Dec. 1, 1959 L. L. LONG ET AL 2,914,806

METHOD FOR FORMING AND TREATING FIBERS

Filed Oct. 19, 1956 3 Sheets-Sheet 1

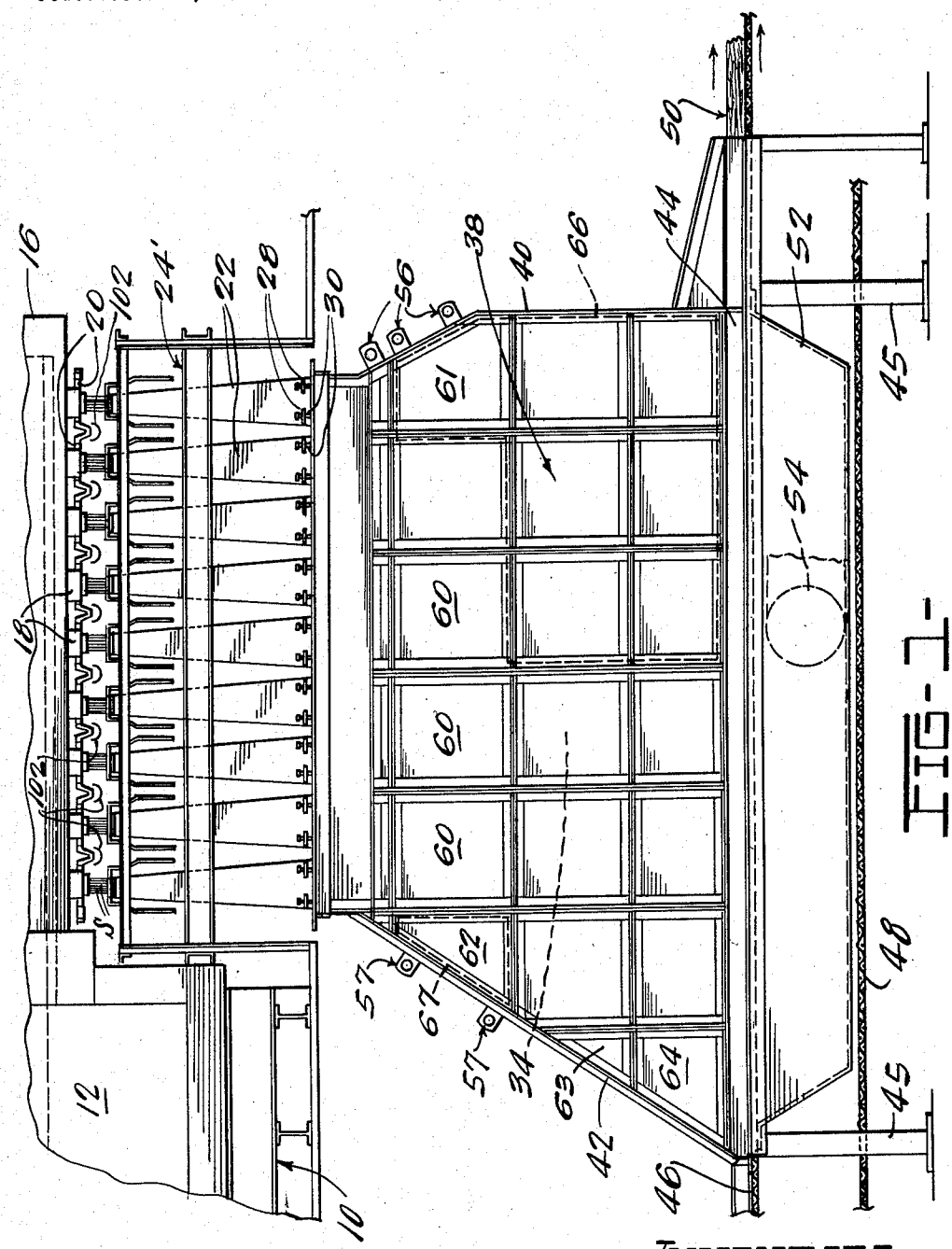



FIG. 1

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Filed Oct. 19, 1956 3 Sheets-Sheet 2

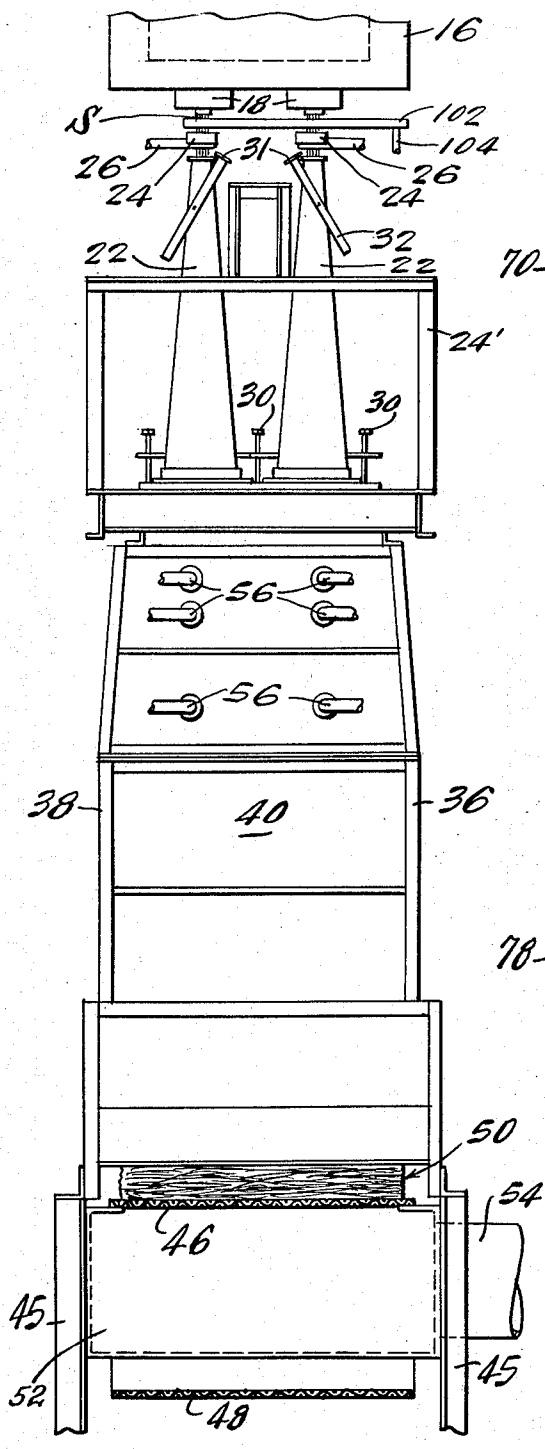



FIG-2-

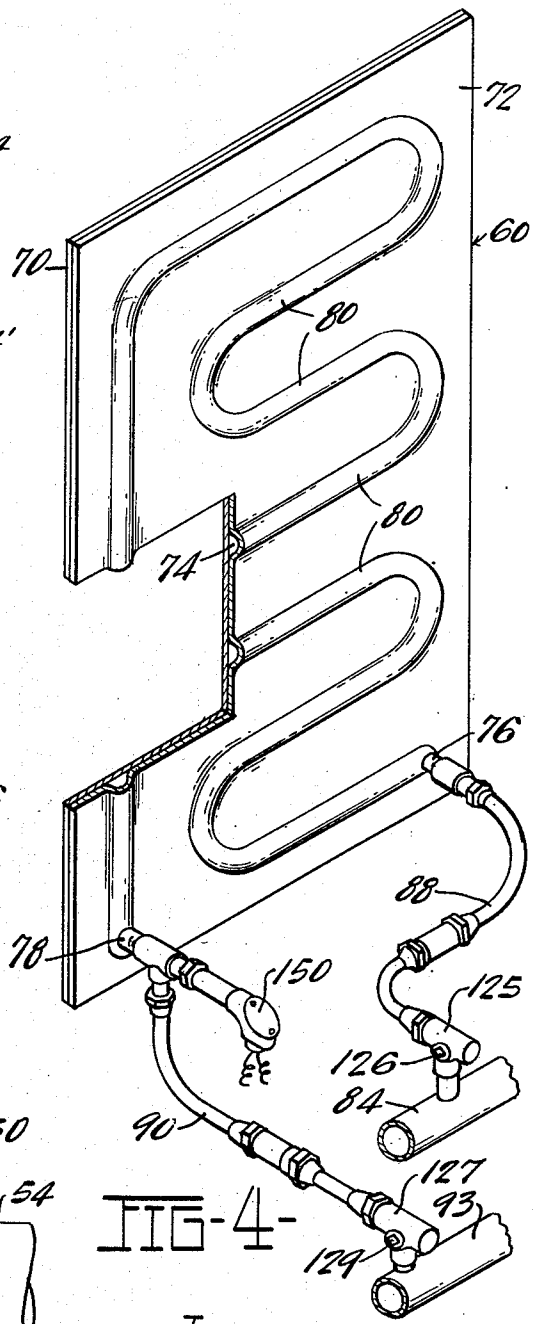



FIG-4-

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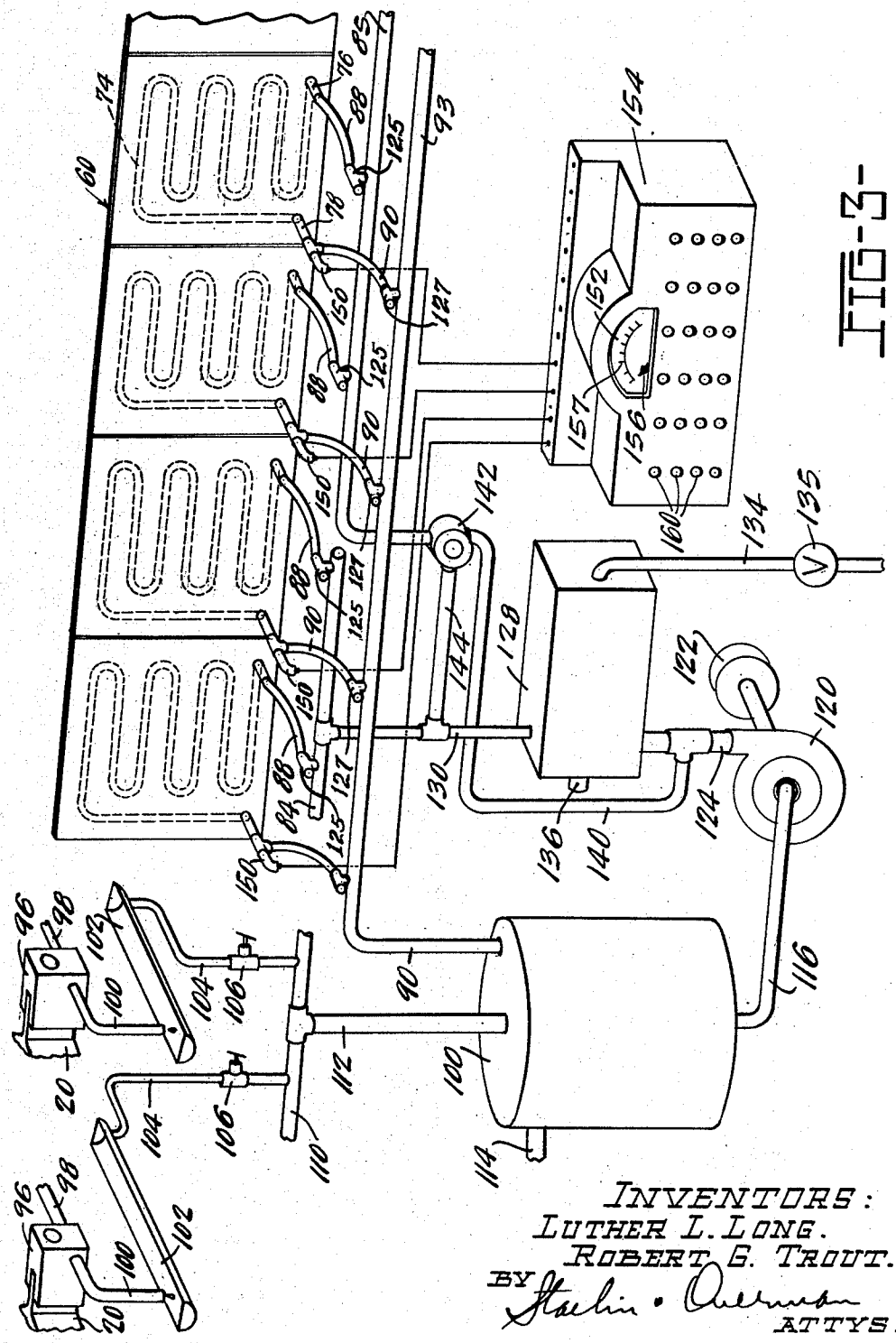



FIG-3-

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# METHOD FOR FORMING AND TREATING FIBERS

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Application October 19, 1956, Serial No. 617,133

1 Claim. (Cl. 18—47.3)

This invention relates to method for forming and treating or processing fibers and more particularly to method for producing and treating fibers formed of glass or other mineral material under controlled conditions.

It is conventional practice in forming fibers from heat-softenable materials such as glass, slag or fusible rock to engage a comparatively large number of fine streams of mineral material with high velocity blasts such as blasts of steam moving in the general direction of the streams for attenuating the streams to fibers. The steam of the blasts and the fibers being formed move through spouts into a fiber forming hood or chamber defined by a walled structure. It is a practice to apply or distribute a binder, adhesive or other fiber coating material into the forming hood and onto the fibers while they are in flight toward a fiber collecting zone or region. The fiber collecting region usually includes a moving conveyor of the foraminous or reticulated type, the fibers being collected upon the upper flight of the conveyor beneath which is disposed a suction chamber.

The suction chamber is connected with a suction blower or means for establishing a reduced or subatmospheric pressure effective beneath the fiber collecting flight of the conveyor to assist in the deposition of the fibers upon the conveyor flight as well as to convey away spent gases of the attenuating blasts.

Various kinds and types of fiber coating material may be delivered onto the fibers depending upon the ultimate use to be made of the fibers. Where the end product is a mat of fibers, it is desirable to apply to the fibers a binder or adhesive resin which when set or cured imparts a degree of mass integrity to the mat or product formed from the fibers. Typical of the binders used are phenol formaldehyde, urea formaldehyde, melamine formaldehyde resins or the like. The temperature in the fiber forming hood or chamber is somewhat critical as the coating resins or material must be maintained at relatively constant temperatures because of their critical characteristics such as flow-life and cure-time. Such resins because of their limited dilutibility must be used in fairly concentrated form. It has been found that the optimum temperature range in a forming hood is usually between 200° F. and 280° F. This temperature is established by the heat radiated from the molten glass and that derived from the super heated steam of the blasts utilized to attenuate the material to fibers. However, if the temperature is too high, the heat losses become excessive and if the temperature is too low, vaporization of the water in the binder solution does not ensue, a condition which requires increased heat to subsequently cure the binder in a curing oven.

Furthermore the binder or fiber coating material under normal hood temperatures tends to partially cure and adhere to and build up upon the walls of the fiber forming hood or chamber, necessitating frequent shutdowns in order to remove the material from the chamber walls.

Attempts have been made to exercise a measure of control over the temperature of the forming hood by



varying the amount of binder solution or to inject or introduce additional water but neither method has been satisfactory and has little or no effect upon the tendency of the adhesive or binder and binder laden clumps of fibers to cling to or pile up on the interior wall surfaces of the forming hood.

The present invention relates to a method for controlling the temperature adjacent the inner walls of a forming hood or chamber preventing or minimizing the adhesion of fiber coating material to the inner walls of the hood.

An object of the invention is the provision of a method for regulating or controlling the temperature of the walls of a fiber forming hood in a manner whereby a film or layer of moisture or condensation is established and maintained on the interior surfaces of the hood without materially affecting the temperature in the central region of the fiber forming hood or chamber.

Another object of the invention is the provision of a method for maintaining various sections or regions of the interior wall of a fiber forming hood just below the dew point of the hood atmosphere whereby a continuous film of moisture or condensation is maintained in all areas of the sections even though the ambient temperatures vary within comparatively wide ranges.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

Figure 1 is an elevational view of a fiber-forming apparatus embodying a fiber-forming hood adapted to carry out the method of the invention;

Figure 2 is an elevational view of the front end of the apparatus shown in Figure 1;

Figure 3 is a schematic view illustrating an arrangement for regulating the delivery of temperature controlling fluid through the passages in the wall sections or panels and means for indicating the temperatures of individual sections, and

Figure 4 is an isometric view illustrating one of the wall sections or panels and fluid connections therefor.

While the method of the invention is especially useable and adaptable for regulating or controlling the temperatures of various surface regions of a fiber-forming hood of a fiber-forming apparatus, it is to be understood that the principles of the invention may be employed wherever the same may be found to have utility.

Referring to the drawings in detail, and more especially Figures 1 and 2, there is illustrated a fiber-forming apparatus of the character wherein groups of streams of heat-softenable mineral material such as glass, slag or fusible rock are attenuated to fibers by directing steam or other gaseous blasts into engagement with the streams. The fibers so formed are treated or impregnated with a suitable binder, adhesive or other coating materials, the treated fibers being collected in a mass upon a moving surface which continuously conveys the mass of collected fibers away from the fiber-forming chamber.

The mass of fibers may be compacted or sized to produce a mat of desired density and dimension. The apparatus shown in Figures 1 and 2 is inclusive of a frame structure **10** of conventional character which supports a melting furnace **12** in which glass batch or other heat-softenable fiber-forming material is introduced and heat applied to reduce the glass batch to a molten or flowable state.

The melting furnace **12** is equipped with an elongated forehearth **16** provided with a glass receiving channel

which receives refined glass in a molten state from the furnace 12. Arranged in spaced relation lengthwise of the forehearth 16 is a plurality of feeders or bushings 18 which are secured adjacent the bottom wall or floor of the forehearth 16 by means (not shown).

Each of the feeders or bushings 18 is formed with a group of small orifices or openings through which streams of molten glass or other material are discharged from the forehearth 16. Electrical heating means 20 are provided for the feeders in order to maintain the glass in the feeders at the proper viscosity to provide for the constant discharge from the feeders of streams of glass of uniform size.

In the present embodiment, as exemplified in Figure 2, the forehearth is equipped with two parallel rows of feeders or bushings, and arranged beneath each feeder or bushing 18 is a fiber-forming spout 22 for receiving a group of the streams from a feeder and into which blasts of steam or other gas are directed for the purpose of attenuating the streams to fibers. Disposed adjacent the entrance of and above each of the spouts is a blower 24, each blower receiving super-heated steam through a supply tube or manifold 26.

The center region of each blower is provided with a passage to accommodate the vertically flowing glass streams S of a group and each blower is formed with restricted orifices or slots opening into the passage and through which the steam under comparatively high pressure is discharged in the form of blasts adjacent each side of a group of streams, the gases of the blasts moving downwardly at high velocities in the general direction of flow of the glass streams.

The high velocity blasts engage the streams and draw or attenuate the material of the streams to fibers.

As shown in Figures 1 and 2, the spouts are supported upon a suitable frame 24' in a manner whereby they may be tilted or rocked into positions out of the path of the glass streams when repair or service becomes necessary. The lower end regions of the spouts are provided with laterally extending projections 28, each of which is provided with a threaded member 30, the threaded members 30 between the spouts acting as fulcrums to facilitate tilting movements of the spouts 22.

Each spout is thus adapted to be tilted to bring the upper entrance end out of registration with the adjacent group of glass streams S when a feeder or blower is not in use or for purposes of repair or adjustment. When a spout 22 is moved or tilted to an ineffective position, a cover plate 31 carried by a pair of arms 32 is moved into position to close the entrance of the tilted spout so as to prevent an upward draft through the spout from the fiber-forming chamber or hood 34. The spout construction and mounting means therefor are of the character illustrated and described in detail in the Kleist and Slayter Patent No. 2,287,006, granted June 16, 1942.

The spouts 22 are in direct communication with a fiber-forming hood or chamber 34 positioned beneath the spouts. The hood or chamber is defined by walls formed of a plurality of panels or sections hereinafter described in detail embodying an arrangement for regulating and controlling the wall temperature of various regions of the chamber walls.

The chamber is formed with sidewalls 36 and 38, a front end wall 40 and a rear wall 42 forming a generally trapezoidal-shaped chamber or hood 34. The chamber is supported upon a frame 44 including struts 45 which are supported by or rest upon a floor or other suitable supporting surface.

The attenuated fibers moving through the chamber 34 are adapted to be collected upon the upper flight 46 of an endless belt-like conveyor 48, the conveyor being of a foraminous or reticulated type. The conveyor 48 is supported and driven by suitable rollers (not shown) whereby the upper flight 46 is longitudinally advanced through the base of the fiber-forming chamber 44, in a



right hand direction as viewed in Figure 1. The fibers which have been treated with binder, adhesive or other coating material in the forming hood 34 accumulate in a mass which is properly sized to form a mat 50 and which may be passed through a curing or drying oven to set the binder or adhesive on the fibers.

During flight of the attenuated fibers through the hood or chamber 34, a binder, adhesive or other coating material is delivered or sprayed onto the fibers by applicators 56 and 57 mounted on the front and rear walls 40 and 42. Binders such as phenol-formaldehyde, urea-formaldehyde or other resinous coating material or adhesive may be sprayed under pressure into the chamber by the applicators or nozzles 56 and 57.

Disposed beneath the upper flight 46 of the conveyor is a receptacle or suction box 52 which is connected by means of a pipe 54 with a suction blower or other source of reduced pressure for establishing a region of reduced pressure beneath the flight 46 and in registration with the base of the fiber-forming chamber 34. The suction or reduced pressure in the suction box 52 is effective through the apertures in the conveyor to assist in the deposition of the newly formed fibers upon the conveyor flight 46 and to convey away the spent gases of the attenuating blasts.

It should be noted from Figure 1, that the major area of the front wall of the hood is substantially vertical and the rear wall 42 is inclined downwardly and rearwardly. As the flight 46 of the conveyor 48 advances or moves in a right hand direction as viewed in Figure 1, the accumulation of fibers increases as the conveyor approaches the exit through an opening in the front wall 40.

Due to the accumulation and increasing thickness of the fibers toward the right hand zone of the fiber forming chamber 34 as viewed in Figure 1, the steam or other spent gases of the blast tend to be diverted toward a zone adjacent the inclined rear wall 42 as the gases are directed through the unimpeded region of the foraminous conveyor because of the negligible quantity of fibers at the entrance of the conveyor flight into the fiber forming chamber.

The gases of the steam blasts are at elevated temperatures and due to their diversion toward the rear wall 42 as above pointed out, the adjacent wall regions defining the fiber forming chamber tend to a higher temperature than the wall regions adjacent the right end zone of the chamber 34 as viewed in Figure 1.

Binders such as phenol-formaldehyde are heat curable and at the temperatures obtaining in the chamber 34 may be partially cured resulting in clumps or tufts of binder-laden fibers clinging or adhering to the walls as well as partially cured binder accumulating or building up on the walls.

The invention embraces a method of and means for regulating and controlling various interior surface regions or areas of the walls of the chamber or hood 34 so as to effect a condensation or formation of moisture on the interior wall surfaces and thereby prevent or minimize the accumulation of binder and binder-laden fibers on the walls.

The construction and arrangement of the walls of the hood defining the chamber 34 includes an assemblage of individual panels, wall units or sections. In the side wall construction 38 shown in Figure 1, the major number of the panels are of generally rectangular shape as indicated at 60. The panel section 61 at the upper right hand region of the forming hood is of trapezoidal shape while the sections 62, 63 and 64 adjacent the rear wall of the hood are of triangular shape. The panels, units or sections of the sidewall 36 are similarly configurated.

It will be noted that several of the sections adjacent the frontal region of the hood are circumscribed or embraced by broken lines as at 66 and that the uppermost triangular section 62 is circumscribed by broken line 67. It has been found that the regions of the interior surfaces

of the walls of the hood bounded by the broken lines **66** and **67** tend to be of a lesser temperature then the remaining wall sections **60** shown in Figure 1.

The invention involves selective control of the temperature of each of the panels or wall sections so that the temperatures of the inner surfaces of the panels or units are maintained just below the condensation or dew point of the atmosphere in the hood so as to cause the formation and continuous maintenance of a film of moisture on the inner surfaces of the wall sections, panels or units as the fibers and binder do not readily adhere to the wetted surfaces and precuring of binder near the walls is substantially eliminated.

Each of the panels, sections or units forming the walls of the hood **34** is provided with a channel, passage or duct to facilitate the circulation of a temperature controlling liquid. Figure 4 is illustrative of one form of wall panel or section **60** embodying a means for accommodating a temperature controlling fluid or medium. Each section includes a substantially flat or uniplanar plate or layer **70** and a second plate or layer **72** which is welded, bonded or otherwise joined to the panel **70**. The components or layers of the panels may be of metal such as stainless steel, aluminum or other suitable material.

The panel **72** is formed with a continuous recess or channel **74** which, as shown in Figure 4, is generally of serpentine configuration. The recess **74** together with the adjacent surface of the panel **70** forms a continuous duct, channel or passage. One end region or terminus of the channel **74** is connected with an inlet pipe **76** and the other terminus of the channel is connected with an exit pipe or outlet **78**.

The parallel regions **80** of the passage **74** are closely disposed in order to bring the temperature control fluid into contact with the inner plate or panel **70** in juxtaposed regions so that substantially the entire area of the inner plate or panel **70** may be maintained at a substantially uniform temperature under the influence of the temperature of the fluid flowing through the channel, recess or passage **74**.

While the panel or section illustrated in Figure 4 is of substantially rectangular shape, it is to be understood that the sections **61**, **62**, **63** and **64** and the panel sections at the ends of the fiber forming hood are provided with channels of the same general configuration as that shown in Figure 4. The panels are secured to adjacent panels by welding or by bolts so as to provide sealed joints between adjacent panels.

It has been mentioned herein that the inner walls at the forward region of the fiber forming hood and the inner wall at the upper portion of the rear zone of the hood are generally cooler during fiber-forming operations then the remaining areas of the walls of the hood. In order to adequately exercise effective temperature control over the interior surface regions of the fiber forming hood so that all wall areas be of a temperature adjacent but below the dew point, the hot and cold regions of the walls are preferably supplied with temperature controlling fluid at different temperatures.

As shown diagrammatically in Figure 3, the temperature controlling fluid is delivered to groups of panels or sections by means of dual manifolds or headers **84** and **85**. The manifold **84** is connected by means of tubes **88** with the inlet pipes **76** of the panels or sections **60** circumscribed by the broken lines **66** and the rear area **67** of the fiber forming hood which are usually of a temperature lower then that of the remaining areas or regions of the chamber walls.

Hence it is desirable to deliver to manifold **84** or header and to the panels or the sections connected thereto, a fluid at a higher temperature then that delivered to the manifold or header **85** which supplies fluid to the panels or sections adjacent the higher temperature regions of the fiber forming hood. Each of the outlet pipes **78** from



the panels is connected by means of a tubular connection **90** with a return manifold or drain pipe **93**.

While any suitable temperature controlling fluid in the form of gas or liquid may be utilized as a temperature controlling medium, it has been found that water provides a very satisfactory fluid for maintaining temperature control of the wall panels. Any suitable source of water at a desired temperature may be utilized in the temperature control system. The water may be supplied from a boiler (not shown) and delivered into a reservoir or tank **100** through suitable piping.

In the embodiment illustrated, the water at the desired temperature is obtained from water cooling jackets disposed adjacent the electrical terminals **20** connected with the glass feeders **18** (shown in Figure 1) for reducing the temperature of the electrical terminals. In Figure 3 there is illustrated diagrammatically cooling jackets **96** which are supplied with cooling fluid such as water through pipes **98**. The cooling jackets **96** are provided with outlet pipes **100** which direct the fluid discharged from the jackets into collecting or drain troughs or channels **102**.

Interposed between each of the inlet tubes **88** and the manifold **84** or **85** is a three-way valve **125**, the valve member of which may be regulated by manipulation of the valve controlling element **126**. Each of the outlet tubes **90** from the cooling panels is connected with a three-way valve **127** which, in turn, is connected with the return manifold or drain pipe **93**. The valve member in valve **127** may be regulated by manipulation of the element **129**. Through the individual valve arrangement for each panel the rate of flow of fluid through each individual panel may be accurately controlled and determined. The drain troughs or channels are connected by means of pipes **104** and valves **106** with a pipe or manifold **110** which is connected by means of a pipe or tube **112** with the reservoir or tank **100**. Thus the water leaving the cooling jackets **96** is at elevated temperature and is delivered into the tank **100**. It has been found that the temperature of the water delivered into the reservoir or tank **100** is at about 90° F. The tank **100** is not under pressure and is provided with an overflow tube or pipe **114** which may convey the excess water to a boiler or other facility.

The reservoir or tank **100** receives the return flow of water or other fluid from the panels or sections through the drain tube **93**. The temperature controlling fluid, such as water from the reservoir **100**, flows through a pipe or duct **116** to a circulating pump **120** preferably of the centrifugal type which is driven by an electrically energized motor **122** or other suitable source of power. The discharge pipe **124** from the pump outlet extends through a heat exchanger or heat transfer unit **128** and the outlet pipe **130** from the heat exchanger conveys the fluid or water directly into the header **84**.

The heat exchanger **128** is supplied with a heated fluid as for example, steam delivered into the exchanger through an inlet pipe **134**, the flow of which is controlled by a valve **135**. The heat exchanger is provided with a steam outlet pipe **136** which returns the steam at reduced temperature or condensate to the boiler or other source for reheating.

The water in the reservoir or tank **100** is normally maintained at a temperature of about 90° F. The temperature of the water to be delivered to and circulated through the panels adjacent the hottest regions of the fiber forming hood is controlled by mixing water at different temperatures by means of a mixing valve which may be manually set at the temperature desired. As shown in Figure 3, a pipe **140** is connected with the pump discharge pipe **124** and conveys water at a temperature of about 90° F. through a bypass around the heat exchanger **128** to a manually controlled mixing valve **142**. The pipe **130**, which conducts higher temperature water from the heat exchanger to the manifold

84, is in communication with the mixing valve 142 by means of pipe 144.

The header or manifold 85 is directly connected with the mixing valve 142 as shown in Figure 3.

Thus water at approximately 90° F. passes from the pump discharge pipe 124 through pipe 140 to the mixing valve 142, and water which has passed through the heat exchanger 128 and is at a higher temperature flows to the mixing valve through pipes 130 and 144. The temperature of the water discharged from the mixing valve into the header 85 will be at a temperature for which the mixing valve 142 is manually adjusted.

The water at a higher temperature supplied to the header 84 may be between 130° and 160° F. while the temperature of the water delivered from the mixing valve 142 into the header 85 may be at a temperature of from approximately 100° to 140° depending upon the size of the forming hood and the operating temperatures at which the glass or other mineral material is attenuated into fibers. In a typical installation, the temperature in the fiber-forming hood or chamber 34 is usually between 200° F. to 280° F.

The purpose and objective of circulating a temperature controlling fluid through the ducts or passages 74 in the cooling panels is to maintain the interior wall areas or surfaces of the panels just below the dew point. Due to the comparatively large amounts of steam or superheated steam projected into the forming hood as attenuating blasts, the hood contains a large amount of moisture at an elevated temperature. Hence by cooling the panels or reducing their temperatures within a range of from 100° to 160° F. or more, the temperature ambient the interior surfaces of the panels will be reduced below a dew point even though the dew point temperature within the hood may be considerably above room temperature.

The temperature of the fluid or water delivered from the heat exchanger into the header 83 is controlled by an automatic controller (not shown) of conventional construction which may be set to the desired temperature for the hot side or header 84 of the divided supply header and such temperature will be automatically maintained. The arrangement includes means for readily and instantly determining the temperature of the fluid existent at the region of its discharge from a panel. As shown in Figures 3 and 4, a thermocouple 150 is associated with each of the outlet pipes 78.

Each of the thermocouples is in circuit with an indicating instrument 152 contained within a housing 154. The instrument 152 is provided with a movable indicator 156 which cooperates with a dial 157 graduated in degrees Fahrenheit. The housing 154 is equipped with a plurality of individual switches 160, a switch being connected with each thermocouple 150 disposed at the outlet of the fluid passage in each individual panel.

Thus an operator by manipulating the proper switch 160 is enabled to obtain an indication on the instrument 152 of the temperature in degrees Fahrenheit of the water or other fluid at the discharge region thereof from a panel. If the operator ascertains that a certain wall region in the fiber forming hood is not at the proper temperature or below the dew point, adjustment of the temperature of the temperature controlling fluid or manipulation of the flow control valves 125 and 127 may be made at the individual panel until the abnormal temperature condition is corrected.

Another advantage is derived through the use of the method and apparatus of the invention where a heat-curable binder or adhesive is directed onto the fibers by the binder applicators 56 and 57. For example, a binder such as phenol-formaldehyde may be partially cured or polymerized under the influence of the elevated temperature existent in the fiber forming chamber. By reducing the ambient temperature of the walls or panels of the chamber so that moisture or condensation is present on the panel surfaces, the heat curable binder will not be cured or set up in the region of reduced temperature adjacent the chamber walls.

The temperature controlling panels forming the front and rear end walls of the fiber forming hood may be connected to receive fluid from either of the headers 84 or 85 dependent upon the temperature of the hood at the region adjacent each panel. Thus certain of the end wall panels may be connected with one header while other panels may be connected with the other header.

Through the method and arrangement of the invention, an effective and efficient control is exercised over the temperature of the walls of the fiber-forming hood or chamber to establish and maintain a film of condensation or moisture on the chamber walls to eliminate or minimize the accumulation of binder or fiber coating material or clumps of fibers on the walls.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

We claim:

A method of forming and processing fibers including attenuating streams of heat-softened mineral material to fibers by engaging the streams with high velocity gaseous blasts, directing the attenuated fibers through a walled chamber, delivering a coating material onto the fibers in the chamber, circulating a fluid through passage in the chamber walls, and controlling the temperature of the fluid to maintain the temperature of the chamber walls below the dew point to effect condensation of moisture on the interior surfaces of the walls to avoid adhesion of the fiber coating material to the walls.

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