

July 28, 1936.

T. LYDON

2,048,749

STEAMING OVEN

Filed June 23, 1933

4 Sheets-Sheet 1

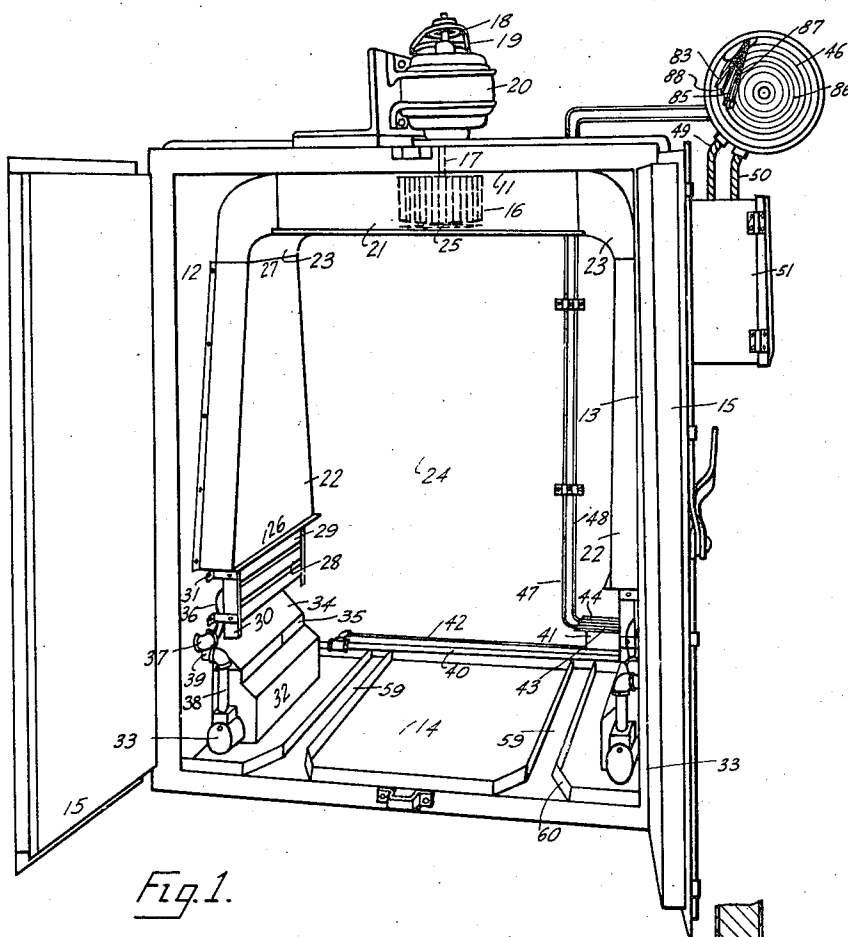


Fig. 1.

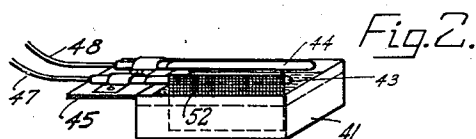


Fig. 2.

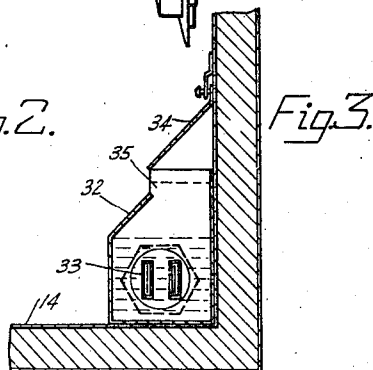


Fig. 3.

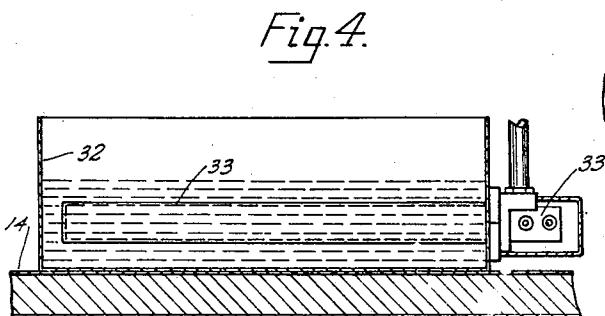


Fig. 4.

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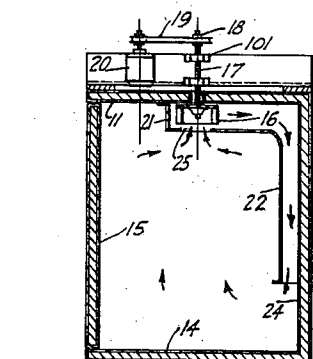


Fig. 6.

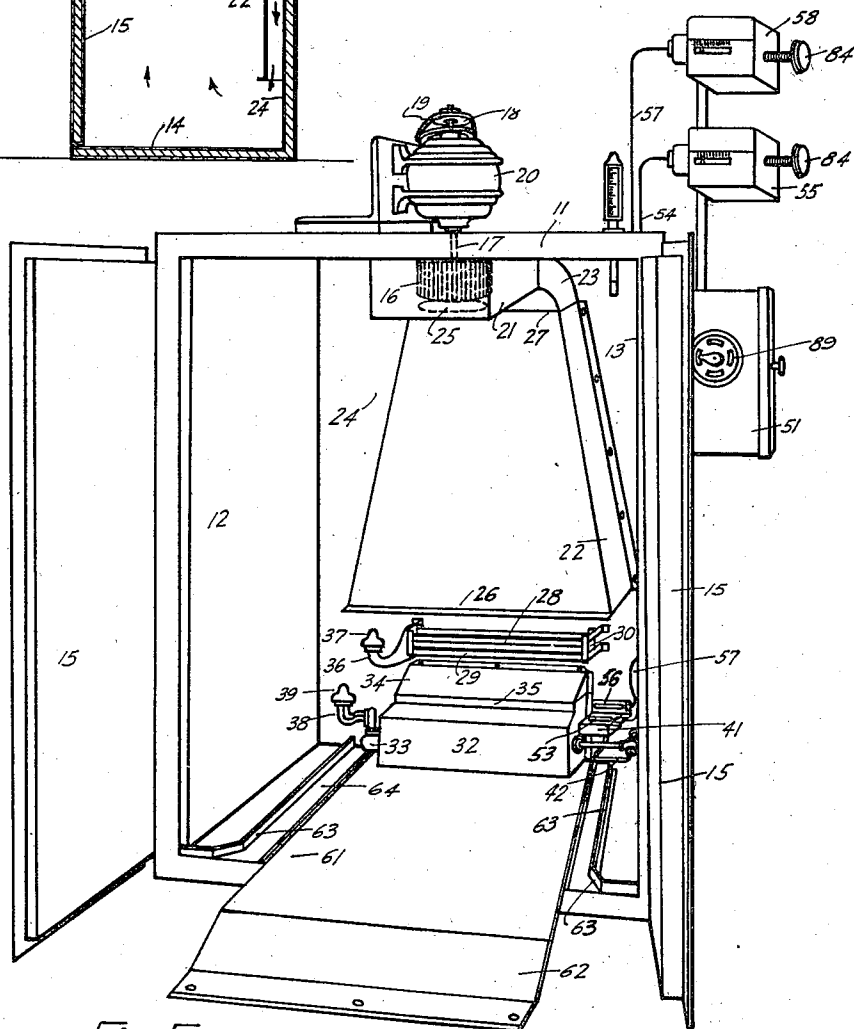


Fig. 5.

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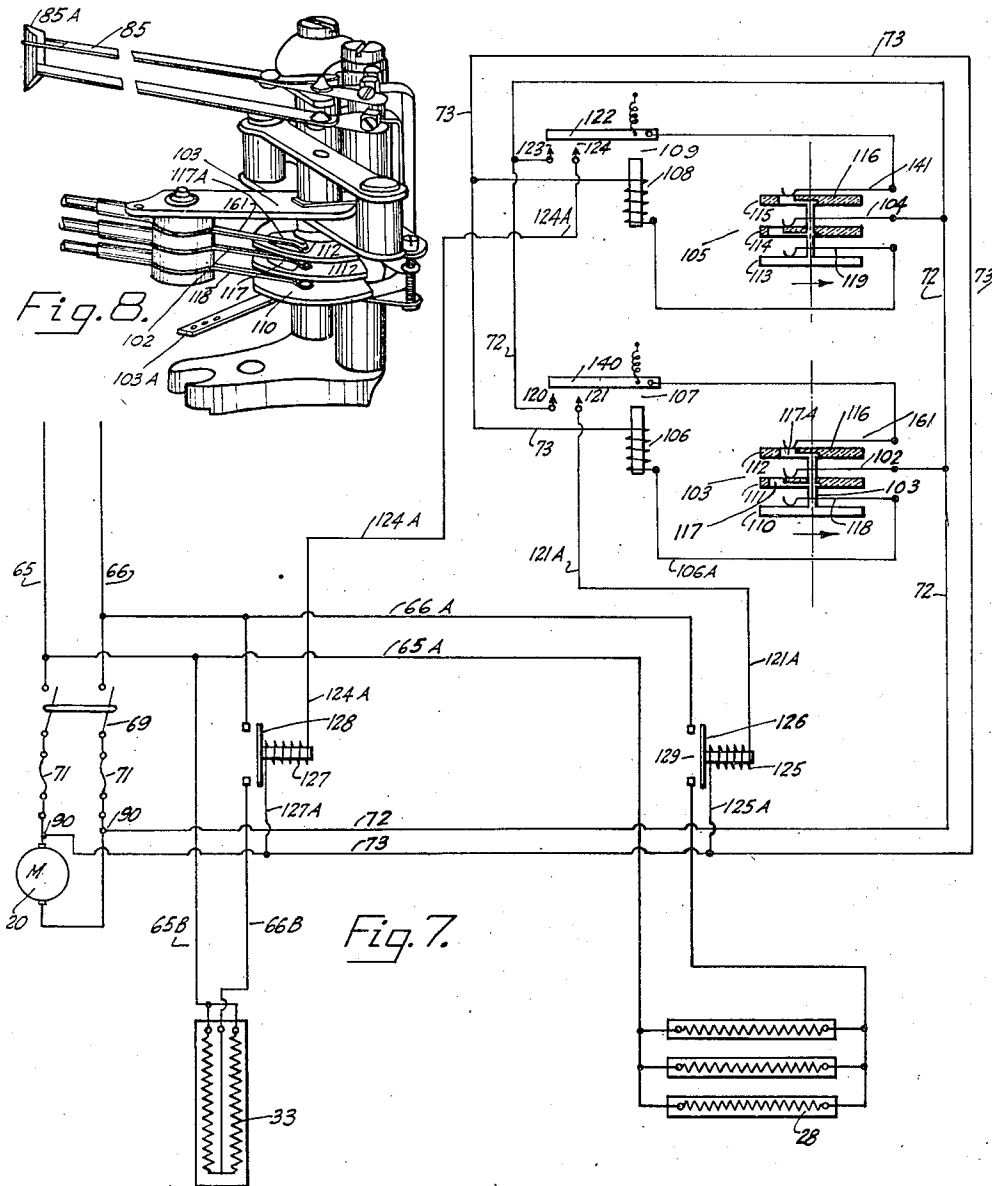
T. LYDON

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STEAMING OVEN

Filed June 23, 1933

4 Sheets-Sheet 3



INVENTOR.
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July 28, 1936.

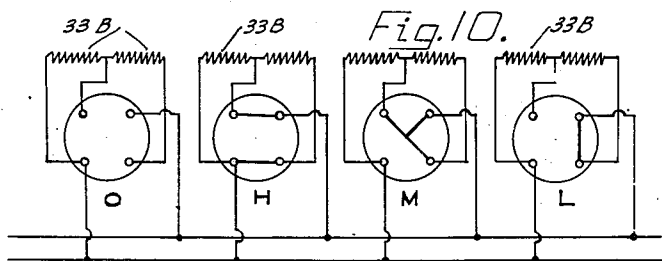
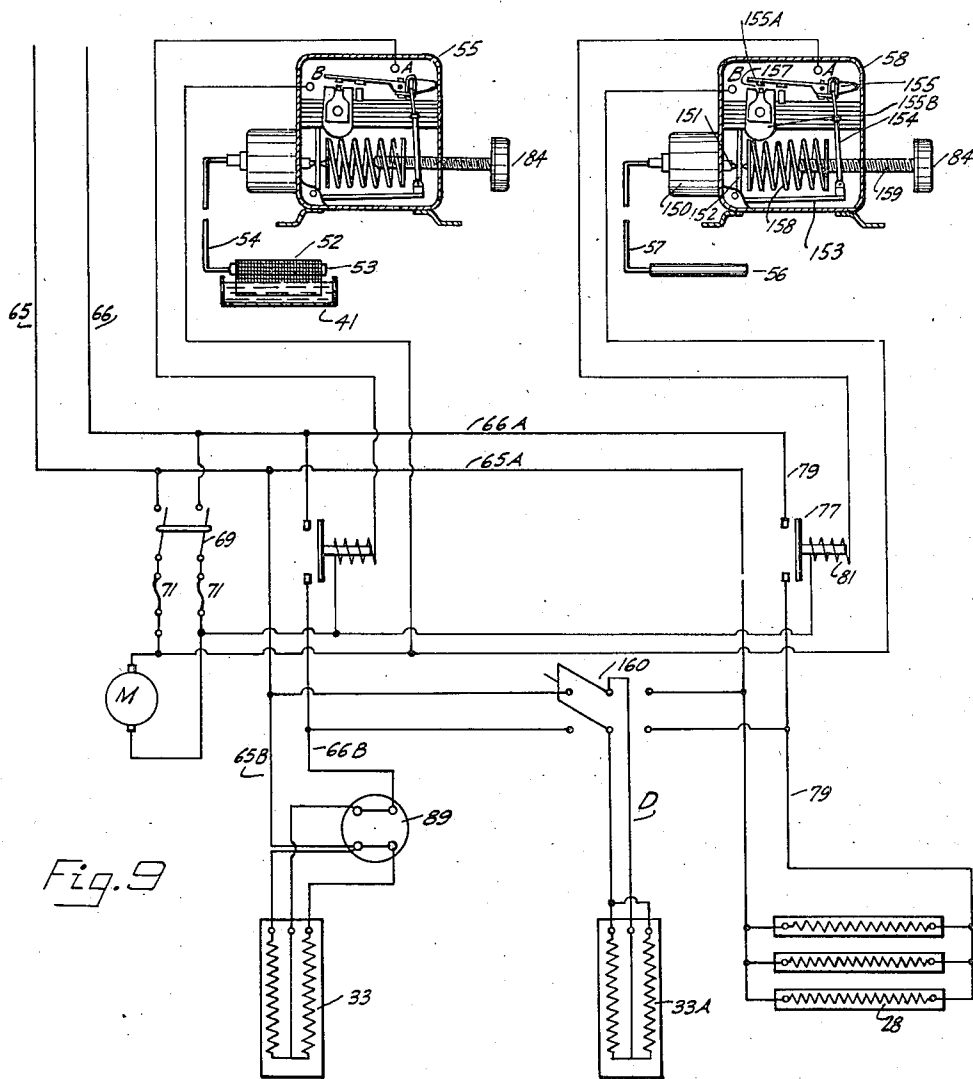
T. LYDON

2,048,749

STEAMING OVEN

Filed June 23, 1933

4 Sheets-Sheet 4



INVENTOR.
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UNITED STATES PATENT OFFICE

2,048,749

STEAMING OVEN

Timothy Lydon, New York, N. Y.

Application June 23, 1933, Serial No. 677,263

9 Claims. (Cl. 28—58)

This invention relates to improvements in steaming ovens, and more particularly to ovens for setting the twist in silk and rayon yarns.

Silk and rayon yarns when being spun on bobbins are twisted, the number of turns per inch that the yarn is twisted and the number of threads twisted together being determined by the material for which the yarn is to be used. A wide variety of yarns are manufactured, some of low twist, some of high twist. Hosiery "tram" for the manufacture of silk hose generally belongs to the low twist group, whereas "crepe" is manufactured from yarn consisting of several threads twisted together many times and belongs to the high twist group.

When silk or rayon which has been twisted, is uncoiled from the bobbin on which it is spooled, it will snarl and knot and this tendency has to be removed before the yarn can be put through the succeeding manufacturing processes. Processing the silk so that it loses this snarling tendency is known as "setting the twist".

The operation of setting the twist has for a considerable time been performed by placing the yarn in a box or vault into which live steam was introduced. This method was sometimes used after a partial vacuum had been formed in the box in which the yarn was placed. The partial vacuum was to secure better penetration of the silk.

While the above method gave quick results, as a general rule there was always the danger of injuring the yarn. This injury consisted of degumming, baking and water spotting. Silk yarn contains essential natural gums and oils which render it easily injured by temperature and moisture conditions. Excessive temperature or moisture may so change the nature of these oils that the yarn is completely spoiled; this may be done by baking or degumming. When steam was admitted in this old method the silk was affected by the full temperature and latent heat of the steam, and heat was concentrated near metal as for instance where the bobbins had metal heads. The yarn shrank and stuck together and often hardened, so that a special winding or redrawing operation had to be performed to prepare the silk for further operations.

Rayon yarn was injuriously affected in a somewhat similar manner and in addition water spotting or blotches on the yarn caused by condensation of the steam thereon, caused fading of the yarn, making further operations more expensive and difficult and the product of lower quality.

Another objection to the old method of intro-

ducing live steam is that there was no proper system of control and the product was never uniformly set. Results varied with the technique of the operator, the amount of steam introduced, and the time allowed. Silk was often soiled by steaming by substance carried by the water.

Another objection was non-uniformity caused by lack of proper heat diffusion and the consequent over heated spots near the steam entrance port and condensation at points remote from the steam entrance port.

Still another and most important objection to the old system of steaming was that in certain cases of high twist crepe, it was found impossible for the steam to penetrate the silk on the bobbin. Consequently the twist was not satisfactorily set.

Another means of setting the twist is known as water setting. This consists in soaking the silk on the bobbins, in water for a certain length of time and then drying the silk in an oven or drying room. The principal disadvantage of this system was the length of time it took, sometimes 24 hours, and the resulting heavy investment in bobbins and equipment.

A disadvantage common to both of these old systems is the injury that results to the bobbins and staining to the silk by dirt carried by the moisture.

An object of the present invention is to provide an oven, in which air and vapor may be admixed to obtain a desired temperature and humidity.

A further object of the present invention is to provide an oven, in which air and vapor may be constantly admixed and heated to a desired temperature and humidity and constantly circulated through a charge of silk placed therein so that the vapor is made available for absorption by the silk.

A further object of the present invention is to provide an apparatus which will set the twist in silk or rayon yarn so that no baking or degumming of the yarn occurs from excess temperature or moisture.

A further object of the present invention is to provide an apparatus which will uniformly set the twist in silk and rayon yarns, in such a manner that condensation of water on the silk and consequent water spotting, soiling, degumming and hardening of the yarn is eliminated.

A further object of the present invention is to provide an apparatus which will uniformly set the twist in silk and rayon yarns without water spotting, degumming or baking and which may be easily put in operation by throwing a switch.

A further object of the present invention is to

provide an apparatus of this kind which may be started by throwing a switch and which is provided with automatic control of temperature and humidity to enable the operator always to easily maintain the desired operating conditions and the desired results from day to day.

A further object of the present invention is to provide an apparatus of this kind which is provided with automatic control of temperature and humidity to enable the operator to readily set the desired degree of temperature and humidity required by any variety of yarn.

A further object of the present invention is to provide an apparatus of this kind which may be easily operated and easily loaded, and in which the temperature and humidity may be definitely regulated and quickly changed to suit different loads.

A further object of the present invention is to provide a silk steaming box which will enable the operator to always obtain a uniform thorough set throughout the whole batch of silk and provided with automatic control of temperature and humidity to prevent overheating or excessive wetting of the silk even if the box is allowed to run too long.

Thus objects of the present invention are to provide an apparatus for setting the twist in silk and rayon yarns which will be complete and self-contained with automatic temperature and humidity control to provide and maintain an atmosphere of a desired temperature and humidity inside the apparatus and to constantly circulate this atmosphere throughout the full loading capacity of the apparatus, and to automatically maintain this condition without additional attention after starting.

Other objects and advantages of my invention will hereinafter appear.

I attain these objects by the steaming oven and the appurtenances thereof, two forms of which are shown in the drawings, or by any mechanical equivalents or obvious modifications of the same.

In the drawings,

Fig. 1 is a perspective view of one form of my steaming oven, showing the vapor generators at each side.

Fig. 2 is an enlarged view of the small water tank showing the wet and dry bulbs used in connection with the control instrument.

Fig. 3 is a cross sectional view of the vapor generator.

Fig. 4 is a view in longitudinal section of the vapor generator.

Fig. 5 is a perspective view of another form of my steaming oven showing the vapor generator at the back of the oven.

Fig. 6 is a cross sectional view of this form of steaming oven, showing the fan drive and air circulating system.

Fig. 7 is a wiring diagram of a simplified electric control circuit used in connection with the control instrument shown in Fig. 1.

Fig. 8 is a perspective view of a single action controller movement assembly similar to that used in the control instrument of Fig. 1 and the electric control circuit of Fig. 7.

Fig. 9 is a wiring diagram of a simplified electric control circuit such as is used with the control instruments indicated on the steaming oven of Fig. 5.

Fig. 10 is a wiring diagram showing the different heater connections which are made by the operation of the three heat switches of Fig. 9.

Like characters of reference refer to like parts throughout the different views.

The steaming ovens are of panel construction consisting of outer and inner metal casings with heat insulating material about 2 inches thick therebetween. 11 designates the roof, 12 and 13 the sides, 14 the floor and 15 the doors of the oven. The inner metal casing of these panels are made of rust proof alloy.

A centrifugal fan or blower 16 is overhung interiorly of said oven under the roof 11 thereof, to revolve in a horizontal plane, and is secured to a vertical shaft 17, supported in suitable gearings 101 in Fig. 6, said shaft is secured at its upper end to a suitable source of power consisting of pulleys 18, belt 19, and motor 20.

Said blower 16 is enclosed by a casing 21. In Fig. 1 this blower casing extends across the width of the oven to connect at each side to the air distributing ducts 22, and the elbow pieces 23. Inside the blower casing 21 and around the periphery of the blower 16 are placed scroll pieces not shown which efficiently distribute the air from the fan in each direction towards the air distributing ducts 22.

The air distributing ducts 22 are shown with sloping sides so that the bottom ends 26 are wider than the top ends 27, where the ducts are connected to the elbow pieces 23. This gradual enlargement of the ducts 22 from the top to the bottom greatly facilitates diffusion of the air which is circulated through them and this diffusion occurs throughout the volume of the oven.

Underneath the air distributing ducts 22 and directly in the path of the air being discharged therefrom, are disposed the electric heater assemblies 28 which consist of electric strip heaters 29 supported by and fastened to suitable brackets 30. The brackets are fastened to and supported on the walls by clips 31.

Below the heater assemblies 28 and resting on the floor 14 of the oven are situated the vapor generators 32 constructed of rust proof alloy and equipped with electric immersion heaters 33. The vapor generators are provided with sloping removable covers 34, and vapor diffusing openings 35, through which the vapor generated inside the vapor generators escapes to become mixed with the air being blown over them.

As indicated, electrical leads 36, to convey current to the strip heaters 29 are brought through the sides of the oven at 37. The leads 38 to the immersion heaters are brought through the oven at 39.

The vapor generators 32 are connected by piping 40 to a constant level water reservoir not shown, on the outside of the oven. A small water tank 41 is connected by smaller piping 42 to the same constant level reservoir. This small water tank provides moisture for the wet bulb 43.

In Fig. 1 the small water tank 41 is shown in the right hand rear corner of the oven. Secured to a flange 45 on the tank are the wet and dry bulbs 43, 44 of a two pen indicating recording controller 46, on the outside of the oven. The tubing 47, connects the temperature sensitive wet bulb 43 with the controller 46, the tubing 48 connects the temperature sensitive dry bulb 44 with the controller 46. The make and break contact points of the wet bulb circuit are connected by leads 49 to a relay in the panel box 51. The leads 50 connect the contact points of the dry bulb to a relay in the panel box 51. The wet bulb 43 differs from the dry bulb 44 in 75

that a wick 52 which keeps it moist is suspended from it into the water in the tank 41.

In Fig. 5 a simpler form of control is indicated. The wet bulb 53 shown above the small water tank 41 is connected by the tube 54 to the wet bulb thermostat 55 and the dry bulb 56 is connected by the tube 57 to the dry bulb thermostat 58.

In Fig. 1 a typical loading arrangement for trucks with wheels, is shown. The wheel tracks 59 are installed on suitable centers to fit the bobbin-board trucks being used. The guide pieces 60 help to guide the wheels of the truck into these tracks.

In Fig. 5 an arrangement is provided to allow the use of lift trucks and skids. The floor plate 61 with sloping runway 62 in front is provided to support a lift truck, the guides 63 guide the supporting legs of the skid so that when the jack lift truck is lowered the legs of the skid rest on the flanges 64 of the guides.

In Fig. 7, I show the wiring diagram such as I use with the temperature controller 46 shown in Fig. 1. From the power lines 65 and 66 is brought off a double pole switch 69. Between the power lines and the blower driving motor 20 are placed the fuses 71.

From the junction points 80 between the fuses and the motor a control circuit 72, 73 is taken off as indicated. This control circuit has a lead 72 which is connected to the contact brush 102 of the dry bulb commutator contact assembly 103 of the controller shown at the upper right of Fig. 1 and in part in Fig. 8.

This controller is of well known construction and need not be here described. It is sufficient to say that expansion of fluid in the bulb 44 causes fluid from the tube 48 to expand a bellows which moves the lever 103a thereby rotating the assembly 103.

The lead 72 is also connected to the contact brush 104 of the wet bulb commutator contact assembly 105 similar to the assembly 103. The lead 73 is connected to the magnet coil 106 of the dry relay 107 and to the coil 108 of the wet relay 109.

The commutator assembly 103 (Figs. 7 and 8) has three commutator discs 110, 111 and 112. The commutator assembly 105 has three similar commutator discs 113, 114 and 115. The lower commutator discs 110 and 113 on each assembly are the common contacts and their entire contact surface is heavy rolled silver on gilding bronze. The center and top commutator discs 111 and 114 on each assembly are of bakelite and have metallic inserts 117 and 117a set flush with the bakelite surface.

The end of the coil 106 of the relay 107 is connected by conductor 106a to the contact brush 118 engaging the lower disc 110. The end of the magnet coil 108 is similarly connected to the contact brush 119, of the lower disc 113. The relay 107 has a contact arm or armature 140 adapted, when attracted, to close the circuits through the contacts 120 and 121. Similarly the arm 122 opens and closes the circuits through the contacts 123 and 124.

As indicated the contact arm 140 is connected to the contact brush 161 and the contact arm 122 is connected to the contact brush 141. The contact 121 is connected by conductor 121a to the coil 125 of the relay 126. Similarly the contact 124 is connected by conductor 124a to the coil 127 of the relay 128. The magnet coils 125 and

127 are as indicated connected by conductors 125a and 127a to the line 73. When the relay 126 is deenergized, the switch 129 is open and current cannot pass through the lines 65A and 66A to the dry heaters 28 and when the relay 128 is open the current cannot flow through the lines 65B and 66B to the immersion heater 33.

Fig. 8 shows a single action commutator assembly such as is used in the temperature controller shown in Fig. 1 and in this circuit. This view shows the relationship of the brushes, commutator lever 103a and recording pen arm 85 carrying the pen 85a for recording on the record disc. The commutator contact assembly complete with contact discs 110, 111, 112 is pivoted on the same axis of rotation as the pen arm 85.

To describe the operation of this circuit I will first confine myself to the dry bulb circuit.

The commutator discs are assembled to rotate as a unit, by the pressure set up in the temperature sensitive bulb. Rising temperature causes rotation in a clockwise direction looking down on the commutators.

The lower commutator disc 110 is the common contact and has its entire surface of silver on gilding bronze. The center and top commutators are bakelite with metallic inserts. In Figs. 7 and 8, the commutator assembly 103 is at the position of the temperature which the controller is set to maintain. That is, the upper brush 161 is shown on the metallic segment 117a while the middle brush 102 is on the bakelite surface out of contact with the segment 117.

The brushes are in the same vertical plane and the angle of rotation between on and off positions of the assembly is represented by the respective positions of the corresponding edges of the metallic segments. The three segments are electrically connected with each other through the control shaft 103a of the assembly.

When the temperature of the bulb is too low, that is, below the control point and the electrical current is turned on by closing the switch 69, brushes 102 and 161 are in contact with their respective metallic segments 117, 117a. Current flows from line 72 through the center brush 102 and center commutator to bottom commutator and brush 118 and thence through conductor 106a to the coil 106 to lead 73, and the relay arm 140 closes on contacts 120 and 121. Thereupon current flows from line 72 through brush 102, shaft 103a, to the top commutator segment 117a and then through contact arm 140, contact 120, conductor 121a to the coil 125, which is thereby energized and closes the switch 129 and the circuit 65A, 66A to the heaters 28.

While the circuit 65A, 66A is closed, the oven is heating up and the motor 20 is running so that the fan circulates the air inside the oven and brings the heated air in vigorous contact with the temperature sensitive bulb. As the temperature of the bulb increases the pressure inside the bulb increases and the commutator assembly rotates. When the control point is reached the metallic segment 117 on the center commutator disc leaves the brush 102, and the circuit through this brush 102 is broken but the relay 107 is held locked, since current still flows through line 73 (left of Fig. 7), coil 106, conductor 106a, discs 110, shaft 103, segment 117a, brush 161, arm 140, contact 120, at line 72. This circuit remains closed until the temperature reaches the point when the segment 117a on the upper disc leaves the brush 161, breaking said circuit and deenergizing coil 106. This opens the relay 107 and

consequently the relay 126 and switch 129; and the current to the heaters 28 is interrupted.

The temperature will now begin to decrease and the brush 117a on the top commutator will again contact the metallic segment but contacts 120, 121 are not engaged and the relay will not close until the temperature drops to the point at which the brush 102 on the center commutator again makes contact with the metallic segment 117, completing the circuit through brush 118 and coil 106 as first explained. The relay coil 106 becomes again energized and the relay 106 again closes, and the relay 126 again closes the heater circuit 65A, 66A. The commutator movement is counter clockwise to close the circuits.

The control point is set by the position of the dry bulb pointer 83, which determines the temperature at which the metallic segment on the top and center discs will make contact with the brushes. The dry temperature recording pen 85a records on the chart 86 the rise and fall of the dry temperature within the oven.

The operation of the circuit which is controlled by the wet bulb 43 is entirely similar in nature, the wet bulb temperature being used to control the current through the circuit 65B, 66B to the immersion heater 33. The wet bulb temperature is recorded on the chart 85 by the wet bulb temperature recording pen 87.

In Fig. 9 I show a wiring diagram of a simplified electric control circuit such as is used with the control instruments which I indicate on the form of my steaming oven shown in Fig. 5.

In this circuit the wet bulb thermostat 55 and the dry bulb thermostat 58 are of the snap action bellows operated type. When the temperature of the dry bulb 56 increases the pressure inside the bellows 150 which causes the point 151 to move against the lever 152, which turns the lever 153 so that the arm 154 exerts a downward pull on the snap mechanism 155. When a certain temperature is reached the downward pull becomes great enough to cause the snap mechanism 155 to operate to pull the end 155a free from the magnet 155b and open the electrical contact between the points at 157. When the contact points at 157 are in contact current can flow between the terminals A and B. The spring 158 exerts a pressure against the lever 152 and this pressure may be increased or diminished by turning the adjusting screw 159 by the knob 84. In this manner the thermostat can be adjusted and set so that it operates to open the circuit at a certain desired temperature and to close it when this temperature falls a few degrees, the number of degrees the temperature will drop before the points close again is known as the differential.

When the switch 69 is thrown in and the oven is cold the thermostat points at 157 will be closed and current will flow through the coil 81 and the relay 77 will close so that current may flow through the line 79, to the dry heaters. When the temperature is reached at which the thermostat is set, the contact points at 157 will open and the relay 77 will interrupt the current to the heaters 28.

The operation of the wet bulb thermostat 55 is similar in operation and controls the flow of current to the immersion heater 33. The wet bulb 53 is indicated with a wick 52 dipping into the small tank 41.

In the circuit to the immersion heater 33 I have indicated a three heat switch 89, by which

the heating capacity of the immersion heater can be varied.

I have also indicated an auxiliary immersion heater 33A which may be connected to the same circuit as the immersion heater 33 or to the same circuit as the air heaters 28, by means of a double throw switch 160.

In Fig. 10 I have shown the four different operating positions of the three heat switch. The resistances 33B represent the resistances inside the immersion heater. In the position O the switch is "Off", and no current flows through the resistances. In the position H the switch is on "High", and the resistances are in parallel and operate to their full heating capacity. In the position M the switch is on "Medium" heat and one resistance has current flowing in it while the other has no current. In the L position the switch is on "Low" heat and the resistances are in series with one another so that they operate at their lowest wattage.

By operating the three heat switch on the different positions of "High", "Medium" and "Low", I can vary the rate at which vapor will be developed inside the steaming oven during the time that the current is flowing in this circuit.

By means of the double throw switch 160 I have indicated another means of varying the rate of vapor generation inside my steaming oven. When the immersion heater 33A is connected to the same circuit as the air heaters 28, the current to this immersion heater will be controlled by the dry bulb thermostat. When the immersion heater 33A is on the same circuit as the immersion heater 33, it will be controlled by the wet bulb thermostat.

Another alternative arrangement consists of placing a three heat switch at the point D in the line to the immersion heater 33A.

It can readily be seen that by means of the three heat switch 89, the double throw switch 160 and a three heat switch in the alternative position D, a great variety of rates of vaporization may be obtained, to suit a wide variety of conditions.

When the dry bulb thermostat cuts out part of the immersion heat, the rate of vapor generation is cut down and the tendency toward condensation is greatly diminished, yet there is no great lag of the vapor generation behind the air heating because when the oven is heating up to the dry bulb temperature all of the immersion heat is on and when this point is reached half of the immersion heat is cut off by the dry bulb thermostat. A milder steaming condition can be effected by reducing the output of the immersion heater 33A by the auxiliary three heat switch in the position D.

The arrangement of switches above to vary the rate of vapor generation makes it possible to easily adjust my steaming oven so that materials which have different hygroscopic and other physical qualities can be readily steamed and in such a manner that the optimum rate and amount of moisture absorption takes place. As an example, high twist crepes require a high humidity to effect a good set and are not susceptible to damage by condensation, where such condensation does not take place in large quantities from live steam. On the other hand hosiery tram does not require a high humidity and it is highly desirable that there be no condensation. Rayon is quite susceptible to condensation and it is here that mild steaming and lack of condensation is extremely important.

The rate of vapor generation is also of importance when small loads of material are placed in the steaming oven. The rate of vapor generation can be reduced to correspond with the absorp-

5 tive capacity of the load.

The operation of my steaming oven is as follows: The operator loads the silk or rayon on which he wishes to set the twist on perforated pin or bobbin boards, then loads the boards on a

10 truck or skid and places them in the steaming oven and closes the doors. Knowing the temperature, relative humidity and time which gives him the most satisfactory results he sets his control instruments accordingly.

15 If the operator was using the controller 46 shown in Fig. 1 he would set the dry bulb pointer 83 at the dry bulb temperature he desired and wet bulb pointer 88 at the wet bulb temperature he desired. If he wished to get 94% relative humidity in the oven at 170° F. he would set the dry

20 bulb pointer at 170° F. and the wet bulb pointer at 167° F.

The operator when using the thermostats indicated in Fig. 2 would select and set his temperatures on these thermostats by turning the adjusting knobs 84, to give him the temperature that he desired.

The doors are closed, the water supply to the tanks is turned on and the oven is ready to operate. The oven is started up by merely closing the switch 69. By throwing in this switch, the motor and fan are started up and the control circuits are energized. Since the oven is cool the control circuits will be closed and energy will

35 flow to the strip heaters 29 and the immersion heaters 33.

As soon as the water in the vapor generators 32 is heated vapor is given off. This vapor is immediately taken up and carried away with the

40 warm air coming out of the distributing ducts 22 and over the electric strip heaters 29. This action continues and the temperature and humidity of the air which is being circulated up through the silk increases up to the point at which the automatic controls are set.

With the controller shown in Fig. 1 the dry bulb temperature is indicated and recorded by the pen 85a on the 24 hour chart 86. The wet bulb temperature is also indicated and recorded on the same chart by another pen 87. When the dry bulb pen 85 reaches the temperature at which the dry bulb pointer 83 is set it makes the electrical contact as above described which interrupts the flow of current in a relay which in turn opens a relay which prevents further flow of current to the strip heaters 29. In a similar manner when the wet bulb pen 87 reaches the temperature at which the wet bulb pointer 88 is set, the control circuit and passage of power to the immersion heaters 33 is interrupted.

The motor and blower are always running during the time that the switch 69 is closed and the air which is increasing in temperature and humidity is being blown up through the truck or skid load of silk or rayon. By this process the application of heat and humidity is gradual, progressive, steady and uniform throughout the load of yarn. A visible indication of what is being done is recorded on the chart 86 and this provides a check and reference sheet of great value. Different varieties may be readily run from time to time and the temperature and humidity conditions changed by merely changing the position of the pointers 83 and 88. After the temperatures of the wet and dry bulbs fall below the

settings of their respective pointers the heat is again turned on by the control circuits. In this manner the correct humidity is maintained and never exceeded. The silk or rayon is maintained in a circulating atmosphere which is in no way

injurious to its delicate nature.

It will be noticed that in the forms of my invention shown in the drawings, that the blower 16, blower casing 21, distributing ducts 22 and electric heaters are all inside the oven. They are all under the influence of the heated air within the oven and consequently all except the heaters are at the temperature of the air. For this reason there is no tendency for the moisture in the circulated air to condense on cold surfaces as all of the circulating system is inside the insulated shell of the oven.

In the same manner the trucks and bobbins on which the silk and rayon are spooled, are heated to the same temperature as the air which is circulating through them. An operator may consequently bring out silk or rayon from my steaming oven with a perfect uniform set and at the same time without any condensation, water spotting or other injury to the silk.

When my steaming oven is used for setting the twist in silk or rayon, the yarn and the sensitive gums and oils contained therein are never given the sudden temperature changes that they receive when treated with live steam. The process in my oven is better suited to the nature of the silk, and the air circulating system by constantly diffusing the air, makes the humidity inside the oven constantly and uniformly available. This is the reason that the results are so very fine and that these ovens have proved of such enormous benefit to the industry.

In the old steaming method, it was necessary because of degumming, water spotting, etc., to re-draw the silk from the bobbins on which it was steamed to other bobbins before winding on cones. Because of the better results obtained with my oven, this operation has been eliminated and great economies have resulted. Plants have found it possible to run at a profit whereas with the old steam boxes they could not do this.

In Fig. 5 is indicated a three heat switch 89 on the panel board 51 and this is sometimes inserted in the circuits to the immersion heaters to enable the operator to have a selection as to the amount of heat he wishes to use, and the rate of heating he wishes to obtain.

This has the effect of delaying the rate of humidity increase with respect to the rate of temperature increase and assures that the charge is heated before a high relative humidity is developed. In this way condensation is absolutely prevented. This is particularly desirable in rayon treatment.

It will be noticed that in the forms of my steaming ovens here shown, the vapor generators are small and contain a relatively small volume of water. This makes the oven operation faster and more sensitive by reducing the amount of water required to be heated.

It will also be noticed that the water in the vapor generators has not a large surface area and is covered from the direct blast of the air, so that the increase in humidity of the air depends entirely on the vapor generated by heat and not by contact between the air and the water surface. This makes the humidity control entirely dependent on the temperature control system and the air does not increase in humidity after the vapor ceases to be generated.

It will be further noticed that the sensitive wet and dry bulbs are so placed that they are in a blast of air just below the discharge from the air distributing ducts. This air circulation on the bulbs renders them very sensitive to changes in temperature and humidity.

I have shown here only an electrical application of my invention but do not restrict myself to this heating medium alone. Obvious modifications of these electrical ovens would be ovens using steam coils and steam heated water tanks or ovens using gas radiators and gas operated immersion heaters, with suitable controls. I therefore do not restrict myself to electrical heat as the energy for my steaming ovens but intend to include the other obvious mechanical equivalents and modifications of the same within the scope of my invention. I have selected electricity because of its simplicity of application and general desirability.

I claim as my invention and desire to secure by Letters Patent:

1. A method of setting the twist in silk, said method comprising placing in a heat-insulated enclosure a quantity of loosely assembled bobbins of silk; causing a rapid thorough circulation of air in said enclosure through said bobbins; gradually raising the temperature and humidity of said air from atmospheric conditions, at a rate to raise them to a maximum temperature of about 130°-200° F. and a maximum humidity to about 50 to 98% relative humidity, in about 5 to 60 minutes; and maintaining said maximum temperature and humidity for from 5 to 60 minutes.

2. A method of setting the twist in silk and rayon yarns, said method comprising placing in a heat insulated enclosure a quantity of loosely piled bobbins of said yarn; rapidly circulating through said bobbins in said enclosure a mixture of heated air and vapor, gradually increasing the temperature and humidity of said mixture of air and vapor until the dry bulb temperature is 180° F. and the wet bulb temperature is 170° F.; automatically controlling the wet and dry bulb temperatures at these points to maintain a predetermined relative humidity; continuing to rapidly circulate this heated mixture of air and vapor for a period of from 5 to 45 minutes.

3. A method of setting the twist in silk, said method comprising placing in a heat-insulated enclosure a quantity of separated bobbins of silk; causing a rapid thorough circulation of air in said enclosure through said bobbins; passing electric currents through conductors in water and in air within the enclosure to cause gradually raising of the temperature and humidity of said air from atmospheric conditions; causing the conditions within the enclosure to automatically control the currents to maintain a maximum temperature of about 160° F. to 170° F. and a maximum humidity to about 80% to 94% relative humidity, and maintaining said maximum temperature and humidity for about 15 to 40 minutes.

4. A method of treatment for setting the twist in silk, and rayon yarn, said method comprising placing in a heat-insulated enclosure a quantity of separated quantities of the yarn; causing a thorough rapid circulation of air in said enclosure through said yarn; gradually raising the temperature and humidity of said air from atmospheric conditions to a predetermined maximum temperature, while raising the temperature

of the air at a faster rate than the humidity and thereby maintaining the temperature of the air, yarn and interior surfaces of the enclosure above the dew point and the relative humidity well below the dew point, at all times during the treatment before and after said maximum temperature and humidity are reached; thereby to prevent condensation on such surfaces, and yarn and consequent water spotting of the yarn and consequent soiling, fading, elongation, shiners and degradation of value; and maintaining said maximum temperature and humidity, long enough to insure thorough penetration of moisture into, and setting of, the interior yarn without excessive heating or moisture at outer parts; said maximum and the temperatures of said treatment being at all times maintained at less than degumming and baking temperatures.

5. A method of treatment for setting the twist in silk and rayon yarn, said method comprising placing in a heat-insulated enclosure a quantity of separated bobbins of yarn; causing a thorough rapid circulation of air in said enclosure through said bobbins; gradually raising the temperature and humidity of said air from atmospheric conditions, at a rate to raise them to a maximum temperature of about 130° F. to 200° F. and a maximum humidity to about 50% to 98% relative humidity, in about 5 to 60 minutes, thereby gradually raising the temperature and humidity of the yarn; raising the temperature of the air at a faster rate than the humidity and maintaining the temperature of the air, bobbins, yarn and interior surfaces of the enclosure well above the dew point and the relative humidity well below the dew point, at all times during the treatment before and after said maximum temperature and humidity are reached; thereby to prevent condensation on such surfaces, bobbins and yarn and consequent water spotting of the yarn and consequent soiling, fading, elongation, shiners and degradation of value; and maintaining said maximum temperature and humidity for about 25 to 60 minutes, long enough to insure thorough penetration of moisture into, and setting of, the interior yarn without excessive heating or moisture at the outer parts, thereby insuring regularity of setting and facilitating use with automatic machines; the temperature of said treatment being at all times maintained at less than degumming and baking temperatures, thereby avoiding sticking, and the cost of consequent extra rewinding, and avoiding contraction of the yarn mass from the head of the bobbin and consequent excessive breakage and tying during winding after the treatment.

6. A method of setting the twist in silk, rayon or like material, said method comprising placing in an enclosure a quantity of the material; causing a thorough circulation of air in said enclosure adjacent to said material; raising the temperatures and humidity of said air from atmospheric conditions, to a temperature of about 130 to 200° F. and a maximum humidity to about 50 to 98% relative humidity in about 5 to 60 minutes; and maintaining said maximum temperature and humidity for 40 to 180 minutes.

7. A method of setting the twist of silk, rayon and like material, said method comprising placing silk or rayon of normal moisture content in air in an enclosure; raising the temperature of said air and material while maintaining the temperature of the air higher than the dew point of said air; and then maintaining the temperature and humidity of the air simultaneously at

about 130° to 200° F. and 50 to 99% relative humidity for about 40 to 180 minutes to set the twist of the material.

8. A method of treatment for setting the twist 5
in silk and rayon yarns, said method comprising placing in a heat insulated enclosure a quantity of yarn to be treated, causing a thorough circulation of air through said enclosure, raising the temperature and humidity of said air from atmospheric conditions, at a rate to raise them to 10
a maximum temperature of about 120° to 210° F. and a maximum humidity of about 40% to 99% relative humidity, in about 5 to 60 minutes thereby raising the temperature and humidity of 15
the yarn; maintaining the dry bulb temperature of the air at all times above the wet bulb temperature during the interval of increasing temperature and humidity, thereby to prevent condensation occurring on the yarn, and maintaining 20
said maximum temperature and humidity for about 5 to 180 minutes, long enough to insure

thorough penetration of moisture into and setting of the yarn without excessive heating, thereby insuring uniformity of setting and freedom from degradation of value.

9. A method of treatment for setting the twist 5
in silk and rayon yarn said method comprising placing in a heat insulated enclosure a quantity of yarn; causing a thorough circulation of air inside said enclosure, raising the temperature and humidity of said air from atmospheric conditions 10
to a maximum temperature of about 120° F. to 210° F. in about 5 to 90 minutes, while maintaining the temperature of the air above the dew point during the cycle of increasing temperature, thereby to prevent condensation and wetting, 15
and maintaining the air at said maximum temperature for a period of about 5 to 180 minutes, long enough to set the twist thoroughly and uniformly.

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