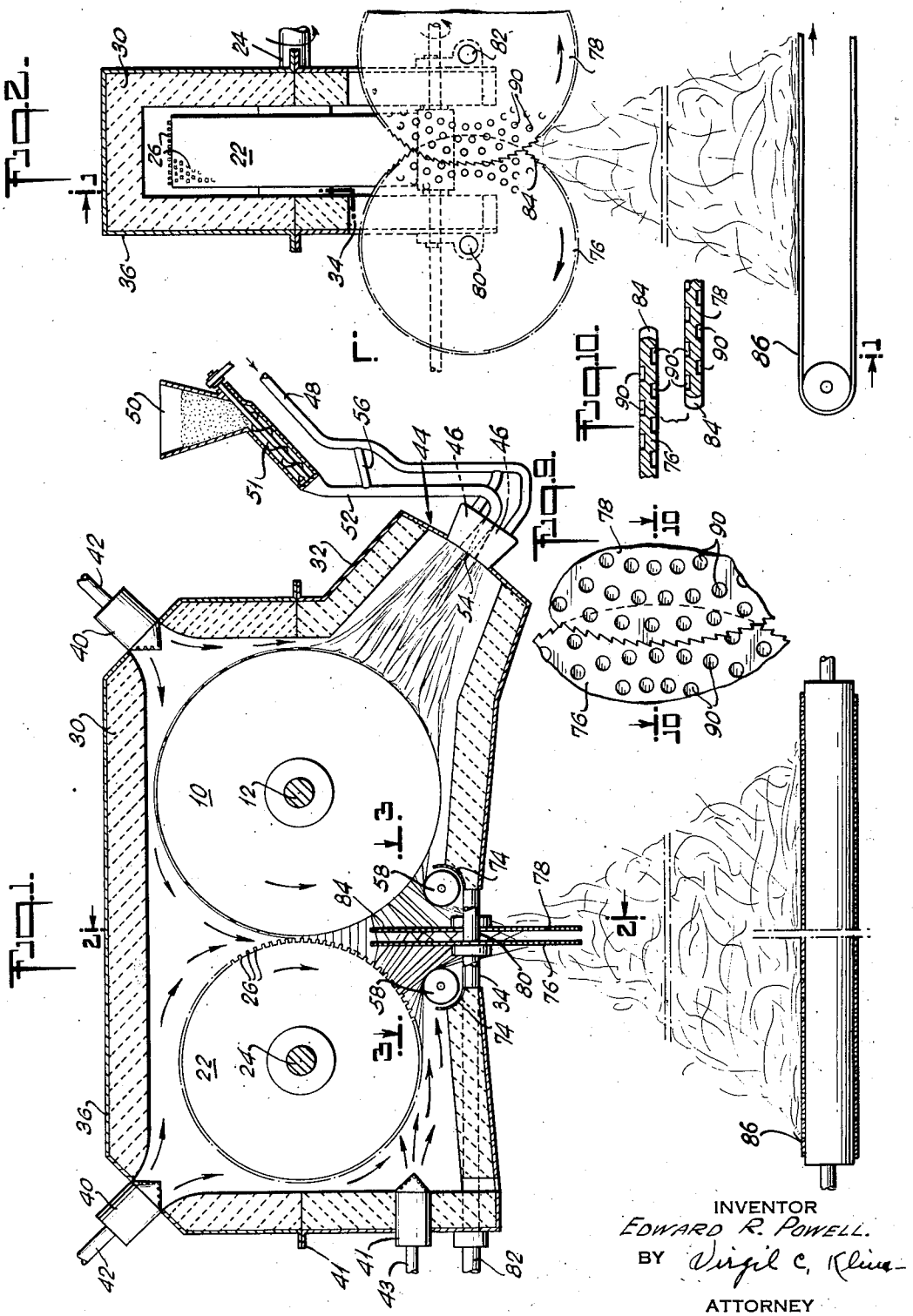
Aug. 5, 1952 E. R. POWELL 2,605,499

METHOD AND APPARATUS FOR DRAWING FINE FIBERS

Filed Sept. 1, 1950 2 SHEETS—SHEET 1



INVENTOR
EDWARD R. POWELL.
BY Virgil C. Kline
ATTORNEY

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Filed Sept. 1, 1950 2 SHEETS—SHEET 2

Fig. 3.

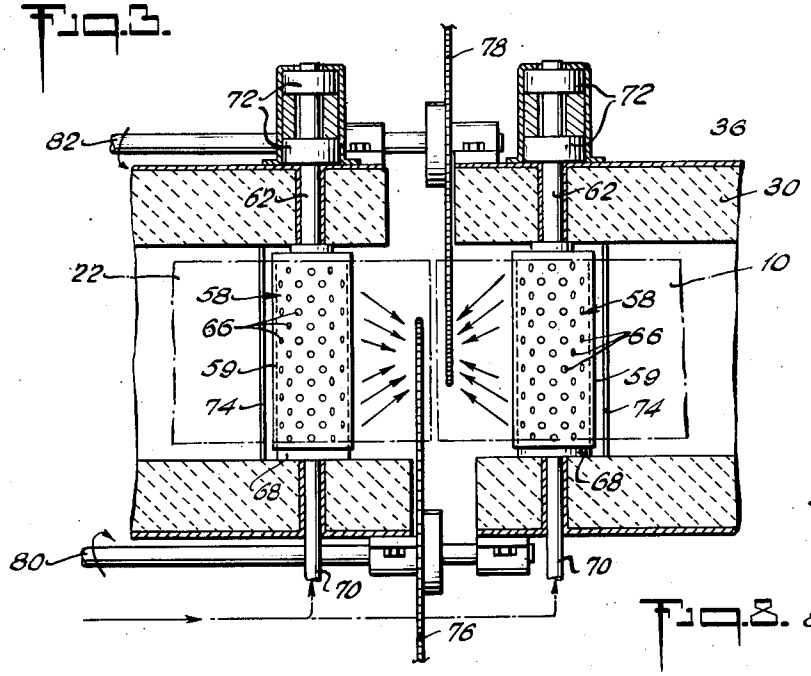


Fig. 7.

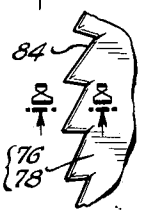


Fig. 8.

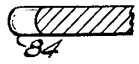


Fig. 4.

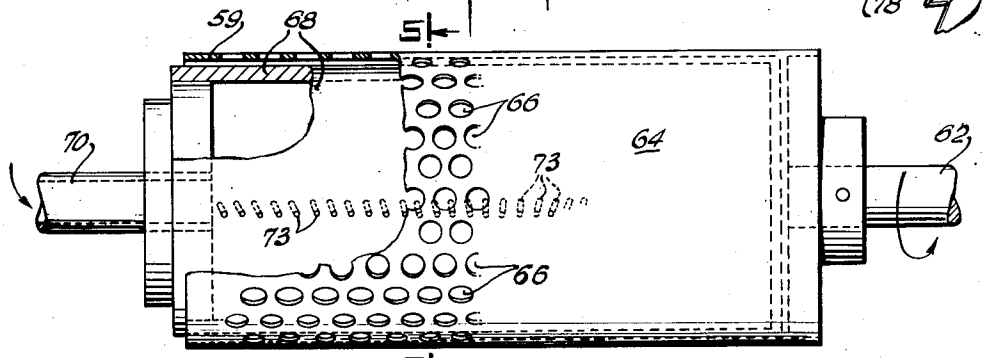


Fig. 5.

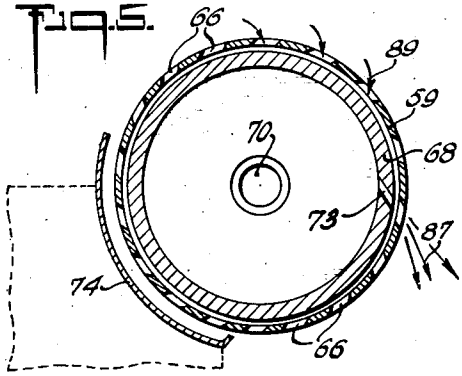
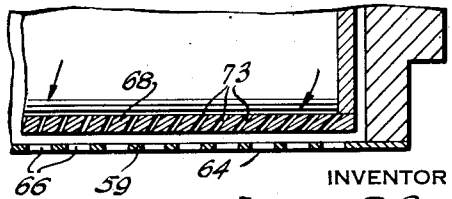


Fig. 6.



INVENTOR
EDWARD R. POWELL.
BY Virgil C. Kline
ATTORNEY

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METHOD AND APPARATUS FOR DRAWING FINE FIBERS

Edward R. Powell, North Plainfield, N. J., assignor to Johns-Manville Corporation, New York, N. Y., a corporation of New York

Application September 1, 1950, Serial No. 182,820

18 Claims. (Cl. 18—2.4)

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The instant invention relates to a method of and apparatus for producing fine fibers of glass and similar thermoplastic and meltable materials and is an improvement upon my prior application, S. N. 118,815, filed September 30, 1949, of which it constitutes a continuation-in-part as to all common subject matter. It will be appreciated that in this application, as in my said prior application, the term "glass" is used in a generic sense to include glass compositions, synthetic low alkali glasses, organic and synthetic glasses, mineral wool compositions, and other meltable materials.

In my prior application I have disclosed an apparatus for and method of drawing fine fibers from thermoplastic materials of the type mentioned, the operations involving the formation of a glass layer on the surface of a rotating body and the contact with the layer by a plurality of protuberances or points, preferably supported on an adjacent rotating body, whereby fibers are drawn from the surface of the layer by the protuberances upon continued rotation of the body. The fibers thus initiated are drawn out into longer fibers by forces applied transversely of the lengths of the fibers while they are still attached to the layer of material and to the protuberances. The instant invention has for its principal object the provision of an improved method and apparatus for drawing out the fibers formed between the glass layer and the protuberances.

Another object of the invention is the provision of a method and apparatus in which the fibers are picked up and pulled in a direction transverse to their lengths to further draw them out, by devices such as discs rotating in opposite directions. Portions of the discs overlap so that the fibers are carried between the discs and held against their peripheries.

A further object of the invention is the provision of a fiber drawing apparatus and method including members rotated at high speed located adjacent the surfaces of the fiber drawing bodies and in the path of the fibers extending between the bodies, the rotatable members assisting in the fiber drawing action. A still further object of the invention is the provision of such apparatus and method in which the fibers are held in frictional contact with the members, the frictional contact being maintained in part by induced pneumatic forces. More particularly, an object of the invention is the provision of an apparatus and method in which the rotatable members comprise perforated hollow casings with

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jet nozzles located within the casings, the nozzles directing jets through the walls of the casings and in downwardly converging paths and in the general direction of movement of the fibers, whereby the fibers are held in frictional contact with the casings by the jets, as well as by induced air currents entering the casings above the jets.

Another object of the invention is the provision of such apparatus in which the rotatable hollow casings and the jets, while themselves operating as fiber drawing means, also cooperate with the discs in the fiber drawing operation, the converging jets being directed toward the discs to carry the fibers therefrom. Although the perforated casings may be separately rotated, preferably they are driven by the jets. The discs may also be separately driven or be driven by the jets. For the latter purpose they are provided with perforations, indentations, or other means for impingement by the jets.

My invention will be more fully understood and further objects and advantages thereof will become apparent when reference is made to the following more detailed description of the invention and to the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of an apparatus embodying the invention, the view being taken on the line 1—1 of Fig. 2;

Fig. 2 is a transverse sectional view of the apparatus of Fig. 1, taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view on an enlarged scale, taken on the line 3—3 of Fig. 1;

Fig. 4 is a detail elevational view with parts broken away for clearness of illustration, of a fiber drawing element shown in assembly in Figs. 1, 2 and 3;

Fig. 5 is a sectional view, taken on the line 5—5 of Fig. 4;

Fig. 6 is an enlarged detail sectional view of a portion of the device of Figs. 4 and 5;

Fig. 7 is an enlarged detail view of a portion of the drawing disc shown in Figs. 1, 2 and 3;

Fig. 8 is a sectional view, taken on the line 8—8 of Fig. 7;

Fig. 9 is a detail view illustrating a modification of a portion of the apparatus shown in Figs. 1 and 2; and,

Fig. 10 is a sectional view, taken on the line 10—10 of Fig. 9.

Referring now to the drawings, the apparatus includes a rotor or body 10 mounted on a shaft 12 for rotation in the direction indicated by the arrow. Rotor 10 is of a construction to permit heating from room temperature to 1800° F. or

above without strain or eccentricity and to be mechanically stable and run true at elevated temperatures.

A second rotor 22 is mounted on a shaft 24 lying in parallelism with shaft 12. Rotors 10 and 22 are in alignment and portions of their peripheral surfaces lie in adjacent, parallel, but non-contacting relationship. The peripheral surface of rotor 10 is preferably smooth, while that of rotor 22 is provided with a multiplicity of protuberances or projections 26, suitably equally spaced at relatively close intervals over the peripheral surface of the rotor. For example, the protuberances may be placed from 64 to 400 to the square inch. Rotor 22 is of different and preferably smaller diameter than rotor 10, but otherwise, and except for the protuberances, is of similar construction to rotor 10. It is mounted for rotation in the direction indicated by the arrow, that is, in a direction opposite to rotor 10 and so that the upper peripheries of the rotors approach each other. The rotors are driven by any suitable means (not shown) at the same, or substantially the same, peripheral speeds.

Rotors 10 and 22 are enclosed, or substantially enclosed, by a housing 30 having an extension 32 in the lower corner adjacent rotor 10. The housing is cut away at the bottom and part way up the side walls, as indicated at 34, to provide room for the fiber drawing and removal apparatus later to be described. The housing may consist of a steel shell 36 lined with refractory material of a character to resist excessive erosion under the temperatures involved. The housing is of a width to closely embrace the rotors, as particularly illustrated in Fig. 2, and of such length and height that the refractory lining is relatively close to the peripheries of the rotors, except at the corners, and particularly at extension 32. Suitably the housing and refractory lining are made in sectional form to permit their mounting around the rotors.

Burners 40 are mounted in apertures in the upper corners at the opposite ends of the housing to direct their flames along the refractory walls. A burner 41 is also positioned in the end wall of the housing to direct its flame along the lower side of rotor 22. The burners, which may be of conventional type, are connected by fuel lines 42 and 43 respectively, to a suitable supply (not shown) of a fuel, such as a mixture of gas and air.

Mounted in extension 32 is a raw material melting and projecting device, indicated generally at 44. This device consists of burners 46 positioned to direct converging flames against the adjacent peripheral surface of rotor 10. The burners are connected by a supply line 48 to any suitable source of fuel (not shown), such as a mixture of gas and air under such pressure that a high velocity blast is set up. Raw fiber forming material in particulate form is discharged into the blast issuing from burners 46. To this end a supply means for the particulate matter, such as hopper 50, is mounted adjacent housing 30. The hopper is provided with a screw feed 51 driven at a controlled speed to deliver the raw material at a selected rate into a feed conduit 52 and thereby to a nozzle 54 having its outlet located between burners 46. Preferably a portion of the gaseous fuel from supply line 48 is by-passed to the feed line 52 to issue from nozzle 54 with the particulate matter. For this purpose a connecting tube 56 may be provided between the fuel supply line 48 and the feed line 52.

Fiber drawing and attenuating means is located in the cut-away portion of the housing and in position to intercept the path of the fibers drawn between rotors 10 and 22. This means includes rotatable members 58 (see particularly Figs. 3–6 inclusive). Each of these members comprises a hollow casing 59 having an open, and suitably, a closed end. Each of the casings is carried by a shaft 62, which may be welded or otherwise secured to the closed end of the casing, the shaft being mounted in anti-friction bearings 72. Suitably two bearings are employed at the one end of each shaft, as illustrated, to provide the required stability. The circumferential wall 64 of the casing is provided with a multiplicity of rows of perforations 66, the perforations as best shown in Fig. 5 extending angularly through the walls of the casing and being arranged in staggered rows.

A stationary, cylindrical member or container 68 is mounted within each casing 59. Container 68 is closed at both ends and its interior is in communication by a conduit 70 with any suitable source of fluid under pressure, such as compressed air or steam. Conduit 70 is mounted in fixed position to support container 68 with its peripheral wall adjacent, but spaced from, the inner surface of wall 64 of the casing. The wall of container 68, which is relatively thick to resist the pressures involved, is provided with a line of perforations 73 substantially in the horizontal plane of the axis of the container. Perforations 73, which are substantially smaller than perforations 66, are pointed outwardly and downwardly to direct converging jets of fluid, as illustrated particularly in Figs. 4 and 6.

Curved baffles 74 are mounted adjacent the lower rear circumferential areas of the members 58, the baffles suitably being carried by the housing.

Located between members 58 are fiber pulling devices 76 and 78 suitably comprising discs mounted for rotation on shafts 80 and 82, respectively, the shafts in turn being supported in bearings carried by the housing or other fixed portion of the apparatus. The discs are so mounted and are of such diameter as to have portions of their peripheral surfaces extending relatively into the bight between rotors 10 and 22, and to have portions lying in overlapping, spaced relationship, as best illustrated in Fig. 3.

Referring particularly to Figs. 7 and 8, the peripheral edges of discs 76 and 78 are provided with fiber grasping means which suitably take the form of teeth, hooks or file cuts 84 positioned to have their prongs or teeth pointing toward the direction of rotation of the discs. The edges of the prongs or teeth are suitably rounded to reduce abrasion on the fibers carried thereby. It will be appreciated that other configurations may be used for the fiber grasping means.

The discs are rotated with or on shafts 80 and 82 at the same, or substantially the same, relatively high speed by any suitable means which may be a driving device operably connected to the shafts, or may be jets directed against the discs, as will be hereinafter more fully explained. The discs are rotated in opposite directions and with their upper peripheries approaching.

Suitable apparatus is provided below the casing for collection of the fibers produced by the apparatus described above. This may comprise a

foraminous or open work conveyor 86 on which the fibers settle to be continuously carried from the place of formation. A suction box (not shown) may be located below the upper reach of the conveyor to aid in the fiber collecting and felting operation, if desired.

In the operation of the apparatus described above and in carrying out the method of the instant invention, glass of a suitable composition, which may be any of those available for fiber drawing, is supplied in particulate form to hopper 50. It is fed thereby to the nozzle 54 and discharged therefrom into the blast issuing from burners 46 to be melted thereby and deposited on the surface of drum 10 as a layer of molten glass. The specific functioning and operation of the glass feeding and melting devices are more fully explained in my copending application, S. N. 176,282, filed July 28, 1950, to which reference is made for an understanding of this portion of the apparatus and method.

The layer of glass on rotor 10 is carried by the rotor to the bight between it and rotor 22 at which point the protuberances or points 26 contact or dip into the glass layer on rotor 10. As the surfaces of the rotors move apart on continued rotation, each of the protuberances 26 which has dipped into or been contacted by the glass layer, draws a fiber from the layer whereby a multiplicity of parallel fibers extend between the protuberances and the layer, the fibers being elongated as the surfaces of the rotors continue to separate.

The parallel fibers formed between rotors 10 and 22 are carried into positions where they are picked up by the teeth or other fiber grasping elements of discs 76 and 78, the fibers being lapped between the discs and carried downwardly and simultaneously elongated as more of the molten material or glass is drawn from the protuberances and the layer. The discs are driven at peripheral speeds which may be several or many times that of the rotors. During this operation the fibers are drawn into contact with rotating members 58 and into the path of the converging blasts issuing through the perforated surfaces 64 of the rotating members. Containers 68 within the casings of members 58 serve as baffles to prevent a large discharge of air or other gas, except in the direction indicated by the arrows 87 in Fig. 5, and also in conjunction with the jets, cause induced air currents inwardly through the perforations of the casings above the jet nozzles as indicated by the arrows 89 in Fig. 5. Both these induced air currents and the jets tend to intensify the frictional contact of the fibers with the casings. The latter being driven at high speeds by the jets, that is, at peripheral speeds which are many times higher than that of the rotors, complete the drawing of the fibers from the available molten material on the rotors in the form of long, extremely fine fibers. The rotating members thus serve the dual function of assisting the drawing action and of preventing snarling of the fibers as they finally break loose from the protuberances and the glass layer, respectively, this taking place at, or adjacent, the bottom of the arc of rotation of the rotors. Breaking or burning off of the fibers from the rotors is assisted on one side by the flame issuing from burner 46 which sends tongues of flame along the bottom of the adjacent rotating member 58, and on the other side by burner 41 which similarly sends tongues of flame along the bottom of the adjacent rotating member 58.

The fluid jets, being directed in converging paths downwardly and against the discs 76 and 78, remove the fibers from the fiber grasping prongs and carry the fibers downwardly to be collected on conveyor 86 or other suitable fiber collecting device.

The discs may be rotated by an independent drive device but, as previously mentioned and as illustrated particularly in Figs. 9 and 10, similarly as the members 58, be driven by the jets. For this purpose their lateral faces are provided with suitable means, such as indentations 90, upon which the jets impinge to exert a driving action.

The apparatus and method described above fully attain the several objects of the invention. Relatively long, extremely fine fibers are expeditiously produced. The overlapping high speed pulling discs insure the grasping and drawing out of the fibers formed between the rotors, the rotating members 58 and the jets issuing therefrom contributing to the fiber drawing operation. The rotating members also prevent entanglement of the fibers as they break or are burned off from the rotors.

Having thus described my invention in rather full detail, it will be understood that these details need not be strictly adhered to but that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. A method of making fibers comprising drawing a succession of fibers, contacting said fibers during the fiber drawing operation with spaced means moving in opposite directions in overlapping, circular paths to grasp the fibers and carry them in a direction transverse to their lengths to elongate the same, and conveying the elongated fibers by said means into the path of a gaseous blast.

2. A method of making fibers comprising drawing a succession of fibers between moving bodies, and contacting said fibers during the fiber drawing operation by spaced annular devices rotating in opposite directions in overlapping, circular paths to grasp the fibers and to stretch the fibers and carry them in a direction transverse to their lengths into the path of converging fluid jets.

3. A method of making fibers comprising drawing a succession of fibers between moving bodies carrying supplies of fiber forming material, frictionally contacting said fibers during the fiber drawing operation by surfaces moving at high speed, and maintaining the frictional contact between the fibers and the surfaces for an interval to elongate the fibers by drawing additional material from the supplies of fiber forming material on the bodies.

4. A method of making fibers comprising drawing a succession of fibers between moving bodies carrying supplies of fiber forming material, frictionally contacting said fibers during the fiber drawing operation by surfaces moving at high speed, pneumatically intensifying such frictional contact, and maintaining the frictional contact for a sufficient interval to elongate the fibers by drawing additional material from the supplies of fiber forming material on the bodies.

5. A method of making fibers comprising drawing a succession of fibers between moving bodies carrying supplies of fiber forming ma-

terial, bringing the fibers during the fiber drawing operation into frictional contact with cylindrical members rotating at high speed, and maintaining the frictional contact between the fibers and the cylindrical members for a sufficient interval to elongate the fibers by drawing additional material from the supplies of fiber forming material on the bodies.

6. A method of making fibers comprising drawing a succession of fibers between moving bodies carrying supplies of fiber forming material, bringing said fibers during the fiber drawing operation into contact with cylindrical members rotating at high speed, pneumatically intensifying such frictional contact, and maintaining the frictional contact between the fibers and the cylindrical members for a sufficient interval to elongate the fibers by drawing additional material from the supplies of fiber forming material on the bodies.

7. A method of making fibers comprising drawing a succession of fibers between moving bodies carrying supplies of fiber forming material, contacting the fibers during the fiber drawing operation with means moving in a direction transverse to their length to elongate the same and to carry them into frictional contact with surfaces moving at high speed, pneumatically intensifying such frictional contact, and maintaining the frictional contact between the fibers and the surfaces for a sufficient interval to elongate the fibers by drawing additional material from the supplies of fiber forming material on the bodies.

8. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, and means for pulling said fibers in a direction transverse to their lengths, said fiber pulling means including spaced fiber grasping devices mounted for movement in opposite directions in overlapping, circular paths.

9. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, means for pulling said fibers in a direction transverse to their lengths, said fiber pulling means including spaced fiber grasping devices mounted for movement in opposite directions in overlapping, circular paths, and means for directing a gaseous blast against said fibers.

10. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, means for pulling said fibers in a direction transverse to their lengths, said fiber pulling means including spaced fiber grasping devices mounted for movement in overlapping, circular paths, rotatable members on opposite sides of said fiber grasping means and in the path of the fibers carried thereby for frictional contact therewith, and means for directing a fluid blast against the fibers.

11. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, means for pulling said fibers in a direction transverse to their lengths, said fiber pulling means including spaced fiber grasping devices mounted for movement in overlapping, circular paths, rotatable members on opposite sides of said fiber grasping means and in the path of the fibers carried thereby for frictional contact therewith, and means for directing a fluid blast from said members and against the fibers to intensify the frictional contact between the fibers and the members and to carry the fibers from the fiber grasping means.

12. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, means for pulling said fibers in a direction transverse to their lengths, rotatable members on opposite sides of said fiber pulling means and in the path of the fibers carried thereby, and means for directing a gaseous blast against the fibers to intensify the frictional contact between the fibers and the members and to carry the fibers from the fiber pulling means.

13. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, means for pulling said fibers in a direction transverse to their lengths, perforated, hollow, rotatable members supported on opposite sides of said fiber pulling means and in the path of fibers carried thereby, and means for directing fluid blasts through the perforated walls of the members and against the fibers.

14. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, a pair of rotatable discs having fiber grasping peripheries with overlapping portions lying in the path of the fibers whereby the discs grasp the fibers and carry them in a direction transverse to their lengths, rotatable members supported on opposite sides of the pair of discs and in the path of the fibers carried thereby, and means for directing a gaseous blast from adjacent the rotatable members and against the fibers carried by the pair of discs.

15. In an apparatus for producing fibers, means for forming a body of fiber forming material, means movable relatively away from the body for contacting the body and drawing a succession of fibers therefrom, a pair of rotatable discs having fiber grasping peripheries, means supporting the discs with overlapping portions in the path of the fibers, means for rotating said discs in opposite directions, hollow, perforated, cylindrical members on opposite sides of the discs and in the path of the fibers, means supporting said cylindrical members for rotation, and means for setting up gaseous blasts within said cylindrical members and for directing the blasts through the perforations thereof and against the fibers carried by the discs.

16. In an apparatus for producing fibers, a rotor having a peripheral surface, means for forming a layer of molten material on said surface, a second rotor, elements projecting from the peripheries of the second rotor, means mounting said second rotor for rotation with said elements moving into and out of contact with said layer to draw fibers therefrom whereby said fibers elongate as said elements move away from said first rotor, hollow, perforated, cylindrical members, means supporting said members adjacent the surfaces of said rotors, and means for set-

ting up gaseous blasts within said cylindrical members and for directing the blasts through the perforations thereof in converging paths transverse to the lengths of the fibers.

17. In an apparatus for producing fibers, a rotor having a peripheral surface, means for forming a layer of molten material on said surface, a second rotor, elements projecting from the peripheries of the second rotor, means mounting said second rotor for rotation with said elements moving into and out of contact with said layer to draw fibers therefrom, hollow, perforated, cylindrical members mounted for free rotation adjacent the surfaces of the rotors, and means for setting up converging gaseous jets directed through the perforated walls of said cylindrical members and in a direction transverse to the lengths of the fibers.

18. In an apparatus for producing fibers, a rotor having a peripheral surface, means for forming a layer of molten material on said surface, a second rotor, elements projecting from the peripheries of the second rotor, means for mounting said second rotor for rotation with said elements moving into and out of contact with said layer to draw fibers therefrom, discs having fiber grasping peripheries, means supsorting the discs to have overlapping sections in the path of the succession of fibers, hollow, perforated, cylindrical members on opposite sides of the discs and adjacent the surfaces of the rotors, means for setting up gaseous blasts within said hollow, cylindrical members, means for directing the blasts through the perforations thereof in converging paths and against said discs, and means on said discs for causing rotation thereof by said blasts.

EDWARD R. POWELL.

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