Jan. 13, 1959 A. J. FAUCHER 2,867,913

APPARATUS FOR DRYING AND HUMIDIFYING MATERIALS

Filed May 24, 1956 2 Sheets-Sheet 1

Fig. 1

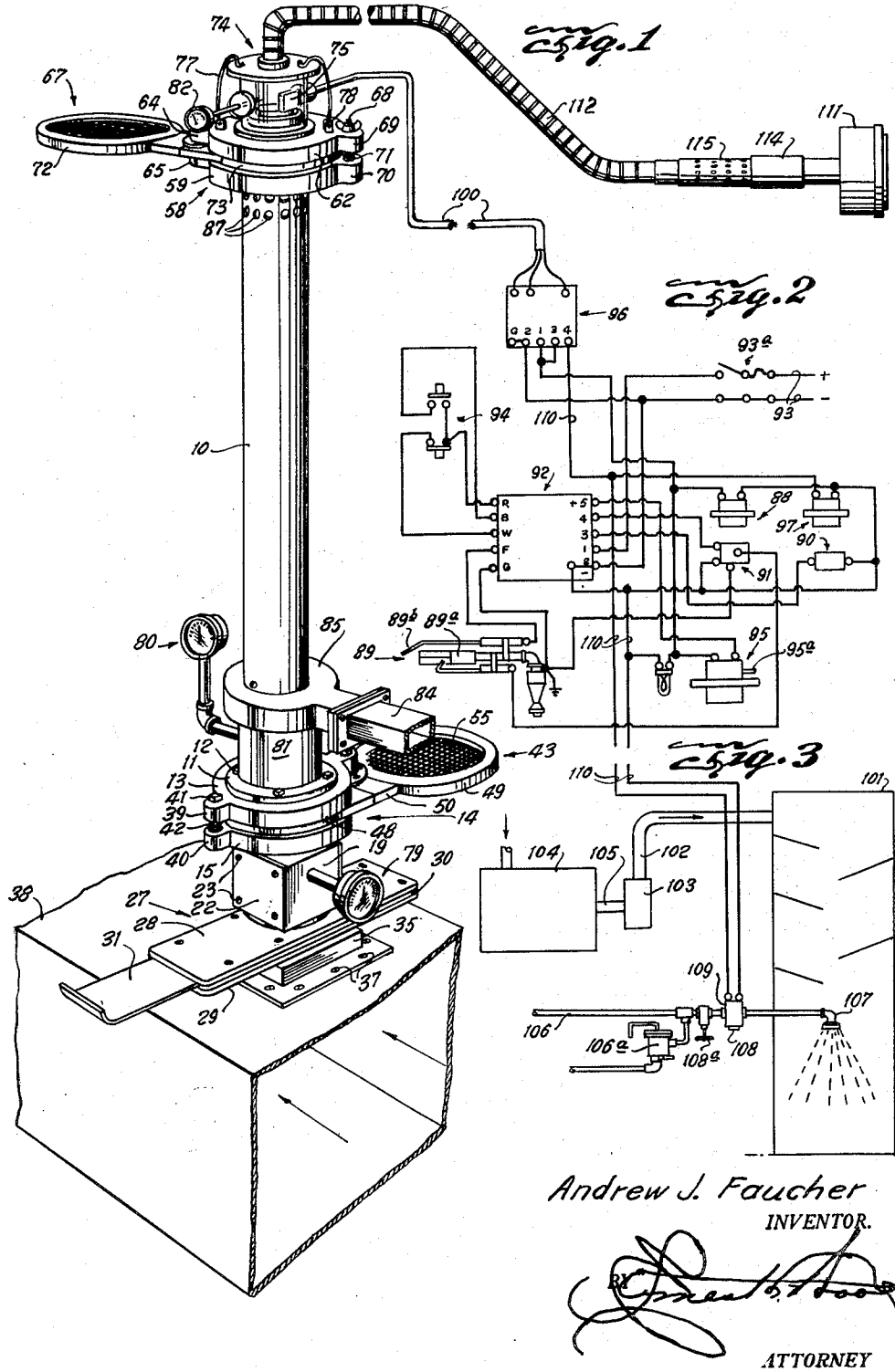


Fig. 2

Fig. 3

Andrew J. Faucher
INVENTOR.

BY

ATTORNEY

Jan. 13, 1959 A. J. FAUCHER 2,867,913

APPARATUS FOR DRYING AND HUMIDIFYING MATERIALS

Filed May 24, 1956 2 Sheets-Sheet 2

Fig. 4

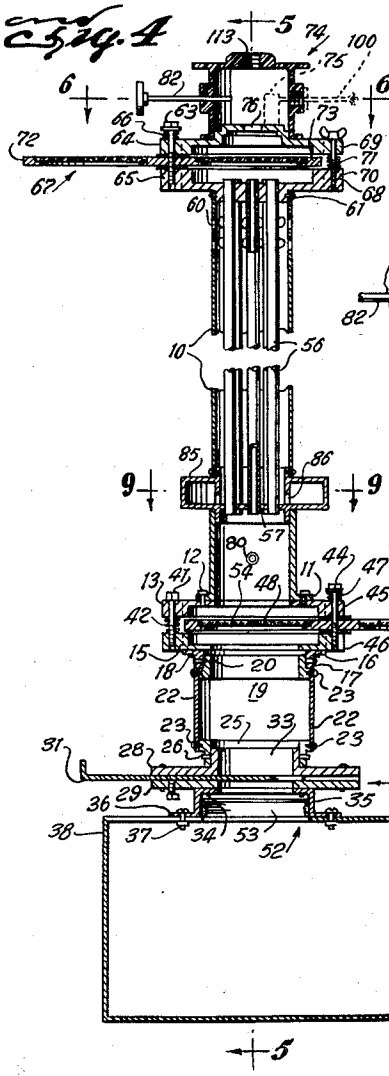


Fig. 6

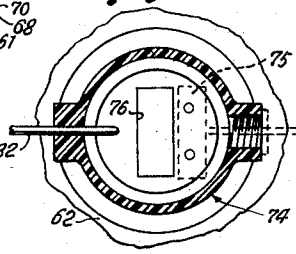


Fig. 5

Fig. 7

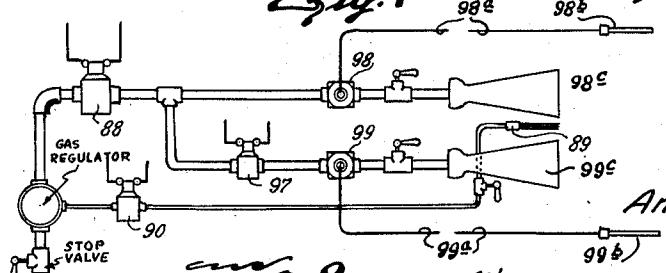


Fig. 9

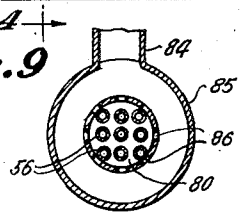
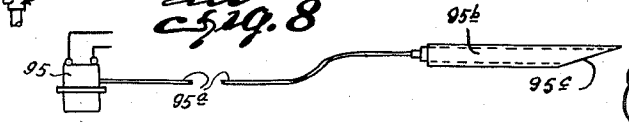


Fig. 8



Andrew J. Faucher
INVENTOR.

BY

ATTORNEY

United States Patent Office

2,867,913

Patented Jan. 13, 1959

2,867,913

APPARATUS FOR DRYING AND HUMIDIFYING MATERIALS

Andrew J. Faucher, Arlington, Tex.

Application May 24, 1956, Serial No. 586,961

10 Claims. (Cl. 34—46)

This invention relates to hygrostats and more particularly to apparatus for drying or moistening materials.

In handling and processing of materials such as cotton, grain and other commodities, it is generally the practice to employ gas fueled hot air generators which supply heat to a drier or to the ducts through which the materials are conveyed to and from a drier. It often happens, as in the case of cotton, for example, that the commodity as received is too dry and so water or steam is sprayed into the drier or the ducts to and from the drier in which the cotton is conveyed. Regulation, such as it is, is done by manually adjusting the valve or valves controlling the flow of the water or steam to some form of spraying means. The results are far from satisfactory, even with frequent adjustment, because of the varying conditions of the cotton entering the system and because of the very narrow range in moisture content permissible for best results. Thus, the condition of the cotton is seldom uniform, and it often becomes too wet.

Cotton should be dried or moistened under controlled conditions to obtain uniformity and the most desirable moisture content, for optimum results in processing. This is the principal object and attainment of the present invention. It comprises an automatic system for drying or moistening materials including an automatic and continuous moisture sampling device incorporating an adjustable moisture sensing unit connected to immediately responsive controls which provide the degree of drying or moistening required to deliver a uniform product with the desired moisture content.

Another object of the invention is to provide a device for controlling the electrical circuit responsible for igniting and extinguishing certain burners of a gas fueled hot air generator, especially as employed in drying materials and also, for energizing and de-energizing an electro-magnetic valve in said circuit for controlling humidification of the materials.

Another object of the invention is to provide a moisture sampling and controlling device which is readily portable and can be connected in the materials drying and humidifying system at any desired location.

More particularly, the moisture sampling and sensing device consists of a cylinder, in the top of which is mounted a moisture sensing element to which is conveyed by pressure or suction samplings of air from a material duct or drier through a group of flues extending in parallelism longitudinally through the cylinder and cooled by air introduced from the atmosphere into the cylinder about the flues, the said air samplings being constrained to pass through revolvable filters for the removal of lint and other entrained matter likely to incapacitate the moisture sensing element. The moisture sensing element is connected electrically with the electrical circuit incorporating control of certain burners of the hot air generator, and likewise control of an electro-magnetic steam valve which is actuated in the off-periods of these burners of the hot air generator, to restore moisture to the materials when too dry.

Other objects will become manifest as the description proceeds when considered with the annexed drawing showing one form of the invention, wherein:

Fig. 1 is a perspective view of a moisture sampling device incorporating moisture sensing control constructed according to the invention.

Fig. 2 is a wiring diagram incorporating electrical burner control and ignition to show electrical connection therewith of the moisture sensing unit of the sampling device of the invention.

Fig. 3 is a schematic view of a typical materials drying system incorporating a hot air furnace and steam humidifier, and showing the electrical connection between the steam valve actuating solenoid and the moisture sensing unit of the sampling device of the invention.

Fig. 4 is a vertical sectional view of the sampling device of the invention taken on line 4—4 of Fig. 5.

Fig. 5 is a vertical sectional view taken on line 5—5 of Fig. 4.

Fig. 6 is a transverse sectional view taken on line 6—6 of Fig. 4.

Fig. 7 is intended to show schematically the gas pipe connections between the gas regulator which is connected to a supply source, and two stages or groups of burners, with relative positions of the control valves.

Fig. 8 is intended to show the air switch and vacuum tube with orifice which is located in the duct at the intake side of the blower, and

Fig. 9 is a transverse sectional view taken on line 9—9 of Fig. 4.

Continuing with a more detailed description of the drawing, reference is made to Figs. 1, 4 and 5 which illustrate the moisture sampling device of the invention which includes a moisture sensing unit, as used in conjunction with a materials drying system and particularly the electrical control circuit incorporating the pilot valve, ignition burner valves and the steam humidifier shown as an element in the schematic view of Fig. 3. The moisture sampling device of the invention consists of a tubular body made up of a cylinder **10** having an annular flange **11** formed on its lower end by which it is secured with bolts **12** to the upper section **13** of a filter housing, generally indicated by reference numeral **14**. The lower section **15** of the filter housing **14** is secured to an annular flange **16** of an annulus **17** by bolts **18**.

A clean-out housing **19** has a circular reduced upper end **20** concentrically received in and secured to the annulus **17**. Closure plates **22** are secured to opposite sides of the clean-out housing **19** by means of bolts **23** (Fig. 4). The lower end **24** of the cleanout housing is likewise made in circular form and reduced to be received by an annulus **25** and held therein by circumferentially spaced pins **26** which extend through the reduced end **24** and the annulus **25**.

A damper housing, generally indicated by reference numeral **27**, consists of an upper elongate plate **28** and a parallel lower elongate plate **29** and between the side edges of the plates **28** and **29** are spaced strips **30** (Figs. 1 and 5) to separate the plates sufficiently to slidably accommodate the damper **31**. Screws **32** connect the two plates **28** and **29** and the spaced strips **30** together.

The annulus **25** earlier referred to is affixed to or formed on the upper plate **28** of the damper housing **27** and the lower plate **29** of the damper housing is secured, by means of bolts **34** to a trash diverter housing **35** which has a flange **36** thereon by which it is secured, by means of bolts **37**, to a materials duct or transition **38** or to any other part of a materials drying system, depending upon where a moisture sample can best be taken.

Returning to the filter housing **14**; it will be observed in Figs. 1 and 5 that aligned ears **39** and **40** are formed on one side of the upper and lower sections **13** and **15**

of the housing 14 respectively, which are provided with matching holes receiving a bolt 41. A coil spring 42 surrounds the bolt 41 between the ears 39 and 40 and enables the two plates to yield relative to each other so that a filter, generally referred to by reference numeral 43, can be freely rotated about a vertical axis formed by a bolt 44 (Fig. 4) which extends freely through an ear 45, formed on the upper section 13 of the filter housing 14 and is threaded into an ear 46 formed on the lower section 15 of the housing and in alignment with the ears 45. A coil spring 47 surrounds the bolt 44 between the ears 45 and 46 so that the two plates or sections 13 and 15 may yield relative to each other as the filter 43 is rotated.

The filter 43 consists of two circular frames 48 and 49, joined together by an arm 50. The arm 50 carries a ball bearing race 51 through which the pivot bolt 44 extends and is adapted to reduce friction when one filter frame is rotated to a position for cleaning while the other filter frame is moved to operative position within the housing 14. This enables the hygrostat to continue functioning without danger of lint and other foreign matter entrained in the air samplings fouling the moisture sensing element to be identified presently.

As a further deterrent to trash entering the unit with the air stream, a trash diverter 52 is situated in the trash diverter housing 35 and consists of a series of parallel, inclined ribs 53 against which trash moving through the duct 38 with the material impinges and only the smaller particles of foreign matter are permitted to pass and these are caught by the filters 54 and 55, mounted in the frames 48 and 49, respectively. The filters actually consist of screens under which are placed air pervious material which reduces velocity of the air and eliminates practically all of the dust and other finely divided substances.

Within the cylindrical body 10 of the hygrostat is a group of parallel flues 56 (Figs. 4 and 5) whose lower ends are sealed in a transverse partition 57 so that air rising within the unit will be constrained to pass upwardly only through the flues 56 and will emerge therefrom into a second filter housing, generally indicated by reference numeral 58.

The filter housing 58 consists of a lower section 59, showing an annular boss 60 formed on its underside which is received by the upper end of the cylinder 10 and secured by screws 61. The upper ends of the flues 56 within the cylinder pass through and are sealed in holes formed in the lower housing section 59. An upper housing section 62 is connected yieldably to the lower section 59 by a bolt 63 (Fig. 4) which passes freely through an ear 64 formed on one side of the upper housing section 62 and is threaded into an aligned ear 65 on the lower housing section 59. A coil spring 66 surrounds the bolt 63 between the ears 64 and 65, hence the upper housing section 62 is capable of slight upward displacement to permit rotation of the filter, generally indicated by reference numeral 67, about the bolt 63 which also constitutes the pivot point for the filter. Opposite the bolt 63, a bolt 68 (Fig. 4) passes freely through an ear 69 formed on the upper housing section 62 and is threaded into an aligned ear 70 on the lower housing section 59. A coil spring 71 surrounds the bolt 68 between the ears 69 and 70 and functions in the same manner as the spring 66.

The filter 67 is identical to and interchangeable with the filter 43, shown per se in Fig. 1 and therefore need not be further described. The frames 72 and 73 of the filter 67 are rotatable alternately into position so that one filter can be cleaned while the other continues to serve to collect foreign matter entrained in the rising air which escaped the cleaning action of the first filter 43.

After passing through the upper filter, the air enters the housing 74 of the moisture sensing unit 75 through a slot 76 in the top of the upper filter housing section 62. The moisture sensing unit housing 74 is held in position by means of spring clamps 77 (Figs. 1 and 5) whose lower ends are pivoted at 78 to the filter housing section 62 and whose upper ends clampingly engage over the edges of the top of the housing 14.

It is evident from the foregoing that a quantity of air moving with the material passing at high velocity through the duct 38 will rise into the unit between the diverter ribs 53. The temperature of the air is first determined by a dial thermometer 79 which enters the clean-out chamber 19. As the air continues upwardly, it passes through the operatively disposed filter 54 or 55, as the case may be and into the flues 56. In passing, the pressure or minus pressure of the air is determined by a dial pressure suction gauge 80 which communicates with a tubular section 81 between the lower end of the cylinder 10 and the upper section 13 of the lower filter housing 14. The air continues upwardly through the flues at a greatly reduced velocity which is further reduced by passing through the upper filter preliminary to entering the housing 74 of the moisture sensing unit 75 in which the temperature of the air is determined by a thermometer 82 whose stem enters the said housing, as shown in Figs. 1, 4, and 5.

In order to reduce the temperature of the sample air before it reaches the sensitive moisture sensing unit 75, a blower 83 has a discharge duct 84 which communicates with an annular air chamber 85 interposed between the lower end of the cylinder 10 and the tubular section 81. Air from the chamber 85 enters the cylinder 10 through circumferentially spaced apertures 86 therein and flows around the flues 56, as it rises in the cylinder 10, thereby cooling the flues and the sample air flowing upwardly therethrough. The cooling air emerges from the cylinder through the apertures 87 at the top of the cylinder.

Fig. 2 is intended to show how the invention is electrically connected between the moisture sensing unit of the moisture sampling device just described, and the burners, Fig. 7, of the hot air furnace of Fig. 3, and the moisture supply to the spray nozzle in the drier, also indicated symbolically in Fig. 3.

Fig. 3 is intended to show schematically how the invention sets into operation a humidifying spray in a materials drier when at the same time a group of burners Figs. 2 and 7, in the hot air furnace are cut-off.

In Fig. 3 the material drier is identified broadly by reference numeral 101, to which is connected the material duct 102, which extends from the blower 103. The blower 103 is connected to the hot air furnace 104, by a duct 105. Entering the drier 101 is a steam pipe 106, carrying on its inner end a spray head or nozzle 107. A steam valve 108 is incorporated in the steam line 106 and is actuated by a solenoid 109, to which are connected wires 110 leading from the relay amplifier 96 to be described presently.

The hot air furnace, symbolized in Fig. 3, is provided with two groups or stages of gas burners, 98*c*, 99*c*, Fig. 7, which are supplied with gas through the electrically operated main gas valve 88, Figs. 2, and 7. The pilot burner assembly 89 has the pilot burner 89*a* which ignites both groups of burners and which is supplied with gas by the electrically operated pilot gas valve 90. The ignition transformer 91 is electrically connected to the pilot burner for automatically igniting it. A more detailed description of the pilot burner assembly will also be given presently. The foregoing electrically operated appurtenances are connected to the principal relay assembly 92. This relay assembly is connected to a source of power 93 and its output is controlled by the start-stop switch 94. An air (vacuum) switch 95 is connected in the power output of this relay to the main gas valve already mentioned. A relay amplifier 96 is also connected to the output side of this air switch, and its power output is controlled by the moisture sensing unit 75.

The gas supply to one group of the hot air furnace burners is additionally controlled by the electrically operated auxiliary gas valve 97. This auxiliary gas valve is connected to the power output of the relay amplifier. The electrically operated steam or moisture valve **108** which controls the flow of moisture to the spray nozzle **107** in the drier **101**, is also connected to the power output of the relay amplifier. The moisture valve is normally open while the auxiliary gas valve is normally closed. When the relay amplifier is energized by the moisture sensing unit **75**, the auxiliary gas valve opens and at the same time the moisture control valve to the spray nozzle in the drier closes. The air switch mentioned above is an over-all control connected on the load side of the principal relay at its output to the main gas valve. This switch is operated by a diaphragm connected to the orifice piece **95***b* by the tubing **95***a*. The orifice piece is located in the duct **105** at the blower intake with its open end **95***c*, pointing toward the blower, and is actuated by the vacuum created in the duct **105** by the blower **103** when it is in operation.

The gas supply to each group of burners of the hot air furnace is further controlled independently by the thermostat operated snap-action gas valves **98**, **99**, Figs. 2 and 7, one for each group. The thermo-tubes which operate these valves are located in the drier or in the duct beyond the drier. The valves are set for a maximum temperature cut-off and are adjustable for a given range of temperature. Their main purpose is to insure absolute protection of the material being handled against damage from excess heat. For example, in the case of cotton, the thermostat operated gas valve in the gas line to the first group of burners normally controlled by the electrically operated main gas valve, is set to cut-off at 125° F., and the thermostat operated gas valve in the gas line to the second group, normally controlled by the electrically operated auxiliary gas-valve, is set at, say, a maximum of 250° F. Thus all drying or moistening as determined by the moisture sensing unit and carried out through the electrically operated valves takes place at or below the pre-set maximum temperature, eliminating possible damage or lowering of the quality of the cotton from excess heat. Likewise with other materials.

The electrical loop through the moisture sensing unit is the variable in a Wheatstone bridge of the relay amplifier in which the current flow across the bridge is electrically amplified. This amplified current actuates a relay which opens and closes a switch between the power input to the relay amplifier and its power output to which the electrically operated auxiliary gas valve **97** and the electrically operated moisture supply valve **108** are connected, as previously stated.

The principal relay includes an electronic network controlling a relay which connects the power input to the power output leading to the main gas valve, the pilot gas valve and the ignition transformer. The electronic network has a circuit to the pilot burner comprising an electronic electrode **89***b* located at the pilot burner with a ground return from the pilot burner. The flow of current in this circuit depends upon the presence of a flame between electronic electrode and the pilot burner which has the ground return. The network includes a delay element arranged to cutoff the power output if for any reason the pilot burner fails to ignite within a predetermined time after the electrically operated pilot gas valve is opened and the ignition transformer is energized. When the pilot burner ignites, the main gas valve is opened and the ignition transformer is cut-off.

It is apparent that either stage or group of burners can be more or less or equal in number those the other, an arrangement which is largely determined by the commodity to be processed and its probable normal moisture content as received. Furthermore, the first stage or group can also be controlled by a second moisture sensing unit and relay amplifier, the second moisture sensing unit also being placed in the moisture sampling device.

The purpose of the described arrangement is to automatically cut-off one group or stage of burners of the hot air furnace through the moisture sensing unit when the material being processed becomes too dry or is dry upon entering the system. At the same time, the steam valve **108** is opened to humidify or rehumidify the material, either in the drier **101**, itself, or in any duct leading to or from the drier, as described. On the other hand, if the material being processed is too moist, the steam valve **108** is closed and the burners of the hot air furnace are re-ignited, as determined by the action of the moisture sensing element **75** which is influenced by the moisture or lack of moisture in the air sample being continuously moved by pressure or suction through the body of the instrument.

Returning to Fig. 1 of the drawing: sample air for the most part, is moved through the hygrostat under its own pressure. However, there are cases where pressure does not exist and under these conditions, suction is set up in the tubular housing of the apparatus by means of a small air pump **111** which is connected to the moisture sensing element housing **74** through a flexible tube **112**. One end of this tube is connected to the air pump **111** and its opposite end is connected by a threaded opening **113** (Figs. 4 and 5) in the top of the housing **74**. To control the suction in the tube **112**, a sleeve **114** (Fig. 1) is slidable over a perforated section **115** of the tube **112**.

Manifestly, the construction as shown and described is capable of some modification and such modification as may be construed to fall within the scope and meaning of the appended claims is also considered to be within the spirit and intent of the invention.

What is claimed is:

1. In combination with a materials drying system having an electrical circuit incorporating electrically actuated burner valves and a steam humidifying valve, a moisture control device comprising an elongate tubular body disposed to receive at its lower end a sampling of air entrained with materials moving through said system, a plurality of relatively parallel flues extending longitudinally through the upper portion of said body having their upper and lower ends sealed against passage of air other than said sampling of air, means for cooling said flues to reduce the temperature of the sampling of air ascending therethrough, a moisture sensing element in the upper end of said tubular body with which said sampling of air is brought into intimate contact, means for filtering from said sampling of air foreign matter entrained therein in its course through said tubular body, separate means spaced apart longitudinally in said tubular body for determining the pressure and temperature of the sampling of air passing upwardly therethrough and means connecting said moisture sensing element electrically in said electrical circuit to effect alternate opening and closing of the circuit to said burner and steam valves according to variations in the moisture content of the materials processed through said system.

2. In combination with a materials drying system having an electrical circuit incorporating electrically actuated burner valves and a steam humidifying valve, a moisture control device comprising an elongate tubular body disposed to receive at its lower end a sampling of air entrained with materials moving through said system, a plurality of flues extending through the upper portion of said body having their upper and lower ends sealed against passage of air other than said sampling of air, means for cooling said flues to reduce the temperature of the sampling of air ascending therethrough, a moisture sensing element in the upper end of said tubular body with which said sampling of air is brought into intimate contact, means for filtering from said sampling of air foreign matter entrained therein in its course through said tubular body, separate means in said tubu-

lar body for determining the pressure and temperature of the sampling of air passing therethrough and means connecting said moisture sensing element electrically in said electrical circuit to effect opening and closing of the circuit to said burner and steam valves according to variations in the moisture content of the materials processed through said system.

3. The structure of claim 2, in which said filtering means is comprised of a pair of circular screened frames pivoted therebetween in offset relation to the longitudinal axis of said tubular body for alternate disposition in alignment with said longitudinal axis.

4. The structure of claim 2, and means in the lower end of said tubular body for deflecting trash entrained in said sampling of air seeking entrance into said tubular body with said air.

5. In combination with a materials humidifying and rehumidifying system having an electrical circuit incorporating an electrically actuated burner valve and a humidifying valve, a device for controlling said burner valve and said humidifying valve according to the moisture content of the materials being processed through said system comprising a tubular body connected in said system and through which a sample of air from said system is constrained to pass, a series of parallel, longitudinally extending flues in the upper half section of said tubular body through which said sample of air is constrained to pass in its course through said tubular body, means for cooling said flues to reduce the temperature of the sampling of air ascending therethrough, a moisture sensing element in said tubular body having electrical connection in said electrical circuit and with which said sample of air is brought into intimate contact to effect alternate opening and closing of said circuit to said burner and said humidifying valves according to the moisture content of said material.

6. The structure of claim 5, and a damper in the lower portion of said tubular body for controlling the volume of air entering said tubular body.

7. The structure of claim 5, and a trash diverter in the lower end of said tubular body for deflecting major trash as said air enters said tubular body.

8. In combination with a materials humidifying and rehumidifying system having an electrical circuit incorporating an electrically actuated burner valve and a humidifying valve, a device for controlling said burner valve and said humidifying valve according to the moisture content of the materials being processed through said system comprising a tubular body connected in said system and through which a sample of air from said system is constrained to pass, a moisture sensing element in said tubular body having electrical connection in said electrical circuit and with which said sample of air is brought into intimate contact to effect alternate opening and closing of said circuit to said burner and said humidifying valves according to the moisture content of said material, a series of parallel, longitudinally extending flues in the upper half section of said tubular body through which said sample of air is constrained to pass in its course through said tubular body, and means for cooling said flues to reduce the temperature of the sample of air ascending therethrough.

9. In combination with a materials humidifying and rehumidifying system having an electrical circuit incorporating an electrically actuated burner valve and a humidifying valve, a device for controlling said burner valve and said humidifying valve according to the moisture content of the materials being processed through said system comprising a tubular body connected in said system and through which a sample of air from said system is constrained to pass, a moisture sensing element in said tubular body having electrical connection in said electrical circuit and with which said sample of air is brought into intimate contact to effect alternate opening and closing of said circuit to said burner and said humidifying valves according to the moisture content of said material, and a pair of longitudinally spaced filters in said tubular body through which said sample of air is constrained to pass in its course through said body to said moisture sensing element.

10. The structure of claim 9, in which said filters are composed of a pair of frames carrying filter screens, said filters being pivoted therebetween to said tubular body in offset relation to the longitudinal axis of said tubular body whereby one of said filter screens will be operatively disposed within said tubular body while the companion filter frame will be disposed exteriorly of said tubular body.

References Cited in the file of this patent

UNITED STATES PATENTS

1,100,171	Brown	June 16, 1914
1,815,648	De Mers	July 21, 1931
2,128,176	Bast et al.	Aug. 23, 1938
2,137,769	Crawford	Nov. 22, 1938
2,143,505	Arnold	Jan. 10, 1939
2,489,455	Leone	Nov. 29, 1949
2,541,219	Dueringer	Feb. 13, 1951