Nov. 8, 1966 C. J. STALEGO 3,284,180

APPARATUS FOR PRODUCING FIBERS FROM HEAT-SOFTENABLE MATERIAL

Original Filed Oct. 19, 1961 2 Sheets-Sheet 1

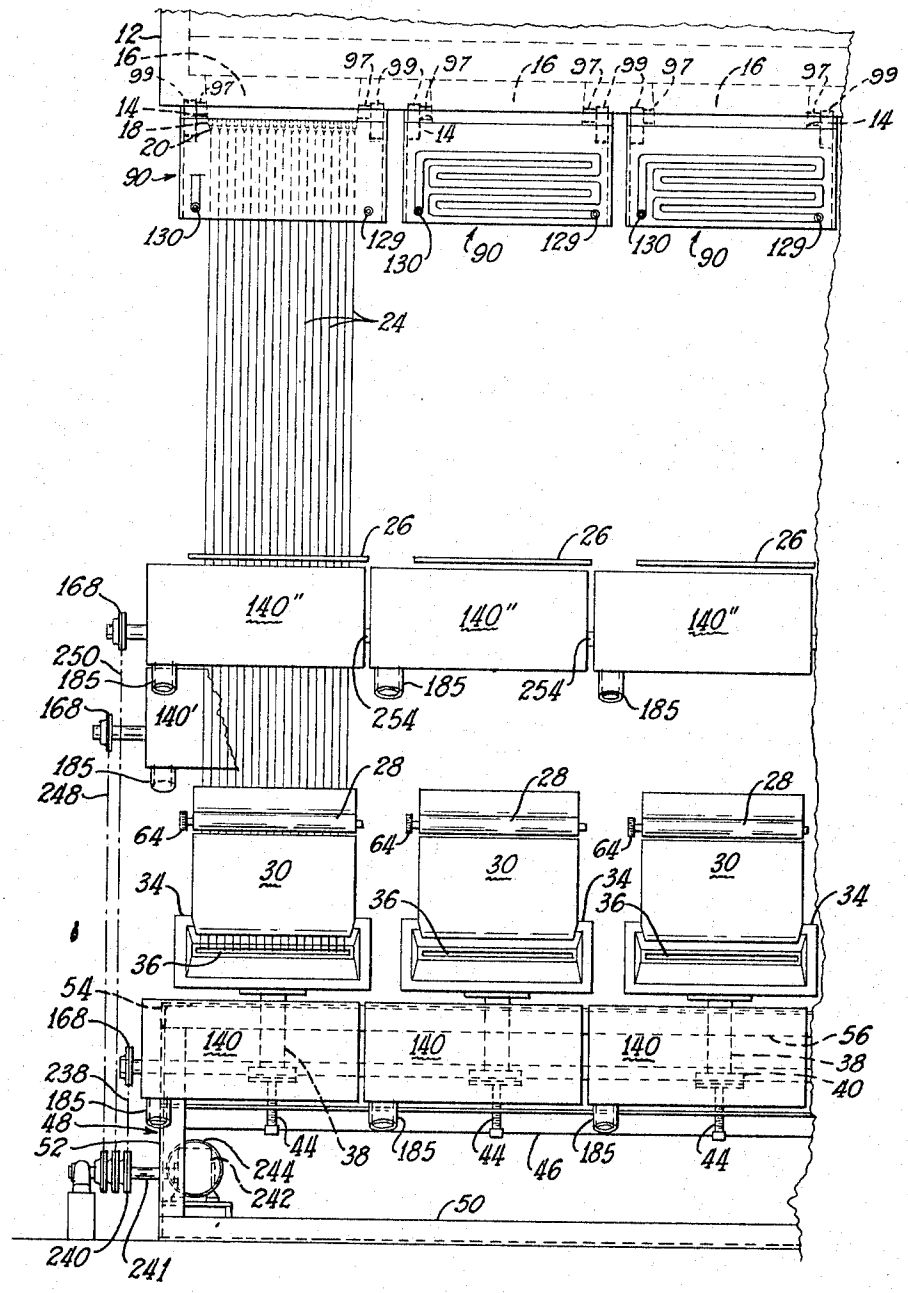


Fig. 1

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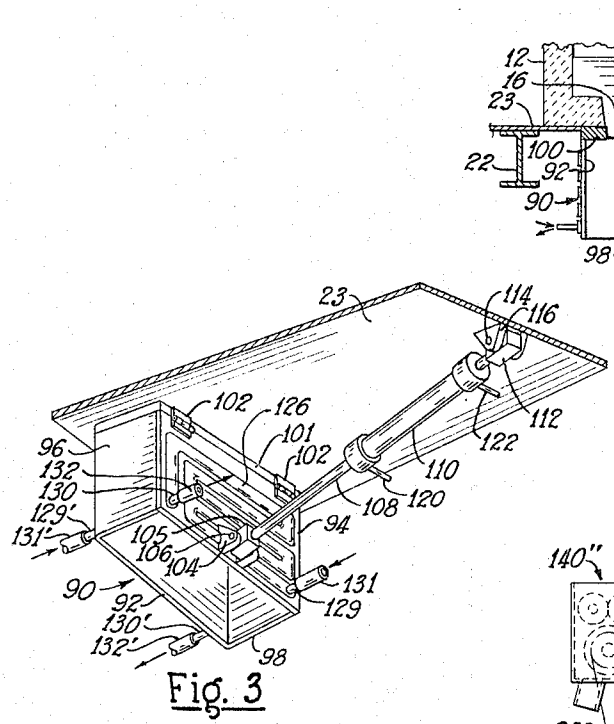


Fig. 3

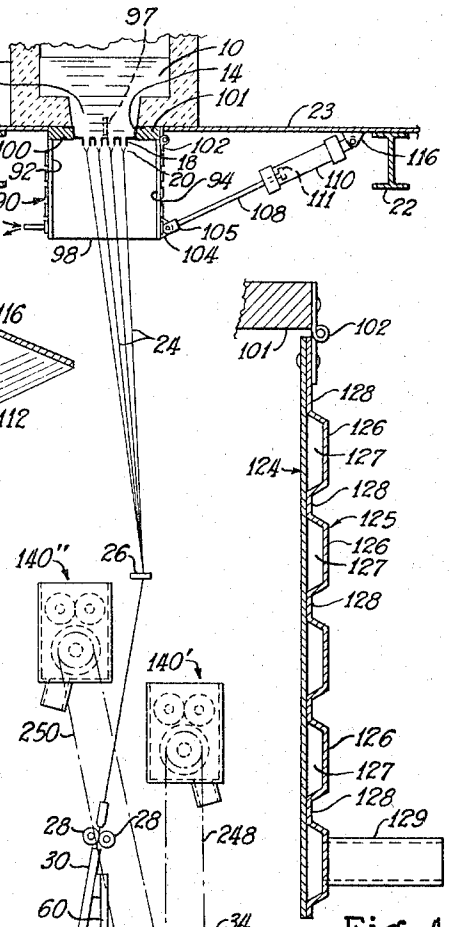


Fig. 4

Fig. 2

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APPARATUS FOR PRODUCING FIBERS FROM HEAT-SOFTENABLE MATERIAL

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Original application Oct. 19, 1961, Ser. No. 146,197, now Patent No. 3,233,991, dated Feb. 8, 1966. Divided and this application Mar. 24, 1965, Ser. No. 442,274
5 Claims. (Cl. 65—12)

This application is a division of my copending application Serial No. 146,197, now Patent Number 3,233,991.

This invention relates to a method of and apparatus for producing fibers from heat-softenable materials and more especially to a method of and apparatus for producing fibers from heat-softenable mineral materials such as glass, slag or fusible rock.

Fibers of glass and similar materials have been formed or produced by attenuating streams of glass to primary filaments and the primary filaments delivered into a comparatively high temperature, high velocity gaseous blast wherein the material of the filaments is softened and the softened material drawn out or attenuated to fibers by the forces of the blast. It has been found that in the formation of primary filaments from the streams of material that variation in the size of the primary filaments is encountered and when such primary filaments are attenuated to fibers by a blast that substantial variation in the fiber size occurs in the end product.

This variation in fiber size is due primarily to variations in size of the primary filaments as the filaments of larger diameter and hence higher volume are attenuated to fibers of substantially larger size than those fibers attenuated from filaments of lesser diameters. Since the volume of glass in a primary filament increases in proportion to the square of the diameter of the filament and the volume of glass delivered in plurality of streams from a supply increases linearly in proportion to the number of primary filaments, it follows that a small increase in the diameter of a filament or filaments will effect a large increase in the throughput of glass, assuming that other factors remain constant. Under operating conditions where the streams of glass are delivered from a feeder in an uncontrolled environment, substantial variations in primary filament size and hence variations in volumetric throughput of glass have been encountered resulting in substantial variations in size of fibers formed by the attenuating blast. In an uncontrolled environment it has been found under certain operating conditions that about 10% of the blast attenuated fibers are coarse fibers constituting as high as 63% by weight of the blast attenuated fibers. A mat formed of fibers with such variance in size is of poor resilience, is low in thermal properties and in general is of inferior quality.

The present invention embraces a method of establishing a controlled environment at the region of delivery of the streams of glass or other heat-softened material from a supply whereby improved attenuation of the streams to primary filaments and improved attenuation of the primary filaments to fine fibers is attained.

An object of the invention resides in control of the ambient conditions at the region of the delivery of the streams of glass from a supply whereby primary filaments of substantially uniform size are formed from the streams and, through the provision of more uniform primary filaments, the fine fibers formed therefrom by blast attenuation are of more uniform size through improved attenuating efficiency.

Another object of the invention resides in a controlled environment at the region of delivery of the streams from a supply wherein heat is withdrawn from the streams enabling a substantial increase in the throughput of heat-softenable material per unit of time as the pull rates for the primary filaments may be increased by reason of more uniform size of primary filaments produced with a consequent increase in the yield of fine fibers of more uniform size.

Another object of the invention resides in a method of forming primary filaments of more uniform size whereby the efficiency of attenuation of the filaments to fibers by a high velocity blast is increased by reason of a more uniform distribution of the volume of glass in the blast.

Another object of the invention resides in an apparatus embodying a shield for controlling the environment of the streams delivered from the supply, the shield arranged to accommodate a circulating temperature controlling fluid for controlling the ambient conditions at the region of the streams to provide primary filaments of uniform characteristics.

Another object of the invention resides in the provision of a shield for controlling the environment at the region of the delivery of streams from a supply having a retractable component which enables the primary filaments to be readily threaded into a guide arranged to direct the filaments into an attenuating blast.

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 front elevational view of a form of apparatus embodying the invention for forming fibers from heat-softenable materials;

FIGURE 2 is a side elevational view of the apparatus shown in FIGURE 1 with certain parts shown in section;

FIGURE 3 is a perspective view of an arrangement of the invention providing environmental control for the streams of heat-softened material;

FIGURE 4 is a fragmentary detail sectional view through a component of the environmental control arrangement for the streams.

While the apparatus illustrated is particularly adapted for carrying out the method of forming primaries from streams of glass and attenuating the primaries into fine fibers, it is to be understood that the method and apparatus of the invention may be employed for forming and processing fibers from other heat-softenable materials which may be converted to fibers by the application of attenuating forces.

The apparatus illustrated in FIGURES 1 through 4 is particularly adaptable for forming fibers from heat-softenable mineral materials such as glass wherein groups of streams of glass from a supply are attenuated to continuous primary filaments and the groups of filaments directed into attenuating blasts of hot gases whereby the advancing primary filaments are softened by the heat of the blasts and the softened material drawn or attenuated into fibers by the forces of the blasts, the fibers being collected out of the blasts upon a suitable collecting surface.

A supply 10 of molten glass or other heat-softened material may be provided by a forehearth 12 which may be connected to a suitable melting furnace or tank (not shown) adapted to contain glass batch which is reduced by heat in a conventional manner to a molten or flowable condition in the furnace, the molten glass flowing from the furnace into the forehearth.

Disposed beneath the forehearth 12 is a plurality of spaced feeders or bushings 14 formed of an alloy of platinum and rhodium or other suitable material having high heat resistance properties, the feeders or bushings being in communication with the forehearth through suitable ver-

tical channels or wells 16. The bottom or floor of each of the feeders 14 is fashioned with a plurality of projections or tips 18 arranged in parallel rows as shown in FIGURE 1, the tips or projections being provided with orifices through which the molten glass or other material from the supply flows in comparatively fine streams 20.

The forehearth construction 12 is supported by horizontally disposed structural members 22 and plates 23 as shown in FIGURE 2. The bushings or feeders 14 are preferably electrically heated by conventional means (not shown) to facilitate accurate control of the temperature of the glass in the feeders. The groups of streams 20 of glass from the feeders are drawn or attenuated into groups of primary filaments or linear bodies 24 for subsequent delivery into attenuating blasts.

The filaments 24 of each group are passed through means 26 for maintaining the filaments 24 in spaced relation in the manner shown in FIGURE 1. The filaments are engaged with pull rolls or nip rolls 28, the filaments of each group passing through a guide means 30 for delivery into an attenuating blast B emanating from an internal combustion burner or blast establishing means 34 provided for each group of primary filaments. The general arrangement of this character for forming primary filaments into fibers by blast attenuation forms the subject matter of the pending application of Stalego and Leaman, Serial No. 523,753, now Patent No. 3,002,224.

In the embodiment illustrated in FIGURE 1 there are three feeders 14 arranged in transversely aligned relation, it being understood that more may be employed if desired. A filament distributing means 26, pull rolls 28 and a guide means 30 are provided for each group of filaments, each group of filaments being delivered into a gaseous blast B emanating from a transversely elongated restricted orifice 36 formed in each of the burner constructions 34. Each of the blast establishing means or combustion burners 34 is preferably individually supported by a stub shaft 38 supported by a plate 40.

The plate supporting means 40 for each burner is pivotally mounted upon a shaft 42 to adjust the combustion burner 34 about the pivot of the shaft 42 as an axis. Each of the burner supporting plates 40 may be individually adjusted by means of a threaded member 44 supported by a transversely extending structural member or bar 46 forming a part of a supporting frame 48 for the blast burners 34. The frame means 48 supporting the burners is inclusive of a rectangle base 50 supporting upwardly extending members 52 which are secured at their upper extremities to end members 54 and side members 56.

The frame 48 is provided with upwardly extending members 60 which support the primary filament guide means 30 for each group of filaments. The pair of pull rolls or nip rolls 28 of each unit are geared together and the shaft supporting one of each pair of rolls is provided with a sprocket 64. The sprocket 64 may be driven by a motor or other suitable conventional means (not shown) for advancing the filaments 24 into the attenuating blast at the desired rate. The filament advancing rolls 28 are driven at a speed to facilitate the softening and attenuation of the primary filaments by the heat and forces of the blasts B without projecting the filaments through the blasts.

Each of the combustion burners 34 is provided with a confined combustion zone or chamber which receives a combustible mixture such as fuel gas and air through a tube 66, each tube being connected with a manifold 68, the latter being supplied with fuel gas and air in the proper portions to attain high combustion efficiency whereby substantially all of the combustible gases are burned within each burner chamber, but may be burned in part outside the orifice, and the burned gases projected through elongated restricted orifices 36 to provide the attenuating blasts, the burners 34 being arranged in transversely aligned relation as illustrated in FIGURE 1.

The fibers 80 formed by the attenuating blasts B are collected upon the upper flight 70 of a foraminous endless belt type conveyor 72 driven by a roll 74 connected with a suitable driving motor or other means (not shown). The fibers 80 formed by blast attenuation are filtered out of the blast onto the conveyor belt 70 under the influence of subatmospheric pressure established in a chamber 82 provided by a sheet metal receptacle 84, the chamber 82 being connected by means of a pipe or tube 86 with a suction blower (not shown) for establishing subatmospheric pressure beneath the upper flight 70 of the conveyor. The subatmospheric pressure serves to direct the fibers onto the conveyor flight and disposes of the spent gases of the blasts.

The invention is inclusive of a method and means for controlling the ambient conditions at the region of the groups of streams delivered from the feeders or bushings 14. The control involves the provision of a walled or shielded region surrounding each group of streams and the use of a circulating fluid medium for absorbing and conveying heat away from the streams for controlling ambient transitory atmospheric currents in the regions of the groups of streams and thereby attain more effective stabilization of the ambient conditions and effect a reduction in temperature of the walled region embracing each group of streams. As the control arrangements for the groups of streams are substantially identical a description of one will suffice.

In the embodiment illustrated, the shield construction 90 for each of the groups of streams flowing from each bushing is generally rectangular in shape comprising side walls 92 and 94 and end walls 96 and 98. The side wall 92 may be fixedly secured to a member 100 disposed adjacent the lower portion of a bushing 14 forming a portion of a support for the bushing. The side wall 94 is pivotally supported so as to be retractable from its normal position. The wall 94 is secured to a stationary member 101 by hinge means 102 whereby the side wall 94 may be swung about the pivotal axis of the hinge means 102 in a counterclockwise direction as viewed in FIGURES 2 and 4.

The end walls 96 and 98 of each shield unit may be secured to and supported by water cooled terminal clamps 97 of conventional construction (not shown) which are connected to terminals 99 at the end regions of a feeder or bushing 14 for conducting electric energy to the feeder for heating the glass therein, or the shield units may be supported by other suitable means. Means is provided connected with the side wall 94 for effecting retracting movement of the side wall. As shown in FIGURES 2 and 3, the wall construction 94 is provided with a U-shaped bracket 104 to which is secured a head 105 by a pivot shaft 106, the head 105 being secured to one end of a piston rod 108, the latter extending into a cylinder 110 and provided with a piston 111 reciprocable within the cylinder 110.

The end of the cylinder 110 opposite the piston rod is provided with a portion 112 pivotally connected by a pivot 114 with a bracket 116 carried by the plate 23. The end heads of the cylinder 110 are respectively provided with flexible tubes or pipes 120 and 122 for the introduction and withdrawal of fluid to actuate the piston rod 108 to retract the side wall 94 and to return the side wall to its normal position of use.

Manually operable control valve means of conventional character (not shown) is connected with the flexible pipes 120 and 122 for selectively introducing fluid under pressure into the ends of the cylinder 110 to effect reciprocal movement of the piston rod 108 to effect relative movement of the side wall 94. The shield portion or wall 94 is rendered retractable to enable the operator to properly thread the filaments 24 formed from the streams into grooves formed in the spacer or guide member 26 shown in FIGURES 1 and 2 in order to direct the individual primary filaments into their respective slots or grooves formed

in the guide means **30** adjacent a combustion burner **34**.

In the embodiment illustrated, each stationary side wall **92** and each retractable wall **94** is fashioned to provide a channel or duct to accommodate a circulating temperature controlling fluid. FIGURES 3 and 4 illustrate a retractable wall **94** constructed with an inner layer or wall member **124** and an outer layer or wall member **125**. The wall **125** is shaped with a raised portion **126** which is of serpentine or tortuous contour forming with the wall member or lamina **125** a continuous channel or duct **127** through which fluid is circulated. The regions **128** of the wall layer **125** adjacent the raised region **126** are contiguous with the inner wall **124** and are welded or otherwise secured thereto.

The end regions of the channel **127** are in communication with inlet and outlet pipes **129** and **130** which are connected by flexible tubes **131** and **132** with a supply of fluid for conveying fluid through the duct **127**.

Each of the stationary side walls **92** is of a similar construction providing a continuous duct for accommodating circulating fluid. The ends of the duct in each wall construction **92** is in communication with inlet and outlet pipes **129'** and **130'** which are connected with a supply of fluid by flexible tubes **131'** and **132'**.

The side walls **92** and **94** of the shield construction are of substantially the same construction and accommodate circulating temperature controlling fluid which may be circulating at a controlled rate regulated by conventional valve means (not shown) through the channels or ducts **127**. The end walls **96** and **98** in the embodiment illustrated are not arranged to accommodate temperature controlling fluid but, if desired, may be of a construction similar to that of the side walls **92** and **94** to accommodate circulating temperature controlling fluid. The water cooled terminal clamps **99** however provide some cooling for the adjacent end regions of the feeders.

Any suitable heat absorbing or cooling fluid such as water, air or a refrigerant such as dichlorodifluoromethane or other fluid having heat absorbing characteristics suitable for the purpose may be employed for reducing the temperature and stabilizing the ambient conditions within the shield in the region of the streams.

By shielding the streams of glass at the region of attenuation of the streams to primary filaments from transitory atmospheric currents or air turbulence and by reducing the temperature through continuously conveying away heat absorbed from the streams by the circulating fluid, the streams are attenuated to primary filaments of substantially uniform size to thereby increase the throughput as all of the uniformly sized primary filaments may be successfully attenuated to fine fibers by the attenuating blast.

As the primary filaments are substantially of uniform size, the blast attenuated fibers formed therefrom will be of more uniform size and hence a mat formed from such fibers will be less brashy and have improved insulating properties and better resilience.

The invention is inclusive of means for disposing of breakout filaments when breakouts occur and for continuously disposing of filaments when any of the burners **34** are out of service for repair or replacement without interrupting the continuous formation or attenuation of the remaining primary filaments which are being delivered into the blasts from the operating burners of the installation. The means for disposing of such primary filaments is of a character to sever or chop the filaments into short lengths so that the waste filaments can be readily conveyed away from the fiber-forming apparatus.

One or more filament disposal means may be employed in the manner and in the positions as hereinafter pointed out. As shown in FIGURE 2, a filament disposal means **140** is illustrated as disposed beneath each of the filament guides **30** for the purpose of receiving and disposing of filaments when the adjacent burner or blast establishing means is not operating. A similar means **140'** may be employed in the position shown in FIGURE 2 to dispose of filaments which break out from the rows of filaments at the right-hand region of the stream feeder, and another disposal means **140''** may be positioned as shown in FIGURE 2 to dispose of breakout filaments from the rows of filaments at the left-hand region of the stream feeder.

The sprocket **168** of each end unit is driven by a chain **238** from a sprocket **240** carried upon a shaft **241** which is driven by a speed reducing gearing (not shown) contained in a housing **242**, the speed reducing gearing being driven by a motor **244**. If filament disposal units are arranged in the positions shown at **140'** in FIGURES 1 and 2, the units are driven by a chain **248** from a sprocket mounted upon the motor shaft **241**. If filament disposal units are disposed at the positions indicated at **140''**, the unit is driven by a chain **250** from a sprocket mounted upon the motor shaft **241**.

Where three sets of filament severing units are employed concomitantly for each group of filaments from a feeder, then three sprockets and three chains are preferably employed for driving the three units or other suitable drive means may be employed. With particular reference to FIGURE 1, it will be seen that three filament choppers are provided for each of the groups of filaments from the feeders.

In the use of the chopping device in a position indicated at **140** in FIGURES 1 and 2, the filaments projected through the guide **30** are delivered into the nip region of the rolls **170** and **171** and are conveyed to the cutting instrumentality **164** and are thereby severed into short lengths which are discharged through the discharge chute **185**. By this method filaments may be continuously attenuated from the glass streams without interrupting the stream flow of attenuation when one of the blast producing burners **34** is out of service or is being replaced, as the filaments normally delivered to the said burner are continuously chopped up and conveyed away through the tube **185**.

The filament chopping device or instrumentality disposed in the position indicated at **140'** facilitates the delivery of breakout filaments from the rows of streams at the right-hand region of the feeder **14** so that such breakout filaments may be fed into the device **140** without impairing continued attenuation of the remaining filaments. Breakout filaments from the streams at the left-hand zone of the feeder **14**, as viewed in FIGURE 2, may be directed into the filament chopping instrumentality disposed in the position indicated at **140''**.

Through the use of one or more filament severing and disposing instrumentalities of the character described, continuous attenuation of filaments **24** may be carried on even if a burner needs replacement or if one or more filaments break out from a group as the fugitive filaments are chopped up until the operator rethreads such filaments into a guide **30**.

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

I claim:

1. Apparatus for processing heat-softened glass, in combination, a feeder containing the heat-softened glass having orifices for flowing a group of streams of the glass, support means for the feeder, means engaging filaments formed from the streams for attenuating the streams to filaments, and an imperforate walled enclosure supported in substantially air tight relation to the feeder and surrounding the group of streams to isolate the streams from ambient atmospheric currents, a wall region of the enclosure having channel means accommodating heat conducting fluid for controlling temperature conditions at the region of the group of streams.

2. Apparatus for processing heat-softened glass, in combination, a feeder containing heat-softened glass hav-

ing orifices for flowing a group of streams of the material, support means for the feeder, means engaging filaments formed from the streams for attenuating the streams to filaments, a walled enclosure supported in substantially air tight relation to the feeder and surrounding the group of streams, said enclosure having opposed imperforate metal side walls, each side wall fashioned with a group of substantially parallel ducts accommodating circulating heat-absorbing fluid for conveying away heat from the group of streams, one of said walls being pivotally mounted for movement away from the group of streams, and motive means for moving the pivotally supported wall away from normal position to facilitate access to the feeder.

3. Apparatus for processing heat-softened glass, in combination, a feeder containing heat-softened glass having orifices for flowing a group of streams of the material, support means for the feeder, means engaging filaments formed from the streams for attenuating the streams to filaments, a walled enclosure supported in substantially air tight relation to the feeder and surrounding the group of streams isolating the group of streams from ambient atmospheric currents, said enclosure having opposed imperforate metal side walls, each side wall fashioned with a serpentine-shaped channel accommodating circulating heat-absorbing fluid for conveying away heat from the group of streams, one of said walls being pivotally mounted by the support means for movement away from the group of streams to facilitate access to the feeder.

4. Apparatus for processing heat-softened glass, in combination, a feeder containing heat-softened glass having orifices for flowing a group of streams of the glass, support means for the feeder, means engaging filaments formed from the streams for attenuating the streams to filaments, a shield of rectangular shape supported in substantially air tight relation to the feeder and surrounding the group of streams, said shield having side walls and end walls, each of the side walls being laminated of two layers of metal, one layer of each wall having a raised linear portion forming with the other layer a channel accommodating heat-absorbing fluid, and inlet and outlet pipes connected with the ends of each channel for conveying fluid into and away from the channel to convey away heat absorbed from the streams.

5. Apparatus for processing heat-softened glass, in combination, a feeder containing heat-softened glass having orifices for flowing a group of streams of the glass, support means for the feeder, means engaging filaments formed from the streams for attenuating the streams to filaments, a shield of rectangular shape supported in substantially air tight relation to the feeder and surrounding the group of streams, said shield having side walls and end walls, each of the side walls being laminated of two layers of metal, one layer of each wall having a raised linear portion of serpentine contour forming with the other layer channel means accommodating heat-absorbing fluid, inlet and outlet pipes connected with the channel means for conveying fluid into and away from the channel means to convey away heat absorbed from the streams, one of said side walls being hingedly mounted for retractable movement away from normal position, and fluid actuated means connected with the hingedly mounted side wall for moving the said side wall to operative and retracted positions.

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