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(54) SYSTEMS AND METHODS FOR PRODUCING A BUNDLE OF FILAMENTS AND/OR A YARN

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D01D 13/00	(2006.01)

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(57) **ABSTRACT**

Systems for producing M yarns, wherein M≥1, include N extruders, M spin stations, and a processor, wherein N>1. Each extruder includes a thermoplastic polymer having a color, hue, and/or dyability characteristic, which are different from each other. Each spin station produces one yarn comprising at least one bundle of filaments. Each spin station comprises at least one spinneret through which filaments are spun from at least two molten thermoplastic polymer streams received by the respective spin station and N spin pumps upstream of the spinneret for the respective spin station. Each spin pump is paired with one of the N extruders. The processor is in electrical communication with the N*M spin pumps and is configured to adjust the volumetric flow rate of the polymers pumped from each spin pump to achieve a ratio of the polymers to be included in each M yarn.

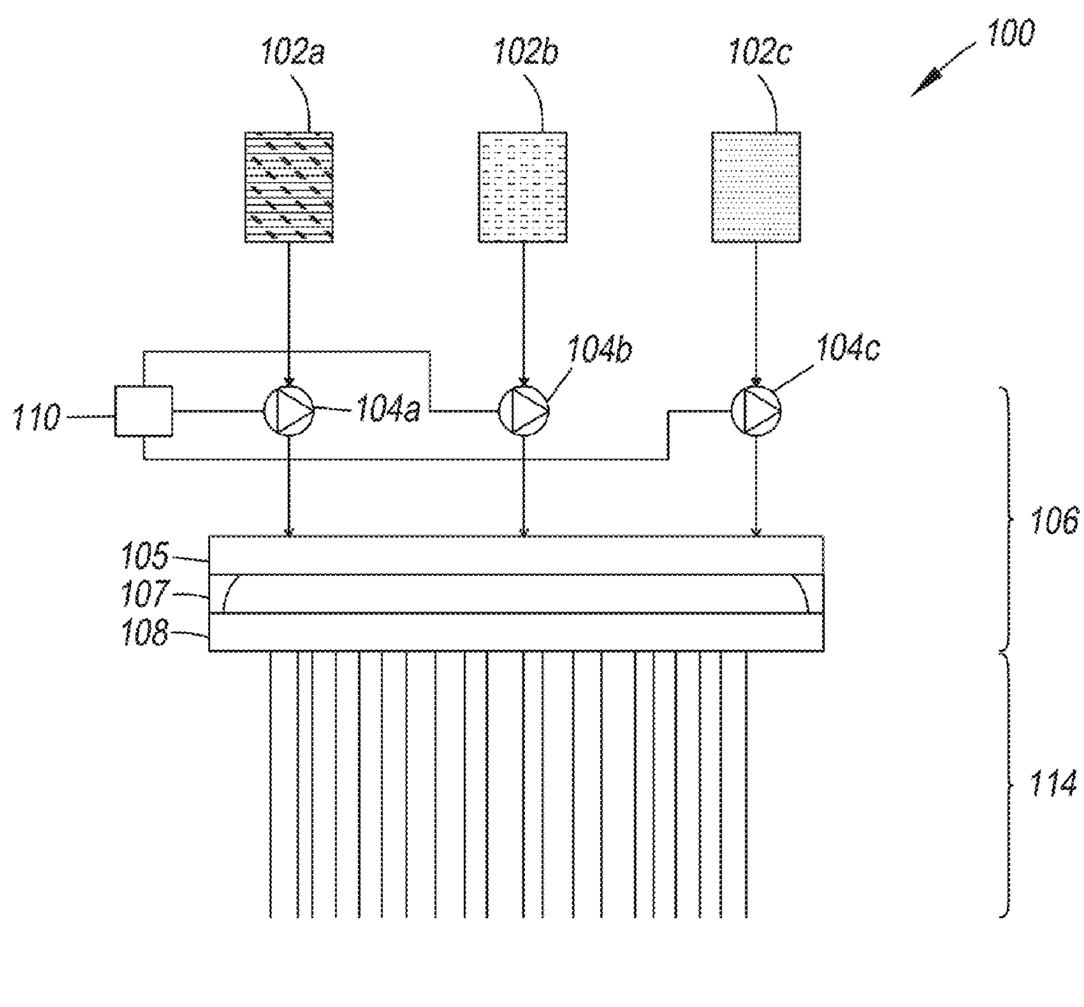
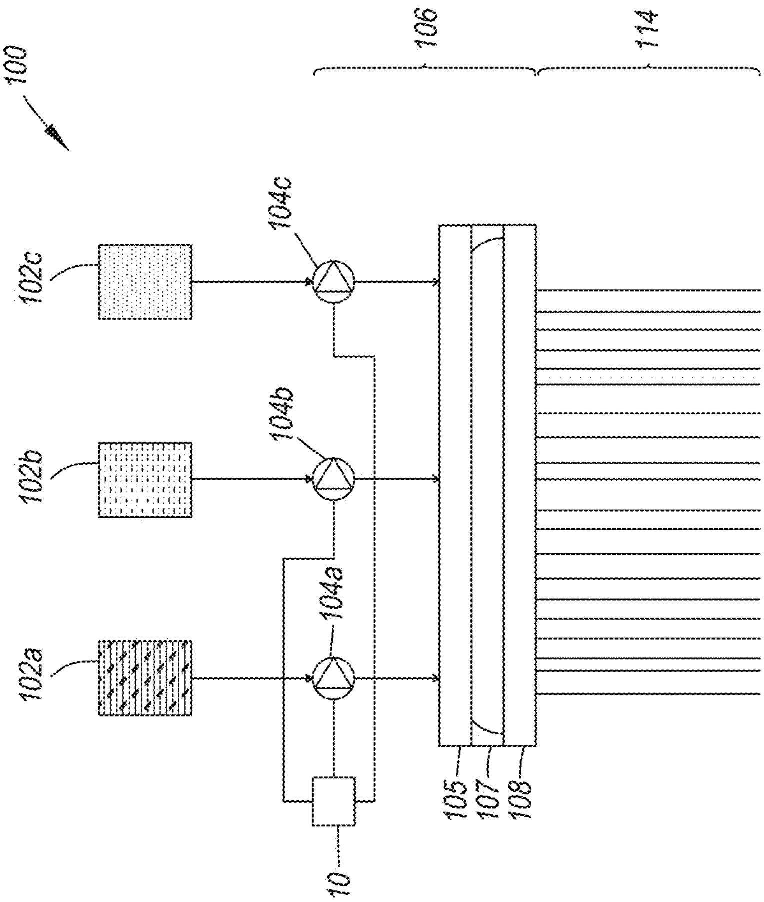


Fig. 1



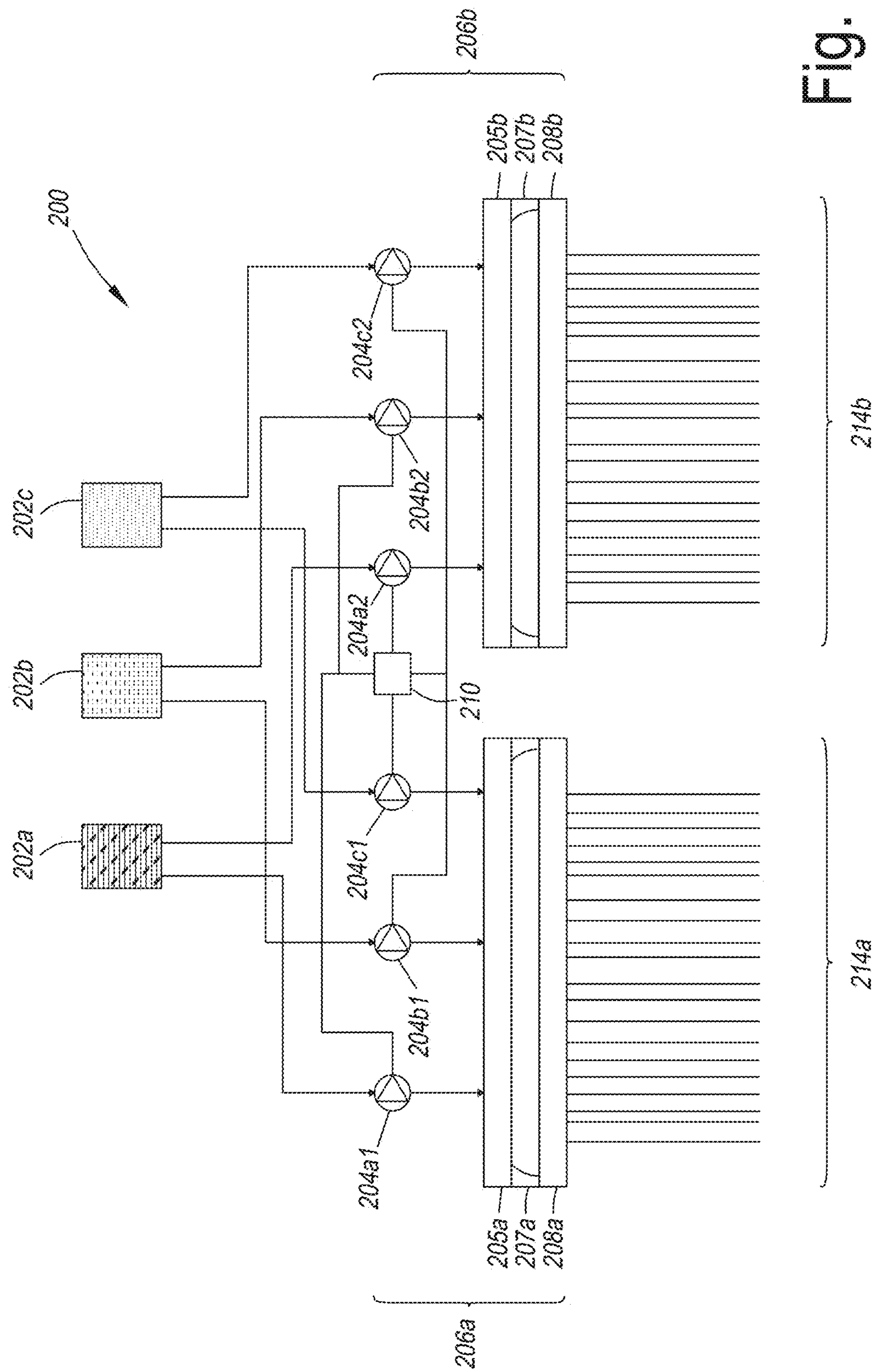

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Fig. 2

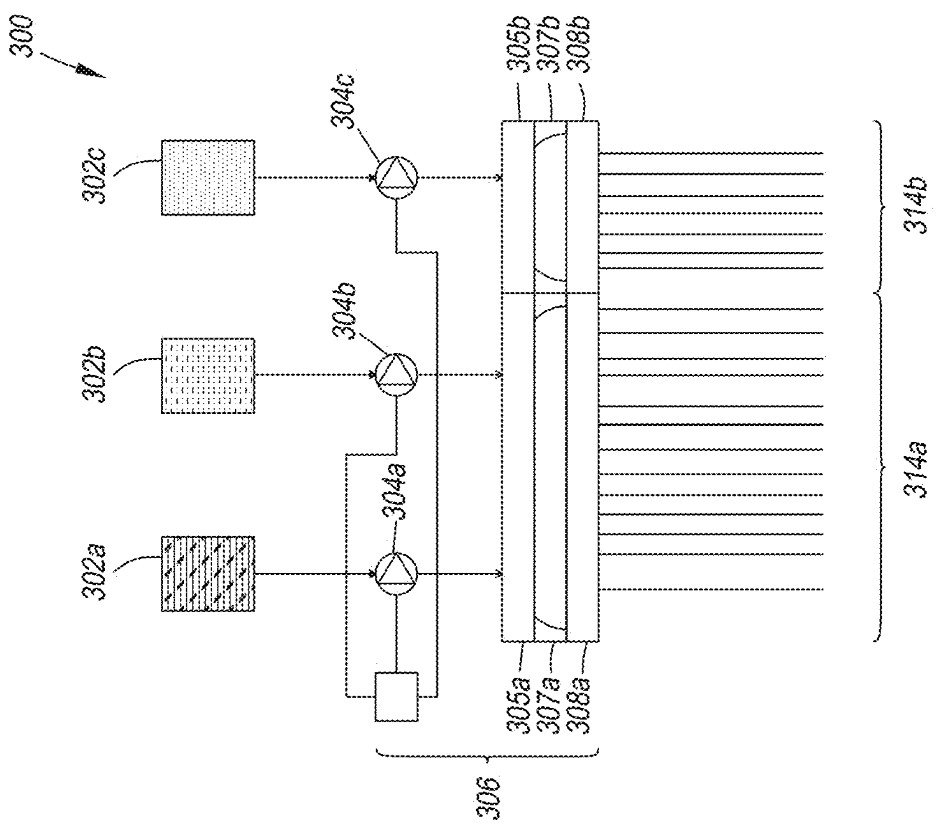
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Fig. 3A

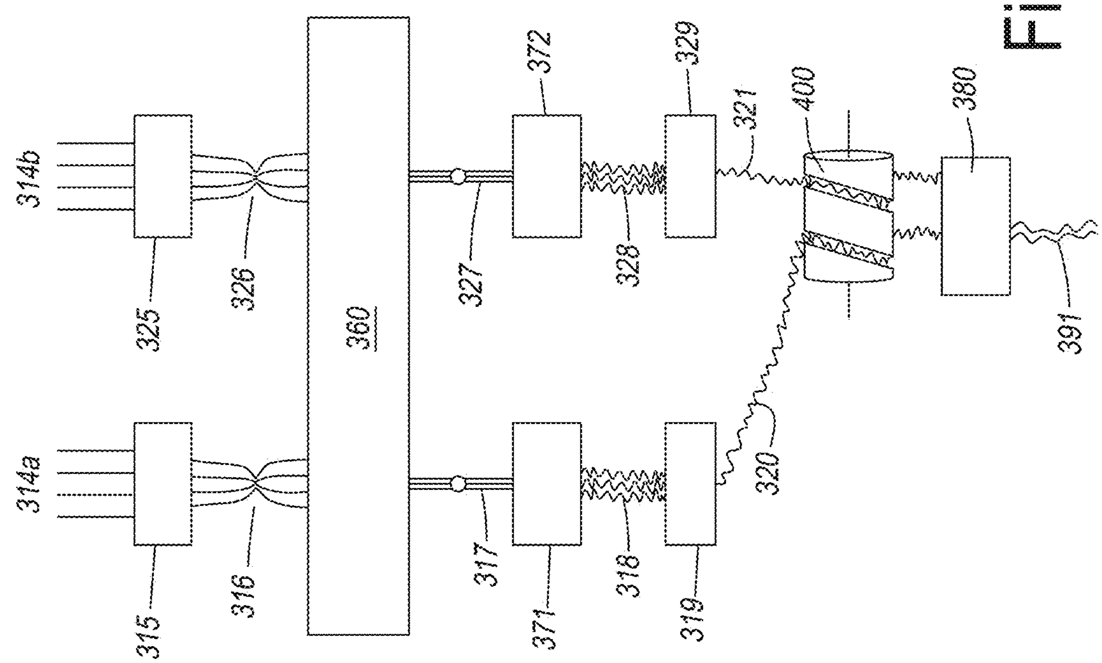
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Fig. 3B

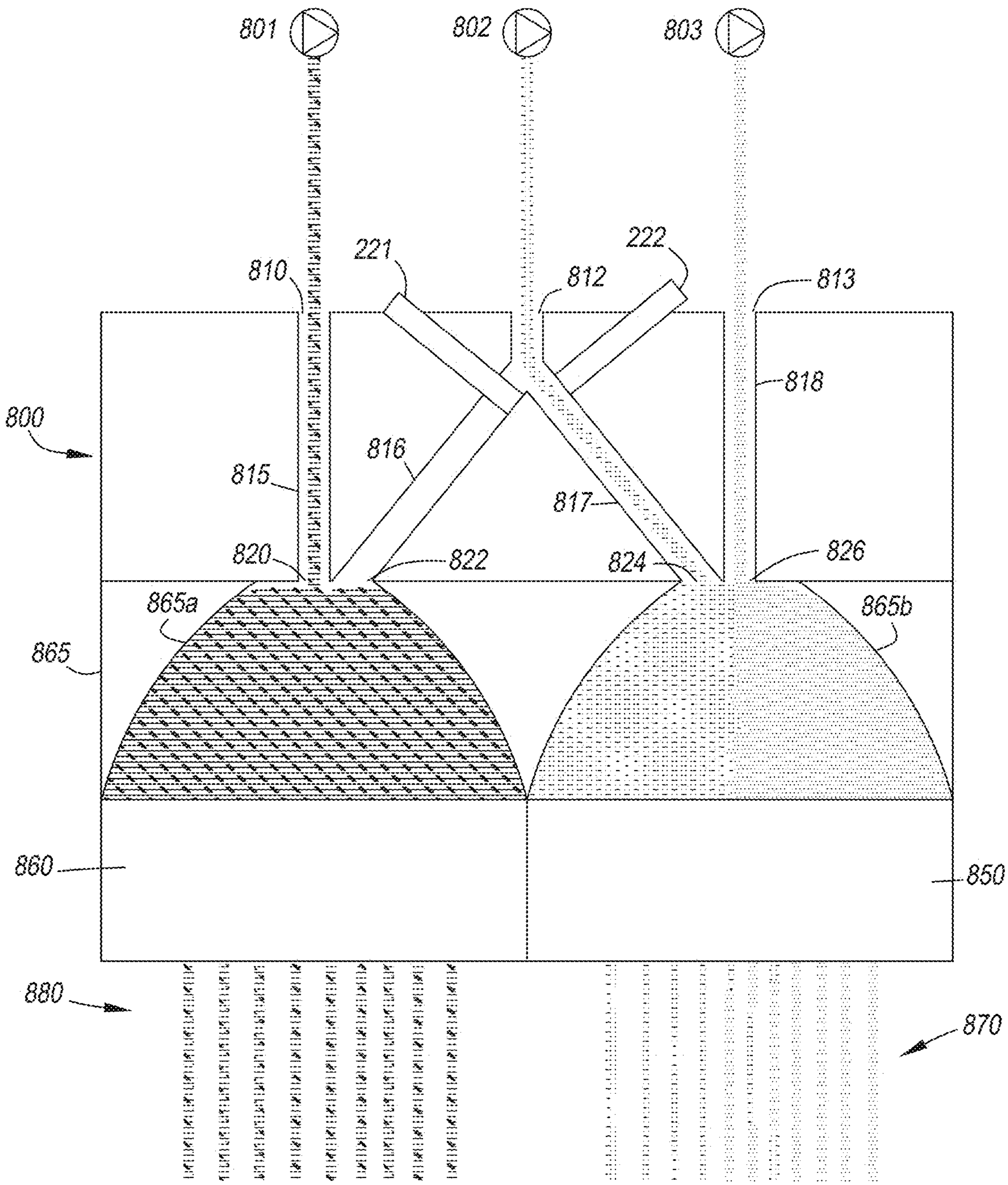
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Fig. 4A

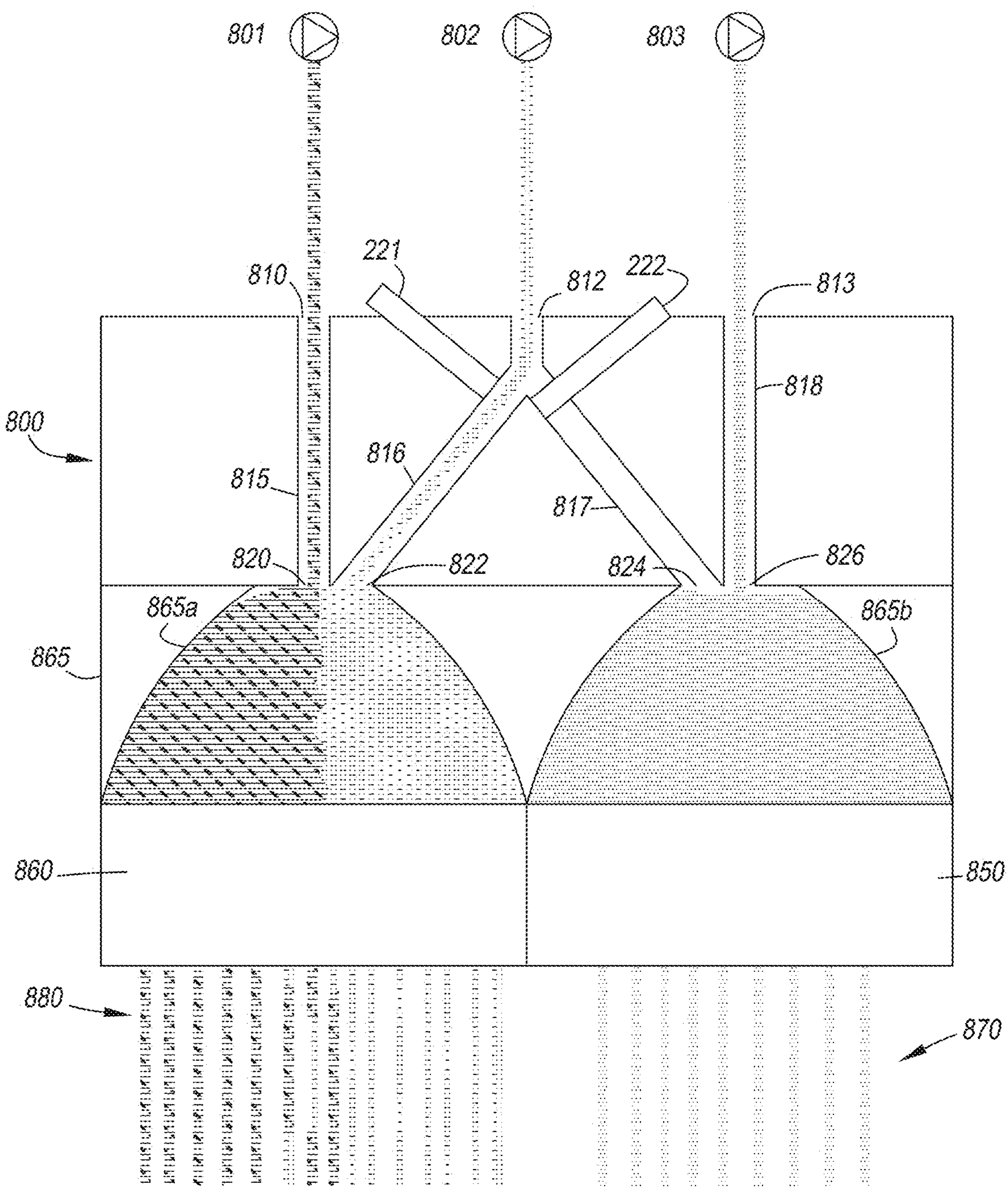
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Fig. 4B

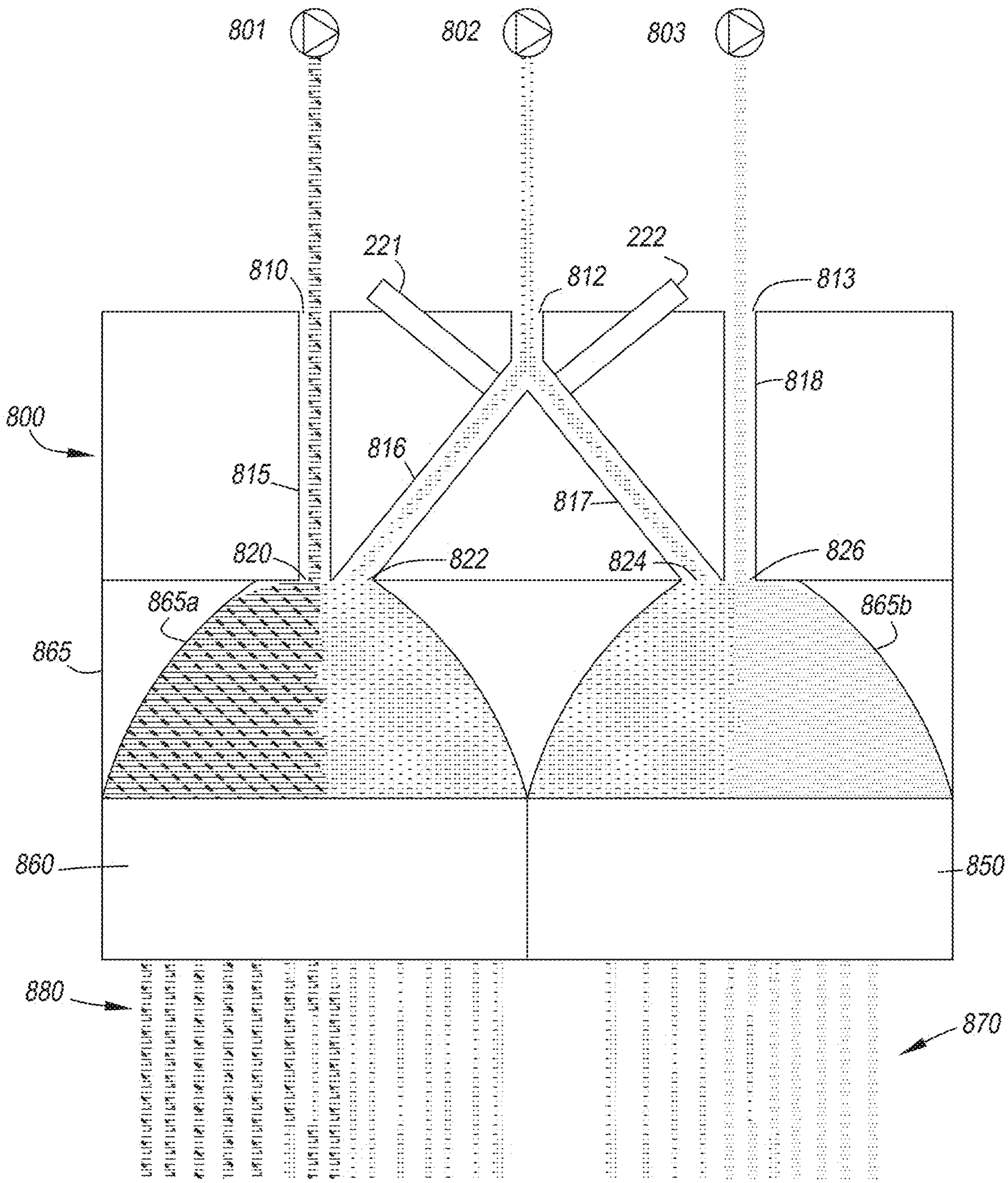
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Fig. 4C

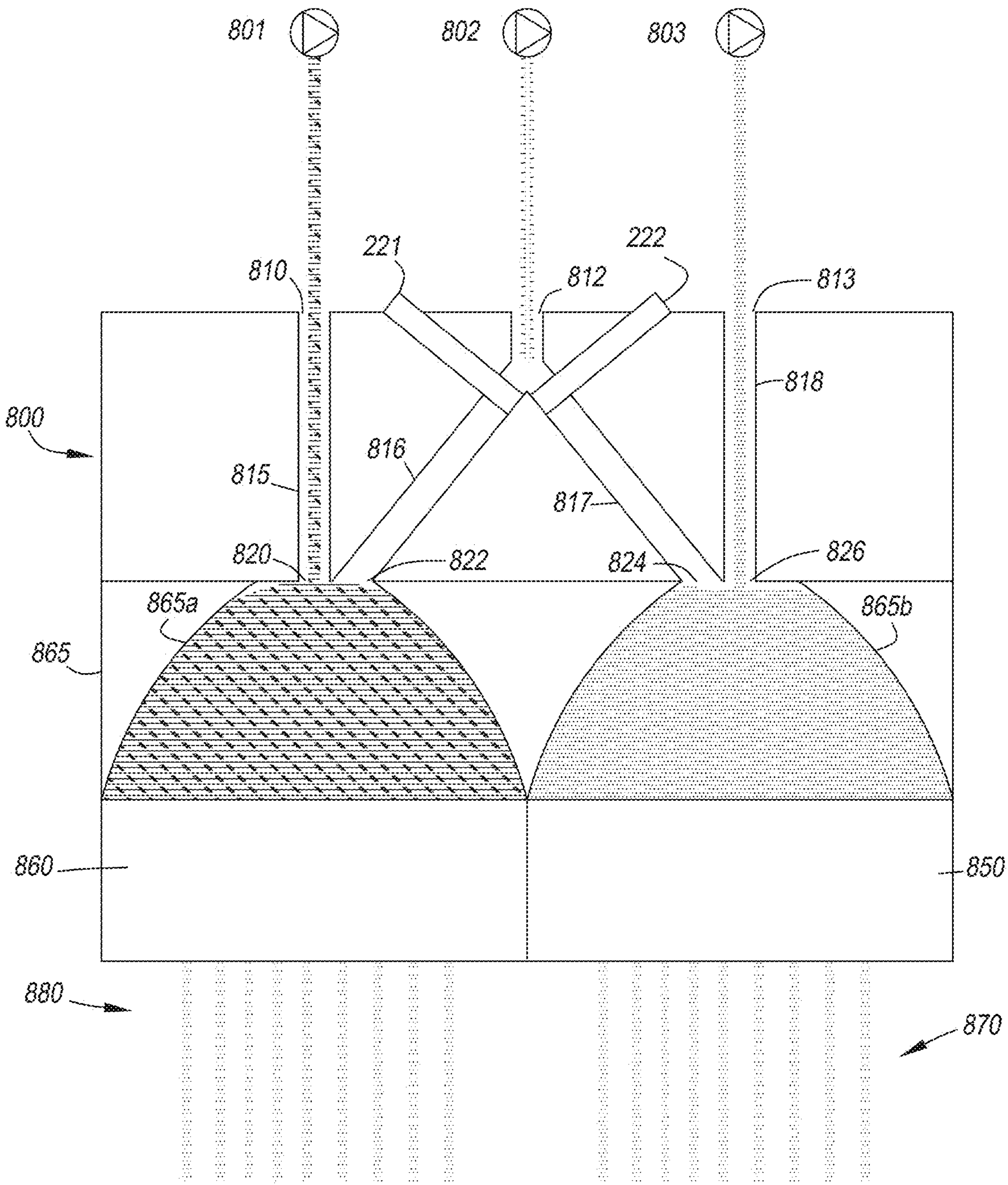
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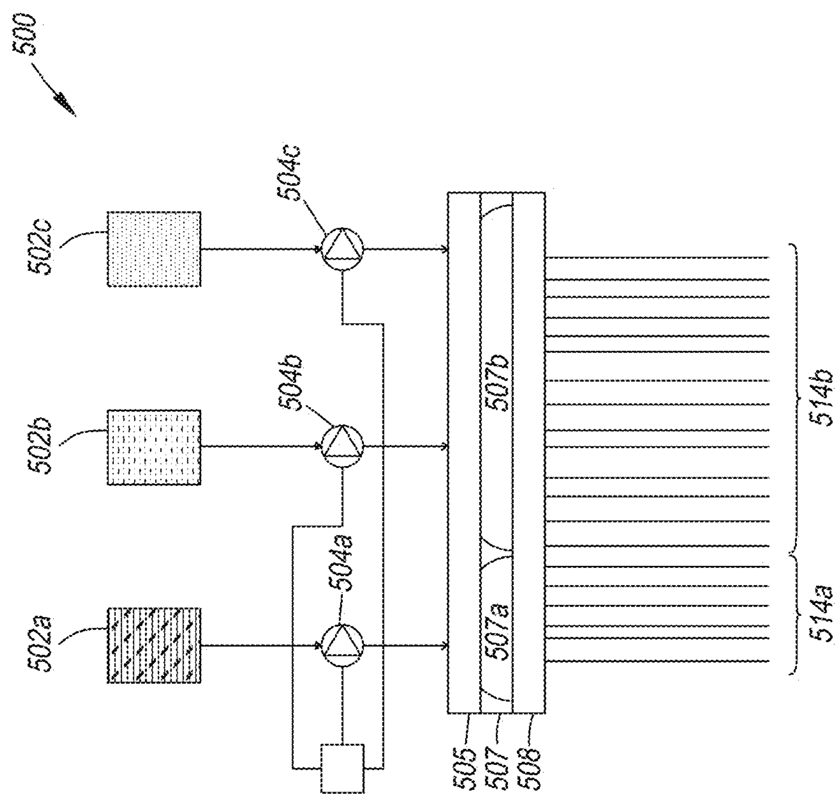
Fig. 4D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504b
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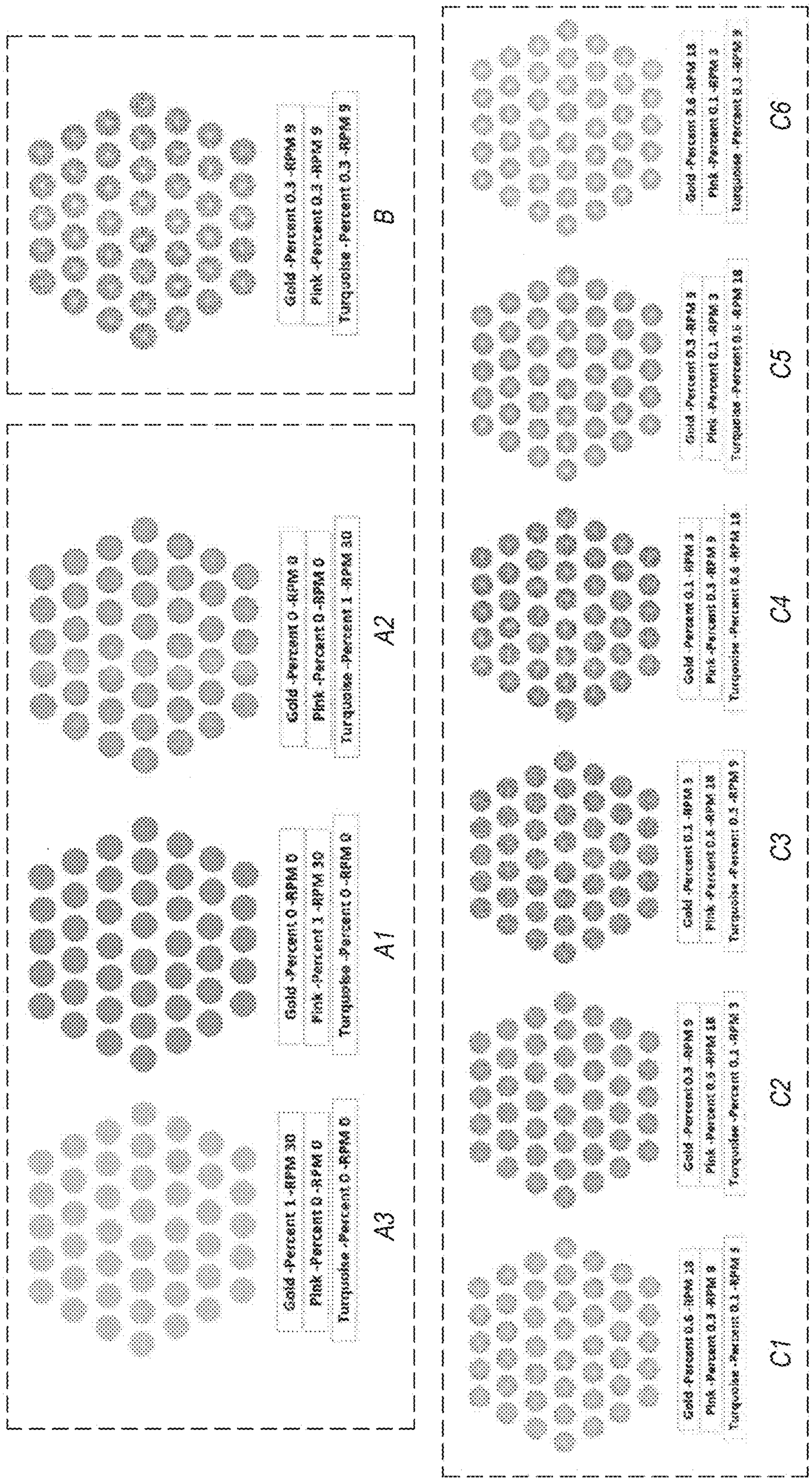
507b
514a
514b

Fig. 5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Turquoise -Percent 0 -RPM 0
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Pink -Percent 0 -RPM 0
Turquoise -Percent 1 -RPM 30
A2
Gold -Percent 0.3 -RPM 9
Pink -Percent 0.3 -RPM 9
Turquoise -Percent 0.3 -RPM 9
B
Gold -Percent 0.6 -RPM 18
Pink -Percent 0.3 -RPM 9
Turquoise -Percent 0.1 -RPM 3
C1
Gold -Percent 0.3 -RPM 9
Pink -Percent 0.6 -RPM 18
Turquoise -Percent 0.1 -RPM 3
C2
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Pink -Percent 0.6 -RPM 18
Turquoise -Percent 0.3 -RPM 9
C3
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Pink -Percent 0.3 -RPM 9
Turquoise -Percent 0.6 -RPM 18
C4
Gold -Percent 0.3 -RPM 9
Pink -Percent 0.1 -RPM 3
Turquoise -Percent 0.6 -RPM 18
C5
Gold -Percent 0.6 -RPM 18
Pink -Percent 0.1 -RPM 3
Turquoise -Percent 0.3 -RPM 9
C6

Fig. 6

Fig. 7B

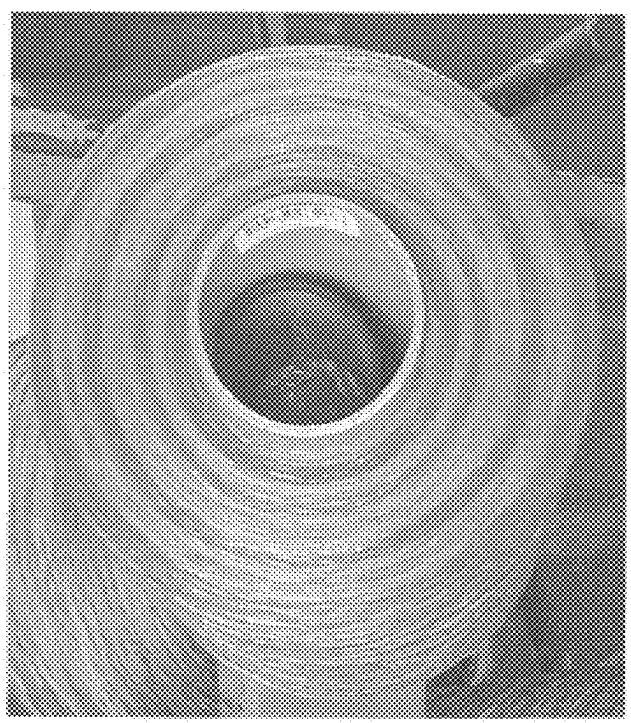


Fig. 7A

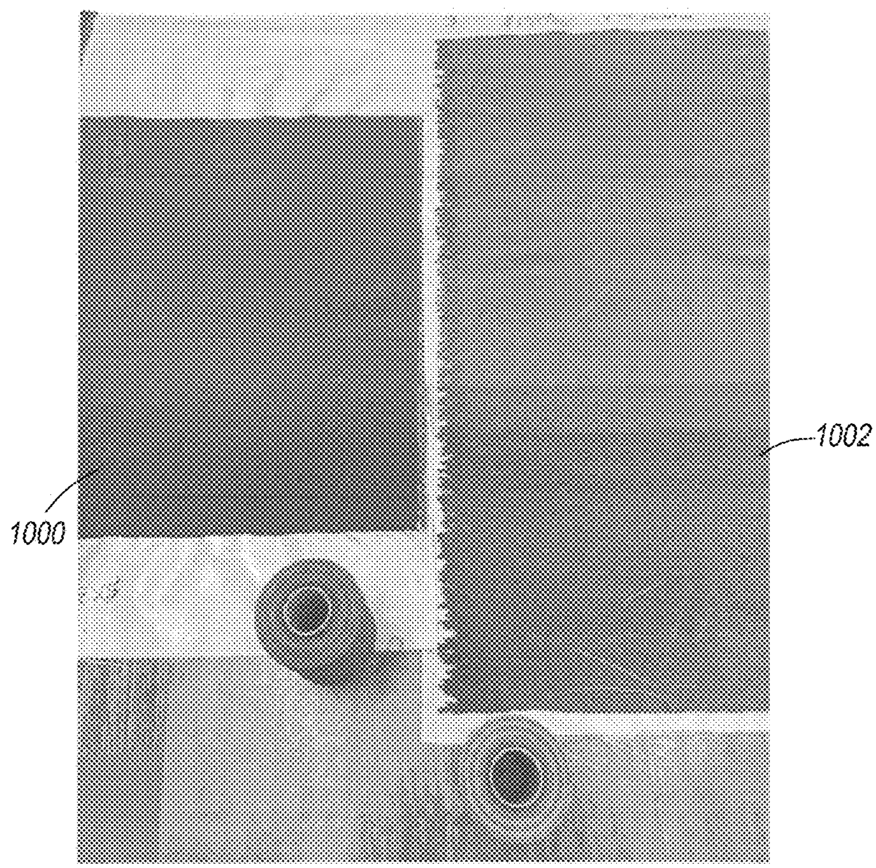


Fig. 8

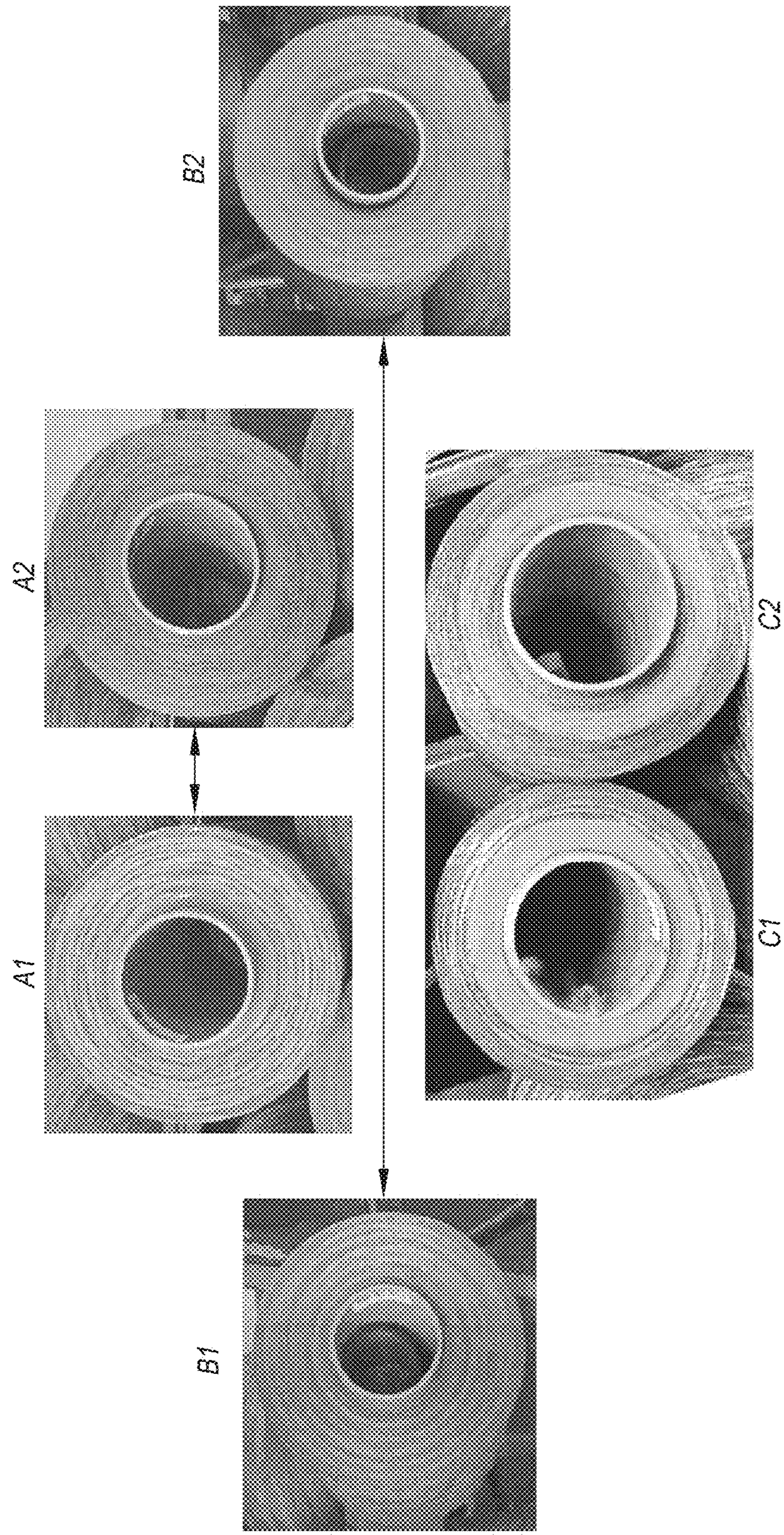
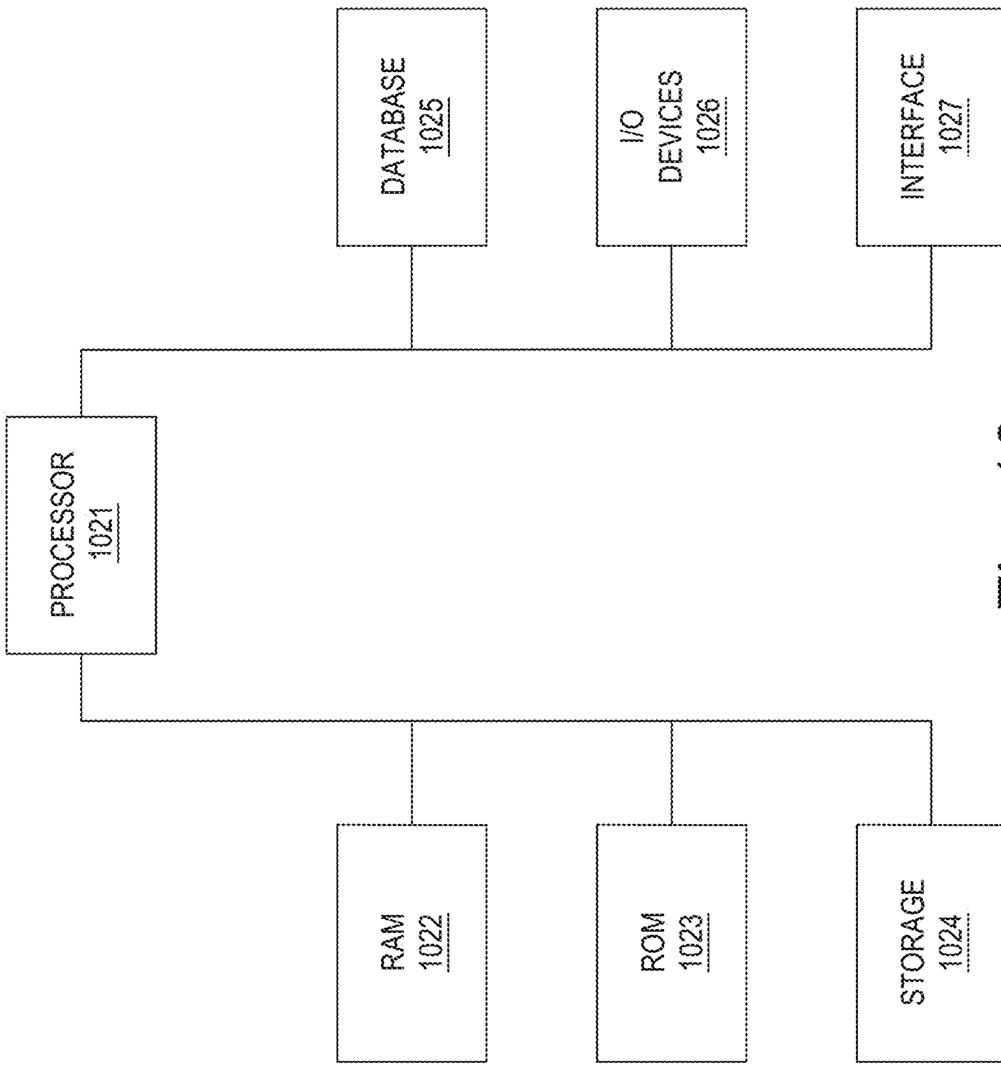


Fig. 9


PROCESSOR
1021
RAM
1022
ROM
1023
STORAGE
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DATABASE
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I/O
DEVICES
1026
INTERFACE
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Fig. 10

SYSTEMS AND METHODS FOR PRODUCING A BUNDLE OF FILAMENTS AND/OR A YARN

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. application Ser. No. 17/349,731 filed Jun. 16, 2021, which claims the benefit of U.S. Provisional Pat. App. No. 63/039,637, filed Jun. 16, 2020, and U.S. Provisional Pat. App. No. 63/039,626, filed Jun. 16, 2020.

BACKGROUND

[0002] Melt spun filaments, such as melt spun filaments of PET are known in the art. Some types of polymers, hence filaments, strands or bundles, are difficult to dye, or to provide with a color varying along the length of the filament, bundle or strand.

[0003] It is known to change the color of filaments in a bundle by changing the dye sourcing. However, this process is time consuming and can be wasteful. In addition, it is also known in US Published Patent Application No. 2010/0297442 to vary the output of spin pumps when spinning a plurality of filament bundles that each have a different color to provide a color variation along the length of a composite thread made with the plurality of filament bundles.

[0004] However, a need in the art exists for systems and methods for improving the color variation of a bundle of filaments and/or a yarn.

BRIEF SUMMARY

[0005] Various implementations include systems and methods of providing multifilament bundles of melt spun polymer filaments that provide a color variation along the length of the filament, bundle, or strand.

[0006] A first aspect includes a system for producing at least one bundle of filaments. The system includes N extruders, wherein N is an integer greater than 1, at least one spin station for receiving molten thermoplastic polymer streams from the N extruders, and a processor. Each extruder includes a thermoplastic polymer having a color, hue, and/or dyability characteristic, and the colors and/or hues of the N extruders are different from each other. Each spin station includes at least one spinneret through which a plurality of melt-spun filaments are spun from at least two of the molten thermoplastic polymer streams received by the spin station and a group of N spin pumps upstream of the spinneret. Each spin pump is in fluid communication and is paired with one of the N extruders. The processor is in electrical communication with the N spin pumps and is configured to execute computer readable instructions that cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped by each spin pump to achieve a ratio of the thermoplastic polymers to be included in a yarn comprising the filaments spun from the spinneret. In some implementations, the number of extruders N is 3 or 4.

[0007] In some implementations, the instructions further cause the processor to determine the volumetric flow rate of each thermoplastic polymer to be pumped by each spin pump and generate the instructions to the spin pumps based on the volumetric flow rate determinations.

[0008] In some implementations, the instructions also cause the processor to adjust the timing of the volumetric flow rate changes and hence adjust the corresponding denier and/or color changes in the yarn. The instructions cause the processor to adjust the speeds and volumetric flow rates of some or all of the spin pumps for an amount of time based on a desired color variation in the yarn.

[0009] In some implementations, the instructions cause the processor **110** to randomize the amount of time that the speeds and volumetric flow rates through some or all of the spin pumps are varied.

[0010] In some implementations, the spin station is a first spin station, and the group of N spin pumps are the first group of N spin pumps. The system further comprises a second spin station and a second group of N spin pumps upstream, wherein each spin pump of this second group of spin pumps is in fluid communication and is paired with one of the N extruders. The ratio is a first ratio for the first spin station, and the instructions further cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump of this second group of spin pumps to achieve a second ratio of the thermoplastic polymers to be included in the filaments spun from the spinneret of the second spin station. In some implementations, the first ratio and the second ratio are different.

[0011] In some implementations, the system comprises M spin stations and M groups of N spin pumps upstream of the at least one spinneret for each M spin station, wherein each spin pump of each of the M groups of spin pumps is in fluid communication and is paired with one of the N extruders, and wherein the instructions further cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump of each of the M groups of spin pumps to achieve M ratios of the thermoplastic polymers to be included in the filaments spun from the at least one spinneret of each M spin station. According to some implementations, at least two ratios of the M ratios are different. In other implementations, all of the M ratios are different.

[0012] In some implementations, the at least one spinneret is a single spinneret through which the N polymer streams are spun, and the N polymer streams are combined prior to being spun through the single spinneret.

[0013] In some implementations, the N polymer streams are at least partially mixed prior to being spun through the single spinneret.

[0014] In some implementations, an average denier per filament of each of the plurality of filaments varies by ±5% along a length of each filament.

[0015] In some implementations, the at least one spinneret comprises a first spinneret and a second spinneret, and each spin station comprises at least one manifold disposed between the spinnerets and the N pumps, the manifold directing at least two of the N polymer streams to the first spinneret and at least one of the N polymer streams to the second spinneret.

[0016] In some implementations, the manifold is a static manifold.

[0017] In some implementations, the manifold is a dynamic manifold.

[0018] In some implementations, the dynamic manifold comprises N inlets and at least N+1 outlets, wherein each inlet is in fluid communication with a respective one of N extruders, and at least one inlet is in communication with at least two outlets via channels that extend between the inlet and the outlets and comprises at least one valve that controls flow of the thermoplastic polymer stream between the at least one inlet and the at least two outlets.

[0019] In some implementations, the spin station further includes at least one mixing plate disposed between the at least one spinneret and the at least one manifold, the at least one mixing plate defining one or more channels through which one or more molten thermoplastic polymer streams flow through the at least one mixing plate to the at least one spinneret.

[0020] In some implementations, the filaments spun from the spinneret include at least a first group of filaments and a second group of filaments, wherein the first group of the filaments have a first color, hue, and/or dyability characteristic, the first color, hue, and/or dyability characteristic being extruded from a first of the N extruders, and the second group of the filaments have a second color, hue, and/or dyability characteristic, the second color, hue, and/or dyability characteristic being extruded from a second of the N extruders. In some implementations, the filaments spun from the spinneret further include a third group of filaments, wherein the third group of the filaments have a third color, hue, and/or dyability characteristic, wherein the third color, hue, and/or dyability characteristic is a mixture of the first color, hue, and/or dyability characteristic and the second color, hue, and/or dyability characteristic.

[0021] In some implementations, the system further comprises at least one drawing device to elongate said N bundles of spun filaments; an initial tacking device upstream to or integrated within the at least one drawing device to tack at least one of said N bundles of spun filaments prior to or during the elongation of the N bundles of spun filaments; at least one texturizer to texturize said N bundles of elongated spun filaments; and a final tacking device to tack said N bundles of texturized spun filaments to provide a BCF yarn.

[0022] In some implementations, the at least one texturizer comprises at least a first texturizer and a second texturizer, and at least one of said N bundles of spun filaments is texturized individually from the other N bundles of spun filaments through the first texturizer.

[0023] In some implementations, the at least one texturizer comprises N texturizers, and each of said N bundles of spun filaments are texturized individually from each other through respective N texturizers.

[0024] In some implementations, the system further comprises an intermediate tacking device and a mixing cam disposed between the at least one texturizer and the final tacking device, the intermediate tacking device for tacking at least one of said N bundles of texturized spun filaments and the mixing cam for positioning tacked and texturized bundles relative one to the other before reaching the final tacking device.

[0025] In some implementations, the system further comprises at least one drawing device to elongate said N bundles of spun filaments; at least a first texturizer and a second texturizer, wherein at least one of said N bundles of elongated spun filaments is texturized individually through the first texturizer separately from the other said N bundles of elongated spun filaments; and a final tacking device to tack said N bundles of texturized spun filaments to provide a BCF yarn.

[0026] In some implementations, the system further comprises an intermediate tacking device disposed between the at least one texturizer and the final tacking device, the intermediate tacking device for tacking at least one of said N bundles of texturized spun filaments.

[0027] In some implementations, the system further comprises a mixing cam disposed between the at least one texturizer and the final tacking device, the mixing cam for positioning tacked and texturized bundles relative to one to the other before reaching the final tacking device.

[0028] In some implementations, the system further comprises at least one drawing device to elongate said N bundles of spun filaments; at least one texturizer to texturize said N bundles of elongated spun filaments; a second tacking device disposed between the texturizers and the final tacking device, the second tacking device for tacking at least one of said N bundles of texturized spun filaments; and a final tacking device to tack said N bundles of texturized spun filaments to provide a BCF yarn.

[0029] In some implementations, the system further comprises a mixing cam disposed between the texturizers and the final tacking device, the mixing cam for positioning tacked and texturized bundles relative to one to the other before reaching the final tacking device.

[0030] In a second aspect, a bundle of filaments produced using the system above is provided.

[0031] In some implementations, a yarn comprising the bundle of filaments according to the second aspect is provided. In some implementations, the yarn is a bulked continuous filament (BCF) yarn. And, in some implementations, a carpet comprises pile made with the yarn.

[0032] In a third aspect, a method to produce at least one bundle of filaments is provided. The method includes (1) providing N streams of molten thermoplastic polymer, wherein N is an integer greater than 1, and each stream has a different color, hue, and/or dyability characteristic; (2) providing at least one spin station having N feeds for receiving the N streams of polymer, the spin station comprising at least one spinneret and a group of N spin pumps, each pump pumping one of the N streams of polymer to one of the N feeds, the N spin pumps being disposed upstream of the at least one spinneret and at least two of the N feeds being in fluid communication with one of the at least one spinnerets; and (3) adjusting a volumetric flow rate of each thermoplastic polymer stream pumped to the respective feed of the spin station to achieve a ratio of the thermoplastic polymer streams to be included in a yarn comprising the filaments spun from the at least one spinneret.

[0033] In some implementations, the at least one spin station comprises a first spin station and a second spin station, and the ratio is a first ratio, wherein the volumetric flow rate of each polymer stream pumped to the respective feed of the first spin station is based on the first ratio of the streams to be included in the filaments spun by the spinneret of the first spin station, and the volumetric flow rate of each polymer stream pumped to the respective feed of the second spin station is based on a second ratio of the streams to be included in the filaments spun by the spinneret of the second spin station. For example, in some implementations, the first ratio and the second ratio are different.

[0034] In some implementations, each of N streams of molten thermoplastic polymer are provided by one of N extruders such that each stream remains separated from other streams until reaching the spin station.

[0035] In a fourth aspect, a bundle of filaments produced using the method above is provided.

[0036] In some implementations, a yarn comprising the bundle of filaments according to the fourth aspect is provided. In some implementations, the yarn is a bulked continuous filament (BCF) yarn. And, in some implementations, a carpet comprises pile made with the yarn.

[0037] In a fifth aspect, a system for producing M yarns is provided, wherein M is an integer greater than 1. The system includes N extruders, M spin stations, and a processor. N is an integer greater than 1, and each extruder includes a thermoplastic polymer having a color, hue, and/or dyability characteristic. The colors and/or hues of the N extruders are different from each other. Each spin station is for producing at least one bundle of filaments and for receiving molten thermoplastic polymer streams from the extruders. Each spin station comprises at last one spinneret through which a plurality of melt-spun filaments are spun from at least two of the molten thermoplastic polymer streams received by the respective spin station and a group of N spin pumps upstream of the spinneret for the respective spin station, wherein each spin pump is in fluid communication and is paired with one of the N extruders. The processor is in electrical communication with the N*M spin pumps and is configured to execute computer readable instructions that cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump to achieve a ratio of the thermoplastic polymers to be included in each of the M yarns comprising the filaments spun from the at least one spinneret of the respective M spin station.

[0038] In some implementations, for each of the M spin stations, the filaments spun from the respective at least one spinneret include at least a first group of filaments and a second group of filaments. The first group of the filaments have a first color, hue, and/or dyability characteristic, the first color, hue, and/or dyability characteristic being extruded from a first of the N extruders, and the second group of the filaments have a second color, hue, and/or dyability characteristic, the second color, hue, and/or dyability characteristic being extruded from a second of the N extruders.

[0039] In some implementations, the filaments spun from the respective at least one spinneret of each of the M spin stations further include a third group of filaments, the third group of the filaments have a third color, hue, and/or dyability characteristic, wherein the third color, hue, and/or dyability characteristic is a mixture of the first color, hue, and/or dyability characteristic and the second color, hue, and/or dyability characteristic.

[0040] In some implementations, the ratio to be included in each of the M yarns are different.

[0041] In a sixth aspect, a yarn comprising a plurality of filaments is provided, wherein each filament has a color and/or hue that extends from an external surface to a center thereof and for at least a subset of the plurality of filaments, the color and/or hue of each filament within the subset varies along a length of the filament. In some embodiments, the filaments are solid-dyed (also referred to herein as solution-dyed). In some embodiments, the plurality of filaments has at least a first set of filaments and a second set of filaments, wherein the first set of filaments has a first color and/or hue at a radial cross section of the plurality of filaments and the second set of filaments has a second color and/or hue at the radial cross section, and the first color and/or hue is different than the second color. In some embodiments, the sixth aspect is a bulked continuous filament (BCF) yarn.

[0042] In a seventh aspect a yarn comprising a plurality of filaments is provided, wherein said plurality of filaments has at least a first set of filaments and a second set of filaments, wherein the first set of filaments has a first color, hue, and/or dyability characteristic at a radial cross section of the plurality of filaments and the second set of filaments has a second color, hue, and/or dyability characteristic at the radial cross section, and the first color, hue, and/or dyability characteristic is different than the second color, hue, and/or dyability characteristic. In some embodiments, the seventh aspect is a bulked continuous (BCF) yarn.

[0043] Clearly, the yarns of the sixth and/or seventh aspect may or may not be obtained using the methods, bundle of filaments, and/or systems of the aspects listed above. The yarns of the sixth and/or seventh aspect may further show preferred characteristics equal or similar to those of the yarns produced by such methods and/or systems, without necessarily having been obtained in that manner.

[0044] In an eight aspect, a carpet, rug, or carpet tile (collectively referred to herein as "carpet") is provided comprising pile made with the yarn of the sixth and/or seventh aspect and/or obtained using the methods, bundle of filaments, and/or systems of any of the first through fifth aspects.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] Example features and implementations are disclosed in the accompanying drawings. However, the present disclosure is not limited to the precise arrangements shown, and the drawings are not necessarily drawn to scale.

[0046] FIG. **1** illustrates a schematic diagram of a system according to one implementation.

[0047] FIG. **2** illustrates a schematic diagram of a system according to another implementation.

[0048] FIG. **3**A illustrates a schematic diagram of a spinning system according to another implementation.

[0049] FIG. **3**B illustrates a schematic diagram of optional post-spinning processes for the spinning system in FIG. **3**A.

[0050] FIGS. **4**A-**4**D illustrate a cross-sectional view of a dynamic manifold according to one implementation.

[0051] FIG. **5** illustrates a schematic diagram of a spinning system according to another implementation.

[0052] FIG. **6** illustrates results of color sequencing testing by operating the pumps in FIG. **1** at different speeds to change the color of the filaments, according to one implementation.

[0053] FIG. **7**A illustrates a roll of BCF yarn produced by spinning each color of thermoplastic polymer individually but adjusting the pumps for each color to yield different colors, according to one implementation.

[0054] FIG. **7**B illustrates a roll of BCF yarn produced by using the system of FIG. **1** and the color sequencing described in relation to FIG. **6** for sequences C1-C6, according to one implementation.

[0055] FIG. **8** illustrates a comparison of carpets having piles made from the BCF yarns shown in FIGS. **7**A and **7**B.

[0056] FIG. **9** illustrates a comparison of rolls of BCF yarn produced according to the system described in relation to FIG. **7**A and FIG. **1** and according to various pump speed ratios.

[0057] FIG. **10** illustrates an example computing device that can be used according to embodiments described herein.

DETAILED DESCRIPTION

[0058] Various implementations include systems and methods for producing a bundle of filaments, yarn made therefrom, and carpets made from the yarn. The system allows for the color effect of or mix of colors within a bundle of filaments to be changed by altering the volumetric flow rate of spin pumps that are in fluid communication and paired with a plurality of extruders that each include a thermoplastic polymer having a different color, hue, and/or dyability characteristic than the other extruders.

[0059] For example, in various implementations, the system includes N extruders, wherein N is an integer greater than 1, at least one spin station for receiving molten thermoplastic polymer streams from the N extruders, and a processor. Each extruder includes a thermoplastic polymer having a color, hue, and/or dyability characteristic, and colors, hues, and/or dyability characteristics of the N extruders are different from each other. Each spin station includes at least one spinneret through which a plurality of melt-spun filaments are spun from at least two of the molten thermoplastic polymer streams received by the spin station and a group of N spin pumps upstream of the spinneret. Each spin pump is in fluid communication and is paired with one of the N extruders. The processor is in electrical communication with the N spin pumps and is configured to execute computer readable instructions that cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped by each spin pump to achieve a ratio of the thermoplastic polymers to be included in the filaments spun from the at least one spinneret.

[0060] In addition, in some implementations, each spin station also includes at least one manifold (static or dynamic) and at least one mixing plate wherein each mixing plate defines at least one channel. The at least one mixing plate is disposed between the at least one manifold and the at least one spinneret.

[0061] For example, FIG. **1** illustrates a schematic diagram of a system according to one implementation. The system **100** includes a first extruder **102***a*, a second extruder **102***b*, a third extruder **102***c*, and a spin station **106** having a manifold **105**, a mixing plate **107**, a spinneret **108**, a first spin pump **104***a*, a second spin pump **104***b*, and a third spin pump **104***c*. The system **100** also includes a processor **110** in electrical communication with the spin pumps **104***a*, **104***b*, **104***c*. The first spin pump **104***a* is in fluid communication and is paired with the first extruder **102***a*, the second spin pump **104***b* is in fluid communication and is paired with the second extruder **102***b*, and the third spin pump **104***c* is in fluid communication and is paired with the third extruder **102***c*.

[0062] Each extruder **102***a*, **102***b*, **102***c* includes a thermoplastic polymer having a color, hue, and/or dyability characteristic. The colors, hues, and/or dyability characteristics in each extruder **102***a*, **102***b*, **102***c* are different from each other. The manifold **105** of the spin station **106** receives molten thermoplastic polymer streams from the extruders **102***a*, **102***b*, **102***c*. Spin pumps **104***a*, **104***b*, **104***c* pump the molten thermoplastic polymer through the manifold **105**, which feeds the molten thermoplastic polymer to the mixing plate **107** and then through the spinneret **108**, and the spinneret **108** spins the molten thermoplastic polymer streams into melt-spun filaments **114**.

[0063] Examples of thermoplastic polymers that may be used for the filaments named in any of the first through seventh aspects include polyamides, polyesters, and polyolefins. For example, the polymer may be aromatic or aliphatic polyamide, such as PA6, PA66, PA6T, PA10, PA12, PA56, PA610, PA612, PA510. The polyamide can be a polyamide blend (copolymer) or homopolymer or partially recycled or fully based upon recycled polyamide.

[0064] In other implementations of any of the first through seventh aspects, the polymer may be polyester, such as polyethylene terephthalate (PET), polybutyl terephthalate (PBT), or polytrimethylene terephthalate (PTT). The PET can be virgin PET or partially or fully based upon recycled PET, such as the PET described in U.S. Pat. No. 8,597,553.

[0065] In yet other implementations of any of the first through seventh aspects, the polymer may be a polyolefin, such as polyethylene (PE) or polypropylene (PP). In certain implementations, the polymer is PET, PTT, PP, PA6, PA66 or PES.

[0066] In some implementations of any of the first through seventh aspects, the bundles are made from the same polymer. However, in other implementations, bundles may be made from different polymers.

[0067] According to some implementations, the polymer of the filaments may be solution dyed polymer. In some implementations, the solution dyed polymer filaments are space dyed after processing (also referred to as "over dying"). And, in other implementations, the filaments are not solution dyed and are space dyed or dyed regularly after processing. A solution dyed polymer has a coloring agent added to the polymer prior to filament formation out of the spinneret. A space dyed polymer has a coloring agent that is added to the filament after formation out of the spinneret.

[0068] Dyability characteristic refers to a filament's affinity to absorb a dye under the same processing conditions. For example, non-solution-dyed filaments may appear white after spinning due to the lack of presence of dye molecules, pigments, or other molecules that would provide a different color than the material substrate. When subjected to a dyeing process, for example PET using disperse dyes, a molten stream formed with a deep dye PET would have a darker color saturation than a molten stream produced with a traditional PET.

[0069] The processor **110** is configured to execute computer readable instructions that cause the processor **110** to adjust the volumetric flow rate of the thermoplastic polymer pumped by each spin pump **104***a-c* to achieve a ratio of the thermoplastic polymers to be included in the filaments **114** spun from the spinneret **108**. Adjusting the volumetric flow rate of the thermoplastic polymer extruded from each of the extruders **102***a*, **102***b*, **102***c* adjusts the ratio of the thermoplastic polymers in the filaments **114**, which changes the overall color, hue, and/or dyability characteristic of the bundle of filaments **114** spun through the spinneret **108**. The ratio of the thermoplastic polymers to be included in the filaments **114** refers to the ratio of colors, hues, and/or dyability characteristics from each extruder that are included in the bundle of the filaments **114**. The colors, hues, and/or dyability characteristics of the spun filaments **114** may include filaments having the color, hue, and/or dyability characteristic of the polymer in the first extruder **102***a*, filaments having the color, hue, and/or dyability characteristic of the polymer in the second extruder **102***b*, filaments having the color, hue, and/or dyability characteristic of the polymer in the third extruder **102***c*, and/or filaments having a color, hue, and/or dyability characteristic that is a mixture of the colors, hues, and/or dyability characteristics from the extruders **102***a*, **102***b*, **102***c*. For example, the filaments **114** may include a first group of filaments that have the color, hue, and/or dyability characteristic of the thermoplastic polymer from the first extruder **102***a*, a second group of filaments that have the color, hue, and/or dyability characteristic of the thermoplastic polymer from the second extruder **102***b*, a third group of filaments that have the color, hue, and/or dyability characteristic of the thermoplastic polymer from the third extruder **102***c*, and/or a fourth group of filaments that have a color, hue, and/or dyability characteristic that is a mixture of the colors, hues, and/or dyability characteristics from the extruders **102***a*, **102***b*, and/or **102***c*. For example, at least a portion of the filaments in the fourth group may have a color and/or hue that is a mixture of two or more colors and/or hues of the streams. In addition or in the alternative, at least a portion of the filaments in the fourth group may have different colors and/or hues along different portions of a length of the filament and/or within a radial cross section of at least one filament within each of the portions along the length of the filament. For example, a first portion of a length of a filament may have a first color and a second portion of the length of the filament may have a second color. As another example, a portion of the length of the filament may have a color that is a mixture of two or more colors. And, as another example, a radial cross section of a filament through one portion of the length of the filament may have two or more different colors and/or hues than the radial cross section of the filament at another portion of the length of the filament. When brought together into one yarn, the groups of filaments provide a blended color appearance.

[0070] This system **100** allows for filaments to be made having more colors and/or hues than the number of extruders providing each color or hue. For example, if the extruders **102***a*-**102***c* each have thermoplastic polymers solution dyed red, blue, and yellow, various ratios of these thermoplastic polymers yield filaments having these colors and combinations thereof, such as purple, orange, and green.

[0071] For example, in some implementations, the speed of each spin pump **104***a*-**104***c* is at least 2 RPM. And, in certain implementations, a maximum speed of each spin pump **104***a*-**104***c* is 30 RPM. However, in other implementations, the maximum speed of each spin pump may be higher. If other process controls are the same, increasing the RPM of the spin pump **104***a*-**104***c* increases the linear density, or titer (e.g., also referred to as "denier per filament", "denier per fiber" or "DPF")) per filament.

[0072] In addition, the average denier of each bundle of filaments can be increased or decreased by changing the speed of the pumps. In some implementations, once selected, the average denier of the bundle of filaments spun through the spinneret **108** of the spin station **106** is constant or does not vary more than ±5%, according to some implementations. By increasing the average denier of a bundle, the color from that bundle is visibly more prevalent in the yarn. For example, the speed of the pump providing at least one of the molten thermoplastic polymer streams to the spin station may be increased while the speed of the pumps providing the other molten thermoplastic polymer streams to the spin station may be kept the same or decreased, resulting in the yarn having more of the color of the stream being pumped at a higher speed than the other streams. Increasing and decreasing the speed of at least one or more pumps can also be varied according to a certain frequency and amplitude, in some implementations, creating portions of a length of the bundle that have a different color(s), hue(s), and/or dyability characteristic(s) than other portions of the length.

[0073] In some implementations, the instructions also cause the processor **110** to adjust the timing of the volumetric flow rate changes and hence adjust the corresponding denier and/or color changes in the yarn. For example, the following description is for a sequence of steps performed by the processor **110**. At step 1, the instructions cause the spin pump **104***a* to be at a higher speed (for example, 50% of maximum speed) and the spin pump **104***b* and **104***c* to be at a lower speed (for example, each at 25% of maximum speed) for an initial x1 seconds (for example, x1 is 1 sec, 2 secs, 3 secs, 4, secs, 5 secs, 6 secs, 7 secs, 8 secs, and so on). The amount of time that a specific combination of spin pump speeds is held determines the length of the particular color pattern produced by the combination of the spin pump speeds in the yarn. After the initial x1 seconds, at step 2, the instructions cause the processor **110** to change the speeds of the pumps such that the spin pumps **104***a* and **104***b* are at a lower speed (for example 25% of maximum speed) and the spin pump **104***c* is at a higher speed (for example 50% of maximum speed) for x2 seconds. In some embodiments, x1=x2, and in other embodiments, x1 is different from x2. At step 3, after the x2 seconds elapses, the instructions cause the processor **110** to change the speeds of the pumps such that the spin pumps **104***a* and **104***c* are at a lower speed (for example at 25% of maximum speed) and spin pump **104***b* is at a higher speed (for example at 50% of maximum speed) for x3 seconds. Again, x3 can be equal to x1 and/or x2. In other embodiments, x3 can be different from x1 and/or x2. After x3 seconds, at step 4, the instructions cause the processor **110** to change the speeds of the pumps such that the spin pumps **104***a*, **104***b*, **104***c* are at the same speed (for example, each at 33.33% of the maximum speed). The above sequence or a variation thereof is repeated to produce the desired color variation in the yarn.

[0074] In another example implementation, the instructions cause the processor **110** to randomize the above steps to produce random color variation in the yarn. For example, an internal clock associated with the processor **110** selects an overall timer with a first random number greater than 0 and to and including y secs (for example, y can be 5 secs, 6 secs, 7 secs, 7.5 secs, 8 secs, 9 secs, 10 secs, and so on). Then the instructions cause the processor **110** to select a second set of random numbers for each of x1, x2, x3, and x4 in step 1-4 above (for example, x1=2 secs, x2=3 secs, x3=1 sec, x4=2 sec). As the instructions cause the processor to execute steps 1-4, the overall timer based on the first random number (for example, y=7.5 secs) decides when the process is reset. In the above example, when the time associated with the overall timer elapses, the instructions cause the processor **110** to terminate step 4 at x4=1.5 secs and restart the process steps from step 1 to step 4. In other embodiments, the steps 1-4 described above can be executed by the processor **110** in any order. The processor can also randomize the sequence of steps 1-4. In other embodiments, the speed of the pumps **104***a*, **104***b*, **104***c* for each of the above steps is randomized. For example, at step 1, the instructions cause the processor **110** to change the speed of the pumps such that pumps **104***a* and **104***b* are at a random lower speed (for example, at 20%

of maximum speed and 28% maximum speed respectively) and spin pump **104***c* is at a higher speed (for example, at 52% of maximum speed).

[0075] In some implementations, the instructions also cause the processor **110** to determine the volumetric flow rate of each thermoplastic polymer to be pumped by each spin pump **104***a*, **104***b*, **104***c* to achieve the desired ratio and generate the instructions to the spin pumps **104***a*, **104***b*, **104***c* based on the volumetric flow rate determinations. However, in other implementations, the volumetric flow rate for each spin pump **104***a*, **104***b*, **104***c* may be determined by another processor or otherwise input into the system **100**. In addition, in other implementations, the instructions to the spin pumps **104***a*, **104***b*, **104***c* may be generated by another processor or otherwise input into the system **100**.

[0076] In some implementations, the computer readable instructions are stored on a computer memory that is in electrical communication with the processor **110** and disposed near the processor (e.g., on the same circuit board and/or in the same housing). And, in other implementations, the computer readable instructions are stored on a computer memory that is in electrical communication with the processor but is remotely located from the processor. In some instances, the processor **110** and memory form a computer device such as that shown in FIG. **10**, which is described below. FIG. **10** illustrates an example computing system that includes a processor, which can include processor **110**. The system in FIG. **10** may be used by system **100**, for example.

[0077] The radial cross-sectional shape of each filament in any of the first through seventh aspects may be the same as the other filaments or different, e.g. depending on the shapes of the openings defined by the spinneret through which each filament is spun. For example, the filaments may have radial cross sections that are circular, oval, trilobal, fox, or other suitable shape. In addition, the filaments may be solid or define at least one hollow void. Similarly, the size of the spinneret openings may be the same or different, depending on the desired denier per filament for each filament.

[0078] In some implementations, the volumetric flow rate being extruded by one of the pumps may be reduced by 90% relative to a baseline volumetric flow rate, which is the total volumetric flow rate being extruded divided by the number of pumps for each spin station. And, in some implementations, the volumetric flow rate may be reduced to zero, assuming that the thermoplastic polymer would not overheat in the spinning station.

[0079] The manifold **105** in FIG. **1** is a static manifold, such as a honeycomb or static mixer. However, in other implementations, the manifold may be a dynamic manifold having multiple inlets in fluid communication with valves for controlling the flow through each inlet and the outlets. The valves are selectively opened or closed to regulate the flow of the thermoplastic polymer streams through the manifold. For example, in some implementations, the dynamic manifold comprises N inlets and at least N+1 outlets, wherein each inlet is in fluid communication with a respective one of N extruders, and at least one inlet is in communication with at least two outlets via channels that extend between the inlet and the outlets and comprises at least one valve that controls flow of the thermoplastic polymer stream between the at least one inlet and the at least two outlets. FIGS. **4A-4D** illustrates an example dynamic manifold **800** that may be used in the spin stations described herein and shown in FIGS. **1-3**. As shown, the dynamic manifold has inlets **810**, **812**, **813**, and each inlet **810**, **812**, **813** is in fluid communication with each pump **801**, **802**, **803**, which is in fluid communication with each extruder (not shown). Inlet **810** is in fluid communication with outlet **820** through channel **815**, inlet **812** is in fluid communication with outlet **822** through channel **816** and with outlet **824** through channel **817**, and inlet **813** is in fluid communication with outlet **826** through channel **818**. A mixing plate **865** is disposed between the dynamic manifold **800** and the spinnerets **850**, **860**. The mixing plate **865** defines two channels **865***a*, **865***b*. An inlet to channel **865***a* is adjacent outlets **820**, **822**, and an inlet to channel **865***b* is adjacent outlets **824**, **826**. An outlet to channel **865***a* is adjacent to and feeds spinneret **860**, and an outlet to channel **865***b* is adjacent to and feeds spinneret **850**.

[0080] Valves **221**, **222** are disposed within channels **816** and **817**, respectively. Valves **221**, **222** are selectively opened and closed to regulate the flow of the thermoplastic polymer stream from pump **802** to the outlets **822**, **824**. As shown in FIG. **4**A, valve **221** is completely closed and valve **222** is completely open, which causes the polymer stream from pump **802** to be fully directed to outlet **824**. Because outlet **824** is adjacent outlet **826** and these outlets **824**, **826** ultimately feed spinneret **850**, the bundle of filaments **870** spun from spinneret **850** include the polymer streams from pumps **802** and **803**. And, because outlet **822** is not receiving any polymer from pump **802**, the bundle of filaments **880** spun from spinneret **860** only includes the polymer stream from pump **801**.

[0081] As shown in FIG. **4**B, valve **222** is completely closed and valve **221** is completely open, which causes the polymer stream from pump **802** to be fully directed to outlet **822**. Because outlet **822** is adjacent outlet **820** and these outlets **822**, **820** feed spinneret **860**, the bundle of filaments **880** spun from spinneret **860** include the polymer streams from pumps **801** and **802**. And, because outlet **824** is not receiving any polymer from pump **802**, the bundle of filaments **870** spun from spinneret **850** only includes the polymer stream from pump **803**.

[0082] As shown in FIG. **4**C, valves **221**, **222** are completely open, which causes the polymer stream from pump **802** to be divided between outlets **822** and **824**. Thus, the bundle of filaments **880** spun from spinneret **860** includes the polymer streams from pumps **801** and **802**, and the bundle of filaments **870** spun from spinneret **850** includes the polymer streams from pumps **802** and **803**. However, the amount of polymer stream from pump **802** that is spun through spinneret **860** is half of the amount that was spun through the spinneret **860** in FIG. **4**B, and the amount of polymer stream from pump **802** that is spun through spinneret **850** is half of the amount that was spun through the spinneret **850** in FIG. **4**A.

[0083] As shown in FIG. **4**D, the valves **221**, **222** are completely closed, which causes the polymer stream from pump **802** to not reach outlets **822**, **824**. In such an instance, the yarn would not include the color and/or hue of the polymer stream from pump **802** while the valve **221**, **222** are closed.

[0084] Although FIGS. **4**A-**4**D show the valves **221**, **222** completely open or closed, the valves **221**, **222** can be partially open/closed to control the amount of polymer stream being fed to the spinnerets **850**, **860**.

[0085] In other implementations, other inlets in the dynamic manifold may have more than one channel between the inlet and multiple outlets and valves within the channels to control the volumetric flow rate of thermoplastic polymer flowing to each spinneret. And, in other implementations, inlets that are in communication with more than one channel may include one valve within the inlet that controls the flow of the thermoplastic polymer stream to the channels that are in fluid communication with the respective inlet.

[0086] In addition, the system **100** may be run at a speed of at least 2600 meters per minute, which is faster than prior art systems, since the denier per filament is not changed during a color change. The speed may be increased or decreased based on the desired appearance. And depending on the operating parameters of the system, a change in speed may not affect the appearance of the yarn.

[0087] Filaments produced using the system **100** have better wear properties because the color and/or dye extends through the full mass of the filament. Having the dye extend through the entire filament also improves the appearance of cut pile in carpets. In addition, the system **100** is faster and less expensive than prior art systems because the average denier per filament and/or the average denier per bundle can be kept substantially constant and the pumps **104***a*-**104***c* do not have to stop to allow for changes in the color of the yarn produced. This system **100** also produces less waste by avoiding the need to stop and start at each color change.

[0088] Various implementations also include a yarn that includes a plurality of filaments. Each filament has a color and/or hue from an external surface to a center thereof, and for at least a subset of the plurality of filaments, the color and/or hue of each filament within the subset varies along a length of the filament. For example, in some implementations, the plurality of filaments has at least a first set of filaments and a second set of filaments, wherein the first set of filaments has a first color and/or hue at a radial cross section of the plurality of filaments and the second set of filaments has a second color and/or hue at the radial cross section, and the first color and/or hue is different than the second color. In some implementations, the yarn is bulked continuous filament (BCF) yarn. The yarn is made according to any of the processes described above and/or by any of the systems described above. In addition, some implementations include a carpet that includes pile made with this yarn.

[0089] Various implementations also include a yarn that includes a plurality of filaments that have at least a first set of filaments and a second set of filaments. The first set of filaments has a first color, hue, and/or dyability characteristic at a radial cross section of the plurality of filaments, and the second set of filaments has a second color, hue, and/or dyability characteristic at the radial cross section, and the first color, hue, and/or dyability characteristic is different than the second color, hue, and/or dyability characteristic. In some implementations, the yarn is bulked continuous filament (BCF) yarn. The yarn may be made according to any of the processes described above and/or by any of the systems described above. In addition, some implementations include a carpet that includes pile made with this yarn.

[0090] In addition, in some implementations, carpet having changing colors, such as the carpet described above, can be made from one continuous BCF yarn, instead of having to stop the process to switch out yarn having a different color.

[0091] The yarn may be a bulked continuous filament (BCF) yarn that may be (1) extruded and drawn in a continuous operation, (2) extruded, drawn, and textured in a continuous operation, (3) extruded and taken up in one step and is then later unwound, drawn, and textured in another step, or (4) extruded, drawn, and textured in one or more operations.

[0092] Furthermore, in some implementations, the BCF yarn could be used as yarn in carpet or in apparel, for example.

[0093] Although the system shown in FIG. **1** has three extruders and three pumps and one spinning station for producing one bundle of filaments, this system can be scaled in other implementations to produce M yarns, wherein M is an integer greater than one. The system allows for the colors and/or hues of the filaments in each yarn to be altered by changing volumetric flow rates of spin pumps in fluid communication and paired with each extruder, without changing the dye sourcing or having to add additional extruders to the system. The system includes N extruders, wherein N is an integer greater than one, M spin stations, and a processor. The N extruders each comprise a thermoplastic polymer having a color, hue, and/or dyability characteristic different from each other. The M spin stations each produce one yarn and receive molten thermoplastic polymer streams from the N extruders. Each of the M spin stations includes at least one spinneret through which a plurality of melt-spun filaments are spun from at least two of the molten thermoplastic polymer streams received by the respective spin station and N spin pumps upstream of the spinneret for the respective spin station, wherein each spin pump is in fluid communication and is paired with one of the N extruders. The processor is in electrical communication with the N*M spin pumps and is configured to execute computer readable instructions that cause the processor to adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump to achieve a ratio of the thermoplastic polymers to be included in each of the M yarns spun from each of the M spin stations.

[0094] According to some implementations, at least two ratios of the M ratios are different. In other implementations, all of the M ratios are different.

[0095] For example, the system **200** in FIG. **2** includes three extruders **202***a*-**202***c* and two spin stations **206***a*, **206***b*. Each spin station **206***a*, **206***b* has a spinneret **208***a*, **208***b*, respectively, and a group of spin pumps **204***a***1**-**204***c***1** and **204***a***2**-**204***c***2**, respectively. Spin pumps **204***a***1** and **204***a***2** are paired with extruder **202***a*. Spin pumps **204***b***1** and **204***b***2** are paired with extruder **202***b*. And, spin pumps **204***c***1** and **204***c***2** are paired with extruder **202***c*. In particular, the first spin station **206***a* includes a first group of spin pumps **204***a***1**-**204***c***1**, and the second spin station **206***b* includes a second group of spin pumps **204***a***2**-**204***c***2**. Each spin pump **204***a***1**-**204***c***1** in the first group of spin pumps is in fluid communication with and is paired with one of the extruders **202***a*-**202***c* and is in fluid communication with the first manifold **205***a*, the first mixing plate **207***a*, and the first spinneret **208***a*. And, each spin pump **204***a***2**-**204***c***2** in the second group of spin pumps is in fluid communication with and is paired with one of the extruders **202***a*-**202***c* and is in fluid communication with the second manifold **205***b*, the second mixing plate **207***b*, and the second spinneret **208***b*. Accordingly, thermoplastic polymer pumped from the extruders **202***a*-**202***c* by the first group of spin pumps **204***a***1**-**204***c***1** is spun through the first spinneret **208***a*, and thermoplastic polymer pumped from the extruders **202***a*-**202***c* by the second group of spin pumps **204***a***2**-**204***c***2** is spun through the second spinneret **208***b*. The denier per filament of the filaments spun through each spinneret **208***a*, **208***b* relative to other filaments spun from the same spinneret **208***a*, **208***b* may be the same or different. And, the denier per filament of the filaments spun through each spinneret **208***a*, **208***b* relative to the filaments spun from the other spinneret **208***a*, **208***b* may be the same or different.

[0096] In some implementations, there is a desire to maintain a constant throughput, or total volumetric flow rate, for each extruder. The total volumetric flow rate extruded from each extruder **202***a*-**202***c* is the sum of the volumetric flow rates pumped by the spin pumps **204***a***1**-**204***c***2** that are paired with the respective extruder **202***a*-**202***c*. For example, the total volumetric flow rate extruded from extruder **202***a* is the sum of the volumetric flow rates pumped by spin pumps **204***a***1** and **204***a***2**. Similarly, the total volumetric flow rate extruded from the extruder **202***b* is the sum of the volumetric flow rates pumped by spin pumps **204***b***1** and **204***b***2**. And, the total volumetric flow rate extruded from extruder **202***c* is the sum of the volumetric flow rates pumped by spin pumps **204***c***1** and **204***c***2**. However, in other implementations, the volumetric flow rate of each pump that is paired with a particular extruder is not limited relative to the volumetric flow rate of the other pumps paired with that particular extruder.

[0097] The processor **210** is configured to execute computer readable instructions that cause the processor **210** to (1) adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump **204***a***1**-**204***c***1** of the first group of spin pumps to achieve a first ratio of thermoplastic polymers to be included in the first bundle of filaments **214***a* spun from the first spinneret **208***a* of the first spin station **206***a* and (2) adjust the volumetric flow rate of the thermoplastic polymers pumped from each spin pump **204***a***2**-**204***c***2** of the second group of spin pumps to achieve a second ratio of the thermoplastic polymers to be included in the second bundle filaments **214***b* spun from the second spinneret **208***b* of the second spin station **206***b*. In some instances, the processor **210** and memory form a computer device such as that shown in FIG. **10**, which is described below. FIG. **10** illustrates an example computing system that includes a processor, which can include processor **210**. The system in FIG. **10** may be used by system **200**, for example.

[0098] In some implementations, the ratio to be included in each of the bundles of filaments **214***a*, **214***b* are different.

[0099] The colors, hues, and/or dyability characteristics of the bundle of filaments **214***a*, **214***b* may include filaments having the color, hue, and/or dyability characteristic of the polymer in the first extruder **202***a*, filaments having the color, hue, and/or dyability characteristic of the polymer in the second extruder **202***b*, filaments having the color, hue, and/or dyability characteristic of the polymer in the third extruder **202***c*, and/or filaments having a color, hue, and/or dyability characteristic that is a mixture of the colors, hues, and/or dyability characteristics from the extruders **202***a*-**202***c*.

[0100] The average denier of the bundle of filaments spun through each spinneret **208***a*, **208***b* is constant or does not vary more than ±5%. However, the average denier per filament of the filaments spun through the first spinneret **208***a* of the first spin station **206***a* may be different from the average denier per filament of the filaments spun through the second spinneret **208***b* of the second spin stations **206***b*.

[0101] In some implementations in which the system has at least three extruders, the thermoplastic polymer streams from at least two of the extruders are spun together but separately from the thermoplastic polymer stream from at least one other extruder. For example, FIG. **3**A illustrates an implementation that is similar to FIG. **1**, showing three extruders **302***a*-**302***c* and three spin pumps **304***a*-**304***c*, except that the spin station **306** includes two spinnerets **308***a*, **308***b*, two mixing plates **307***a*, **307***b*, and two manifolds **305***a*, **305***b*. However, in other implementations, the mixing plates can be one piece and/or the manifolds can be one piece. Thermoplastic polymer streams from extruders **302***a* and **302***b* are pumped into manifold **305***a* by pumps **304***a*, **304***b*, respectively, and are spun into filaments **314***a* through spinneret **308***a*. And, the thermoplastic polymer stream from extruder **302***c* is pumped into manifold **305***b* by pump **304***c* and is spun into filaments **314***b* through spinneret **308***b*. Therefore, the colors, hues, and/or dyability characteristics of the bundle of filaments **314***a* may include filaments having the color, hue, and/or dyability characteristic of the polymer in the first extruder **302***a*, filaments having the color, hue, and/or dyability characteristic of the polymer in the second extruder **302***b*, and/or filaments having a color, hue, and/or dyability characteristic that is a mixture of the colors, hues, and/or dyability characteristics from the extruders **202***a*-**202***b*. Thus, the bundle of filaments **314***a* has a blended appearance based on the streams spun through spinneret **308***a*. And, the colors, hues, and/or dyability characteristics of the bundle of filaments **314***b* has filaments having the color, hue, and/or dyability characteristic of the polymer in the third extruder **302***c*.

[0102] According to some implementations, if the thermoplastic polymer from one extruder is not being mixed with a thermoplastic polymer from another extruder prior to spinning, such as the stream extruded from extruder **302***c* in FIG. **3**A, the variation in the volumetric flow rate of the thermoplastic polymer displaced by the extruder may be based on, but is not limited to, the type of polymer, a size and/or shape of the capillaries of the spinneret, the temperature of the polymer, and the denier per filament of the filaments spun from that spinneret. The volumetric flow rate is greater than zero and can be varied such that the flow of the polymer stream through the spinneret is continuous and supports continuous filament formation.

[0103] In addition, the average denier of the yarn that is made with the bundles **314***a*, **314***b* can be kept substantially constant (e.g., ±5% variation) if the sum of volumetric flow rate of the pumps **304***a* and **304***b* remains substantially constant and if the volumetric flow rate of pump **304***c* remains substantially constant. However, changing the sum of the volumetric flow rate of pumps **304***a* and **304***b* or changing the volumetric flow rate displaced by pump **304***c* may change the average denier of the yarn.

[0104] The bundles **314***a*, **314***b* produced by system **300** in FIG. **3**A can be drawn separately by drawing device **360**, which is a plurality of godets, after the spinning process, assuming that the filaments in bundle **314***b* are not subject to breakage due to their denier per filament, radial cross-sectional shape, or otherwise. The drawing device **360** is at least one or more godets, for example, but in other implementations, it can also include a draw point localizer.

[0105] FIG. **3**B illustrates a schematic diagram of optional post-spinning processes for the spinning system in FIG. **3**A. These optional post-spinning processes enhance the color contributed to the yarn by each bundle of filaments **314***a*, **314***b*. Each process can be used when there are two or more spun filament bundles that have different colors and/or hues. The processes include (1) tacking spun filaments in at least one bundle separately from the other bundles after spinning and prior to or during the drawing process, (2) texturing tacked spun filaments in at least one bundle separately from the other bundles after the drawing process, and (3) tacking textured and tacked spun filaments in at least one bundle separately from the other bundles and feeding the bundles to a mixing cam that feeds the bundles to a final tacking device for tacking together the bundles into a yarn.

[0106] As shown in FIG. 3B, each bundle of spun filaments **314***a*, and **314***b* are tacked individually by a tacking device **315**, **325**, respectively. In other words, each bundle **314***a*, **314***b* is physically separated from the other bundle and only filaments belonging to the respective bundle are tacked together. The tacking devices **315**, **325** are air entanglers. The tacking is done with air entangling every 6 to 155 mm (e.g., 20 to 50 mm). In addition, the tacking devices **315**, **325** may use 2 to 6 bar pressure, but the pressure may increase with an increased number of filaments, increased denier per filament, and/or increased speed of filament production.

[0107] The tacking devices **315**, **325** are air entanglers that use room temperature air for entangling the filaments. In other embodiments, the tacking devices include heated air entanglers (e.g., air temperature is higher than room temperature) or steam entanglers, for example.

[0108] The bundles of tacked filaments **316**, **326** are drawn to the final titer by drawing device **360**, which is a plurality of godets. The godets are each turned at a different speed, according to some embodiments. The draw ratio is typically 1.5 to 4.5. Each filament is drawn to a titer of 2 to 40 titer (or DPF). Two bundles of elongated spun filaments **317**, **327** are provided after drawing.

[0109] When looking along the axial length of the yarn **391**, the position of the filaments originating from bundles **314***a*, **314***b* are more pronounced in the yarn **391** than if the bundles of filaments **314***a* **314***b* had not been individually tacked with tacking devices **315**, **325**. In alternative embodiments (not shown in FIG. 3B), air entanglement can be applied to one or more of the bundles by turning off or on air to **315**, **325**. In addition, in other embodiments, air can be applied constantly or in an on/off sequence to get the desired end effect.

[0110] And, in yet another embodiment (not shown in FIG. 3B), the bundles of spun filaments are first elongated partially before being tacked individually. After the tacking step, the spun, tacked bundles are further elongated to the final denier.

[0111] Next, to further enhance the color of each bundle within the yarn, each bundle of tacked and drawn filaments **317**, **327** are texturized separately through texturizers **371**, **372**, respectively. Following this step, bundles **318**, **328** of texturized filaments are provided.

[0112] The texturizers **371**, **372** may apply air, steam, heat, mechanical force, or a combination of one of more of the above to the filaments to cause the filaments to bulk (or crimp/shrink). The bundles **317**, **327** are texturized to have a bulk (or crimp or shrinkage) of 5-20%. Texturizing individual bundles of filaments separately, when using bundles with different colors and/or hues, provides a more pronounced color and/or hue along the axial length of the BCF yarn. The filaments that are texturized separately tend to stay more grouped together during the rest of the production steps to make the BCF yarn, which results in the color and/or hue of this bundle of spun filaments being more pronounced along the length of the BCF yarn.

[0113] Next, the texturized filaments **318**, **328** are provided to an individual color entanglement process prior to the final tacking at tacking device **380**. In this individual color entanglement process, the bundles **318**, **328** of texturized filaments are fed into separate tacking devices **319**, **329** to tack individually each bundle of texturized spun filaments.

[0114] Tacking devices **319**, **329** are air entanglers that use room temperature air applied at 2 bar to 6 bar pressure, for example, for entangling the filaments every 15 to 155 mm. But the pressure may increase with an increased number of filaments, increased denier per filament, and/or increased speed of filament production. And, in other embodiments, the tacking devices **319**, **329** include heated air entanglers (e.g., air temperature is higher than room temperature) or steam entanglers, for example. The tacking may be done more frequently for a specific look desired. For example, with more frequent tacking, the yarn looks less bulky and the color separation is reduced, which results in a more blended look for the colors.

[0115] After being individually tacked with tacking devices **319**, **329**, the bundles **320**, **321** are guided to a mixing cam **400**. The mixing cam **400** positions bundles tacked by tacking devices **319**, **329** relative to each other prior to being tacked together in final tacking device **380**. The mixing cam **400** is cylindrical and has an external surface defining a plurality of grooves for receiving and guiding the texturized and tacked bundles.

[0116] The mixing cam **400** is rotatable about its central axis or can be held stationary. If rotated, the mixing cam **400** varies which side of the bundles are presented to the tacking jet in the tacking device **380**, which affects how the bundles (and filaments therein) are layered relative to each other. In some embodiments, the positions are randomly varied. The speed of rotation can be changed to provide a different appearance in the yarn **391**. For example, one or more of the bundles **320**, **321** may have a first color on one side of the bundle **320**, **321** and a second color on another side of the bundle **320**, **321**, wherein the sides of the bundle are circumferentially spaced apart but intersected by the same radial plane. It may be desired to have the first color on an exterior facing surface of an arc in a carpet loop in one area of the carpet and the second color on an exterior facing surface of an arc in a carpet loop in another area of the carpet. Rotating the cam **400** may "flip" one or more of the bundles **320**, **321** about its axis such that the desired color is oriented on a portion of the outer surface of the yarn **391** such that the desired color is on the exterior facing surface of the arc in the carpet loop. The undesired color for that portion of the carpet is hidden on the inside facing surface of the loop. Rotation of the cam **400** ensures that the filaments that run on the outside of the loop are changing due to a specific mechanical means and not necessarily natural occurrences in downstream processes.

[0117] When stationary, the positions of the bundles **320**, **321** are directed by the mixing cam **400** to the final tacking device **380** but their relative positions are not varied. In alternative embodiments, the bundles **320**, **321** are fed to the tacking device **380** directly or they are fed via a stationary guide disposed between the intermediate tacking devices **319**, **329** and the tacking device **380**.

[0118] The tacked texturized bundles **320**, **321** positioned by mixing cam **400** are thereafter tacked together by tacking device **380** into a BCF yarn **391**. This tacking is done with air entangling every 12 to 80 mm.

[0119] Tacking device **380** is an air entangler that uses room temperature air applied at 2 bar to 6 bar pressure, for example, for entangling the filaments. But the pressure may increase with an increased number of filaments, increased denier per filament, and/or increased speed of filament production. And, in other embodiments, the tacking device **380** includes heated air entanglers (e.g., air temperature is higher than room temperature) or steam entanglers, for example. The bundles **320**, **321** are tacked and as such provide a BCF yarn **391** comprising an average of 24-360 filaments of 2 to 40 DPF each. The tacking may be done more frequently for a specific look desired. For example, with more frequent tacking, the yarn looks less bulky and the color separation is reduced, which results in a more blended look for the colors.

[0120] The effect of this individual tacking and guidance via a mixing cam cause the colors and/or hues in the yarn to be more structured and positioned. When such yarn is used as for example, a tufting yarn in a tufted carpet, the positioning of the colored bundles in the yarn cause bundles to be more pronounced in the final carpet surface. The positioning of the color and/or hue in the BCF yarn has as effect that this color and/or hue can be locally more present on the top side of the tuft oriented upwards, away from the backing of the carpet, or hidden at the low side of the tuft oriented towards the backing of the carpet. The effect is the provision of very vivid and pronounced color zones on the carpet.

[0121] In the implementations of FIGS. **1**-**3**B, each mixing plate **107**, **207***a*, **207***b*, **307***a*, **307***b* defines a single channel that receives all of the molten thermoplastic polymer streams that flow through the respective manifold **105**, **205***a*, **205***b*, **305***a*, **305***b* that is upstream of the mixing plate **107**, **207***a*, **207***b*, **307***a*, **307***b*. In other words, the mixing plates **107**, **207***a*, **207***b*, **307***a*, **307***b* are not separating the molten thermoplastic polymer streams before the streams flow through the spinnerets **108**, **208***a*, **208***b*, **308***a*, **308***b*. However, in other implementations, the mixing plate may include a plurality of channels for separating or mixing a plurality of molten thermoplastic polymer streams. FIGS. **4**A-**4**D illustrate a mixing plate **865** having two channels **865***a*, **865***b* defined by the plate **865** that receives molten thermoplastic polymer streams from the manifold **800** upstream from the mixing plate **865**. Each channel **865***a*, **865***b* feeds separate spinnerets. Thus, if two or more molten thermoplastic polymer streams are received into one of the channels **865***a*, **865***b*, the two or more streams are at least partially mixed in the respective channel **865***a*, **865***b*.

[0122] Like FIGS. **4**A-**4**D, FIG. **5** illustrates a system **500** that includes a mixing plate **507** defining two channels **507***a*, **507***b* therethrough. The mixing plate **507** is disposed between a static manifold **505** and spinneret **508**. The molten thermoplastic polymer stream from extruder **502***a* is pumped by pump **504***a* into the manifold **505**, which feeds the stream into channel **507***a* of the mixing plate, which feeds the stream through spinneret **508**. The molten thermoplastic polymer streams from extruders **502***b*, **502***c* are pumped by pumps **504***b*, **504***c*, respectively, into the manifold **505**, which feeds the streams into channel **507***b* of the mixing plate, which feeds the streams through spinneret **508**. Thus, the stream from extruder **502***a* is not mixed or spun together with the streams from extruders **502***b*, **502***c* in the manifold **505** or the mixing plate **507**, but the streams from extruders **502***b*, **502***c* are at least partially mixed in the channel **507***b* prior to being spun through the spinneret **508**.

[0123] In some embodiments of any of the first through seventh aspects, the DPF of the filaments in each of the bundles are equal. However, in other embodiments, at least some of the filaments in one bundle may have a different DPF than the other filaments in the bundle. Or, in some embodiments, the filaments in one bundle may have the same DPF as other filaments in the bundle but the DPF of those filaments may be different from the DPF of the filaments in another bundle. And, in some embodiments, the number of filaments in the bundles are equal. And, in other embodiments, the number of filaments in each bundle may differ.

EXAMPLES

[0124] FIG. **6** illustrates the results of a color sequencing test using the system **100** shown in FIG. **1**. For this test, extruder **102***a* had magenta molten Nylon, extruder **102***b* had cyan molten Nylon, and extruder **102***c* had yellow molten Nylon. The pumps **104***a*, **104***b*, **104***c* were operated at the same or different RPMs to change the color of the filaments **114**. The filament colors changed in response to the RPM changes in less than 10 seconds. For example, when pump **104***a* was operated at full capacity (e.g., 30 RPM) and pumps **104***b* and **104***c* were stopped (0 RPM), the filaments **114** were magenta, as shown in A**1**. When pump **104***b* was operated at full capacity (e.g., 30 RPM) and pumps **104***a* and **104***c* were stopped (0 RPM), the filaments **114** were cyan, as shown in A**2**. And, when pump **104***c* was operated at full capacity (e.g., 30 RPM) and pumps **104***a* and **104***b* were stopped (0 RPM), the filaments **114** were yellow, as shown in A**3**. When each three pumps **104***a*, **104***b*, **104***c* were operated at 30% capacity (e.g., 9 RPM each), the filaments **114** were a blended mixture of the three colors, as shown in B. When pump **104***c* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***a* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***b* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**1**. When pump **104***b* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***c* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***c* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**2**. When pump **104***a* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***b* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***c* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**3**. When pump **104***b* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***a* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***c* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**4**. When pump **104***b* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***c* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***a* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**5**. And, when pump **104***c* was operated at 60% of full capacity (e.g., 18 RPM), the pump **104***b* was operated at 30% capacity (e.g., 9 RPM), and the pump **104***a* was operated at 10% capacity (e.g., 3 RPM), the filaments **114** were a blended mixture of the three colors, as shown in C**6**.

[0125] FIG. **7**B illustrates rolls of yarn produced using the system of FIG. **1**. As can be seen, the color of the yarn varies over the length of the yarn, due to the color sequencing changes described above in in relation to FIG. **6** and shown in C**1**-C**6**. However, the color is more blended than the yarn shown in FIG. **7**A. The yarn in FIG. **7**A is made using the same polymers having the same colors as are used in the yarn of FIG. **7**B and by adjusting the pump output to adjust the color of the yarn, but the molten Nylon streams from each extruder are spun separately from each other through separate spinnerets. Thus, by spinning more than one polymer stream together, the yarn has a more blended color. And, FIG. **8** illustrates carpets **1000**, **1002** that have pile made with the BCF yarns shown in FIGS. **7**B and **7**A, respectively.

[0126] FIG. **9** illustrates a comparison of rolls of BCF yarn made according to the system described above in relation to FIG. **7**A (marked A**1**, B**1**, C**1**) with those made with the system of FIG. **1** (marked A**2**, B**2**, C**2**) and according to different pump speed ratios. For example, in one comparison (A1-A2), the pump ratio is 10:4:1 (e.g., the speeds for the pumps for each extruder are varied to be 20:8:2 RPM). In another comparison (B1-B2), the pump ratio is 6:3:1 (e.g., the speeds for the pumps for each extruder are varied to be 18:9:3 RPM). And, in another comparison (C1-C2), the pump ratio is 4:1:1 (e.g., the speeds for the pumps for each extruder are 20:5:5 RPM).

[0127] It is remarked that where notice is made of different or varying colors or hue, at least a color or hue difference as expressed with a Delta E value of 1.0 is preferred. Even better the difference or variation at least encompasses a color or hue difference as expressed by Delta E of at least 5.0 or at least 10.0. Delta E is a measure of change in visual perception of two given colors.

[0128] FIG. **10** illustrates an example computing device that can be used for controlling the pumps of the system **100**. As used herein, "computing device" or "computer" may include a plurality of computers. The computers may include one or more hardware components such as, for example, a processor **1021**, a random access memory (RAM) module **1022**, a read-only memory (ROM) module **1023**, a storage **1024**, a database **1025**, one or more input/output (I/O) devices **1026**, and an interface **1027**. All of the hardware components listed above may not be necessary to practice the methods described herein. Alternatively and/or additionally, the computer may include one or more software components such as, for example, a computer-readable medium including computer executable instructions for performing a method associated with the example embodiments. It is contemplated that one or more of the hardware components listed above may be implemented using software. For example, storage **1024** may include a software partition associated with one or more other hardware components. It is understood that the components listed above are examples only and not intended to be limiting.

[0129] Processor **1021** may include one or more processors, each configured to execute instructions and process data to perform one or more functions associated with a computer for producing at least one bundle of filaments and/or at least one yarn. Processor **1021** may be communicatively coupled to RAM **1022**, ROM **1023**, storage **1024**, database **1025**, I/O devices **1026**, and interface **1027**. Processor **1021** may be configured to execute sequences of computer program instructions to perform various processes. The computer program instructions may be loaded into RAM **1022** for execution by processor **1021**.

[0130] RAM **1022** and ROM **1023** may each include one or more devices for storing information associated with operation of processor **1021**. For example, ROM **1023** may include a memory device configured to access and store information associated with the computer, including information for identifying, initializing, and monitoring the operation of one or more components and subsystems. RAM **1022** may include a memory device for storing data associated with one or more operations of processor **1021**. For example, ROM **1023** may load instructions into RAM **1022** for execution by processor **1021**.

[0131] Storage **1024** may include any type of mass storage device configured to store information that processor **1021** may need to perform processes consistent with the disclosed embodiments. For example, storage **1024** may include one or more magnetic and/or optical disk devices, such as hard drives, CD-ROMs, DVD-ROMs, or any other type of mass media device.

[0132] Database **1025** may include one or more software and/or hardware components that cooperate to store, organize, sort, filter, and/or arrange data used by the computer and/or processor **1021**. For example, database **1025** may store computer readable instructions that cause the processor **1021** to adjust the volumetric flow rate of the thermoplastic polymers pumped by each spin pump to achieve a ratio of the thermoplastic polymers to be included in the filaments spun from the at least one spinneret. It is contemplated that database **1025** may store additional and/or different information than that listed above.

[0133] I/O devices **1026** may include one or more components configured to communicate information with a user associated with computer. For example, I/O devices may include a console with an integrated keyboard and mouse to allow a user to maintain a database of digital images, results of the analysis of the digital images, metrics, and the like. I/O devices **1026** may also include a display including a graphical user interface (GUI) for outputting information on a monitor. I/O devices **1026** may also include peripheral devices such as, for example, a printer for printing information associated with the computer, a user-accessible disk drive (e.g., a USB port, a floppy, CD-ROM, or DVD-ROM drive, etc.) to allow a user to input data stored on a portable media device, a microphone, a speaker system, or any other suitable type of interface device.

[0134] Interface **1027** may include one or more components configured to transmit and receive data via a communication network, such as the Internet, a local area network, a workstation peer-to-peer network, a direct link network, a wireless network, or any other suitable communication platform. For example, interface **1027** may include one or more modulators, demodulators, multiplexers, demultiplexers, network communication devices, wireless devices, antennas, modems, and any other type of device configured to enable data communication via a communication network.

[0135] Various implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the description. Accordingly, other implementations are within the scope of the following claims.

[0136] Disclosed are materials, systems, devices, methods, compositions, and components that can be used for, can be used in conjunction with, can be used in preparation for, or are products of the disclosed methods, systems, and devices. These and other components are disclosed herein, and it is understood that when combinations, subsets, interactions, groups, etc. of these components are disclosed that while specific reference of each various individual and collective combinations and permutations of these components may not be explicitly disclosed, each is specifically contemplated and described herein. For example, if a device is disclosed and discussed every combination and permutation of the device, and the modifications that are possible are specifically contemplated unless specifically indicated to the contrary. Likewise, any subset or combination of these is also specifically contemplated and disclosed. This concept applies to all aspects of this disclosure including, but not limited to, steps in methods using the disclosed systems or devices. Thus, if there are a variety of additional steps that can be performed, it is understood that each of these additional steps can be performed with any specific method steps or combination of method steps of the disclosed methods, and that each such combination or subset of combinations is specifically contemplated and should be considered disclosed.

[0137] The terminology used herein is for the purpose of describing particular implementations only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a", "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

1.-**31**. (canceled)

32. A method to produce at least one bundle of filaments comprising:

providing N streams of molten thermoplastic polymer, wherein N is an integer greater than 1, and each stream has a different color, hue, and/or dyability characteristic;

providing at least one spin station having N feeds for receiving the N streams of thermoplastic polymer, the spin station comprising:

(i) at least one spinneret,

(ii) at least one dynamic manifold comprising N inlets and at least N+1 outlets, wherein each inlet of the N inlets receives a respective one of the N streams of thermoplastic polymer, and wherein at least one inlet of the N inlets is in communication with at least two outlets of the at least N+1 outlets via channels that extend between the inlet of the at least one inlet and the outlets of the at least two outlets and comprises at least one valve that controls flow of the respective polymer stream between the at least one inlet and the at least two outlets, and

(iii) a group of N spin pumps, each spin pump pumping one of the N streams of thermoplastic polymer to one of the N feeds, and at least two of the N feeds being in fluid communication with one of the at least one spinneret, the N spin pumps being disposed upstream of the dynamic manifold; and

adjusting a volumetric flow rate of each thermoplastic polymer stream pumped to the respective feed of the spin station to achieve a ratio of the thermoplastic polymer streams to be included in a yarn comprising filaments spun from the at least one spinneret.

33. The method of claim **32**, further comprising determining the volumetric flow rate of each thermoplastic polymer to be pumped by each spin pump and an amount of time during which the determined volumetric flow rate of each thermoplastic polymer is pumped by each spin pump.

34. The method of claim **33**, further comprising randomly varying the amount of time during which the determined volumetric flow rate of each thermoplastic polymer is pumped by each spin pump.

35. (canceled)

36. The method of claim **32**, wherein the at least one spin station comprises a first spin station and a second spin station, and the ratio is a first ratio, wherein the volumetric flow rate of each thermoplastic polymer stream pumped to the respective feed of the first spin station is based on the first ratio of the thermoplastic polymer streams to be included in the filaments spun by the spinneret of the first spin station, and the volumetric flow rate of each thermoplastic polymer stream pumped to the respective feed of the second spin station is based on a second ratio of the thermoplastic polymer streams to be included in the filaments spun by the spinneret of the second spin station.

37. The method of claim **36**, wherein the first ratio and the second ratio are different.

38. The method of claim **32**, wherein each of N streams of molten thermoplastic polymer are provided by one of N extruders such that each thermoplastic polymer stream remains separated from other thermoplastic polymer streams until reaching the spin station.

39.-**58**. (canceled)

59. The method of claim **32**, wherein:

the filaments spun from the at least one spinneret include at least a first group of filaments and a second group of filaments,

the first group of filaments have a first color, hue, and/or dyability characteristic, the first group of filaments being extruded from a first of the N extruders, and

the second group of the filaments have a second color, hue, and/or dyability characteristic, the second group of filaments being extruded from a second of the N extruders.

60. The system of claim **59**, wherein: the filaments spun from the at least one spinneret further include a third group of filaments, the third group of the filaments have a third color, hue, and/or dyability characteristic, wherein the third color, hue, and/or dyability characteristic is a mixture of the first color, hue, and/or dyability characteristic and the second color, hue, and/or dyability characteristic.

61. A method of producing a yarn, comprising:

providing N extruders, wherein:

each extruder is configured to extrude a stream of polymer melt, and

N is an integer greater than 1;

providing M spin stations, wherein:

each spin station is configured to receive a portion of each stream of polymer melt from each of the N extruders,

a first spin station of the M spin stations is configured with a mixing plate comprising a plurality of channels, and

M is an integer greater than 1;

providing N spin pumps for each of the M spin stations, wherein each spin pump of the N spin pumps for each of the M spin stations is fluidly connected to one of the N extruders, and fluidly connected to its respective spin station;

extruding N streams of polymer melt, wherein each of the N streams of polymer melt is extruded from only one of the N extruders;

receiving the N streams of polymer melt by the first spin station of the M spin stations;

wherein:

a first of the N streams of the received polymer melt flows through a first channel of the plurality of channels, and

a second of the N streams of the received polymer melt flows through a second channel of the plurality of channels;

spinning a plurality of bundles of filaments, wherein:

a first bundle of filaments is spun from the first of the N streams of received polymer melt, and

a second bundle of filaments is spun from the second of the N streams of received polymer melt;

texturing the first bundle of filaments and the second bundle of filaments wherein the first bundle of filaments is textured separately from the second bundle of filaments;

combining the first bundle of filaments with the second bundle of filaments.

62. The method of producing a yarn of claim **61**, comprising: measuring a volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations.

63. The method of producing a yarn of claim **62**, comprising: adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations to achieve a ratio of the N streams of polymer melt to be spun into the plurality of bundles of filaments.

64. The method of producing a yarn of claim **63**, comprising:

measuring a volumetric flow rate for each of the received N streams of polymer melt flow for each of the spin stations;

receiving the N streams of polymer melt by the second spin station of the M spin stations;

spinning at least one group of bundles of filaments from the N streams of received polymer melt.

65. The method of producing a yarn of claim **64**, comprising:

adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations to achieve a first ratio of the N streams of polymer melt to be spun into the plurality of bundles of filaments; and

adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the second spin station of the M spin stations to achieve a second ratio of the N streams of polymer melt to be spun into the at least one group of bundles of filaments.

66. The method of producing a yarn of claim **65**, wherein the first ratio is different from the second ratio.

67. A method of producing a yarn, comprising:

providing N extruders, wherein:

each extruder is configured to extrude a stream of polymer melt, and

N is an integer greater than 1;

providing M spin stations, wherein:

each spin station is configured to receive a portion of each stream of polymer melt from each of the N extruders,

a first spin station of the M spin stations is configured with a manifold, and

M is an integer equal to or greater than 1;

providing N spin pumps for each of the M spin stations, wherein each spin pump of the N spin pumps for each of the M spin stations is fluidly connected to one of the N extruders, and fluidly connected to its respective spin station;

extruding N streams of polymer melt, wherein each of the N streams of polymer melt is extruded from only one of the N extruders;

receiving the N streams of polymer melt by the first spin station of the M spin stations;

wherein a first of the N streams of the received polymer melt flows into and mixes with a second of the N streams of the received polymer melt flows in the manifold;

spinning at least M bundles of filaments after the first and second streams of the N streams of received polymer melt flows are mixed in the manifold.

68. The method of producing a yarn of claim **67**, comprising: measuring a volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations.

69. The method of producing a yarn of claim **68**, comprising: adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations to achieve a ratio of the N streams of polymer melt to be spun into the plurality of bundles of filaments.

70. The method of producing a yarn of claim **67**, comprising:

measuring a volumetric flow rate for each of the received N streams of polymer melt flow for each of the spin stations;

receiving the N streams of polymer melt by the second spin station of the M spin stations;

spinning at least one group of bundles of filaments from the N streams of received polymer melt.

71. The method of producing a yarn of claim **70**, comprising:

adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the first spin station of the M spin stations to achieve a first ratio of the N streams of polymer melt to be spun into the plurality of bundles of filaments; and

adjusting the volumetric flow rate of each of the received N streams of polymer melt flow for the second spin station of the M spin stations to achieve a second ratio of the N streams of polymer melt to be spun into the at least one group of bundles of filaments.

72. The method of producing a yarn of claim **71**, wherein the first ratio is different from the second ratio.

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