

April 18, 1961

J. A. BRIGGS, JR., ET AL

2,979,766

MELT-SPINNING APPARATUS

Filed Feb. 23, 1960

2 Sheets-Sheet 1

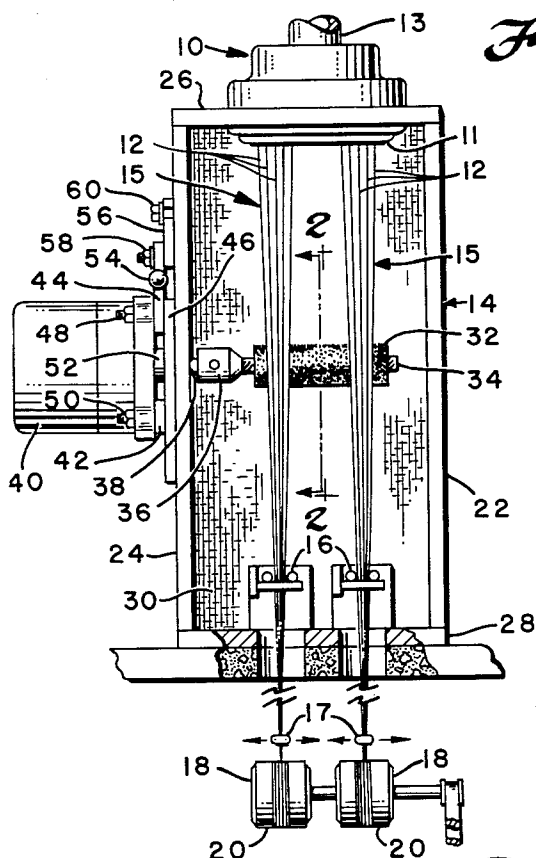


Fig. 1.

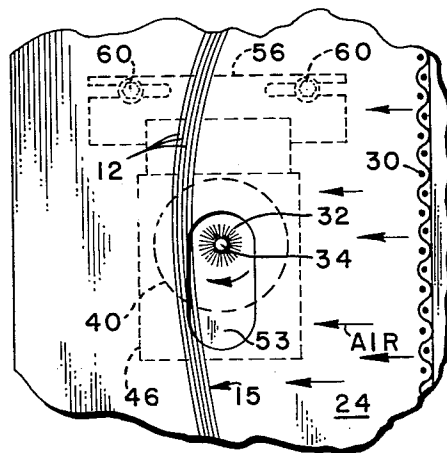


Fig. 2.

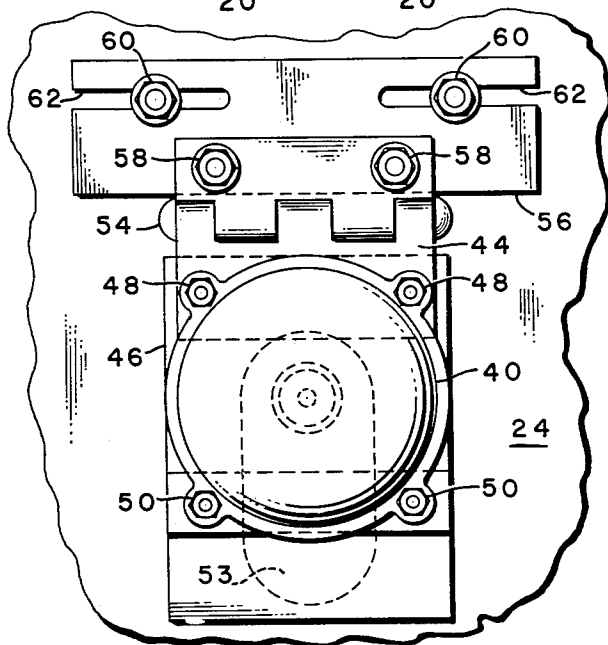


Fig. 4.

INVENTORS
JOSEPH A. BRIGGS, JR.
ROBERT L. GARDNER
BY

Stanley M. Tarter
ATTORNEY

April 18, 1961

J. A. BRIGGS, JR., ET AL

2,979,766

MELT-SPINNING APPARATUS

Filed Feb. 23, 1960

2 Sheets-Sheet 2

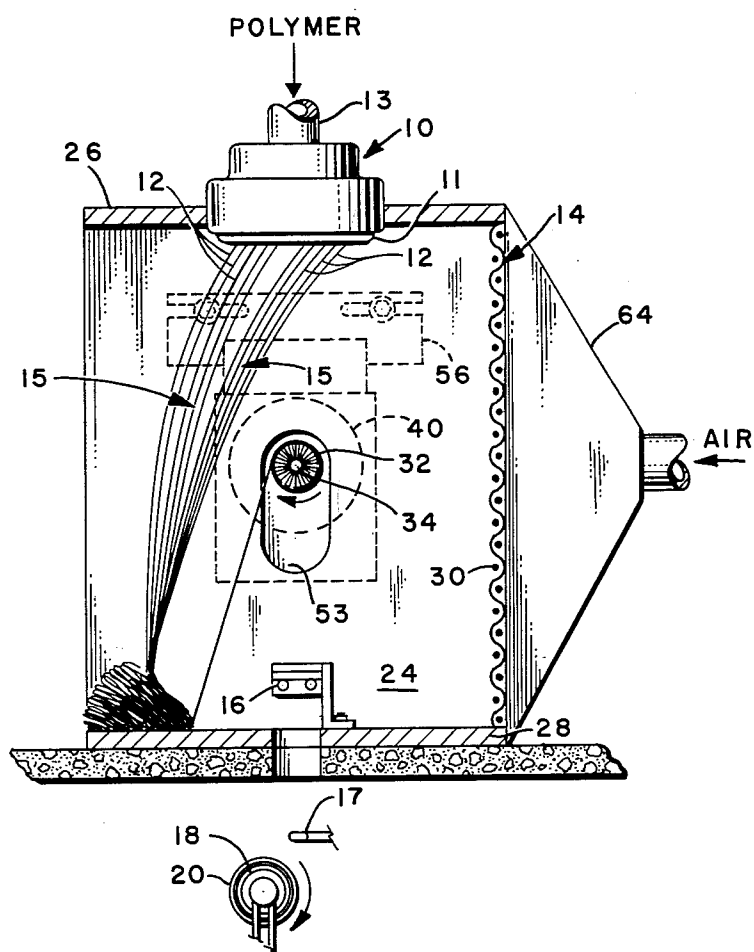


Fig. 3.

INVENTORS
JOSEPH A. BRIGGS, JR.
ROBERT L. GARDNER
BY

Stanley M. Tarter
ATTORNEY

1

2,979,766

MELT-SPINNING APPARATUS

Joseph A. Briggs, Jr., and Robert L. Gardner, Pensacola, Fla., assignors to The Chemstrand Corporation, Decatur, Ala., a corporation of Delaware

Filed Feb. 23, 1960, Ser. No. 10,293

7 Claims. (Cl. 18—8)

This invention relates to the production of filaments by the melt-spinning method. More particularly, it relates to improvements in an apparatus for producing filaments and the like from linear high polymeric thermoplastic organic filament-forming compositions according to melt-spinning procedures.

In the manufacture of filaments from high polymeric filament-forming compositions by melt-spinning procedures, the polymer to be shaped into filaments is normally heated to the molten or plastic state but below the decomposition temperature thereof. The molten or plastic mass is extruded at a constant rate and under pressure through small orifices in a spinneret to form molten streams of polymer. The molten polymer streams issuing from the spinneret are directed vertically downward from the spinneret into a cooling atmosphere, usually air, where they are cooled and caused to solidify into individual filaments. The filaments are then brought together. A finish is applied to the filaments, and the filaments are collected in an orderly manner for further processing. To assist in cooling and solidifying the molten streams, air or like gas is impelled or blown against the filamentary streams. It can be appreciated readily that the filamentary streams after emerging from the spinneret until sufficiently cool are particularly sensitive to deformation. Accordingly, the art has found it generally necessary to direct the cooling gas against the filamentary streams while the streams pass downwardly through a protective cell or chamber and to avoid a turbulent flow of the cooling gas. Particularly advantageous results are obtained when the directional movement of the cooling air is transverse with respect to the downward direction taken by the moving streams of polymer, care being taken that the gas flow at a given point is uniform in magnitude and direction. Such mode of solidifying the molten streams of polymer by cooling with air may be accomplished by providing along one side of a conventional spinning chamber a foraminous or perforated partition pervious to air and by impelling the cooling air to pass through said partition and horizontally across the chamber in heat-exchanging contact with the traveling filamentary streams. The air is allowed to escape through the side of the chamber opposite to the foraminous partition. The force of the air contacting the filamentary streams is usually sufficient to cause the streams to assume an arcuate path during part of their travel down the spinning chamber. That is to say, the filamentary streams are blown outwardly by the cooling air and thereby do not follow the long axis of the conventional spinning chamber as they would if there were no positive transverse movement of the air.

For various reasons the physical characteristics and properties of the filaments produced may vary over a period of time as they are being melt-spun and collected on take-up devices, e.g. reeled onto bobbins. Often this variation occurs in the denier or cross-section of the filaments. Hardly ever is the variation in the denier by way of increase. That is to say, variations of increased denier have not been found generally to be a problem. It has been found that the denier of the melt-extruded fila-

2

ments is reduced when leaks in the metering pumps which are propelling the molten polymer to the spinneret, channeling of the molten polymer in the filter sand pack of the spinneret assembly, clogging of the spinneret orifices, fluctuations of the gas flow through the spinning chamber or the like are experienced. Such reductions in denier give rise to considerable processing difficulties in textile mills during conversion of the filamentary material into fabric or the like, as well as in the orientation stretching of the filaments usually performed in an operation subsequent to the melt-spinning by the filament manufacturer.

In the past various devices have been proposed for detecting variations in denier of filamentary materials; but these have not been completely satisfactory for a variety of reasons when same are used in connection with a melt-spinning apparatus. In the first place, these devices almost invariably require considerable instrumentation. In addition, they are complicated in operation, often involve various moving parts and are quite expensive to construct.

Perhaps even more important is the fact that the devices of the prior art primarily are concerned with detecting defects or variations in denier of filamentary material during various processing operations conducted subsequently to the initial winding of the filaments on spin bobbins after melt-spinning. The known devices ordinarily include means responsive to the variations in denier of the moving filamentary material to stop the supply thereof. However, once extrusion of molten polymer is commenced in the melt-spinning operation, it is not at all convenient to stop extrusion of the polymer through the spinneret until the polymer in the reservoir of the spinneret is exhausted. Hence, the prior art apparatus have not been found suitable for detecting variations in denier of melt-spun filaments during the production thereof.

It is an object of the present invention to provide a new and novel spinning apparatus for use in the production of melt-spun filaments.

It is a further object of this invention to provide a new and novel spinning apparatus adapted to prevent collection of melt-spun synthetic filaments when they exhibit an undesirable deviation as to denier uniformity during production thereof.

It is a further object of this invention to provide a new and novel apparatus adapted to prevent collection of melt-spun synthetic filaments when they exhibit an undesirable reduction in denier during melt-spinning without stopping the extrusion of the polymer being shaped into said filaments.

Other objects and many of the advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing in which like reference numerals designate like parts throughout the figures thereof.

In general the objects of the present invention are accomplished by providing one or more melt-spinning devices adapted to shape and discharge molten or plastic organic filament-forming materials into one or more streams, to cool the streams into solid filaments and thereafter to collect the filaments in an orderly form. Each spinning device includes means for shaping the molten or plastic material into streams, such as a spinneret having a suitable number of orifices in the face thereof, and means for collecting the filaments produced. The device includes a protective spinning chamber adapted to receive the shaped streams which are directed downwardly therethrough and wherein the extruded streams are cooled and solidified into filaments by a non-turbulent flow of gas being impelled against the streams. Means

3

are provided for diffusing the gas flow and directing the gas against the shaped streams transversely of the normal extrusion axis and with sufficient force that the streams moving downwardly are caused to assume an arcuate or curved path during their passage through said spinning chamber. Each spinning device contains a filament accumulator for gripping filaments being produced that display variations in denier. The accumulator is positioned in proximity of the arcuate path and preferably between the shaping means and collecting means and in the area defined by the arcuate path of the filaments and the normal extrusion axis. The accumulator is adapted to collect irregular filaments at a rate such that the filaments are broken between the accumulator and the collecting means but at a linear rate less than the linear extrusion rate such that the filaments are caused to amass or heap in a conspicuous assemblage interjacent to the shaping means and collecting means. The operator of the melt-spinning apparatus upon noticing said assemblage of filaments can then investigate and correct the cause of the spinning difficulties with a minimum of filaments of non-uniformity of denier being collected in package form.

With reference now to the drawing, Figure 1 is a front elevational view of a melt-spinning apparatus incorporating one embodiment of the improvement of the present invention;

Figure 2 is a fragmentary sectional view of part of the apparatus taken along line 2—2 of Figure 1 and looking in the direction of the indicating arrows which illustrates the arcuate path of the filaments curving from the extrusion axis;

Figure 3 is a side elevational view partly in section of the apparatus taken from the right hand side of Figure 1 with the side wall of the apparatus removed for convenience of illustration and showing the conspicuous accumulation of defective melt-spun filaments; and

Figure 4 is a fragmentary side elevational view of part of the apparatus taken from the left hand side of Figure 1 and showing a specific mounting means for a motor employed in the apparatus of the present invention for powering the filament accumulator.

In the drawing reference numeral 10 generally indicates a spinneret assembly which incorporates a spinneret 11 through whose orifices a molten or plastic filament-forming polymer is extruded or shaped into a plurality of filaments 12. The molten polymer is pumped or propelled to the spinneret under pressure through a conduit 13 from a suitable source where the polymer is heated to a molten or plastic condition. The face of the spinneret preferably is horizontally disposed so that the normal extrusion axis extends vertically downward. Upon extrusion the molten polymer assumes the form of a stream or a plurality of streams of polymer. The streams are received immediately after extrusion by and cooled within the confined or protected area provided by the elongated spinning chamber 14, sometimes referred to as a blow box or a spinning chimney. The filaments in the embodiment shown are grouped into two separate bundles 15. These bundles pass downwardly through the cooling zone within chamber 14 and thence to and through yarn converging guides 16 where the filaments are gathered together in more compact bundles. Thereafter, the bundles of filaments are taken up in an orderly manner. As illustrated the take-up means includes reciprocatably mounted traverse guides 17 adapted to lay the melt-spun filaments on bobbins 18 or the like suitably driven to form filament packages 20. It will be appreciated that the speed of filament take-up on bobbins 18 will be coordinated properly with the extrusion speed so that proper melt-spinning is accomplished.

The spinning chamber 14 having an open front comprises two solid vertical side walls 22 and 24 in spaced apart relationship, a top panel 26 through which the spinneret assembly projects a short distance and a bottom

4

panel 28 provided with openings therein through which the gathered bundles of filaments pass in operation. The back wall of the chamber 14 bridging said side walls 22 and 24 and extending from panel 26 to panel 28 is made of material pervious to gas, such as gauze fabric, felt material, or as illustrated, a fine mesh wire screen 30. The screen will impart a diffused but substantially straight line flow to the cooling gas impelled therethrough so that the cooling gas contacts laterally the vertically moving streams of polymer to cool same into solid filaments.

Between the filament bundles 15 and the wire screen 30 there is positioned a filament accumulator adapted to catch the filaments coming into contact therewith and to entangle same thereon so that the caught filaments will be accumulated. The movement of the filaments will be so impeded or snubbed by the accumulator that the filaments will break between the accumulator and the filament take-up means. The accumulating means illustrated is a rotatably mounted circular brush 32 having projecting bristles adapted to take and retain filaments coming in contact therewith. The brush is mounted on a shaft 34 having a chuck end 36 keyed to an output shaft 38 of an electric motor 40. The motor is energized by suitable electrical connections, not shown. The axis of shaft 34 is perpendicular with respect to the extrusion axis. Instead of a bristled brush, as illustrated, other devices composed of wire, steel wool, coarse fibers, etc., set in a suitable back or handle maybe used if desired, the objective being to catch and accumulate filaments coming in contact therewith. The peripheral speed of the brush 32 in operation is controlled to be less than either the take up speed or the extrusion speed of the filaments.

It will be seen from Figure 2 that in the normal operation where filaments of satisfactory denier uniformity are produced, the air urged through the screen 30 forces the traveling filaments to assume a bow-shaped or arcuate configuration. The brush 32 in operation is positioned preferably in the area defined by the arcuate path and the extrusion axis. When for some reason, such as has been outlined above, a reduction of denier occurs in the filaments being formed, they will no longer billow outwardly and will not follow the arcuate path. In this event the filaments instead will descend directly downward from the spinneret 11 and come into engagement with the bristles of the brush 32. Since the filaments are accumulated at a speed less than the extrusion speed or collection speed, the filaments consequently will be broken between the brush and take-up device and will begin to spill along the bottom of chamber 14 and onto the floor or platform on which the chamber is supported, as can be seen in Figure 3. As indicated above, the attending operator upon seeing this situation then can take the proper steps to obviate the cause of the reduction of the denier of the filaments being produced.

Although it is not entirely clear why filaments of lower denier tend to follow the extrusion axis instead of being pushed outwardly by the horizontal flow of cooling gas, two possible reasons for this have been advanced. Firstly, filaments of lower denier are finer and somewhat smaller in diameter, and thus offer less resistance to the flow of air against them. Accordingly, instead of being blown outwardly the filaments will tend to follow a path more closely corresponding with the extrusion axis. Secondly, the reduction in denier of the melt-spun filaments is often due to a curtailment in the quantity of polymer per unit of time extruded from the spinneret. Since the take-up means is operated at a predetermined and constant speed, any reduction in the amount of polymer extruded will result in an increased tension on the filaments being melt-spun. The increased tension will cause the filaments to assume a path approximating the extrusion axis.

It is often advantageous to mount the brush 32 in such a manner so as to permit easy withdrawal from and horizontal adjustment within the spinning chamber 14. To this end the motor 40 is attached to a spacer block

5

42 and the lower leaf of a double-leaf hinge 44. The motor, together with the block 42 and the lower leaf of hinge 44, is mounted on a backing plate 46 by the use of securing means 48 and 50 to form a rigid construction. Reference numeral 52 indicates a housing for the bearing supporting the output shaft 38 of the motor 40, which extends through an opening (not shown) within the plate 46 and a corresponding opening 53 in the sidewall 24 of the spinning chamber 14.

It will be noted that structurally the hinge articulates around a bolt 54 and is fastened at its top to a horizontally adjustable bracket 56 by means of nut and bolt assemblies 58.

The supporting bracket 56 is attached to and supported from the sidewall 24 by second securing means 60. Elongated slots 62 are provided in bracket 56 to permit horizontal adjustment of the motor and its associated brush in the oval-shaped opening 53 provided in the sidewall 24. With this arrangement the brush 32 can be inserted into the spinning chamber 14 or withdrawn therefrom when the brush 32 is connected with motor 40.

From the above description it is apparent that when it is desired to move the brush 32 from the area within the spinning chamber 14, this can be accomplished by pivoting motor 40 upwardly and to the left, whereupon the brush 32 and the brush shaft 34 are led outwardly through opening 53. After cleaning or changing the brush 32 or perhaps cleaning the spinning chamber, the brush may then be reinserted into the spinning chamber by pivoting the hinge-mounted motor 40 downwardly and to the right.

In the operation of the melt-spinning apparatus as shown the extrusion of the molten or plastic polymer through the spinneret is commenced first during start up. The fans or other gas impelling means situated behind the screen 30 (not shown) are then actuated to cause a flow of gas into compartment 64 through the screen 30 and horizontally through the spinning chamber 14 as shown in Figure 2 by the arrows. The operator then threads the filament ends through the converging guides 16 and traverse guides 17 and onto bobbins 18 to initiate the collection of the filaments thereon. The particular curved path followed by the filaments is a function of extrusion speed, windup speed, cooling gas velocity, etc. Once these variables have been set, then filaments of a particular and predetermined denier are formed and continuously collected on bobbins 18.

With the normal arcuate path of the cooling filament streams having been established, the motor 40 and the brush 32 are swung downwardly so as to position the brush at a point behind the descending filaments and within the curve of the arcuate path. The horizontal positioning of the brush is, of course, accomplished by sideways adjustment of securing means 60 within slots 62. The motor 40 is energized to start the rotation of shaft 34.

When the denier of the filaments becomes reduced, the filaments will tend to move backwardly and come in contact with the rotating brush 32 (as explained above) which causes the filaments to be snubbed and broken in their path of travel on the way to the windup bobbins 18. The filaments which are being extruded then begin to spill upon the floor or spinning platform, thereby giving immediate notice to the operator in attendance that a variation in denier has occurred so that he can take necessary corrective measures.

In the embodiment shown in the drawing the brush 32 is positioned in back of the filament bundles so as to be in a path between the spinneret and the converging guides which path is shorter than the normal arcuate path followed by the blown filaments. Should a variation in physical characteristics of the filaments be anticipated which causes the filaments to billow outwardly more than normal, a filament accumulating brush or the like can then be positioned at a point in a path of travel which

6

is longer than the normal arcuate path and which point lies closer to the open front of the spinning chamber 14. When the filaments billow outwardly too far, they will be snubbed in a manner similar to that discussed above.

The invention is generally applicable to any substance that can be melt-spun. Specific polymeric materials capable of being melt-spun include: nylon 66, nylon 6, nylon 4, nylon 610, nylon 11, and their filament-forming copolymers thereof, e.g., 6/66, 6/610/66, etc.; polyesters derived from terephthalic acid and ethylene glycol and from terephthalic acid and bis-1,4-(hydroxymethyl) cyclohexane; polyethylene and polypropylene; and other substances.

Hence, there has just been described above a simple, inexpensive, and effective apparatus for detecting variations in denier of melt-spun filaments as they are being produced, which apparatus gives notice of irregularities occurring in the spinning process to the operator in attendance. By virtue of this apparatus the collection of filaments of too low a denier is prevented in the early stage of processing; and costly delays and waste of filamentary material in later stages are avoided.

Obviously, many modifications and variations of the present invention are possible in the light of the above teaching. It should be understood, therefore, that the foregoing disclosure relates to only preferred embodiments of the invention and that numerous modifications may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A melt-spinning apparatus for use in the production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting filaments in package form at a predetermined collection rate positioned below said spinneret, a spinning chamber 40 having a top panel through which said spinneret projects and adapted to receive the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush being positioned in the area defined by said extrusion line and said arcuate path and being adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collection rate when denier reduction occurs in the production thereof, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and brush when denier reduction occurs.

2. A melt-spinning apparatus for use in the production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting filaments in package form at a predetermined collection rate positioned below said spinneret, a spinning chamber 65 having a top panel through which said spinneret projects and adapted to receive the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush of circular cross-section having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush being positioned in the area defined by said extrusion line and said arcuate path and being

adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collection rate when denier reduction occurs in the production thereof, a motor operatively connected with said brush for imparting rotation thereto, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and said brush when denier reduction occurs.

3. A melt-spinning apparatus for use in production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting filaments in package form at a predetermined collection rate positioned below said spinneret, a spinning chamber having a top panel through which said spinneret projects and adapted to receive the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush being positioned in the area defined by said extrusion line and said arcuate path and being adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collecting rate when denier reduction occurs in the production thereof, a motor operatively connected with said brush for imparting rotation thereto, said motor being pivotally mounted on a side wall of said spinning chamber so as to permit convenient withdrawal of said brush from said chamber while said brush is connected with said motor, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and said brush when denier reduction occurs.

4. A melt-spinning apparatus for use in the production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting filaments in package form at a predetermined collection rate positioned below said spinneret, a spinning chamber having a top panel through which said spinneret projects and adapted to receive the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush of circular cross-section having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush extending axially horizontally in the area defined by said extrusion line and said arcuate path and being adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collection rate when denier reduction occurs in the production thereof, an electrical motor operatively connected with said brush by means of a drive shaft for imparting rotation thereto, said motor being mounted on a bottom and pivotal leaf of a double-leaf hinge whose upper leaf is secured to a sidewall of said chamber but mounted to be horizontally adjustable with respect to said sidewall, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and said brush when denier reduction occurs.

5. A melt-spinning apparatus for use in the production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting

filaments in package form at a predetermined collection rate positioned below said spinneret, an open front spinning chamber having a top panel through which said spinneret projects and adapted to receive the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush of circular cross-section having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush extending axially horizontally in the area defined by said extrusion line and said arcuate path and being adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collection rate when denier reduction occurs in the production thereof, an electrical motor operatively connected with said brush by means of a drive shaft for imparting rotation thereto, said motor being mounted on a bottom and pivotal leaf of a double-leaf hinge whose upper leaf is secured to a sidewall of said chamber but mounted to be horizontally adjustable with respect to said sidewall, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and said brush when denier reduction occurs.

6. A melt-spinning apparatus for use in the production of filaments from a thermoplastic filament-forming polymer comprising a spinneret for extruding said polymer in a molten condition and discharging said polymer into streams in a path extending downwardly along a vertical extrusion line at a predetermined extrusion rate, means for collecting the resulting filaments in package form at a predetermined collection rate positioned below said spinneret, an open front spinning chamber defined by a top panel through which said spinneret projects, a bottom panel having an opening axially aligned with said spinneret, two side walls in vertical spaced relation and a back wall bridging said side walls and being pervious to gas and extending between said panels, said chamber being positioned between said spinneret and said collecting means and adapted to receive therein the streams of polymer immediately upon extrusion thereof, means for directing a cooling gas through said back wall and laterally against said streams of polymer so as to cool same and with sufficient force to cause same to assume an arcuate path curving from said extrusion line, a rotatably mounted brush of circular cross-section having bristles projecting therefrom and adapted to take and retain filaments coming in contact therewith, said brush extending axially horizontally into the area defined by said extrusion line and said arcuate path and being adapted to collect said filaments at a rate less than the extrusion rate and at a rate less than the collection rate when denier reduction occurs in the production thereof, an electrical motor operatively connected with said brush by means of a drive shaft for imparting rotation thereto, said motor being mounted on a bottom and pivotal leaf of a double-leaf hinge whose upper leaf is secured to a sidewall of said chamber but mounted to be horizontally adjustable with respect to one of said sidewalls, whereby the filaments become broken between said brush and said collecting means and collect in a heap interjacent to said spinneret and said brush when denier reduction occurs.

7. The apparatus defined in claim 6 wherein the collecting means include a driven bobbin and an associated traverse guide.

References Cited in the file of this patent

UNITED STATES PATENTS

2,255,426	Lamesch	Sept. 9, 1941
2,535,561	Bastian	Dec. 26, 1950
2,711,054	Urbanetti	June 21, 1955
2,838,879	Schuller	June 17, 1958