April 15, 1947. E. FLETCHER ET AL 2,418,873

APPARATUS FOR ATTENUATING THERMOPLASTIC MATERIALS

Filed March 14, 1942 2 Sheets-Sheet 1

Fig. 1.

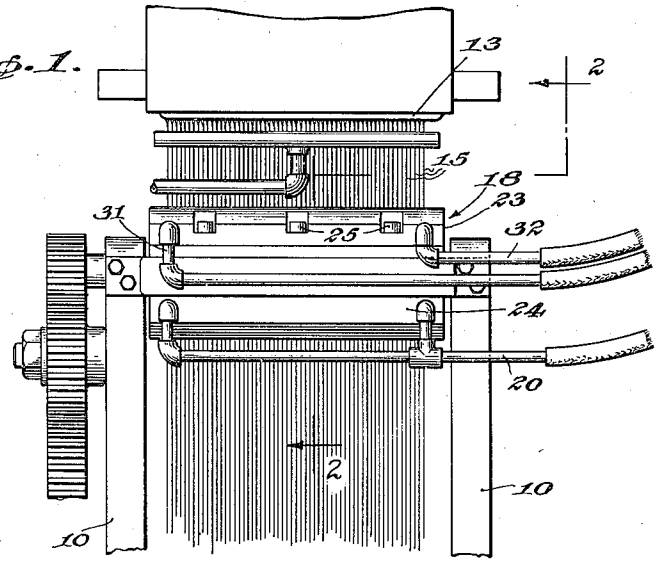
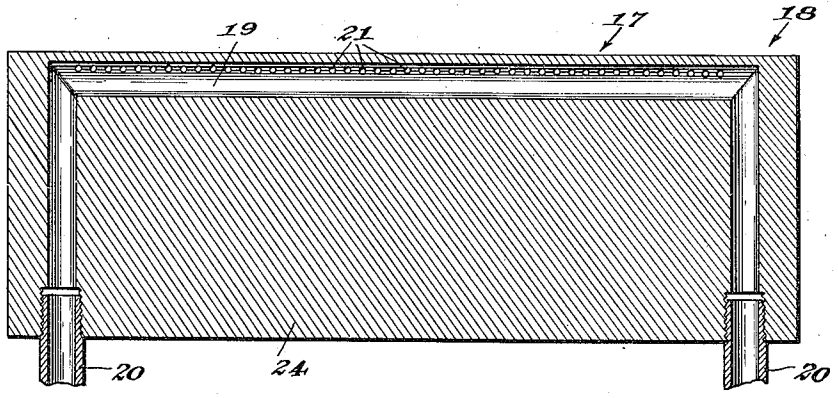


Fig. 4.



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Fig. 2.

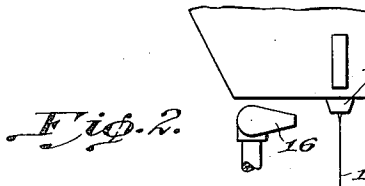
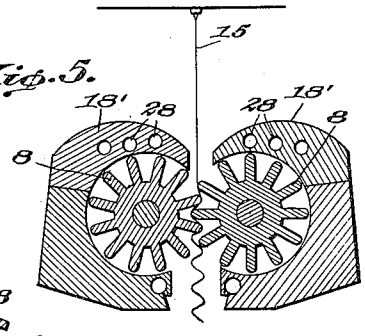
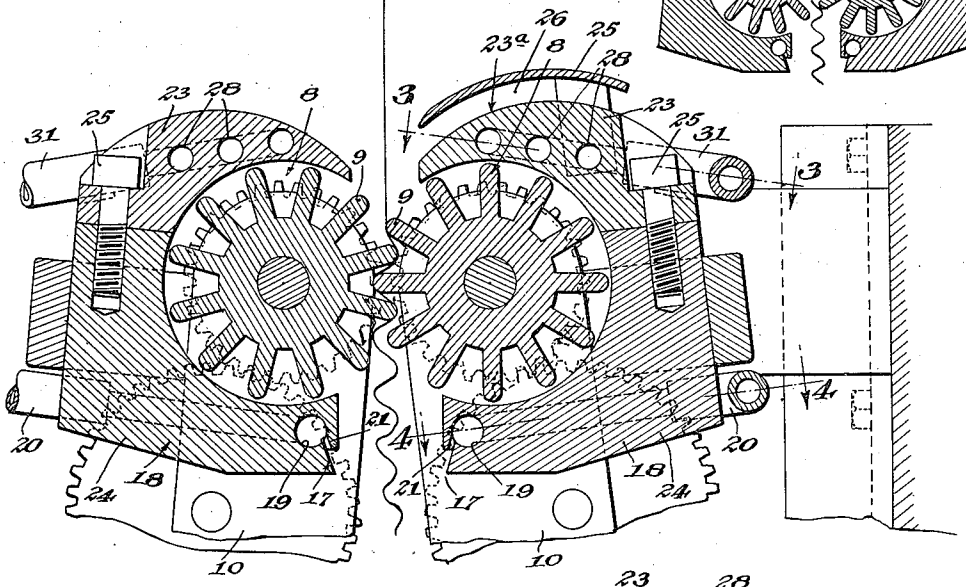


Fig. 5.





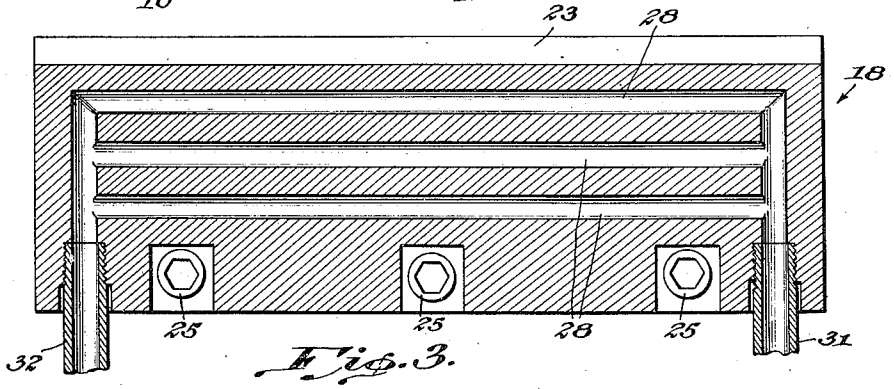


Fig. 3.

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2,418,873

APPARATUS FOR ATTENUATING THERMOPLASTIC MATERIALS

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Application March 14, 1942, Serial No. 434,668

10 Claims. (Cl. 49—17)

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This invention relates to a method and apparatus for forming and attenuating fibers which may be either straight or crimped. More particularly, this invention relates to the manufacture of fibers from glass, although it will be apparent as this description proceeds that the principles involved may be advantageously employed in connection with other thermoplastic materials which are capable of being extruded or flowed through an orifice.

Several methods have been proposed for attenuating a stream issuing from an orifice in a container for the desired molten material to be attenuated. One method is shown in the United States Slayter Patent No. 2,230,272 dated February 4, 1941, and comprises flowing a stream of material between intermeshing gears or gear-shaped rotors. The rotors are revolvable at a high rate of speed and coact with one another to tractively engage the stream and apply sufficient pulling force on the stream to attenuate it to a fiber. In cases where it is desired to manufacture crimped or curly fibers, the temperature of the stream is regulated so that as it passes between the traction means it is of the correct plasticity to be deformed or crimped by the gear-shaped members and solidified in this form.

In the above method and, in, fact, with any method where a fiber of brittle material is projected into a relatively quiescent atmosphere, particular care must be taken to control the rate of projection of the fiber so that the reactive force applied to the fiber by the atmosphere will not break the fiber into short lengths. In other words, where the length of the fibers is to be maintained, there is a practical upper limit for the rate of attenuation of the fibers in methods of manufacture of the general type briefly described above.

It is one of the objects of this invention to remove the above limitation and to thereby enable expediting production by increasing the rate of attenuation of the fibers. More particularly, the present invention contemplates eliminating the limitation referred to above by applying a pulling force on the fiber as it is projected into the atmosphere as by imparting movement to the atmosphere in the general direction of movement of the fiber. In this case the reactive effect of the atmosphere on the fiber is reduced and the rate of attenuation may be correspondingly increased.

It is a further object to provide means for starting flow of the streams from the orifices at an accelerated rate immediately prior to

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engagement of the streams by the attenuating rotors. The rotors are normally rotated at high speed and while rotating are brought together into intermeshing relation and into engagement with the stream. The present invention provides means operative as the rotors move toward each other to cause the streams to speed up and thereby reduce the difference in speed between the stream and the rotors, thereby obtaining smooth starting of attenuation.

Another object of this invention is to apply a pulling force on the fiber issuing from the attenuating rotors during attenuation which is sufficient to prevent breakage of the fiber by the reactive force exerted by the atmosphere but which is preferably less than the force applied to the fiber by the attenuating means so as to enable, when desired, a certain degree of additional deformation of the fiber as it is projected into the atmosphere.

It is a further object of the invention to control the degree of deformation of the fibers caused by their lengthwise projection into the atmosphere independently of the speed of attenuation of the fibers.

In cases where the attenuating means comprises coacting intermeshing gear-shaped members, air turbulence results from the high speed rotation of the members, tending to cool the stream being attenuated and having other adverse effects on attenuation. One of these is the tendency for the atmosphere displaced by the intermeshing teeth of the members to be pumped upwardly toward the orifice and interfere with flow of the stream of molten thermoplastic material issuing from the orifice.

It is an object of the present invention to lessen this air turbulence by evacuating the region adjacent the locus of meshing of the members, and further to cause this evacuation by removing some of the air at the lower side of the attenuating members, thereby decreasing the amount of air acted on by the teeth of the members.

Further, in accordance with this invention any air that is pumped upwardly toward the orifice is controlled by providing a pair of shields respectively associated with the gear-shaped members to guide the flow of air created by these members during rotation, and by forming or arranging the shields so that they are non-symmetrical with respect to a plane parallel with the axes of rotation of the attenuating members and including the path of travel of the stream. As a result, the atmosphere which is displaced by

the interengaging teeth of the gear-shaped members is directed laterally away from the stream and is prevented from interfering with the stream.

Still another object of this invention is to dissipate the heat radiated by the molten glass container to the attenuating rotors and to the shields, thereby permitting desired closer association between the glass feeding means and the attenuating means. In accordance with this invention the cooling is effected by a cooling medium circulated through jackets formed in the shields.

A further object of this invention is to control both the movement of air at the delivery side of the attenuating gears and the air currents created at the intake side of the gears by a unitary compact means, by providing each shield with a blower at the delivery side of the gears and having discharge orifices inclined toward the fiber passing therebetween. This construction enables fluid under pressure to be discharged into the atmosphere beyond the gears in the general direction of movement of the fibers and counteracts undue reactive effect of the atmosphere on the fiber issuing from the gears.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a fragmentary front elevational view of attenuating apparatus constructed in accordance with this invention;

Figure 2 is a semi-diagrammatic view illustrating the attenuating mechanism in cross-section substantially at the line 2—2 of Figure 1;

Figure 3 is a sectional view taken substantially on the plane indicated by the line 3—3 of Figure 2;

Figure 4 is a sectional view taken on the plane indicated by the line 4—4 of Figure 2; and

Figure 5 is a diagrammatic sectional view of a slightly modified form of the invention.

Although the present invention in its broader aspects may be advantageously employed in connection with various different types of attenuating means, it has been found especially useful with mechanical attenuating apparatus of the general type shown in the United States Slayter Patent No. 2,230,272 and is herein described in connection therewith. Briefly, this attenuating apparatus comprises coacting gear-shaped members 8 supported for rotation adjacent one another in such a manner that the teeth 9 on the respective members intermesh without engaging or touching each other. The members are preferably journaled at their opposite ends in supporting arms 10 which are pivoted to a suitable frame structure at points spaced from the rotors so that one or both of the arms may be swung toward and away from each other to move the members into and out of intermeshing relation. The construction is such that a clearance is provided between the teeth of the members to permit streams of thermoplastic material to pass between the meshing teeth without being crushed or squeezed. However, the coacting teeth on the gear-shaped members intermesh sufficiently to impart the tractive force on the streams required to effect attenuation.

As shown in Figures 1 and 2, a glass feeder 13 is suitably supported above the attenuating mechanism and is preferably of the same type shown in the United States Thomas and Fletcher Patent No. 2,165,318. The feeder 13 includes a series of orifices from which streams 15 of a thermoplastic material, such as glass, issue continuously. The temperature of the streams of glass 15 emerging from the feeder 13 may, if desired, be regulated by means of blowers 16 positioned beneath the orifices in a manner similar to that disclosed in the Slayter and Thomas Patent No. 2,291,289 of July 28, 1942. It is to be understood, however, that the use of the blowers 16 depends to a great extent upon the type of glass or other material employed and to design of the feeder and the working temperatures and, accordingly, there are some instances where these blowers may be dispensed with.

The streams of glass issuing from the orifices in the feeder 13 pass between the gear-shaped members 8 and the latter are rotated to effect attenuation of the streams. The means for rotating the gear-shaped members is not fully shown herein but this means may be similar to the means shown in the above identified Slayter patent.

The coacting teeth on the gear-shaped members 8 not only apply a traction force on the streams or fibers to attenuate the latter but may also simultaneously crimp the fibers. Whether or not the undulations in the fibers are permanent depends to a great extent upon the temperatures of the fibers passing between the gear-shaped members and to some extent upon the degree of intermeshing of the teeth on the latter members. If the temperature of the streams is below what may be termed the softening point as they pass between the gear-shaped members, the fibers will only be bent by the members and have a tendency to again straighten out as they leave the members. On the other hand, if the tempertaure of the streams passing between the cooperating gear-shaped members is above the so-called softening point, the undulations formed by the coacting intermeshing teeth 9 will have a tendency to remain.

Regardless of whether crimped or straight fibers are produced, the fibers are projected into the atmosphere at the delivery side of the attenuating rotors at such a high linear velocity that the quiescent atmosphere applies a reactive force on the fibers. The effect of this reactive force depends to a great extent on the circular mill area of the fibers and on the rate that the latter are projected into the atmosphere by the traction device. For example, if the gear-shaped members are rotated at a speed delivering the fibers at about 2,000 feet per minute or over and if the fibers are roughly .001" in diameter, the reactive force of the relatively quiescent atmosphere is sufficient to break some of the fibers into small lengths. Although this critical speed increases as the fiber diameter decreases, the above phenomena still hampers the production rate of the apparatus.

In accordance with the present invention, the above limitation on the speed of attenuation is removed by controlling or reducing the reactive force applied on the fibers as they are projected into the relatively quiescent atmosphere. Upon reference to Figures 2 and 4, it will be noted that a pair of blowers 17 are provided on the lower adjacent edges of a pair of shields 18 positioned one about each of the attenuating rotors. The blowers are respectively positioned on opposite sides of the path of travel of the fibers below the gear-shaped members and each comprises a chamber 19 communicating with a source of fluid under pressure, such as air, through the medium of a conduit 20. The chambers 19 have outlet

orifices 21 inclined toward the path of the streams so that the air from the blowers is directed toward opposite sides of the fibers in the general direction of movement of these fibers.

It follows from the above that the fluid under pressure discharged from the blowers 17 imparts a movement to the atmosphere adjacent the fibers in the general direction of movement of the fibers or, in other words, applies a pulling force on the fibers. In any event, the reactive force of the atmosphere into which the fibers are projected by the rotors is reduced or counteracted to such an extent that the linear velocity of the fibers may be increased greatly beyond the critical speed previously specified without the danger of breaking or detrimentally affecting the fibers.

In the manufacture of crimped or curly fibers, it is advantageous to project the plastic fibers lengthwise into the atmosphere because it has been found that the reactive force of the atmosphere increases the magnitude of the undulations formed in the fibers by the gear-shaped members 8. When this action is desired, the pressure of the fluid discharged from the b'owers 17 is controlled so that the resulting pulling force on the fibers is ample to prevent breaking of the fibers but small enough to permit the fibers to pile up on themselves and increase the magnitude of the crimps. By regulating the speed of the blasts from the blowers 17 the degree of increase in magnitude of the crimps may be controlled independent of the speed of attenuation of the fibers. This provides a desirable flexible regulation of the magnitude of the crimps of the fibers.

The gear-shaped attenuating rotors together with the shields 18 and blowers 17 are arranged for movement toward and from each other so that the teeth 9 of the rotors may be moved into and out of mesh. When operation is to be stopped the rotors, while rotating at attenuating speed, are moved apart into spaced relation to permit the streams to flow therebetween without being attenuated. Gravity causes the streams to continue flowing slowly and the blasts from the blowers 17 may aid in maintaining this flow of the streams. When the rotors are moved back to intermeshing relation the action of the blowers 17 on the streams increases as they approach the streams and the increasing tractive action of the blasts on the streams accelerates their flow so that as the teeth of the rotors come into engagement with the streams, the streams are moving rapidly in the direction of attenuation. This tends to prevent jerking of the streams by the revolving rotors with subsequent possible disruption of the streams.

Owing to the fact that the gear-shaped members are rotated at a relatively high speed, the teeth 9 create considerable disturbance in the ambient atmosphere and this disturbance is controlled by the shields 18 associated with the gear-shaped members 8. The shields, respectively, extend around substantially the entire outer sides of the gear-shaped members and, in the interest of simplicity, each shield is formed of two parts 23 and 24 clamped together by means of screws 25. Also in the interest of economy in manufacture, the chambers 19 of the blowers and their associated discharge orifices 21 are respectively formed in the lower ends of the bottom parts 24 of the shields in the manner previously mentioned and as clearly shown in Figure 4 of the drawings, so that the shields and the blowers 17 are unitary compact structures.

In addition to the shields 18 to limit the air disturbed by the gear-shaped members during rotation of the latter, the region about the locus of meshing of the members is evacuated. This serves to decrease the turbulent air that is created by the members and its effect on the streams being attenuated. The evacuation may be effected in any suitable way but in the present arrangement the blowers 17 beneath the rotors cause a rarefaction of the air in the neighborhood of and below the intermeshing teeth to substantially reduce the quantity of air acted on by the teeth. Even with this arrangement there may be some air pumped upwardly by the members and it is desirable to prevent this air from chilling or otherwise affecting the streams 15 issuing from the orifices of the feeder 13. To accomplish this, the shields at opposite sides of the streams 15 are non-symmetrical so that the air displaced in an upward direction by the action of the intermeshing teeth on the gear-shaped members is directed laterally away from the streams.

In the embodiment of the invention shown in Figures 1 to 4, inclusive, the top rounded surface 23*a* of the shield associated with the gear-shaped member 8 at the rear of the apparatus (at the right in Figure 2) is somewhat higher than the corresponding surface of the front shield. As a result, the air displaced by the engaging teeth on the gear-shaped members tends to follow the more prominent surface and flows over the higher shield in a direction away from the streams 15. This action may be accentuated, if desired, by securing a baffle 25 on the higher shield in such a manner that the baffle coacts with the top surface 23*a* to form an air passage 26. Either the front or rear shield may be higher, as desired, but if the rear shield is selected the current of air from the rotors is blown away from instead of toward the operator.

In the embodiment of the invention shown in Figure 5, the shields 18' are similar in construction to the shields 18 with the exception that the upper ends of the shields terminate different distances from a plane parallel with the rotor axes and including the glass streams 15. This non-symmetrical arrangement also causes a deflection of the air displaced by the coacting teeth on the gear-shaped members over the closer shield edge and therefore laterally away from the streams 15.

In some cases it may be advantageous to cool the shields to dissipate the heat radiated thereto by the bottom of the glass feeder and also to cool the attenuating rotors. In the present instance the above results are obtained by providing the upper part of each shield with a plurality of communicating passages 28 and a suitable cooling medium, such as water, is circulated through these passages from a source of supply, not shown, connected to the passages by the conduits 31, 32. This cooling system affords a relatively simple and effective means for controlling the temperature of the shields and by radiation to maintain proper temperature of the attenuating members so that they efficiently act on the streams passing between the members.

While in describing the present invention particular stress has been placed upon the use of coacting gear-shaped members for attenuating the fibers, it is to be understood that certain of the principles of this invention may be used to advantage in practically any case where fibers are attenuated regardless of the specific mechanism employed for effecting attenuation. Also various other materials of either an inorganic or an or-

ganic nature may be attenuated by the means forming the subject-matter of this invention and examples of these materials are, artificial silk such as "nylon," vinyl acetate, cellulose acetate, resin, sugar, etc. Thus, reservation is made to make such changes in the apparatus and method of manufacture as may come within the scope of the accompanying claims.

We claim:

1. Apparatus for producing thermoplastic fibers comprising rotatable intermeshing gear-shaped members for attenuating and longitudinally projecting a thermoplastic fiber while in a semi-plastic condition into the atmosphere at such a rate of speed that the fiber is deformed by the reactive effect of the atmosphere, and blowers adjacent the members at the side thereof from which the fiber is projected for directing a plurality of jets of fluid under pressure toward opposite sides of the fiber in the general direction of travel of the fiber to reduce the reactive effect of the atmosphere on the fiber.

2. Apparatus for producing crimped fibrous glass comprising in combination with means for flowing a stream of molten glass and a pair of intermeshing gear-shaped attenuating rotors adapted to engage the stream between them and attenuate the stream into a fiber and project the fiber thus formed into the atmosphere, shields individual to said rotors and enclosing said rotors over a substantial portion of the periphery of each exclusive of the intermeshing portions, one of said shields having an upper rounded surface higher than the upper surface of the other shield, whereby air currents created by the meshing of said rotors is deflected laterally, and blowers formed respectively at the lower inner ends of the shields provided with outlet orifices directed in the general direction of movement of the fiber from the rotors to aid in conveying the fibers away from the rotors.

3. Apparatus for producing crimped fibrous glass comprising in combination with means for flowing a stream of molten glass and a pair of intermeshing gear-shaped attenuating rotors adapted to engage the stream between them and attenuate the stream into a fiber and project the fiber thus formed into the atmosphere, shields individual to said rotors and enclosing said rotors over a substantial portion of the periphery of each exclusive of the intermeshing portions, one of said shields having an upper inner edge more closely adjacent a plane parallel with the rotor axes and including the path of said stream than the upper inner edge of the other shield, whereby air currents created by the meshing of said rotors is deflected laterally, and blowers formed respectively at the lower inner ends of the shields provided with outlet orifices directed in the general direction of movement of the fiber from the rotors to aid in conveying the fibers away from the rotors.

4. An apparatus for producing thermoplastic fibers comprising a pair of coacting rotors to engage a stream of molten material and attenuate the stream to a fiber, said rotors being movable toward and from each other to permit engagement and disengagement of said stream, a shield partially surrounding each rotor and movable therewith, and a blower in each shield adapted to act on the fiber issuing from between the rotors when the rotors are in engagement with said stream.

5. An apparatus for producing fibers of thermoplastic material comprising means for flowing a stream of molten material, a pair of coacting gear-shaped rotors to engage the stream of molten material and attenuate it to a fiber and project the fiber into the atmosphere, and blowers adjacent said rotors and alongside the path of the fiber projected by said rotors adapted to direct blasts of gas to engage the fiber issuing from between the rotors.

6. Apparatus for producing fibers of thermoplastic material comprising in combination, means for flowing a stream of molten material, a pair of coacting gear-shaped rotors to engage the stream of molten material and attenuate it into a fiber and project the fiber thus formed into the atmosphere, said rotors being movable toward and from each other to permit engagement and disengagement of said stream, and a pair of blowers adjacent said rotors, each of said blowers being located at the side of the path of the fiber projected by said rotors and mounted for movement with its respective rotor, said blowers being adapted to direct blasts of gas onto opposite sides of and in the general direction of movement of the fiber issuing from between the rotors.

7. Apparatus for producing fibers of thermoplastic material comprising in combination means for flowing a stream of molten material, a pair of coacting gear-shaped rotors to engage the stream of molten material and attenuate it into a fiber and project the fiber thus formed into the atmosphere, and a pair of blowers adjacent said rotors, each of said blowers being located at the side of the path of the fiber projected by said rotors, said blowers being adapted to direct blasts of gas onto opposite sides of and in the general direction of movement of the fiber issuing from between the rotors.

8. An apparatus for producing crimped glass fibers comprising a pair of rotatable attenuating and crimping rolls, means for flowing a stream of molten glass between said rolls, a shield associated with each roll to confine air disturbed by rotation of the roll, a blower formed in the lower edge of the shield for directing air under pressure in the direction of travel of the fibers issuing from the rolls whereby the atmosphere in the area adjacent said issuing fibers is partially evacuated to reduce the volume of air disturbed by said rolls, and cooling means in the upper portion of each shield.

9. Apparatus for producing thermoplastic fibers comprising rotatable intermeshing gear-shaped members, means for supplying a stream of material to said members to be attenuated into fibers, a shield partially enclosing each of said members and having a curved upper surface, the upper surface of one of said shields disposed at a higher elevation than said other shield and adapted to direct air disturbed by the rotation of the gear-shaped members in a direction away from said stream, and a blower in the lower edge of each shield adapted to partially evacuate the area adjacent the attenuated fibers.

10. Apparatus for producing thermoplastic fibers comprising rotatable intermeshing gear-shaped members, means for supplying a stream of material to said members to be attenuated into fibers, a shield partially enclosing each of said members and having a curved upper surface, the upper surface of one of said shields disposed at a higher elevation than said other shield and adapted to direct air disturbed by the rotation of the gear-shaped members in a direction away from said stream, and a blower in the lower edge

of each shield adapted to direct jets of fluid under pressure in a manner to reduce the volume of air disturbed by said rotatable members, and cooling means in the upper portion of each shield.

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