

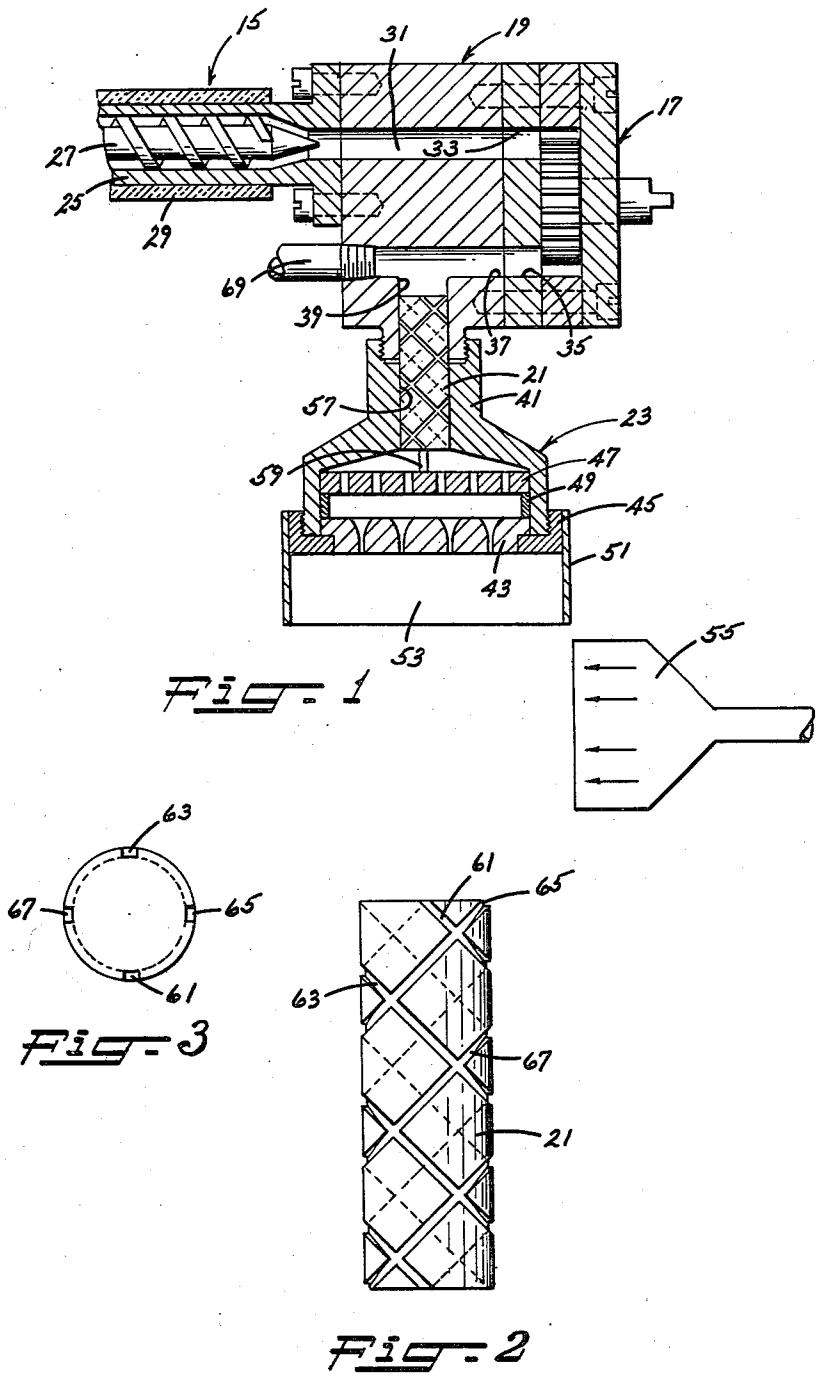
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METHOD AND APPARATUS FOR SPINNING ARTIFICIAL FILAMENTS

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## METHOD AND APPARATUS FOR SPINNING ARTIFICIAL FILAMENTS

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This invention relates to the production of artificial  
filaments and particularly to an improved method and  
apparatus for blending of filament-forming materials prior  
to shaping of the same.

Briefly, in conventional multi-filament spinning operation,  
using for example known melt spinning apparatus, a  
metered stream of molten filament-forming material is  
passed through a screen pack, breaker plate and into a  
multi-orificed spinneret where it is shaped into a plurality  
of individual streams. It has been found, however, that  
channels of high and low velocity flow exist within the  
stream of filament-forming material delivered to the spinneret,  
and that such flow channels persist even after passing  
through the screen pack and breaker plate. The presence  
of such channels of high and low velocity flow are particularly  
noticeable when the stream of filament-forming material  
undergoes a change in direction during its travel to the  
spinneret, and is especially pronounced when spinning a  
filament-forming material having a high melt viscosity.  
In view of the differences in the velocity of flow of the  
various portions of the filament-forming material, the  
flow rates of the filament-forming material extruded  
through the spinneret orifices also differ, with actual measurements  
indicating a variation from orifice to orifice of as much as  
 $\pm 25\%$ . As a result, the filaments of multi-filament  
yarns produced by conventional spinning procedures vary  
considerably from each other in diameter. Accordingly, the  
primary object is to provide a new or improved and more  
satisfactory method and apparatus for use in the production  
of multi-filament yarns.

Another object is to provide an improved method and  
apparatus for multi-filament spinning operations wherein  
filament-forming material is blended just prior to shaping  
of the same so as to provide all portions thereof with  
substantially the same flow velocity.

Still another object is to provide a multi-filament spinning  
apparatus having means for blending different parts of a  
single stream of filament-forming material with each other  
as such stream is advanced toward a filament shaping  
device.

A further object is to provide an improved method and  
apparatus wherein a metered amount of pigment concentrate  
is injected into a stream of filament-forming material and  
uniformly blended therewith as such stream is advanced  
toward a filament shaping device.

These and other objects and advantages of the invention  
will be apparent from the following description and  
accompanying drawing in which:

FIGURE 1 is a vertical section through a portion of the  
apparatus of the present invention;

FIGURE 2 is a side view of one element of the apparatus  
shown in FIGURE 1; and

FIGURE 3 is a top view of the element shown in  
FIGURE 2.

The present invention is directed to melt spinning of  
multi-filament yarns, and more particularly to a method  
and apparatus for forming yarns comprised of a plurality  
of simultaneously shaped filaments which are substantially  
the same in cross-section and color uniformity. In general,  
the objects of this invention are achieved by dividing a  
single stream of molten filament-forming material into a  
plurality of corresponding individual streams which are  
caused to move along confined and intersecting

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paths which lead to a multi-orifice spinneret where they  
are again combined into a single main stream before being  
shaped into filaments. As the individual streams of filament-forming  
material cross with each other, portions of the material from  
each stream are mixed together. As a result, channels of high  
and low velocity flow which may have been present at different  
parts of the single stream of filament-forming material initially  
delivered are thoroughly blended so that all portions of the  
main stream of filament-forming material entering the spinneret  
flow at substantially the same velocity.

In lieu of or in addition to eliminating flow differences  
within a stream of filament-forming material, the method and  
apparatus of the present invention may be employed for  
uniformly blending one or more pigments with the stream of  
filament-forming material as such stream travels toward a  
filament shaping device.

For the sake of simplicity, the method and apparatus of  
this invention are hereafter described as being employed in  
the manufacture of multi-filament yarns from polymers of  
propylene. It will be understood, however, that the teachings  
of the present invention may be employed with other filament-forming  
materials with equally satisfactory results.

With reference to the accompanying drawing, the apparatus  
of the present invention includes a conventional extrusion  
apparatus 15, a metering pump 17 carried by an extrusion  
block 19 in position for receiving molten polymer from the  
extrusion apparatus 15, a blending unit 21 for mixing the  
metered stream of molten polymer delivered by the pump 17,  
and an extrusion assembly, indicated generally at 23, for  
shaping the blended stream of molten polymer into filaments.

As heretofore mentioned, the extrusion apparatus 15 is  
of known construction and includes a barrel 25 into which  
are fed chips or pellets of propylene polymer, a rotatable  
screw conveyor 27 mounted within the barrel 25 for advancing  
the polymer therethrough, and heaters, such as shown at 29,  
which encase the barrel 25 and serve to heat and maintain  
the polymer at a desired elevated temperature, preferably  
ranging from 225° to 250° C.

The helical configuration of the screw conveyor 27 provides  
for a frequent and intimate contact of the polymer with the  
heated surfaces of the barrel 25, in addition to homogenizing  
the polymer and forcing air and other gases therefrom by  
compressing the same as it is converted to a molten condition.  
Preferably, the helical surface of the screw conveyor 27 is  
of reduced pitch along that portion which is adjacent to the  
discharge end of the barrel 25 to further compact the molten  
polymer to a ratio of about 4 to 1 and deliver the same to the  
pump 17 under a generally uniform pressure ranging from  
about 500 to 1500 p.s.i. (pounds per square inch) through a  
passage 31 in the extrusion block 19.

In commercial operations the extrusion block passage 31  
would preferably connect with a header having a series of  
pumps for delivering a metered amount of molten polymer  
to a plurality of individual blending units and extrusion  
assemblies. For the sake of simplicity and ease of description,  
however, the apparatus illustrated includes only a single  
metering pump 17 having inlet and outlet ports 33 and 35  
aligned with passages 31 and 37, respectively, in the extrusion  
block 19. The pump 17 is formed of heat-resistant materials  
to insure uniform and accurate operation at high temperatures  
and, as with conventional metering pumps, includes a pair of  
meshing gears at least one of which is rotated by a suitable  
variable speed drive means. The pump 17 delivers the molten  
propylene polymer into the passage 37 at a desired uniform  
and predetermined rate, preferably under a pressure ranging  
from about 500 to 2500 p.s.i., depending upon the extrusion  
rate desired.

From the extrusion block passage 37 the metered flow of molten polymer passes through a connecting passage 39 and is delivered to the extrusion assembly 23, which includes a housing 41 removably carried by the extrusion block 19, a multi-orifice spinneret 43 secured to the housing 41 by an annular retainer 45, and a breaker plate 47 supported above the spinneret 43 by a spacer ring 49. A heater 51 is preferably provided for maintaining the polymer at a desired uniform temperature just prior to extrusion and extends well below the spinneret face to provide a heated zone, such as indicated at 53, within which the extruded filaments may be elongated by stretching forces applied by conventional take-up means, not shown. As the streams of filamentary material travel away from the extrusion assembly, they are quenched by suitable means, and preferably with a minimum of turbulence, as for example, by a continuous cross-flow of air supplied through a screened duct as shown at 55.

As heretofore mentioned, channels of high and low velocity flow are usually created within the stream of molten polymer as it undergoes a direction change during its travel from the metering pump to the extrusion assembly. With conventional melt extrusion apparatus, such channel flow is evidenced in the finished yarn which includes filaments of different diameters.

In accordance with the present invention flow differences within the polymer stream are eliminated by the unit 21 which serves to blend different portions of the stream together as it travels toward the extrusion assembly. As illustrated, the blending unit 21 is located within the extrusion block passage 39 and a connecting passage 57 in the housing 41 aligned therewith, and is supported above the breaker plate 47 by any suitable means, as for example by a pin 59. The blending unit 21 is of cylindrical shape which fits snugly within the aligned passages 39 and 57 and is provided on its surface with a plurality of helical grooves 61 and 63 which intersect with similar helical grooves 65 and 67 of equal but opposite pitch or hand. Thus, as the metered stream of molten polymer enters the extrusion block passage 39, it is divided into a plurality of individual streams which flow along confined paths as defined by the respective helical grooves 61, 63, 65, and 67. At the locations at which the right-handed and left-handed helical grooves intersect, portions of each polymer stream are carried into the path of the intersecting polymer stream so that repeated blending of the polymer streams is effected. Upon leaving the helical grooves of the blending unit 21, the individual, but now blended streams of molten polymer are again combined into a single main stream, in which all portions of the polymer flow at substantially the same velocity.

The number, size and pitch of the helical grooves provided in the blending unit 21 may be varied from that illustrated on the drawing to satisfy particular operating conditions. It is preferred that the number and characteristics of the helical grooves provided be such as to facilitate the passage of the metered stream of molten polymer delivered by the pump 17 without substantial change in pressure. Further, to insure uniform blending of all portions of the stream of molten polymer, an equal number of grooves of like dimensions and equal but opposite pitch or hand should be provided, with the entrance and exit of the respective grooves being preferably located in diametrically opposed positions.

In addition to insuring that all portions of the molten polymer flow at substantially the same velocity during shaping of the same, the method and apparatus of the present invention may be also employed for securing uniform blending of a pigment with the molten polymer in the manufacture of color multi-filament yarns. Thus, as shown in FIGURE 1 of the drawing one or more streams of pigment may be delivered through a conduit 69 and injected into the stream of molten polymer as it enters the extrusion block passage 39. In a manner as described

above, the combined pigment and polymer streams undergo repeated mixing as they flow along the helical grooves of the blending unit 21 whereby all portions of the stream of polymer delivered to the spinneret are substantially the same, both in color and flow velocity.

It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. Apparatus for melt-spinning of multi-filament yarns including means for rendering thermoplastic polymeric filament-forming material molten, means for shaping the molten polymeric material into a plurality of filaments, walls defining a passage for conducting the molten polymeric material to said shaping means, a pump for delivering the molten polymeric material from said melting means to said passage, and a blending unit seated within said passage and snugly engaging with the walls thereof, said unit having an equal number of right-handed and left-handed intersecting helical grooves extending along its outer surface, said grooves being substantially the same in cross section and length whereby the metered stream of molten polymeric material is divided into a plurality of like individual streams which are blended together as they travel along said intersecting grooves.

2. Apparatus for making multi-filament yarns comprising means including a pump for delivering a metered stream of filament-forming material, means for shaping the delivered filament-forming material into a plurality of filaments, walls defining a passage for conducting the stream of filament-forming material from said pump and to said shaping means, and a blending unit seated within said passage and snugly engaged with the walls thereof, said blending unit including along its outer periphery a first group of helical grooves which are of substantially the same pitch, a second group of helical grooves which are of substantially the same pitch and which intersect with the first group of helical grooves, the helical grooves of said first and second groups of helical grooves having substantially like dimensions and being of opposite pitch whereby the metered stream of filament-forming material is divided into a plurality of individual streams which are blended together as they travel along said intersecting grooves.

3. A method for making multi-filament yarns including the steps of delivering a metered stream of filament-forming material under pressure, separating the metered stream of filament-forming material into a plurality of individual streams, directing the individual streams of filament-forming material along an equal number of corresponding right-handed and left-handed intersecting helical paths which are of substantially the same pitch whereby portions of the individual streams are blended with each other, combining the individual blended streams of filament-forming material into a single stream and shaping the single stream of filament-forming material into a plurality of filaments.

4. A method for making multi-filament yarns including the steps of delivering a metered stream of filament-forming material under pressure, separating the metered stream of filament-forming material into a plurality of individual streams, blending portions of the individual streams of filament-forming material with each other by directing the same along an equal number of right-handed and left-handed intersecting helical paths which are of substantially the same dimensions and pitch, combining the blended individual streams of filament-forming material into a single stream and shaping the single stream of filament-forming material into a plurality of filaments.

5. A method of melt spinning of multi-filament yarns from a polymeric filament-forming material including the steps of delivering a metered stream of molten polymeric material under pressure, separating the metered stream of molten polymeric material into a plurality of individual streams, directing one-half of the individual streams

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of polymeric material along a first group of like helical paths which are of substantially the same pitch, directing the remainder of such individual streams of polymeric material along a second group of like helical paths which are of substantially the same pitch and which intersect with the first group of helical paths whereby portions of the different intersecting streams are blended together, combining the individual streams of blended molten polymeric material into a single stream and shaping the single

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stream of molten polymeric material into a plurality of filaments.

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