

Dec. 11, 1956

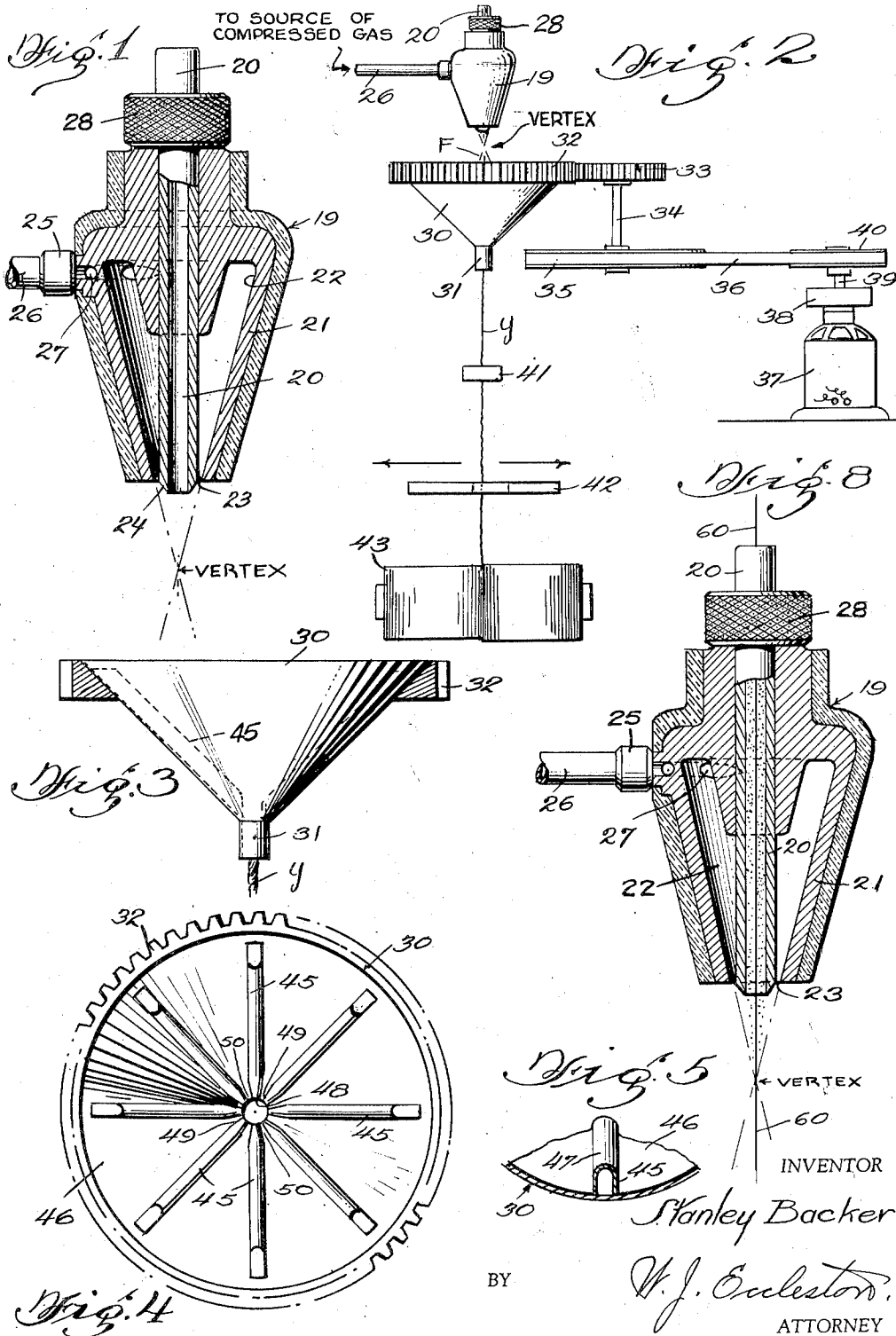
S. BACKER

2,773,282

METHOD OF AND APPARATUS FOR SPINNING YARNS

Filed Jan. 17, 1950.

2 Sheets-Sheet 1



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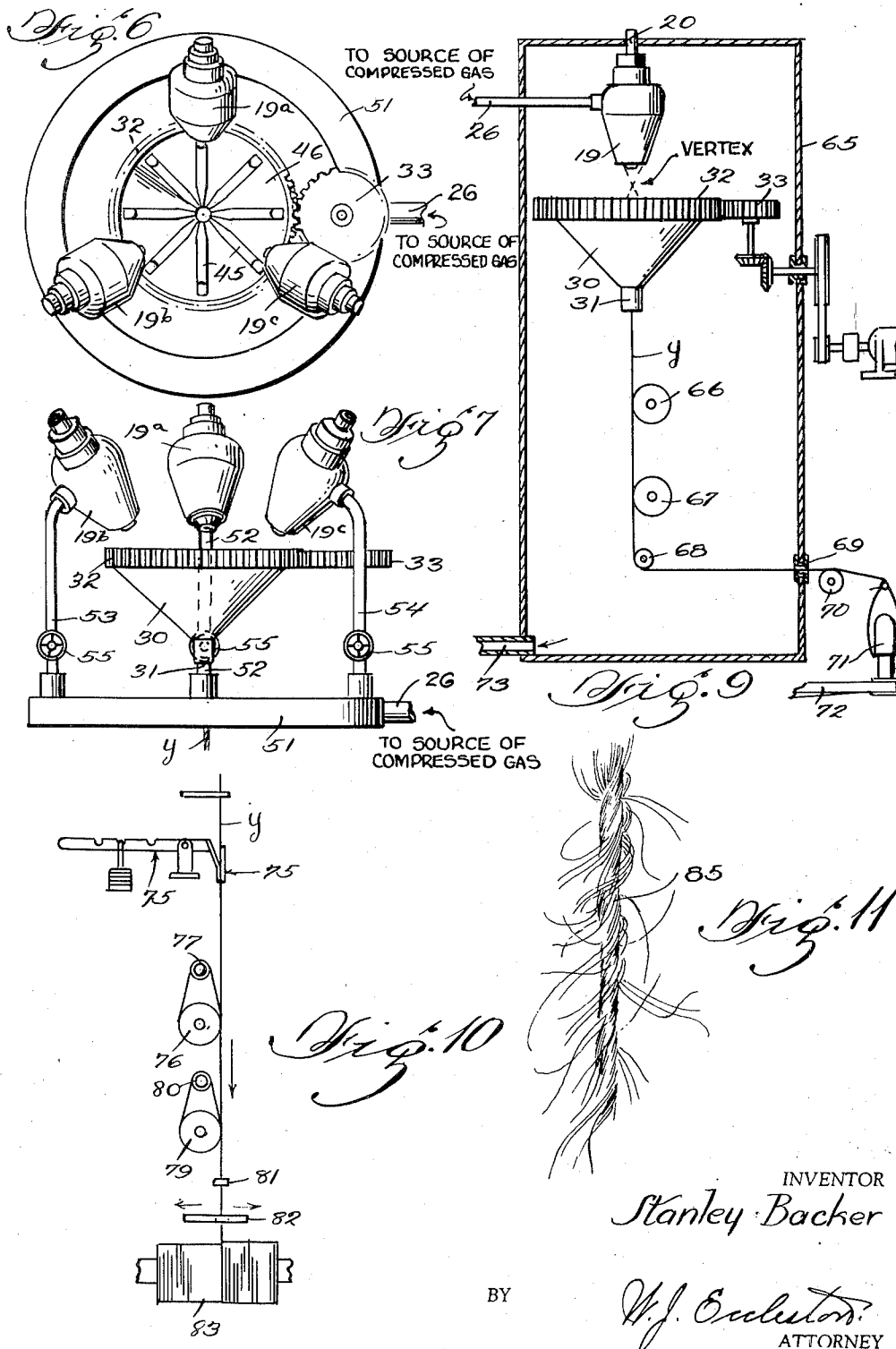
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METHOD OF AND APPARATUS FOR SPINNING YARNS

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5 Claims. (Cl. 18—8)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to a method of and apparatus for manufacturing yarns, especially novelty yarns and bulky substitutes for wool yarns for uses where uniformity of the yarn is not required.

In accordance with the invention, a generally conical nozzle of the type disclosed in the R. K. Ladisch Patent No. 2,571,457, dated October 16, 1951, is employed to form filaments by melt-spraying a pure polymer, copolymer or polymeric mixture, with or without a plasticizer; or the nozzle may spray solutions of polymers or copolymers to form filaments, or may be used to form filaments containing metallic or other solid fillers as disclosed in said patent and in the R. K. Ladisch Patent No. 2,674,025 dated April 6, 1954; or the nozzle under suitable heat conditions may melt-spray glass fibers with or without fillers, as disclosed in the R. G. H. Siu Patent No. 2,722,718 dated November 8, 1955. As soon as they are formed, the filaments are collected on a rotating funnel-shaped device and are twisted thereby to make a yarn of bulky or loose characteristics. In all cases the filaments have an initial curl imparted to them because of the swirling gas blast issuing from the conical nozzle. An important feature is the continued rotation of the free end of the yarn induced by the combined action of the spiraling gas blast and the funnel-shaped device, which insures a coherent yarn structure.

As disclosed in said Ladisch Patent No. 2,571,457, there are certain materials which when molten or in solution may form filaments of varying lengths and degrees of fineness: these materials are termed "filament-forming liquids." This category of materials includes any liquid capable of forming a fiber or a filament when permitted to fall freely as a stream through an elastic fluid, said liquid being generally limited to those materials which exhibit a transformation interval; such liquids will generally produce fibers or filaments having a substantially amorphous character immediately after the formation of said fibers or filaments. It is to be understood that such a liquid may be, but does not have to be, a pure substance; it may be a single molten material or a molten mixture, and may contain other ingredients such as solvents, plasticizers, or solid fillers. It may consist of any combination of the aforesaid or equivalent constituents. It is further to be understood that the expression "to fall freely as a stream" means that the material in liquid state is able to fall solely under the influence of gravity. The above-mentioned elastic fluid may be heated or cooled; it may be under a partial vacuum or under pressure; and in general, it will have those physical conditions which facilitate fiber or filament formation. The elastic fluid may be air, nitrogen, carbon dioxide, steam, a volatilized organic solvent, or any other gas or vapor or combination of gases and/or vapors which will facilitate the formation of fibers or filaments from such liquids

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falling freely as a stream through said gas or vapor. Among the materials useful for forming filaments are many artificial resins, such as cellulose propionate, polyamides of the nylon type, polystyrene, polyvinyl acetate, and cellulose acetate; also certain inorganic glasses of low melting point, as disclosed in the aforesaid R. G. H. Siu patent. Other "filament-forming liquids" are listed in Patent No. 2,571,457 but the filaments formed therefrom are of doubtful utility for making yarns of the type contemplated by this invention.

Further in accordance with the invention, two or more of said nozzles form two or more different types of filaments and these filaments are directed into the collector funnel and then twisted together as described above to form a novelty yarn.

In still another method contemplated by the invention, a single wire or yarn is fed axially through the central tube of the nozzle and down through the collecting funnel and its exit tube, while the freshly spun filaments are twisted and wrapped about the central or axial core formed by the single wire or yarn, the central core being unaffected by the spinning of the filaments or the gas blast or the rotating funnel-shaped device.

A modification of the apparatus encloses the nozzle and collector funnel in a single pressure system with the sole gas exit provided by the yarn exit tube leading from the collector funnel.

Yarn taken from the exit tube may be wound directly on cones or bobbins for subsequent standard processing. Covered yarns or wires may then be run through a softening solution or chamber or vessel containing a heated atmosphere to improve bonding between filaments while maintaining a high degree of flexibility in the protective or ornamental wrapping. Yarn from the exit tube may also be stretched by apparatus of a well known type, thereby to orient the micelles, followed by cooling and setting of the stretched yarns.

In the accompanying drawings showing diagrammatically apparatus which may be used to manufacture yarn in accordance with the invention—

Fig. 1 is a sectional view of one of the nozzles which may be used to form filaments which make up the improved yarn;

Fig. 2 is an elevation on a small scale of the nozzle of Fig. 1 operatively associated with a filament collector and yarn twister, showing the yarn issuing from the exit tube;

Fig. 3 is a side elevation on a large scale of the funnel-like filament collector and yarn twister;

Fig. 4 is a top plan view of the device of Fig. 3;

Fig. 5 is a detail in end elevation showing one of the flutes on the filament collector;

Fig. 6 is a plan view on a small scale showing how three different filaments spun by three nozzles may be collected and twisted to form a novelty yarn;

Fig. 7 is a side elevation of the parts shown in Fig. 6;

Fig. 8 is a sectional view showing a wire fed axially through the central tube of the nozzle together with a "polymer";

Fig. 9 is a sectional elevation showing the nozzle and collector funnel in a single pressure system;

Fig. 10 is an elevation of a known form of yarn-stretching apparatus; and

Fig. 11 is a slightly enlarged elevation of a yarn made from a polymer in accordance with the invention.

Referring first to Fig. 1, the nozzle 19 comprises a straight tube 20 through which the hereinafter defined "polymer" flows either by gravity or under low pressure, and a frusto-conical nozzle body 21 surrounding tube 20 so that the tube axis coincides with the axis of the nozzle body. Body 21 is hollow and has conical internal walls 22 and an open end 23. The discharge end of the axial tube 20 usually projects slightly beyond the open end 23 and

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is beveled as indicated at 24. The opposite end of tube 20 is to be connected with a vessel, pipe or conduit (not shown) feeding a supply of the "filament-forming liquid" as herein defined. A coupling 25 connects a gas supply pipe 26 to the nozzle. Usually the gas supplied to the nozzle will be compressed air but if a non-oxidizing gas must be used, nitrogen, helium, steam, carbon dioxide, or other gas or vapor may be employed; and such gas or vapor will be heated if the "polymer" is melt-sprayed. The gas enters the larger end of the nozzle through port 27, flowing under superatmospheric pressure in a tangential path and then in a contracting spiral path with constantly increasing velocity due to the decreasing diameter of the nozzle toward its discharge end, until finally it emerges as a spiral or whirling jet from the narrow annular space 23 between tube 20 and the open nozzle end. The parts are so arranged that the projecting beveled end 24 of tube 20 does not interfere with or deflect the flow of gas or vapor from the open end 23. The extent of projection of beveled end 24 may be varied by turning a nut 28 which is screw threaded on tube 20 and is swiveled on the end of nozzle 19. Beyond the discharge opening the gas or vapor continues to flow in a contracting spiral path at constantly increasing velocity until it reaches a point (marked "Vertex") which is the vertex of the cone of the internal walls 22. At this point theoretically the velocity becomes infinite, but actually, due to air friction and other causes, is a finite figure of high velocity reaching supersonic velocity, that is, higher than the velocity of sound in air at sea level. The "polymer" or other fluent mass or solution flows out of tube 20 to the "Vertex" and is there broken up into fine filaments, often having a diameter as small as one micron.

The term "polymer," as used above and elsewhere in this specification, denotes a single polymer or copolymer with or without a plasticizer and either molten or in solution at the moment of spraying, or a plurality of polymers and copolymers physically mixed and either molten or in solution, or a polymer mixed with a copolymer and either molten or in solution. Obviously the "polymer" must be such that it will not decompose under the conditions of heat and pressure necessary to form the filaments. Among the polymers and copolymers which may be used are: polystyrene, polydichlorostyrene, polyamides of the nylon type, polyacrylonitrile, polymethacrylonitrile, polymethyl methacrylate, polymethyl acrylate, polyvinylidene chloride, polyvinyl chloride, polyvinyl carbazole, polyvinyl alcohol, polymeric glycol, terephthalate, cellulose acetate, cellulose propionate, cellulose acetate butyrate, cellulose nitrate, ethyl cellulose, polyethylene, halogenated polyethylenes, polybutene, polyisobutylene, polyvinyl butyral, polyvinyl acetate, and silicones.

Where fillers are to be incorporated in the filaments, powdered solids are added in small amounts prior to feeding the "polymer" to the tube 20 of the nozzle. The solids may be powdered metal alloys, powdered metalloids such as selenium or tellurium, or powdered metal such as aluminum, copper, iron, nickel, cobalt and tin. In lieu of powdered metals or alloys, molten metals, molten metalloids or alloys if of low melting points may be added in small amounts to the molten "polymer." Also non-metallic powders such as silica gel and certain pigments may be added in small percentages. Due to the construction of the nozzle, no clogging takes place and relatively coarse powders of many diverse physical characteristics may be added, if they are sufficiently dry to flow through tube 20. The powder particles will be completely encased or enveloped by the polymeric filament envelopes, and if the particles are coarse and present in small proportions they will form pronounced bulges in the filaments, as disclosed in the aforesaid Ladisch Patent No. 2,571,457 and in Ladisch Patent No. 2,612,579.

Referring to Fig. 2, the nozzle 19 is shown as vertical and arranged directly over a funnel-like collector 30 having an exit tube 31, the axis of the collector and its

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exit tube coinciding with the axis of the conical walls 22, or in other words, the collector is directly below the discharge end of the nozzle and receives all the filaments F immediately after they are formed at the vertex. Conventional means to rotate the funnel-like collector on its vertical axis is shown, consisting of gear teeth 32 on the rim of the funnel-like collector, a pinion 33 meshing with gear teeth 32 to rotate the collector, a shaft 34 carrying the pinion, a pulley 35 driving shaft 34, a V-belt 36 driving said pulley, and a motor 37 driving the V-belt through reduction gear box 38, shaft 39 and pulley 40. Filaments F are indicated as forming just beyond the vertex, and after being twisted by the collector in a manner to be presently described, the filaments form a yarn Y which issues from the exit tube and passes through a guide 41 and traverse guide 42 on to a bobbin 43. As will be described later, yarn-stretching means may be used prior to collecting the yarn on said bobbin.

Now referring to Figs. 3 and 4, the funnel-shaped collector 30 has a plurality of straight, radially-disposed flutes 45 fixed to and upstanding from frusto-conical wall 46. As viewed in Fig. 4, the flutes look much like the spokes of a wheel, being equally spaced apart. These flutes have rounded upper surfaces 47, as shown in Fig. 5, and at their inner ends terminate short of the central passageway 48 leading to the exit tube 31, while their outer or upper ends terminate short of the circular rim or top edge of the collector. Portions of the flutes are reduced in width or tapered near their inner ends, as shown at 49, so as to provide guide slots 50 for facilitating movement of the filaments into passageway 48. The rotating collector 30 engages the filaments by means of its flutes and imparts a twist thereto to form a loose or bulky yarn, as indicated at Y. It will be understood that the filaments are thrown centrifugally against the fluted conical walls 46 of the funnel-shaped collector, and then tend to settle towards the mouth of the exit tube, forming a grouping to which a rotary motion is imparted because of flutes 45. At the start, the nozzle is operated momentarily and then shut off, and the ends of the filaments formed during the momentary operation are pulled through the exit tube and onto a pair of rollers or other feeding or collecting means. Nozzle operation being resumed, additional swirling filaments attach themselves to the yarn and are rotated or twisted by the combined action of the air or gas blast from the nozzle and the rotating flutes.

Turning to Figs. 6 and 7, an arrangement is shown of three nozzles 19a, 19b, 19c symmetrically disposed relative to the collector 30, toward the center of which the discharge ends of the nozzle are directed. Only the collector-driving pinion 33 and gear teeth 32 are shown, it being understood that the same driving mechanism shown in Fig. 2, or any other conventional mechanism, may be used. Air or gas is supplied under pressure to an annular header 51 and is distributed through pipes 52, 53, 54 to the several nozzles, with valves 55 to regulate the individual nozzle pressure to suit the different materials being fiberized. Three similar or different "polymers", or two "polymers" and molten glass, or two sources of molten glass and one "polymer" may be formed into filaments which are twisted together to make a yarn. Obviously more than three nozzles may be employed with a single collector thereby to combine more than three different filaments in one yarn, should this be desired. The "bottle-neck" in this instance is the exit tube 31, which must have sufficient capacity to discharge the yarn formed from the filaments; therefore the maximum number of the nozzles used will be determined by the diameter of the exit tube.

Now considering Fig. 8, the nozzle 19 has its material-feeding tube 20 modified in some way (not germane to the present invention) to permit the feeding axially through it of a wire 60 (or a continuous strand of yarn, not shown) while the filaments are formed in the manner

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already described, the filaments necessarily surrounding the wire or yarn as the latter passes through the Vertex on its way to the collector 30, see Fig. 2. The central wire or yarn forms a core which may have radically different physical characteristics from the filaments. The cored yarn so formed may be coated or impregnated or covered in a known manner to provide strands useful for various purposes. In the case of glass filaments which are twisted about a metallic wire, obviously the product could be completed by known methods to form a satisfactory conductor for electricity of low amperage.

A single pressure system is shown in Fig. 9, where a substantially closed compartment 65 surrounds the nozzle-collector assembly, the feed tube 20 being led through the top of the compartment and the gas supply pipe 26 coming in through a side wall. A conventional mechanism, unnecessary to describe in detail, rotates the funnel-like collector 30 so as to twist the filaments together to form a loose yarn Y. Below the exit tube 31 is a roller 66 which is to be considered as supported for rotation about a horizontal axis transverse to the compartment. Yarn Y is carried circumferentially one or more times about roller 66 and then runs down to and around a second roller 67 supported like roller 66. There may be some stretching of the yarn between rollers 66 and 67. From the second roller 67 the yarn extends down to a fixed guide 68 and extends through a guide 69 in the wall of the compartment outwardly to a feed roller 70, thence to a cap-spinning device 71 driven by a belt 72 or other source of power. The yarn may undergo further stretch between roller 67 and feed roller 70. A gas exit 73 at or near the bottom of the compartment provides the sole conduit or outlet for escape of the gas blown into the system through the gas supply pipe 26 (fixed guide 69 being of small dimensions so that scarcely any gas escapes at that point). If preferred, the gas flowing out of exit 73 may be piped to a container and reused. Such a system would be desirable if an expensive gas such as nitrogen were employed to obviate oxidation of the newly spun filaments.

Fig. 10 shows another arrangement for effecting stretching of the yarn after forming it in accordance with any of the described procedures, except the wire cored yarn process of Fig. 8. The apparatus diagrammed in Fig. 10 is known to the prior art and may be considered as used in place of the guide 41, traverse guide 42 and bobbin 43 of Fig. 2, or may be considered as substituted for the yarn-stretching devices of Fig. 9. Here the yarn Y passes through a tensioning device 75, around a positively driven feed roller 76, then about a separating roller 77 and back around feed roller 76 a number of times, the last yarn wrap being around roller 76 alone. The yarn is then passed several times around a positively driven drawing roller 79 (which rotates at a greater peripheral speed than feed roller 76) and its separating roller 80 (the last wrap being around roller 79) and finally goes through a guide 81 and a traverse guide 82 onto a bobbin 83. Where the yarn is nylon or of nylon-like characteristics, a snubbing pin similar to the one described and claimed in the Babcock patent No. 2,289,232 dated July 7, 1942 may be employed with the apparatus just described.

Adverting to Fig. 11, showing slightly enlarged a fragment of cellulose propionate yarn 85 made in accordance with the invention, it is seen that the yarn is bulky and characterized by a fuzzy appearance arising from a multiplicity of filament ends projecting in all directions throughout its length. Such a yarn could be woven or knitted by itself or added to wool yarn, and could also be twisted with wool, cotton, rayon and nylon, as well as other commercial yarns. It would be useful in making insulating fabrics suitable for overcoat linings, etc.

Referring again to Figs. 2, 6, 7 and 9, inasmuch as the flutes receive the swirling blast of air or other gas from the nozzle, I contemplate omitting the motor drive for the funnel-like collector and mounting said collector on

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ball bearings so that it is freely rotatable, and modifying the shape and disposition of the flutes so that they serve as vanes to rotate the collector by the energy of the air blast, while still serving as filament-twisting members. This modification is not shown but will be readily understood.

It is believed that those skilled in the art of making yarns and yarn-like strands will appreciate the many uses to which the products of the invention may be put, therefore no attempt will be made to describe such uses.

Having described my invention, what I claim is:

1. In combination, a nozzle having a connection with a supply of compressed gas and having a fluent material inlet and a discharge end and constructed and arranged to deliver a whirling blast of the gas flowing at supersonic velocity to a point outside of said discharge end so that the fluent material is disrupted at said point; a rotatable filament-collecting and yarn-forming member located just below said point and having a surface adapted to receive all the filaments formed by the action of the nozzle, said member having means mounted on its filament-receiving surface and engaging all the filaments so received and twisting them into a yarn, and an exit tube fixed to and extending out from the center of said member and receiving and discharging said yarn, said member being in the form of a funnel with flutes fixed to and upstanding from the upper frusto-conical face of the funnel, said flutes being spaced at their inner ends from the entrance to the exit tube and being arranged substantially radially relative to the axis of the exit tube.

2. In combination, a supply of compressed gas, a nozzle having a material-feeding tube and having interior frusto-conical walls surrounding the tube and providing a chamber, said chamber having a gas inlet at its larger end and a discharge opening at its smaller end, the feeding tube projecting slightly beyond said discharge opening, the parts being so constructed and arranged that the material fed through the feeding tube moves to the vertex of the cone of said walls, and the gas entering the inlet flows in a spiral path with constantly increasing velocity down to and through the discharge opening and finally reaches said vertex where it exerts a disrupting action on the material; and a rotatable filament-collecting member arranged with its axis in the axis of the nozzle and positioned just beyond the vertex and having a surface which receives the filaments; said filament-collecting member being in the form of a funnel with radially disposed filament-engaging flutes upstanding from the frusto-conical upper surface of the funnel and adapted to engage the filaments and twist them together as said member rotates; and yarn-discharging means on the filament-collecting member.

3. In combination, a filament-collecting and twisting member in the form of a funnel having an exit tube projecting downwardly and axially from the center of the funnel for discharging yarn formed from the twisted filaments, power-actuated means to effect rotation of said member about the axis of the exit tube, and a plurality of filament-forming nozzles located directly above the funnel and discharging filaments downwardly against the concave surface of the funnel; there being three nozzles symmetrically disposed above the filament-collecting member; each nozzle having independent feeding means for a molten mass or a solution capable of forming filaments, and also having gas supply means and an independent valve control for the gas supply means, each nozzle delivering a rotary converging blast of gas just outside the discharge end of the nozzle and reaching supersonic velocity at the point of convergence, thereby to break up the molten mass or solution to form filaments between the discharge end of the nozzle and the filament-collecting member.

4. A method of forming novelty yarns which comprises forming at least two groups of filaments from at least two filament-forming liquids of different character-

istics flowing as separate streams, the forming taking place because of the disrupting action of at least two spiraling blasts of gas surrounding the respective streams of filament-forming liquids and converging to separate vertexes; the spiraling blasts of gas reaching very high velocities at said vertexes and imparting to the multitude of nascent filaments a spiraling motion and a curly form; collecting the several groups of filaments on a conical rotating member whose concavity is directed upwardly and whose center has a discharge outlet and is below said vertexes and which member rotates about a substantially vertical axis in a direction conformable to the spiraling motion of the filaments; the rotation rate of said conical member being such as to twist the groups of filaments together; and conducting the twisted filaments as a single bulky yarn away from the discharge outlet of the conical rotating member.

5. A method of forming novelty yarns which comprises setting up a whirling conical blast of gas reaching a very high velocity at the vertex of the cone; causing a taut flexible core member to travel in its own length axially through said cone and toward and beyond said vertex; causing a filament-forming liquid to flow as a stream within the confines of said cone and toward said vertex, the conical blast of gas having sufficient kinetic energy to disrupt the stream to form a multitude of filaments having a spiral movement because of said blast of gas;

immediately twisting the filaments spirally about the moving core member in a direction conformable to the spiral motion of the filaments; and collecting the cored yarn so formed.

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