and which after drying are transported to staple balers also not shown. The novelty of the invention lies in the control apparatus appended to a substantially conventional dryer.

The dryer as shown in the drawing comprises an endless foraminous belt **10** extending around drive sprockets **12, 14.** Sprocket **14** is driven through chain **16** by gear motor assembly **18.** Optionally, motor **18** has a speed control component **20** which is responsive to a thermocouple **22** located underneath the belt **10** near the exit end of the belt. The upper horizontal leg of belt **10** extends from the input end underneath a shoe **24** which is designed to push the material being dried down onto the belt. In some cases, this shoe is provided with a steam supply and perforations for applying steam to the incoming bulk material. The belt extends into a drying enclosure **26** which is divided into three drying zones **27, 28, 29.** Each zone is substantially the same size and has a configuration essentially the same as that shown by Powischill in U.S. Pat. No. 3,259,995. Each drying zone contains two air circulating fans **30, 30' . . . 32'** and two heat exchangers **34, 34' . . . 36'.** Air that has been brought in from outside is circulated through the heat exchangers, through the fibers and the belt in each zone and then is exhausted from zone **27** through exhaust stack **40.**

Incoming material which is to be dried is transported by a pneumatic system and deposited in cyclone separator **42** from which it drops into feed hopper **44.** The bottom of hopper **44** comprises a feed apron **46** which is driven through chain **48** by variable speed motor **50,** such as a Reeves drive with Airtrol unit attached. At the exit end of apron **46,** there is provided a pin elevator arrangement **52** which is driven through chain **54** by variable speed motor **56.** A withdrawing roll **58** and a scrapping bar **60** are arranged as shown and driven through chain **64** by variable speed motor **62.** Two photoelectric staple level detectors **66, 68** are located in the sides of hopper **44** at locations as shown. The upper detector **66** is arranged to send a signal to the staple cutters when the level of staple to be dried becomes excessive within hopper **44.** Detector **68,** on the other hand, sends signals to stop the belt motor **18** when the level passes below a critical limit and restarts motor **18** when the level rises again above detector **68.** Time delay circuits are provided in connection with the out-

puts of these detectors to avoid reaction to very transient over or under supply.

The novel control features of this invention comprise first a wet and dry bulb temperature transducer **70** located within the stack **40.** Transducer **70** has attached thereto a conventional fluid-to-air transducer so that pneumatic signals are transmitted over lines **71, 71'** to a computing relay **72.**

The dry and wet bulb temperature signals are algebraically combined in the computing relay **72** to provide an output signal to controller **74** proportional to the difference between the dry bulb and wet bulb temperatures and consequently related to the relative humidity of the air in stack **40.** Thus, pneumatic controller **74** (typically a Moore Syncro Station) provides signals for adjusting valve **76** to control the flow of steam through pipe **78** to sparger **80** and out through nozzles **81.** In this way, the quantity of steam forced upward through fan **31'** and down through the sample being dried is based on the relative humidity of the air exhausting from the dryer. This forms the first part of the added control system.

The second part of the novel control system comprises a duel input selective control in which a power level transducer **84** (Halltiplyer WT 31K5) is connected through cable **85** to pin elevator motor **56.** The signal from transducer **84** is passed to a first controller **86** over cable **87** through a conventional voltage-to-air pressure transducer not shown. The output of pneumatic controller **86,** which in the preferred embodiment is Moore Syncro Station, is passed first over line **89,** to a Mercoid switch **90** and then to the start-stop mechanism of motor **50** over line **93.** A second output from controller **86** is transmitted over line **91** to a first input terminal of a booster relay **94** (Moore Products Co., Model 61). A temperature transducer **96** is located under the dryer belt **10** near the exit end of the drying stages and arranged to provide a signal over line **97** to another (Moore Syncro Station) controller **98.** Output from controller **98** is transmitted over line **99** to a second input terminal of booster relay **94.** The output signal from relay **94** is connected over lines **101** and **103,** respectively, to the speed control unit (Airtrol unit) of feed apron drive motor **50.** This signal also goes to recorder **104** (Rustrack Recorder) and thence to a system of readout devices located at the low cutter stations. Relay **94** is designed to select the lower of the two input control signals and transmit its output control signal based on this selection.

This invention provides two important means for the regulation of the moisture content in materials being dried on an endless belt. The relative humidity of the air exhausted through stack **40** is employed to regulate the opening of the valve which controls the amount of steam blown down through the material being dried, thus evening out humidity in the drying air and therefore, reducing potential wet spots in the material. In addition, one signal based on the amount of power being drawn by the pin elevator motor, which is related to the drying load level being imposed on the dryer, is used to provide one possible signal for regulating the rate of supply of material by adjusting the speed of the feed apron **46.** An alternate signal is provided by a readout of the temperature of the air underneath the dryer belt near the dry end of the drying zones. These two signals are employed by respective controllers **86, 98** to provide two signals to a booster relay which selects the lower of the two signals (power level or underbed temperature) to provide the regulating signal for the speed of apron motor **50.**

The utility of this invention lies in the attainment of more uniform product which is desirable. In actual tests, a comparison was made between operation of a dryer under control by the instant invention and runs wherein the dryer was controlled by manual adjustments of the pin elevator and the feed apron speeds. A check of the final product for wet spots in the production caused approximately 20 stops per day for the manual operation of the dryer. However, when the control system of this invention was put into operation on the same dryer, the number of moisture stops per day was reduced to a very low level of only two and this had the corollary effect of increasing possible dryer throughput by about 4 percent. Furthermore, it was found that manual control was able to maintain a dryer rate variation at no better than ± 20 lb. per min. whereas the new system controlled the rate of variation in dryer throughput to a level of ± 10 lb. per min. This obviously provides improved fiber heat treatment uniformity and consequent improvement in dyeability uniformity and uniformity in color of the production.

Although this invention has been described in terms of the present preferred embodiment wherein synthetic textile staple is dried, the novel structure and function of this invention is applicable to the drying of other bulk materials which may be fed by means of a feed apron and pin elevator onto an endless foraminous belt and dried with circulating air. In addition, the invention is described in terms of pneumatic controller devices. Obviously electronic controllers could be substituted and other variations would be apparent to those skilled in the art without departing from the spirit of the present invention.

What is claimed is:

1. In an apparatus for continuously drying material including an endless belt dryer chamber supplied with material by a pin elevator driven by a motor and a feed apron driven by a variable speed motor the improvement comprising: a power level transducer connected to the pin elevator motor for detecting the power consumed by the pin elevator motor and for generating first signals proportional to the power consumed by the pin elevator motor; a temperature transducer located in said dryer chamber for detecting the temperature therein and for generating second signals proportional to the temperature detected; means for comparing said first and second signals and for selecting the lower of said signals; and a controller connected to said feed apron motor for regulating the speed of said feed apron motor, said controller being actuated by the lower of said first and second signals.

2. The apparatus as defined in claim **1,** said dryer chamber having an exhaust duct connected thereto and a steam sparger located therein for admitting steam into said chamber and further including means for detecting relative humidity in said exhaust stack and generating third signals proportional thereto; a controller connected to said steam sparger for regulating the steam flow therethrough, said controller being actuated by said third signals.

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