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COOLING METHOD AND APPARATUS

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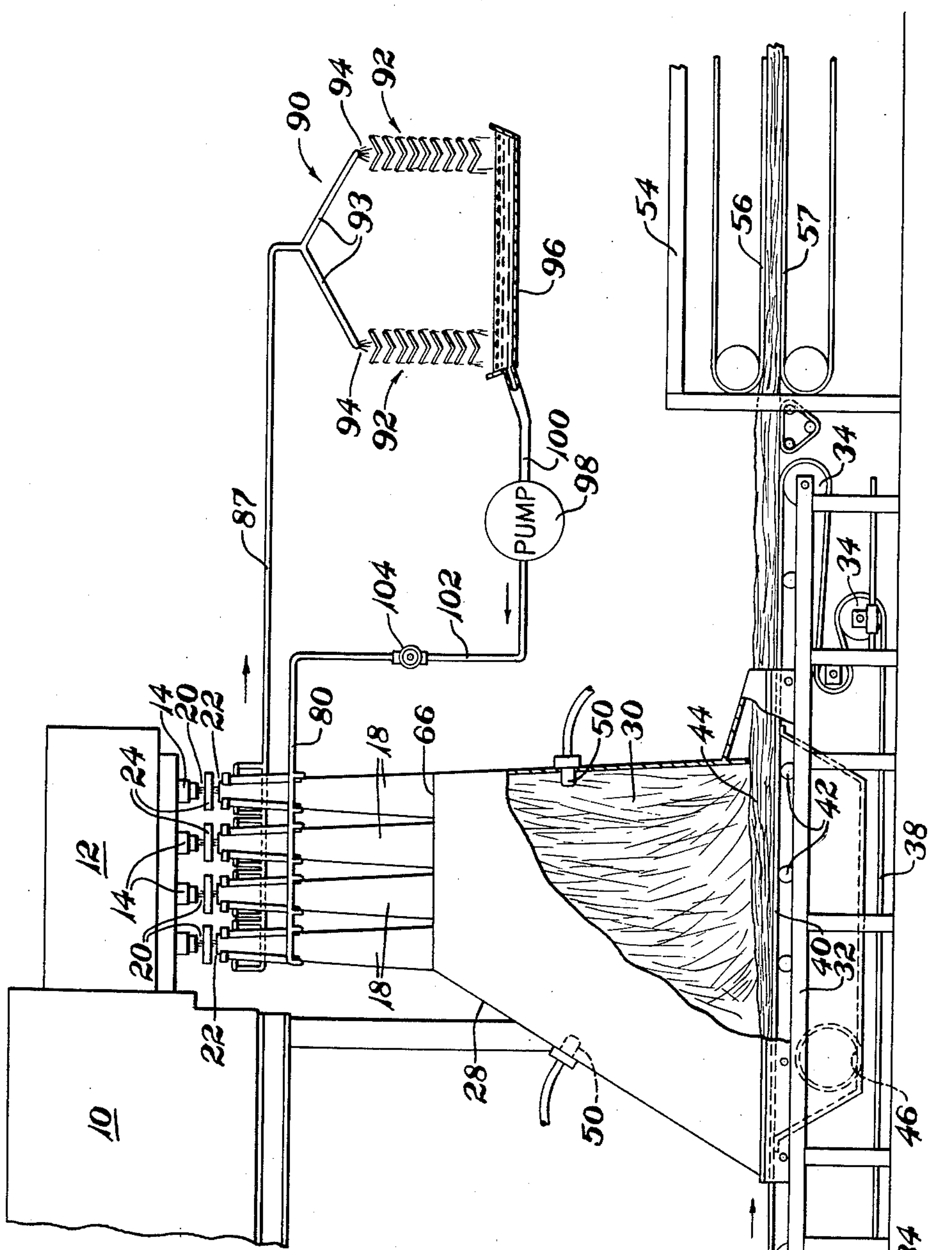

FIG-1

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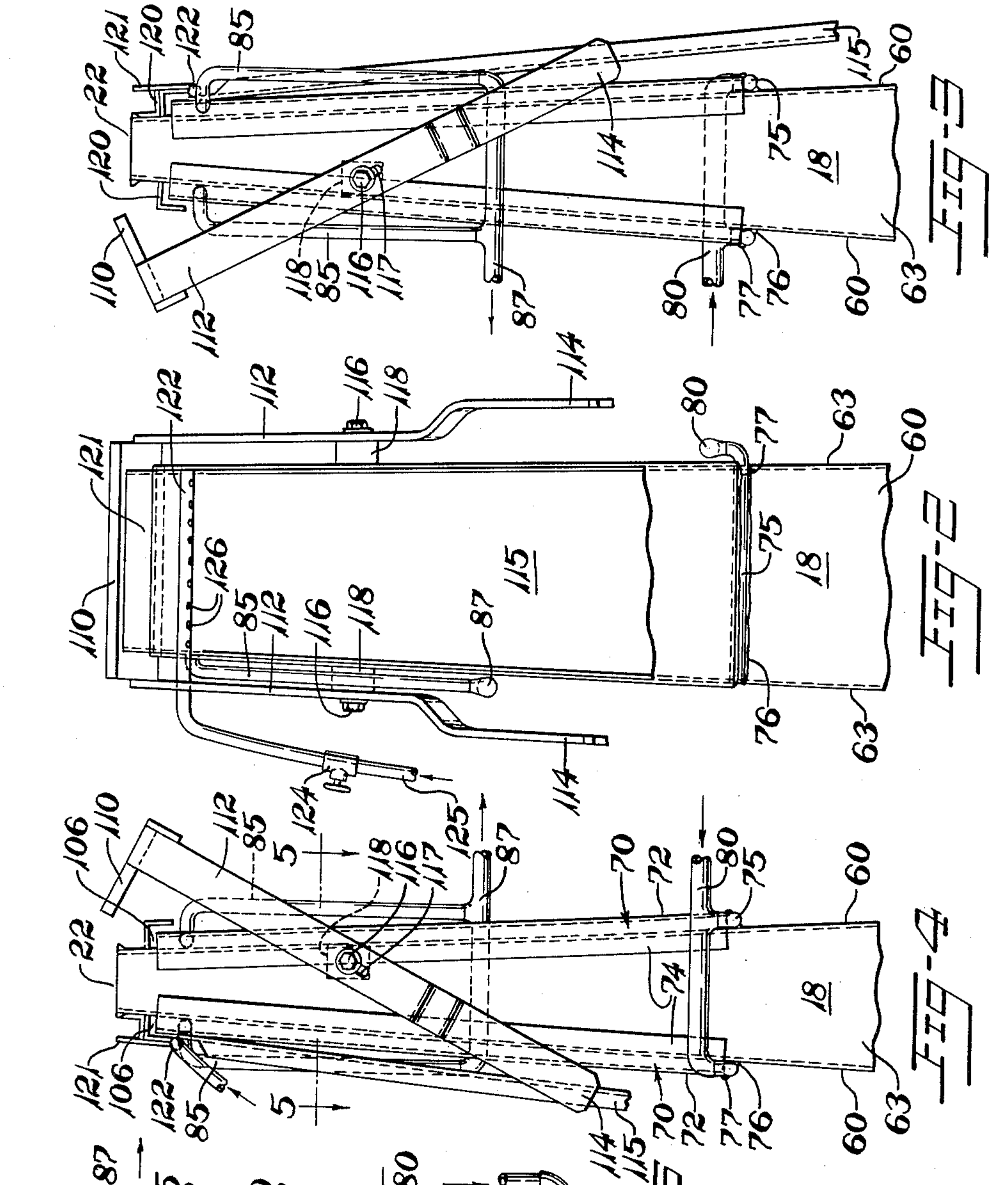

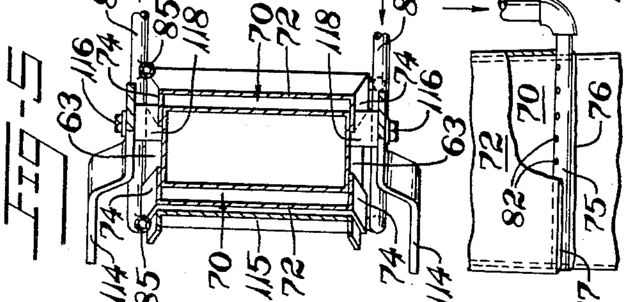

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COOLING METHOD AND APPARATUS

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This invention relates to method and apparatus for cooling chambers into which material is delivered at comparatively high temperatures and more especially to method and apparatus for conducting heat away from a chamber into which molten mineral material is delivered for attenuation to fibers.

In a process of forming or attenuating fibers from molten mineral materials, such as glass, slag or fusible rock, streams of the mineral material are flowed from feeders associated with the forehearth of a melting furnace and are directed downwardly into a chamber, usually referred to as a spout. Disposed at the upper ends of the spouts are blowers arranged to discharge blasts of steam or air downwardly in the general direction of the flow of the streams in the spout, the blasts engaging and attenuating the streams to fibers. The fibers formed by this method are conveyed by the blasts through a forming hood and are collected in a suitable manner, a conventional practice being to collect the fibers upon a foraminous conveyor moving in a direction to convey the collected fibers away from the forming hood for a subsequent processing or treatment.

The temperature of the streams of molten material, for example, glass, entering the spouts is usually within a range of from 2000° F. to 3000° F. The spouts are usually made of sheet metal and have a tendency to warp or be distorted under the influence of the intense heat emanating from the molten material. The newly formed fibers in the spouts are in a tacky state or condition and tend to adhere or cling to the hot interior surfaces of the spouts and to accumulate thereon. When fiber-forming conditions are not optimum at high rates of fiber production, the fibers accumulate in the spouts to an extent as to impede or obstruct the proper movement of the gases of the blasts, a condition which impairs the fiber-attenuating operations. When this occurs, the process must be interrupted and the fiber accumulation removed from the spouts before production can be resumed.

It is conventional practice to introduce a binder or bonding material onto the fibers in the forming hood by spraying the binder from suitable nozzles carried by the forming hood so that the binder is substantially uniformly distributed through the fibers as they are collected upon a suitable surface. A binder such as phenolformaldehyde is well adapted for the purpose in establishing mass integrity in a mat formed from the fibers, the mat of collected fibers with the binder distributed therethrough being passed through a suitable curing zone or oven where the binder is thermally cured or set to retain the fibers in mat formation. Phenolformaldehyde binders of the character used for the purpose may be thermally set at temperatures as low as 300° F. Difficulties have been encountered in the formation of fibrous mats in the above-described manner as the temperatures in the forming hood, due to the heat from the fibers, sometimes rise to the curing temperature of the binder, causing a premature setting of binder on the fibers moving through the forming hood and thus impairing the successful formation of a bonded mat. As a binder such as phenolformaldehyde is thermosettable, premature curing in the forming hood necessitates interrupting the fiber-forming operation until reduced temperature conditions are established in the hood.

Attempts have been made to cool the spouts by sprays of water on the exterior surfaces, but such efforts have been only partially satisfactory and are expensive due to the tremendous amount of water required and the lack of control of the water streams resulting in a nonuniform cooling of the metal, a condition which fosters buckling and warping of the sheet metal walls of the spouts.

The present invention embraces a method of conveying heat away from the spouts of a fiber-forming apparatus whereby an effective control is exercised so as to provide for a substantially uniform cooling of the zones of the spouts subjected to the intense heat from the fiber-forming material.

An object of the invention resides in a method or system of cooling the chambers or spouts through the continuous circulation of a cooling fluid or medium in contact with the walls of the chambers or spouts and the heated fluid or medium passed through a cooling zone or station at which the heat is removed from the fluid or medium and the cooled fluid returned into heat-absorbing contact with the walls of the spouts.

Another object of the invention resides in a method of circulating a cooling medium in contact with a spout of a fiber-forming apparatus wherein a uniform distribution of the cooling medium is obtained over the area to be cooled, the cooling medium being directed through chambers which are under atmospheric or low pressure to avoid distortion of the walls of the chamber.

Another object of the invention resides in a method of effectively conveying heat from a fiber-forming chamber to effectively control the temperature in the fiber-receiving chamber or forming hood to avoid premature curing of binder that may be introduced into the fiber-receiving chamber or hood.

Another object of the invention resides in a cooling apparatus for a fiber-forming chamber embodying a duct system for continuously circulating a cooling medium through suitable jackets vented or controlled in a manner to avoid excessive pressure in the cooling jackets.

Still another object of the invention is the provision of a cooling arrangement for a fiber-forming chamber employing a heat-transferring fluid adapted to convey heat away from a fiber-forming chamber to avoid tendency of the hot fibers to cling or adhere to the walls of the chamber, the arrangement including a substantially closed, fluid-circulating system whereby loss of the cooling fluid or medium is reduced to a minimum or substantially eliminated.

Still another object of the invention resides in effectively cooling the walls of a fiber-forming chamber through the use of a continuously circulating medium to a temperature below that at which the fibers tend to adhere to the walls whereby the rate of production of fibers may be increased.

Still another object of the invention is the provision of a circulating fluid cooling system for fiber-forming chambers wherein the fluid is metered through orifices of comparatively small size whereby the cooling fluid is effectively and uniformly distributed over the entire areas of the walls or surfaces to be cooled and to facilitate and control the delivery of the proper amount of cooling fluid to each of the chambers to be cooled thereby.

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 a semidiagrammatic elevational view showing a fiber-forming apparatus and an arrangement associated therewith for carrying out the method of cooling fiber-forming chambers;

FIGURE 2 is a front elevational view illustrating a cooling jacket disposed at the upper portion of one of the chambers or spouts in which streams of material are attenuated to fibers;

FIGURE 3 is a righthand side elevational view of the construction shown in FIGURE 2;

FIGURE 4 is an elevational view of the opposite side of the construction shown in FIGURE 2;

FIGURE 5 is a horizontal sectional view taken substantially on the line 5—5 of FIGURE 4, and

FIGURE 6 is a detail view of one of the cooling medium distributing elements forming a part of the apparatus of the invention.

The method and apparatus of the invention have particular utility in connection with the apparatus for forming fine glass fibers from molten glass by engaging blasts of steam or air with streams of glass. It is to be understood that the cooling or heat-transferring arrangement of the invention may be utilized for cooling and controlling the temperature of chambers of other forms of fiber-producing apparatus.

Referring to the drawings in detail, there is illustrated in FIGURE 1 a melting furnace or receptacle **10** in which glass batch or other fusible mineral material may be heated to a molten or flowable condition. The furnace **10** is provided with a forehearth **12** which receives molten material from the furnace **10**. In the illustrated embodiment a plurality of feeders or bushings **14** (there being four in the illustrated apparatus) is arranged beneath the forehearth, the bottom walls of each of the feeders being formed with a plurality of orifices or outlets through which flow streams **20** of the glass or other molten material in the forehearth.

The streams of glass or other fiber-forming material are attenuated to fibers by engaging the streams with high velocity gaseous blasts such as steam or air wherein the blasts move in the general direction of travel of the streams. The streams of fiber-forming material and the gaseous blasts are delivered into casings or spouts, there being one spout for each group of glass streams from a single feeder, the spouts being in communication with a hood construction in which the fibers are collected.

As shown in FIGURE 1, a sheet metal casing or spout **18** is disposed beneath each of the feeders **14**, forming a chamber into which flow streams **20** of glass or molten material from the forehearth **12**. Disposed above the entrance **22** of each of the spouts **18** is a blower **24** connected with a source of gas under pressure such as steam or compressed air. Each blower is formed with elongated slots (not shown) disposed at opposite sides of the group of streams of glass from a feeder, the gas under pressure being directed through the slots at a high velocity forming the attenuating blasts. The steam or air blasts from the blowers move in the general direction of flow of the glass streams and engage the streams in the spouts **18**, attenuating or drawing the streams into fine fibers.

The attenuating operation is carried on within the spouts **18** and in a forming hood **28** which is disposed beneath the spouts **18** and into which the attenuating blasts and fibers are directed. The forming hood **28** is of a substantially larger volumetric content than the combined volumetric content of the spouts **18** so that the velocities of the gases of the blasts and the fibers are reduced in the chamber **30** defined by the walls of the forming hood **28**.

Disposed beneath the forming hood **28** is a frame **32** on which is journaled a plurality of rollers **34** supporting an endless conveyor **38** which is moved at a predetermined speed by a motor or other means (not shown). The upper flight **40** of the conveyor **38** passes over and is supported by idler rolls **42** and provides a

surface upon which the fibers in the forming hood **28** are collected to form a mass or mat **44** as shown in FIGURE 1. Positioned beneath the upper flight **40** of the conveyor belt and in registration with the forming hood is a chamber **46** which is connected with a blower or suction means to establish a zone of subatmospheric pressure or suction beneath the upper flight **40** of the foraminous conveyor **38**.

The reduced pressure within the suction chamber defined by the member **46** serves to facilitate the collection and retention of the newly formed fibers upon the upper flight **40** of the conveyor and carries away the spent gases of the blasts from the blowers **24**. The thickness of the collected mass or mat **44** of fibers may be regulated and controlled by varying the speed of movement of the fiber-collecting conveyor **38**. The forming hood is provided with applicators or nozzles **50** for directing a bonding material or binder such as phenol-formaldehyde onto the fibers moving through the forming hood **28**. The binder-impregnated mass or mat of fibers is conveyed into an oven or curing chamber or zone **54**, the mass of fibers being compressed between endless conveyors **56** and **57** which determine the thickness of the bonded mat. The binder in the mat is cured or set in the oven or heating zone **54** so as to maintain mass integrity in the finished mat.

The temperature of the streams of glass is usually about 2200° F. or higher, and a vast amount of heat is radiated from the glass delivered into the spouts **18** for attenuation to fibers. The heat emanating from the intensely hot glass or other molten material heats the inner walls of the spouts **18**, particularly the upper zones thereof; and under certain conditions of operation, the fibers may be in a tacky or plastic condition to the extent that they readily adhere to the heated metal surfaces of the spouts **18**, the tacky fibers rapidly piling up and obstructing the free flow of the streams, thus impairing attenuation of the streams to fibers. The cooling arrangement or method of the invention for reducing and controlling the temperature of the walls of the spouts involves uniform distribution of a cooling fluid or medium over the zones of the spouts desired to be cooled and includes an arrangement for transferring or dissipating the heat in the cooling medium to the atmosphere and recirculating or reusing the cooling medium.

Each of the spouts **18** is formed with side walls **60** and end walls **63**, the walls being formed of sheet metal. The cross-sectional area of the spout is generally rectangular, the walls tapering outwardly and downwardly from the entrance **65** and joining the upper portion of the forming chamber **28** at **66**.

Disposed adjacent to and coextensive with the upper portions of the walls or surfaces **60** of a spout construction is a jacket or chamber **70** adapted to receive a cooling or heat-transferring medium. Each of the jackets **70** is formed of a metal sheet **72** provided with inwardly extending flanges **74**, the flanges overlapping and engaging the end walls **63** as shown in FIGURE 5. The flanges **74** may be welded or otherwise fixedly secured to the end walls of the spout in order to form the chambers **70** which receive and accommodate the cooling medium or fluid.

The lower end of each of the chambers **70** formed by the channel-shaped, sheet metal member **72** is closed by a pipe, tube or duct **75** which is welded to the wall of the spout as indicated at **76** and to the lower edge of wall **72** as at **77** to form a fluid-tight bottom wall for the jacket or chamber **70**. As shown in FIGURES 3 and 4, the pipes or tubes **75** are connected by suitable fittings with a manifold or supply tube or pipe **80** of larger internal diameter than the internal diameters of the tubes **75**, the manifold **80** being disposed as shown in FIGURE 1 to supply cooling medium to the pipes **75** at the lower ends of the several jackets associated with the spouts **18**.

Each of the pipes or tubes **75** is formed with a plurality of comparatively small openings 82, preferably uniformly spaced along the tube 75 and opening into the jacket or chamber 70. By way of example, the pipe 75 may be a 1/4" or 3/8" inside diameter and the openings 82 may be in the nature of 1/32" to 1/16" in diameter. One of the purposes of utilizing a plurality of small openings 82 spaced uniformly along pipes 75 is to distribute the cooling water or other fluid flowing into the chamber 70 throughout the entire transverse area of the jacket or chamber so that incoming cooling fluid is uniformly distributed transversely of the surface area of the plates forming opposed walls of the spouts 18. In this manner the jacketed zones of the spouts 18 will be cooled uniformly and prevent distortion or warping of the spout walls, a condition which obtains when cooling of the wall areas is not uniform.

The upper end zones of the jackets or chambers 70 are preferably open or vented to the atmosphere and provide means for accommodating overflow of the cooling medium in the event the cooling fluid drain system becomes partially clogged or ineffective to carry the fluid away from the cooling jackets at a rate equal to the rate of flow of fluid into the cooling jackets. As particularly shown in FIGURES 3 and 4, a pipe or tube 84 is connected to the upper zone of each of the jackets or chambers 70, forming fluid return ducts through which the fluid is withdrawn or flows away from the jackets or chambers.

The tubes 85 are joined with a main fluid return tube 87 of sufficient size to carry away the fluid from all of the jackets. The arrangement of the invention includes a heat transfer arrangement or means of removing heat acquired from the spouts 18 from the fluid medium in order to reuse or continuously recirculate the fluid medium through the spout-cooling jackets as shown in FIGURE 1. The fluid return tube 87 conducts the heated fluid from the spouts 18 to a heat-removing or transferring device 90. The arrangement shown at 90 may be a conventional cooling condenser consisting of banks or rows of trough-like members 92 in vertically spaced arrangement. The tube 87 may be connected to pipes or tubes 93 for conveying the cooling medium or fluid 94 into the troughs formed by members 92.

The cooling medium or liquid overflows the trough members 92, subjecting the cooling liquid over a large surface area to the atmosphere whereby the heat in the cooling medium is radiated into or transferred to the surrounding atmosphere. The cooled liquid or medium is cooled in a receptacle 96 which is in communication with a pump 98 by means of a feed duct 100.

The pump may be of a conventional fluid-circulating type of a continuous-operating, rotary character or other suitable pumping means which when operated withdraws cooled liquid from the receptacle 96 which receives the cooled liquid from the members 92 through pipe 100 and through a feed pipe 102 through a flow control valve 104 and manifold pipe or supply tube 80, thence into the pipes 75 disposed at the lower ends of the cooling jackets. The valve 104 is intercalated in the fluid feed line so as to regulate the rate of flow of liquid or cooling medium delivered to the jackets 70.

While an aerating condenser 92 is illustrated as a means for withdrawing heat from the cooling liquid, it is to be understood that other methods or apparatus may be employed for removing the heat from the liquid or medium such as refrigeration devices or by forced circulation of a heat-absorbent fluid in heat-transferring relation with the cooling medium. The manifold supply tube 80 and tube 102 connecting the pump 98 with the liquid distributing tubes 75 at the jackets 70 are of substantially larger size than the tubes 75 so that an adequate supply of fluid is distributed substantially uniformly to each of the pipes 75 at the jackets or chambers 70. The fluid return tubes 85 and the return line 87 are of a size to adequately conduct the fluid to the cooling condenser.

In the event that liquid or fluid is delivered into the jackets at a rate in excess of the rate of withdrawal of the liquid from the jackets, the level of the liquid in the jackets may rise and overflow at the zones 106, the overflow moving downward exteriorly of the walls 72.

Through this arrangement, the cooling fluid or medium, which is preferably water because of its ability to readily take up large quantities of heat, is moved continuously through the cooling jackets or chambers 70 through the continuous operation of a fluid-circulating pump 98. The heat acquired from the walls of the spouts 18 during the upward movement of the fluid or water in the jackets 70 is removed from the fluid by the heat transfer means or cooling apparatus 92. Through this arrangement, there is no appreciable loss of cooling fluid or medium, and a continuous supply of cooled fluid or liquid is delivered through the jackets 70.

While it has been found that effective temperature control is attained by disposing the cooling jackets adjacent the opposed side walls of the spouts 18, it is to be understood that the jackets may be extended across the end walls of the spouts so as to effect cooling of all four walls of each of the spouts, if desired. The regulating valve 104 connected in the feed line from the pump 98 to the several cooling jackets may be supplemented by individual regulating valves (not shown) intercalated between the feed manifold 80 and the individual fluid-distributing pipes 75 to effect individual regulation or control of the flow of the cooling fluid to each jacket, if desired. By introducing the cooling fluid at the lower end zones of the cooling jackets or chambers 70, the fluid gradually acquires heat from the walls of the spouts 18 and flows upwardly, not only under the influence of the incoming streams of liquid entering the jackets through the small openings 82 but also through the natural thermosyphon characteristic of the cooling water.

The continuous withdrawal of heat from the zones of the spouts in which the streams of molten material are projected and attenuated to fibers improves the fiber-attenuating operation and greatly reduces or eliminates the tendency for the fibers to adhere to the walls of the spout by reason of the reduction in temperature at the upper zones of the spouts 18.

Each of the spouts is provided with a cover or closure arrangement adapted to be moved over the entrance 65 of a spout in the event that the glass feeder adjacent the spout becomes clogged or ineffective to properly feed streams of glass or molten material into the spout. The closure construction is inclusive of a cover member or cap 110 which is provided with downwardly extending bars or members 112 adjacent the end zones of the spout and extending downwardly and outwardly to provide handle portions 114 which also function as counterweights for the cap 110 and the weight of the upper portions of arms 112. The arms 112 are pivotally supported about the axis of bolts 116 extending through openings or slots 117 in the arms and into threaded openings formed in brackets 118, welded or otherwise secured to the end plates of the spout constructions. The pivotal axis for the closure members provided by the bolts 116 is offset from a central plane through the spout as shown in FIGURES 2 and 4, the closure 110 being shown in open position.

Due to the offset positioning of the pivotal supports or bolts 116, the upper or exterior surface of the cap or closure 110, when in spout-closing position, is inclined downwardly. Thus, when the cap is in spout-closing position, any molten glass moving through the feeder adjacent the closure 110 strikes the closure end, due to inclination thereof, flows from the cap 110 onto a sheet metal chute 115 shown in FIGURE 4 and is conveyed away from the exterior zone of the spout as waste material.

Means is provided for flowing water downwardly in the chute **115** when waste glass is being discharged from the upper surface of the closure **110**. As shown particularly in FIGURES 3 and 4, brackets **120** are welded to each side of the walls **60** and **61** of the spouts to prevent the ingress of foreign matter into the open zones at the upper ends of the jackets or chambers **70**. Secured to one of the brackets **120** as shown in FIGURES 3 and 4 is a baffle or member **121** to which is secured a pipe or tube **122** connected with a source of water supply through a valve **124** and a pipe **125** connected with a source of water supply.

The pipe **122** extends transversely of the sheet metal chute **115** and is formed with a series of spaced openings **126** as shown in FIGURE 2 through which water is discharged onto the surface of the chute **115**, cooling the latter to prevent the waste glass from adhering to the chute. The discharge of water from pipe **122** may be controlled through adjustment of the valve **124**. The valve **124** is opened only when the closure or cap member **110** closes the entrance **65** to the spout to divert waste glass into the chute **115**.

While the arrangement of cooling fluid circulating system illustrated in the drawings includes venting the jackets or chambers **70** to the atmosphere, it may be desirable in certain installations to place the jackets under low fluid pressure where increased rate of fluid flow may be required. In such arrangement, the upper end zones of the jackets may be closed by suitable closure plates welded in position to provide fluid-tight constructions. A pressure-regulating or relief valve is inserted in the return line **87** to control or regulate the pressure in the cooling jackets or chambers. When a closed fluid pressure system is employed, the fluid pressure should be maintained low enough to avoid substantial distortion or flexure of the metal plates or sheets forming the walls of the spouts and cooling jackets associated therewith.

It will be apparent that the arrangement of the invention provides a novel method and apparatus for exercising effective control over the temperature in the spouts, and this control facilities the maintenance of optimum production and reduces or eliminates the tendency of the newly formed fibers to adhere to the inner walls of the spouts and obstruct the same, necessitating shutdowns to clean out the spouts. Through the utilization of the present invention, high production of fibers may be continued indefinitely as the tendency for fibers to block the entrances of the spouts **18** is substantially eliminated. Furthermore, the rate of production of fibers may be increased by increasing the amount of molten glass delivered into the spouts as the spouts are maintained at a lower operating temperature, avoiding or minimizing the tendency of the fibers to cling to the walls of the spouts, and heat from the glass is withdrawn in sufficient quantities by the cooling fluid whereby the temperatures in the forming hood are reduced below the curing temperature of the binder, thereby preventing premature setting of the binder.

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:

1. Apparatus of the character disclosed, in combination, a spout into which streams of molten mineral material are delivered, means for projecting gaseous blasts into the spout for attenuating the material of the streams into fibers, receptacles formed adjacent oppositely disposed walls of the spout adapted to receive a heat absorbing liquid, a wall of each spout forming one wall of a receptacle, said receptacles being vented to the atmosphere, a heat transfer means for cooling the liquid, a plurality of liquid conveying tubes arranged for recirculating liquid through the receptacles and the heat transfer means, and pumping means for moving the liquid.

2. The herein disclosed method including the steps of feeding streams of fiber forming mineral material through a walled region forming a confined zone, directing gaseous blasts into the walled region and engaging the streams of material to attenuate the same to fibers, establishing a chamber adapted to contain a heat absorbing fluid arranged to contact a wall defining the confined zone, conveying heat absorbing fluid into the chamber whereby heat from the fiber forming zone is transferred to the fluid, conveying heated fluid away from the chamber to a fluid cooling station, cooling the fluid at said station, and recirculating the cooled fluid through the chamber.

3. The herein disclosed method including the steps of flowing streams of fiber forming mineral material from a supply through a walled fiber forming zone, directing gaseous blasts into the walled fiber forming zone into engagement with the streams to attenuate the streams to fibers, directing a cooling liquid into contact with a wall of the fiber forming zone, conveying the heated liquid from the region of the fiber forming zone to a cooling station, extracting heat from the liquid at the cooling station, and continuously recirculating the cooled liquid into contact with the wall defining the fiber forming zone.

4. Apparatus of the character disclosed, in combination, means for feeding streams of fiber forming mineral material from a supply, a walled housing into which the streams are delivered, means for directing gaseous blasts into the housing and into engagement with the material of the streams for attenuating the same to fibers, a chamber arranged adjacent the housing, a wall of the housing forming a wall of the chamber, said chamber adapted to receive a heat absorbing fluid, heat transfer means spaced from said chamber for extracting heat from the fluid, means for conducting heated fluid from the chamber to the heat transfer means and for conducting cooled fluid from the heat transfer means to the chamber, and a pump for continuously circulating the fluid through the chamber and heat transfer means.

5. Apparatus of the character disclosed, in combination, a frusto-conically shaped spout, means for flowing streams of fiber forming mineral material from a supply into the spout, means for directing gaseous blasts into the spout and into engagement with the streams for attenuating the material of the streams to fibers, jackets respectively disposed adjacent opposed walls of the spout and forming with the adjacent walls of the spout a pair of chambers adapted to contain a cooling liquid, a pipe forming a lower wall of each of said chambers connected with a supply of cooling liquid for conveying the liquid into the chamber, each of said pipes being formed with longitudinally spaced openings interiorly of the chamber for distributing the cooling liquid throughout the width of each chamber, means for conveying heated liquid away from the chambers, and pumping means for establishing continuous circulation of liquid through the chambers.

6. In combination with a frusto-conically shaped spout, means for flowing streams of fiber-forming mineral material from a supply into the spout, means for directing gaseous blasts into the spout in engagement with the streams for attenuating the material of the streams to fibers, jackets disposed adjacent opposed walls of the spout and forming with adjacent walls of the spout a pair of chambers extending lengthwise of the spout and adapted to contain a cooling liquid, means for conveying cooling liquid into an end region of each of the chambers, means for conveying the liquid away from the other end regions of the chambers to a cooling station, and pumping means

for continuously circulating cooling liquid from the cooling station through the chambers at a regulated rate to maintain the chambers filled with liquid.

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