Aug. 18, 1959

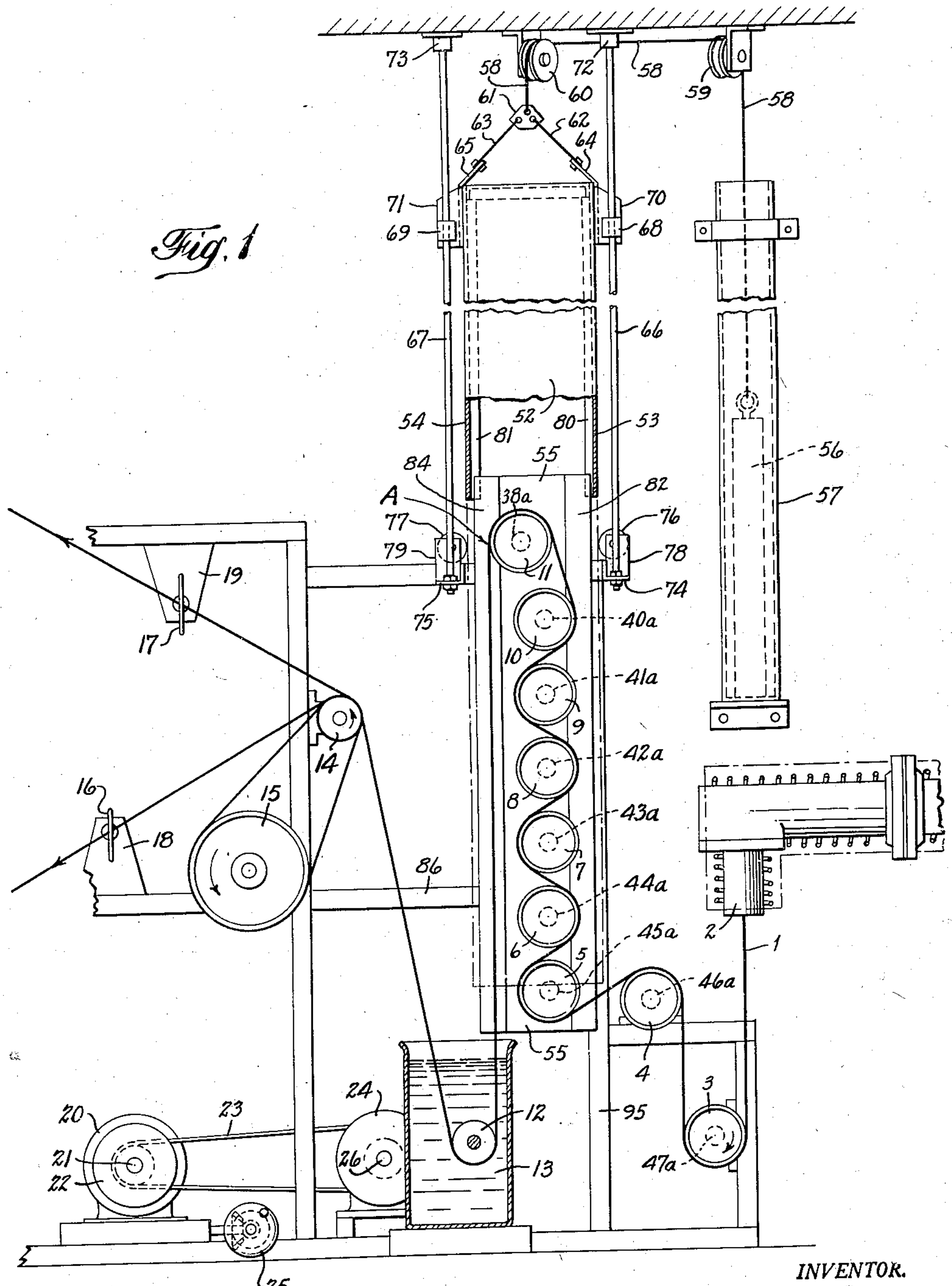
G. SHAW

2,900,220

PROCESS FOR MELT SPINNING AND ORIENTING POLYSTYRENE FILAMENTS

Filed Jan. 8, 1954

4 Sheets-Sheet 1



INVENTOR.
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ATTORNEYS.

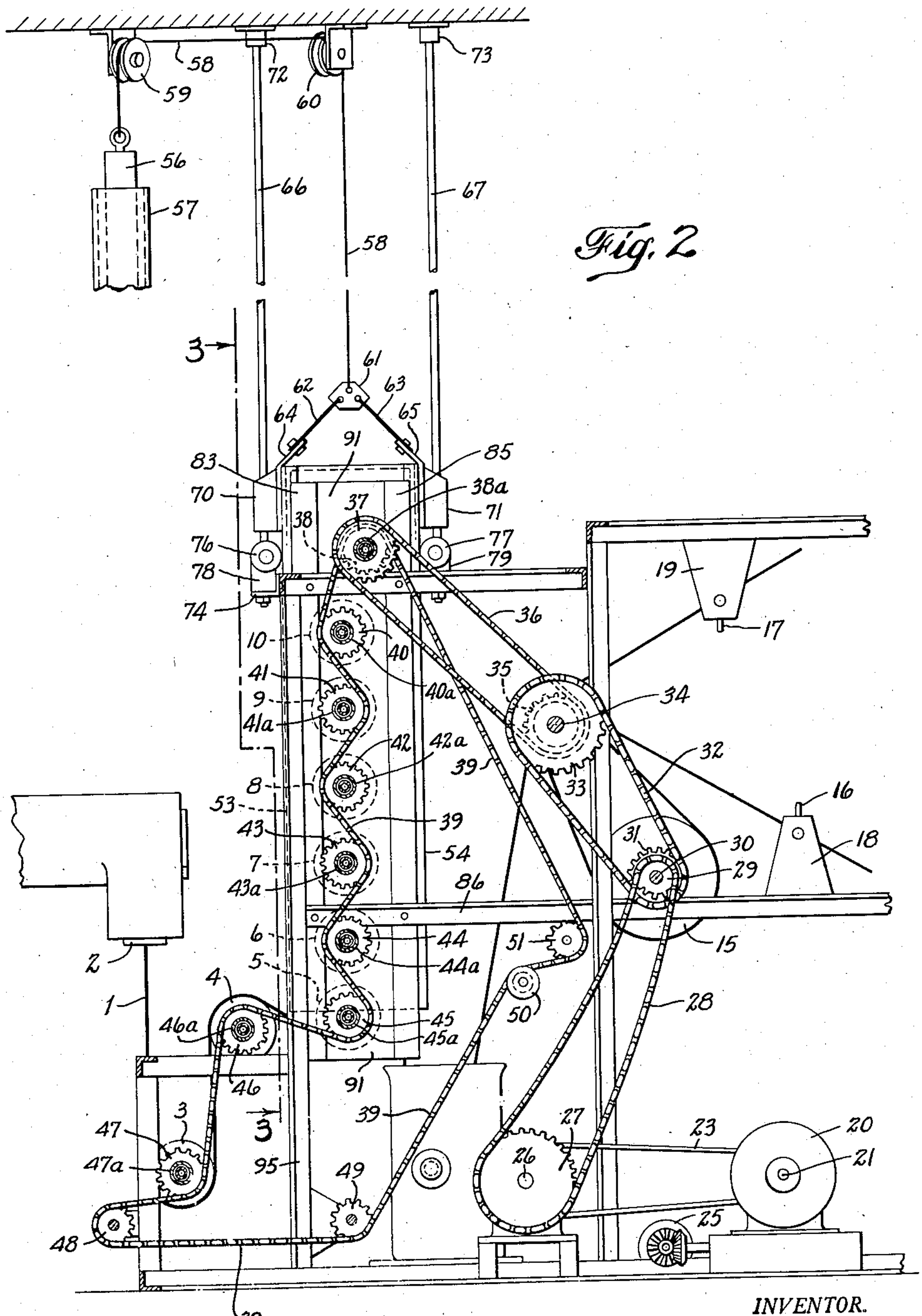

Fig. 2

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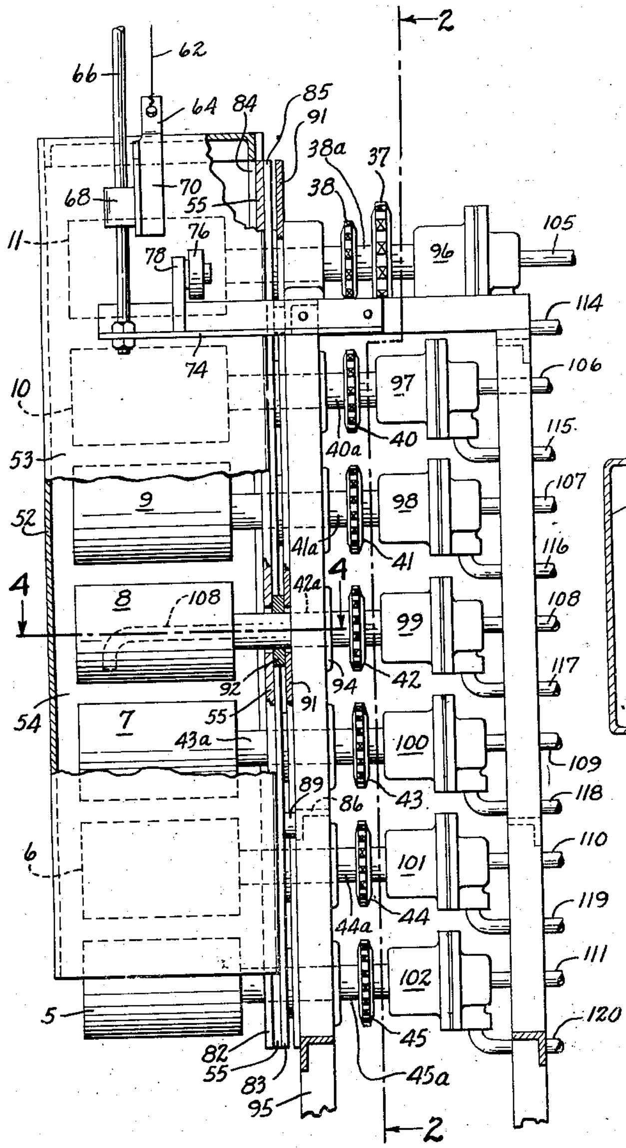

Fig. 3

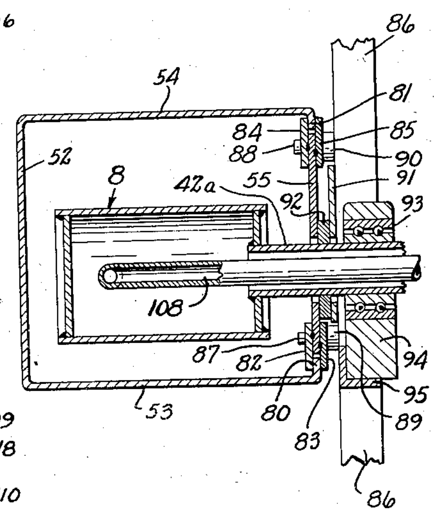

Fig. 4

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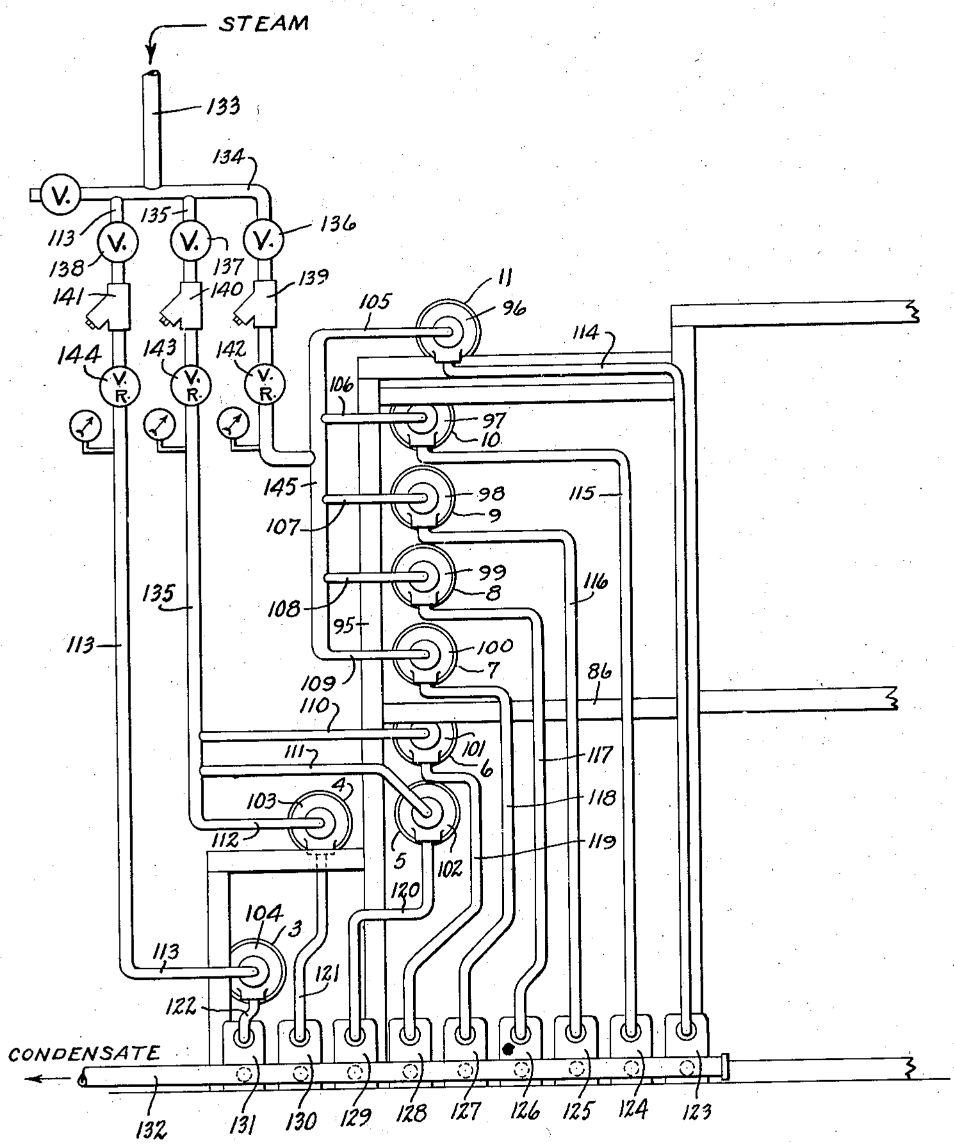

Fig. 5

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United States Patent Office

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Patented Aug. 18, 1959

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PROCESS FOR MELT SPINNING AND ORIENTING POLYSTYRENE FILAMENTS

Gilbert Shaw, Middlebury, Vt.

Application January 8, 1954, Serial No. 402,898

5 Claims. (Cl. 18—54)

The present invention relates to a novel process for orientating filaments, and in particular resinous filaments of the type illustrated by polystyrene monofilaments.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the steps pointed out in the appended claims.

The invention consists in the novel steps, combinations and improvements herein shown and described.

An object of my invention is to provide a novel process for orientating filaments in a safe, simple, efficient and inexpensive manner.

Another object of my invention is to provide a novel process and apparatus for orientating filaments with low breakage of filaments.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one form of the invention, and together with the description, serve to explain the principles of the invention.

Fig. 1 is a front elevation partly in section and broken away of one embodiment of my invention.

Fig. 2 is a rear sectional view taken along the line 2—2 of Fig. 3.

Fig. 3 is a side view as taken along the line 3—3 of Fig. 2.

Fig. 4 is a plan section taken along line 4—4 of Fig. 3.

Fig. 5 is a schematic rear view of the heating arrangement of the present invention.

Prior to my invention, resinous monofilaments, as illustrated by polystyrene monofilaments, were oriented or stretched by extrusion into liquid ethylene glycol, glycerine or concentrated $CaCl_2$ solution bath at a temperature of approximately 210° to 240° F. From the first bath, the polystyrene was carried into a hotter second bath in the range of 230° to 300° F. where stretching or orientation to the extent of 300–1000% took place. The filament then was passed through water baths to remove the heating solution.

The above described process had many disadvantages. There was a considerable heating solution loss which made the process costly. Also, the equipment presented considerable difficulty when threading the filaments through the hot baths. Breakage in the filaments was high and the hazard of using a hot inflammable solvent, such as ethylene glycol, was not desirable.

In order to overcome the above referred to disadvantages, I have devised my present process and apparatus.

In accordance with my process, the filaments from an extrusion die are brought to their orientation temperature by contacting said filament with a heated moving surface and applying a tensioning force to said filaments while at their orientation temperature. More specifically, the filaments are contacted with and conveyed by at least one and preferably a plurality of heated rollers enclosed in a leak-proof hood member, the natural surface friction of the unoriented filaments preventing slippage at the temperatures involved. After the filaments have been adjusted to their orientation temperature, they are subjected to tension forces so that the filaments now under tension are oriented or stretched, after which, while still under tension, they are passed through a cooling bath and thence to filament guides. By cooling the filaments under tension they are in a straight position while cooling, thus resulting in straight oriented filaments.

Preferably, the means for indirectly adjusting the filaments to the desired orientation temperature comprises a vertical stack of heated rollers enclosed in a leak-proof housing. This housing may preferably be insulated and provided with a chromium plated or aluminum external surface to minimize radiant heat loss. Three sides of the housing are vertically adjustable by means of a counterweight construction with the back portion of said housing being fixedly secured to a supporting frame to insure a leak-proof construction. The drive shafts of each of the motor-driven rolls extend through the fixed back of said shafts having a floating brass sleeve which fits snugly around the shaft to accommodate different positions of the shaft.

In order to describe my invention more specifically, reference is now made to the drawings. Extruded unoriented filaments **1**, passing from extrusion die **2**, are cooled a suitable orientation temperature as they are conveyed by heated, motor-driven rollers **3—11** to point A, at which point they are oriented or stretched due to the tensional pull exerted on the filaments. Next, the oriented filaments pass around roller **12** positioned in cooling bath **13** whereby the path of movement is reversed. From roller **12**, the filaments pass around roller **14** to roller **15** and back around roller **14** to filament guides **16** and **17** supported by brackets **18** and **19**. The tensional pull on the filaments at point A is determined by the surface speed of roller **14**.

Heated rollers **3—11** and rollers **15** and **14** are driven by means of a motor **20** in combination with a conventional variable speed pulley arrangement and multiple chain and sprocket drive. The operation of the roller driving means is as follows. Connected to motor shaft **21** of motor **20** is a variable speed V pulley **22** (Fig. 1) which drives pulley **24** by means of connecting belt **23**. Handwheel **25** is provided to adjust the motor supporting plates which in turn adjust the angle of V pulley **22** which controls the speed of the pulley, as is well known to those skilled in the field, such a construction being conventional. Fixedly mounted on shaft **26** of pulley **24** is a sprocket **27** which drives sprocket **29** through chain **28**. Mounted on shaft **30** of sprocket **29** is sprocket **31** and roller **15**. Thus, on the rotation of shaft **30**, roller **15** rotates, as does sprocket **31**, which in turn drives sprocket **33** through chain **32**. The rotation of shaft **34** causes roller **14** and sprocket **35**, connected thereto, to rotate.

On the rotation of sprocket **35**, sprocket **37** is rotated by means of chain **36**, which in turn causes sprocket **38**, mounted on shaft **38***a*, to rotate. A continuous chain **39** is driven by sprocket **38** which causes sprockets **40—47** to rotate. On rotation of sprockets **38** and **40** to **47**, rollers **11** to **3**, respectively, connected to the shafts **38***a*, **40***a* to **47***a* of sprockets **38** and **40** to **47** will also rotate. The chain **39** on passing around sprockets **38** and **40** to **47** continues its path around idler sprockets **48**, **49**, **50** and **51** to complete a continuous circuit.

As shown in Figs. 1 to 4, a housing member comprising integrally connected front **52** and sides **53** and **54** and separate back **55** is provided. Front **52** and sides **53** and **54** are vertically adjustable by means of a counterweight **56** enclosed in casing **57**, said counterweight being attached to one end of rope **58** passing over pulleys **59** and **60** with the other end of said rope **58** being connected to a plate **61** having attached thereto two small ropes **62** and **63**, each having a bracket **64** and **65** attached to its outer end, said brackets **64** and **65** being connected to sides **53** and **54** respectively. Guide rods **66** and **67** passing through guide loops **68** and **69** of supporting brackets **70** and **71** are provided, said brackets **70** and **71** being connected to sides **53** and **54** respectively. The upper ends of rods **66** and **67** are fixedly mounted in supporting bearings **72** and **73** respectively, with the lower ends bolted to L-plates **74** and **75** respectively. Rollers **76** and **77** are provided near the lower ends of said rods, said rollers connected to plates **74** and **75** by brackets **78** and **79**.

As mentioned hereinbefore, the front **52** and sides **53** and **54** of the housing are vertically adjustable due to the above described counterweight construction but the rear **55** is fixedly supported. As best shown in Fig. 4, sides **53** and **54** are provided with inwardly turned lips **80** and **81**, respectively, which are adapted to slide between the spaces provided by vertical strips **82, 83, 84** and **85**, respectively. Strips **82, 83, 84** and **85**, as well as back **55**, are connected to frame member **86** by means of bolts **87**, **88** respectively, strips **83** and **85** being spaced from said frame by collars **89** and **90**.

Also connected to frame **86** is a vertical plate **91** which has a plurality of vertical spaced openings in alignment with a plurality of spaced openings in back **55** through which the respective shafts **38*a*, 40*a*** to **45*a*** pass. As best shown in Fig. 4, each of the shafts, as illustrated by shaft **42*a***, has mounted thereon a floating brass bushing or washer **92** which fits snugly between back **55** and plate **91** to accommodate different positions of the shaft. Each of the shafts passes through a ball bearing unit as illustrated by unit **93** mounted in bearing **94** connected to frame member **95**.

Steam passing through rotary steam joints **96** to **104** (Fig. 5) is transmitted to rollers **11—3**, respectively, by means of pipes **105—113**, as illustrated by pipe **108** (Fig. 4), which telescope in the hollow shafts **38*a*, 40*a*—47*a*** respectively into their respective hollow rollers. As shown in Fig. 4, there is sufficient clearance between the pipe **108** and shaft **42*a*** so that condensate outlets back through the shaft and returns to the steam chest **99**. Each roller is heated in a manner similar to that shown for roller **8** in Fig. 4. On the return of the steam from the respective rollers to the rotary steam joints it is discharged through outlet pipes **114—122** to steam traps **123—131** and to common outlet tube **132**.

Steam is fed to the pipes **105—113** by passing through common inlet pipe **133** through pipe **134** with portions of said steam being taken off through pipes **113** and **135**, said pipes **134, 135** and **113** being respectively provided with valves **136—138**, strainers **139—141** and reducing valves **142—144**. By means of manifold **145**, steam is discharged from pipe **134** to pipes **105—109**; while steam is discharged directly from pipe **135** to pipes **110—112** and directly to pipe **113**.

The mode of operation of the above described embodiment is as follows. The housing is in its down position as shown in Fig. 2 and by manipulating the heating arrangement rollers **3—11** are brought to the desired temperatures, depending upon the type of resin that is to be oriented. Preferably, an increment roller temperature arrangement is used. For example, in orienting a resin filament such as polystyrene monofilaments, roller **3** is heated to 210°–280° F., preferably 210°–220° F., rollers **4—6** from 220°–300° F., preferably 220°–240° F. and rollers **7—11** from 240°–330° F., preferably 240°–310° F.

After the rollers have been adjusted to the desired temperatures, motor **20** is turned on whereby an insignificant first portion of the filaments, which is inferior and unsuitable for orientation, is carried by the rollers **3—11**, **12, 14** and **15** to guides **16** and **17** where it is threaded; this threading phase requiring only a few seconds. Thereafter, the orientable and valuable portions of the filaments are carried by rollers **3—11** to point A, during which time, due to contact with the rollers **3—11**, they are adjusted to their orientation temperature. At this point, due to the tensional force on the filaments determined by the surface speed of roller **14**, the filaments are stretched. The filaments, while still under tension, are then cooled as they are passed through bath **13** by means of roller **12**, after which they pass to roller **14**, then to **15** and back again around **14**, from whence they pass to filament guides **16—17**.

It should be realized that the number of rollers used in accordance with my invention will vary depending upon the surface contact that is needed for the particular monofilament that is being oriented. For a needed surface contact the number of rollers that may be used may be accordingly decreased by using rollers of larger diameter to give an equivalent surface contact length, as will be well understood by those skilled in the field. Likewise, the structure of the housing member may be modified and still be within the spirit of my invention. For example, in place of the housing member as shown in my illustrated embodiment, a housing member may be used wherein only the front fact of the enclosure slides up and down with the back panel, sides and top being stationary.

The invention in its broader aspects is not limited to the specific steps, combinations and improvements described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

I claim:

1. A process for the orientation of extruded polystyrene monofilaments and the like, comprising emerging melted unoriented polystyrene monofilaments and the like from an extrusion die head and bringing said unoriented monofilaments into contact with at least one driven cooling roller heated to a temperature in the range of 210 to 330° F. while maintaining monofilament-roller contact for a sufficient period of time to cool said unoriented monofilaments to orientation temperature in the range of 210 to 330° F., maintaining a sufficiently insulated zone through which said monofilaments pass while being cooled to and while at orientation temperature to control heat loss from said monofilaments to prevent cooling thereof below orientation temperature, maintaining the monofilaments in an unoriented state while they are being cooled to orientation temperature by maintaining sufficient monofilament-roller frictional contact so that the monofilaments in contact with a cooling roller move at substantially the same surface speed as said cooling roller to prevent monofilament roller slippage prior to orientation, and applying a sufficient orienting tensioning force to said monofilaments, after they have been cooled to and while at orientation temperature to stretch said monofilaments to a degree sufficient to produce oriented monofilaments.

2. A process according to claim 1 including cooling the oriented monofilaments while under tension to a temperature below the orientation temperature.

3. A process for the orientation of extruded polystyrene monofilaments and the like, comprising emerging melted unoriented polystyrene monofilaments and the like from an extrusion die head and bringing said unoriented monofilaments into contact with a plurality of driven cooling rollers heated to a temperature in the range of 210 to 330° F. while maintaining monofilament-roller contact for a sufficient period of time to cool said unoriented monofilaments to orientation temperature in the range of 210 to 330° F., maintaining a sufficiently insulated zone through which said monofilaments pass while being cooled to and while at orientation temperature to control heat loss from said monofilaments to prevent cooling thereof below orientation temperature, maintaining the monofilaments in an unoriented state

while they are being cooled to orientation temperature by maintaining sufficient monofilament-roller frictional contact so that the monofilaments in contact with each cooling roller move at substantially the same surface speed as the cooling roller to prevent monofilament-roller slippage prior to orientation, and applying a sufficient orienting tensioning force to said monofilaments after they have been cooled to and while at orientation temperature to stretch said monofilaments to a degree sufficient to produce oriented monofilaments.

4. A process according to claim 3 including cooling the oriented monofilaments while under tension to a temperature below the orientation temperature.

5. A process according to claim 3 including the step of controlling the path of movement of the unoriented monofilaments through the plurality of heated driven cooling rollers in such a manner that opposing sides of said unoriented monofilaments contact adjacent rollers as the monofilaments proceed through the plurality of heated driven cooling rollers.

References Cited in the file of this patent

UNITED STATES PATENTS

1,065,235	Goodman	June 17, 1913
2,260,501	Wynd	Oct. 28, 1941
2,321,635	Taylor	June 15, 1943
2,323,383	Dreyfus	July 6, 1943
2,581,922	Spencer	Jan. 8, 1952
2,631,954	Bright	Mar. 17, 1953

FOREIGN PATENTS

924,312	France	Aug. 1, 1947

OTHER REFERENCES

Ser. No. 715,003, Wulff et al. (A.P.C.), published Apr. 27, 1943.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,900,220 August 18, 1959

Gilbert Shaw

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 16, 26, and 29, for "orientating", each occurrence, read -- orienting --; same column 1, lines 23 and 24, strike out ", combinations and improvements"; line 29, strike out "and apparatus"; line 60, for "the above" read -- these above --; line 65, for "filament" read -- filaments --; column 2, line 24, after "cooled" insert -- to --; column 3, line 62, for "increment" read -- incremented --; column 4, line 23, for "fact" read -- face --.

Signed and sealed this 8th day of March 1960.

(SEAL)
Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents