

Feb. 8, 1944.

W. POOL

2,340,985

PRODUCTION OF STAPLE FIBER YARNS AND LIKE PRODUCTS

Filed May 21, 1941

3 Sheets-Sheet 1

FIG. 1

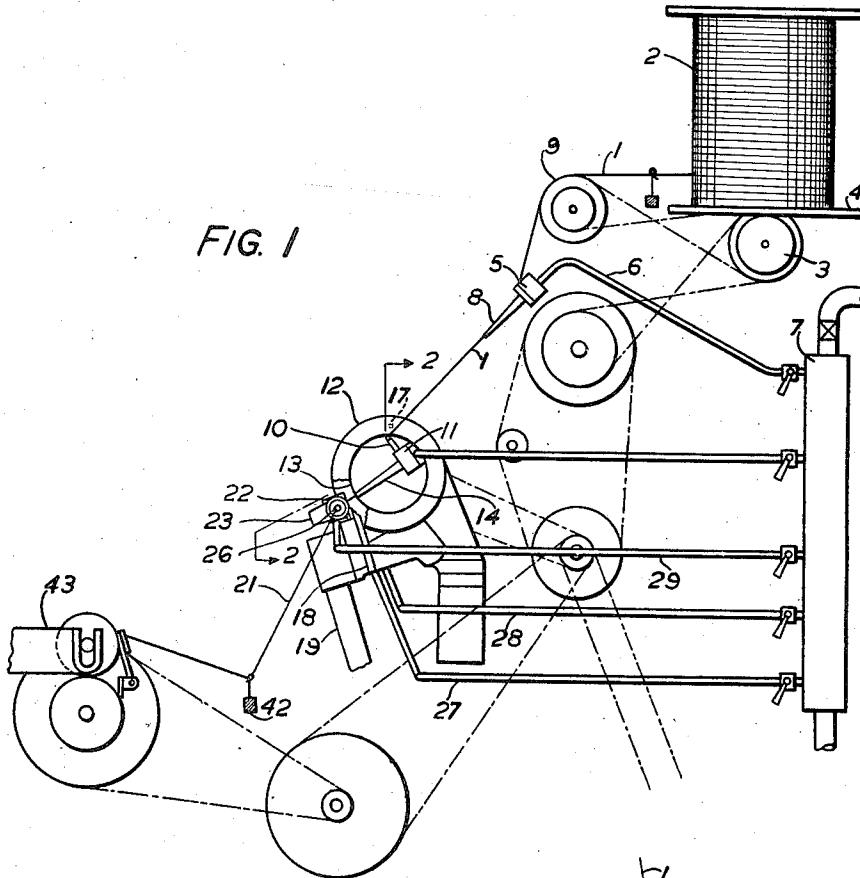
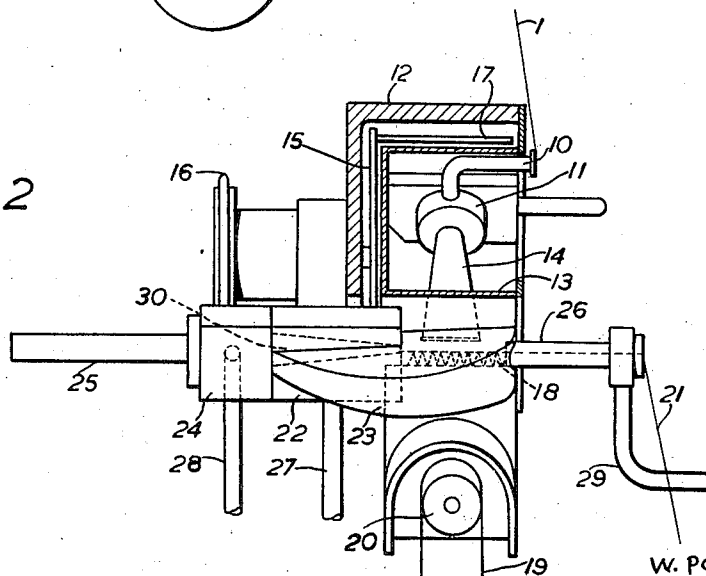


FIG. 2



W. POOL
INVENTOR
W. H. Pool
ATTORNEY

Feb. 8, 1944.

W. POOL

2,340,985

PRODUCTION OF STAPLE FIBER YARNS AND LIKE PRODUCTS

Filed May 21, 1941

3 Sheets-Sheet 3

FIG. 9

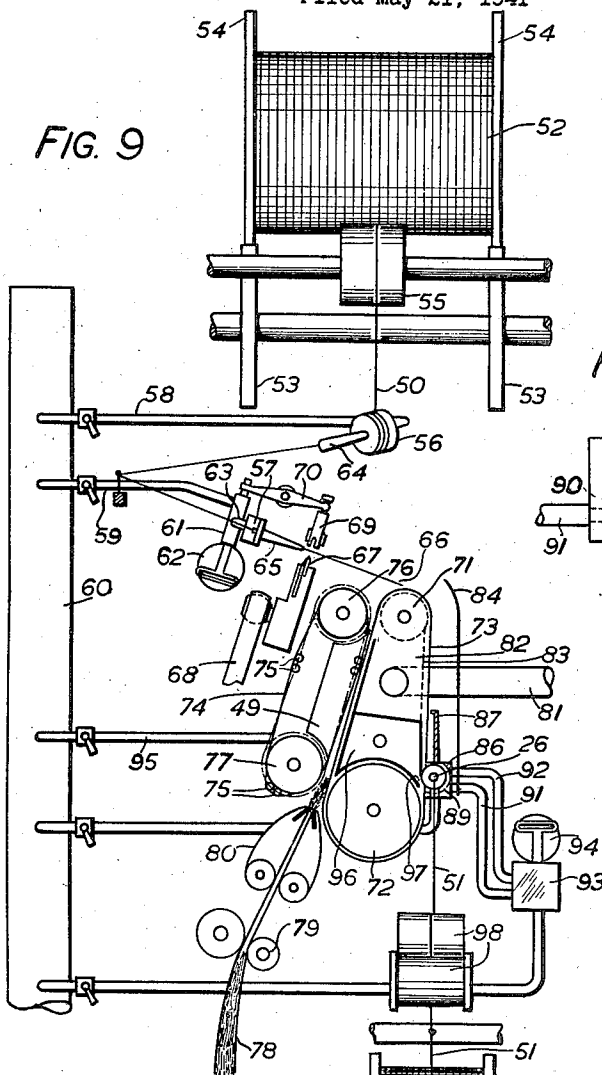


FIG. 11

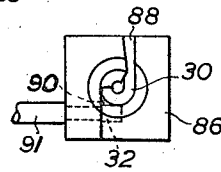
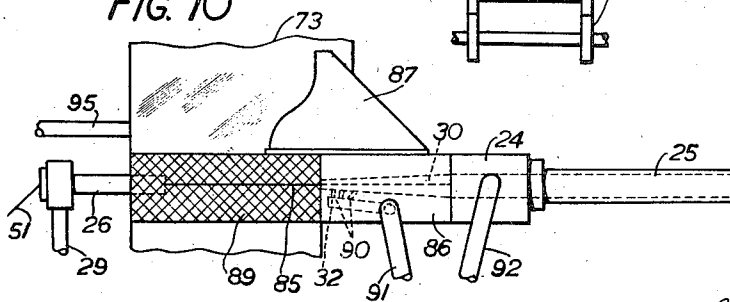


FIG. 10



W. POOL
INVENTOR

J. H. McLaughlin & Co.
ATTORNEYS

UNITED STATES PATENT OFFICE

2,340,985

PRODUCTION OF STAPLE FIBER YARNS
AND LIKE PRODUCTS

William Pool, Spondon, near Derby, England, assignor to Celanese Corporation of America, a corporation of Delaware
Application May 21, 1941, Serial No. 394,424

In Great Britain June 11, 1940

31 Claims. (Cl. 57—2)

This invention relates to the production of staple fiber yarns and like products, and is particularly concerned with the manufacture of staple fiber yarns and like products from continuous filaments.

U. S. Patents Nos. 2,227,911 and 2,258,661 describe methods for manufacturing staple fiber yarns or like products from continuous filaments, in which a succession of flat wide groups of separated fibers are fed to the tail of a staple fiber yarn being produced in a direction across the axis of said tail, said tail being rapidly rotated whereby the ends of the groups of fibers are taken up by said tail, the staple fiber yarn being formed being constantly built up at the tail by the addition, in this manner, of new groups of fibers, and being drawn away as fast as it is formed. In each of the two cases referred to, the tail of the staple fiber yarn being produced is rapidly rotated by applying to it a frictional torque, U. S. Patent No. 2,227,911, describing a method of applying such a torque by means of a rapidly rotating twist tube engaging the staple fiber yarn being produced near the end of the tail, and U. S. Patent No. 2,258,661 describing the rotation of the tail by means of a gaseous vortex induced about said tail as an axis of rotation. In each case the torque is applied at or close to the end of the tail, where the staple fiber yarn being produced is being built up by the addition of new fibers.

According to the present invention, a process for the manufacture of staple fiber yarns and like products comprises feeding a succession of flat wide groups of separated fibers to the tail of the staple fiber yarn being produced in a direction across the length of said tail, applying to said tail at a point at or near the end thereof, and at a second point removed from the end thereof frictional torques in opposite directions, to bring about rapid rotation of said tail, bringing an end of each group of fibers into engagement with said tail as it reaches said tail, whereby said groups of fibers are successively taken up by said tail to form a new tail, and continuously drawing away said staple fiber yarn as it is formed by the successive taking up of said groups of fibers. By these means a staple fiber product may be produced in which, while the appearance of any definite degree of twist in the product is obscured, the fibers are securely interlaced in a more complex fashion than is involved by a mere twisting together of the fibers.

The torque, which is applied in accordance with the invention at two points on the tail of the

staple fiber yarn being produced, is preferably applied at both points by inducing a gaseous vortex having said tail as its axis of rotation. If desired, however, other means may be employed for applying the torque at either or both of these points. For example the twist tube whose use is described in U. S. Patent No. 2,227,911 may be used at one or both points, and if at one point, preferably at the point removed from the end of the tail of the product.

The invention may be employed as a modification of any of the specific methods described in either of the specifications mentioned above. Thus for example the additional means described in U. S. Patent No. 2,258,661 for the mechanical separating of the flat wide groups of fibers may be employed in conjunction with the present invention, or again the means described in the same specification for the mixing of groups of additional fibers with the flat wide groups of separated fibers may be employed.

Two forms of apparatus according to the present invention will now be described in greater detail with reference to the accompanying drawings, in which

Figure 1 is a side elevation of one form of apparatus according to the invention;

Figure 2 is an enlarged front elevation, partly in section on the line 2—2 of Figure 1, of a part of the mechanism shown in Figure 1;

Figures 3 to 6 are detail views of the mechanism shown in Figures 1 and 2;

Figures 7 and 8 are a side elevation and a front elevation respectively showing a particular adaptation of the apparatus shown in Figures 1 to 6;

Figure 9 is a side elevation of a further form of apparatus according to the invention; and

Figures 10 and 11 are details of the apparatus shown in Figure 9.

Referring to Figures 1 and 2, in the apparatus shown therein a supply of continuous filament yarn 1 is drawn from a large package 2 which is rotated by means of a friction wheel 3 engaging with the under side of its lower flange 4 so as to control the rate of delivery of the continuous filament yarn 1. The yarn is drawn from the package 2, as fast as it is delivered, by means of an air ejector device 5, which is supplied with compressed air by means of a pipe 6 from a compressed air header 7 and delivers the filaments from a flat wide nozzle 8. On its way from the package 2 to the ejector device 5, the yarn 1 is drawn over a roller 9 surfaced with material suitably removed in the electrostatic series from

the substance of the filaments, the roller 9 being positively driven at a peripheral speed different from that of the filaments so as to make rubbing contact with them. The rubbing contact of the roller 9 has the effect of electrifying the continuous filaments 1, which assists the ejector device 5, with its flat jet 8, to separate the filaments from one another.

From the ejector device 5 the filaments proceed to a conduit 10 leading them to a second ejector device 11 similar in form to the ejector device 5 and also supplied with compressed air from the header 7. The ejector device 11 is contained in a round casing 12, being secured to the inner wall or lining 13 of the casing 12, and the flat nozzle 14 of the ejector device 11 extends just through said inner wall. Between the inner wall 13 and the outer casing 12 is disposed a disc 15 rotated by means of a sprocket 16 and carrying, at diametrically opposite points, two pins 17 lying in the annular space between the inner wall 13 and the outer casing 12 and adapted, during the rotation of the disc 15, to pass repeatedly across the mouth of the nozzle 14. The outer casing 12 is interrupted to accommodate a cutter 18 of the hair-clipper type which is continuously and rapidly driven by means of a belt 19 engaging with the driving pulley 20 of the cutter. The teeth of the cutter 18 are disposed just outside the range of the two pins 17, and each time the pins 17 pass the mouth of the nozzle 14 they deflect the continuous filaments emerging from the nozzle 14 into the teeth of the cutter 18, whereby the continuous filaments are periodically severed.

Just outside the teeth of the cutter 18 and parallel to the axis of the casing 12 is disposed the tail of the staple fiber yarn 21 being produced, together with the means provided according to the invention for applying frictional torques to said tail, one at a point near the end thereof and the other at a point removed from the end. These means comprise a vortex tube 22, a curved duct 23 associated with the vortex tube 22, a suction ejector 24 having a tail tube 25, and a twist control tube 26. These parts are shown separately in greater detail in Figures 3 to 6. Compressed air is supplied to the parts 22, 24 and 26 respectively by means of the pipes 27, 28 and 29 communicating with the compressed air header 7. As shown in Figures 3 to 6, the vortex tube 22 is in the form of a rectangular block containing a conical passage 30 along the whole length of which communicates V-sectioned passage 31, one side of the V being tangential to the conical passage along its whole length. In addition, there is a chamber 32 on the opposite side of the conical passage to the V-shaped passage 31, the chamber 32 being fed with compressed air by the pipe 27 and being connected to the conical passage by small passages 33, also tangential to the surface of the conical passage 30, and inclined towards the wider end thereof. The suction ejector 24 is in the form of a rectangular block spigoted to the rectangular block of the vortex tube 22 at the wide end of the conical passage 30. The feed pipe 28 communicates with an annular space 35 into which projects the end 36 of the tail pipe 25. Extending into the end 36 of the tail pipe 25 is a flared tube 37 forming a continuation of the conical passage 30 of the vortex tube 22. The compressed air entering through the pipe 28 enters the tail tube 25 by passing between the tubes 36, 37 and thereby induces suction in

the conical passage 30, and the air entering the conical passage through the passages 33 and through the V-sectioned passage 31 (in the latter case under the influence of the induced suction) forms a rapidly rotating vortex with an axial component in the direction of the tail pipe 25.

The air enters the V-shaped passage 31 through the curved duct 23, which is open only on the side opposite the nozzle 14 and the blades of the cutter 18. Thus the ends of the continuous filaments emerging from the nozzle 14 sweep round the curve of the duct 23 under the influence of the air. When a sufficient length of the filaments has emerged from the nozzle 14, the filaments are severed by being deflected into the blades of the knife 18 by the deflector pins 17. In addition, the freshly cut rear ends of the fibers so severed are brought into engagement with the tail of the yarn 21 being formed, which tail extends through the twist control tube 26, past the mouth of the curved duct 23 and into the conical passage 30 of the vortex tube 22. The tail of the yarn 21 is rapidly rotating so that the freshly cut and deflected ends of the fibers are entangled in the tail, while the leading ends of the fibers sweep sideways through the V-sectioned passage 31 into the conical passage 30, so forming a new tail to the yarn 21. The rapid rotation of the vortex in the tube 30 also twists the newly added fibers to form them into the yarn. The twist control tube 26 effects the rapid rotation of the part of the yarn 21 that receives the freshly cut fibers by applying a vortex of air rapidly rotating in the opposite direction to the vortex in the conical passage 30. For this purpose, as shown in Figure 6 the end of the tube 26 is surrounded by an annular space 39 supplied with compressed air through the pipe 29, the compressed air passing through oblique passages 40 through the wall of the tube 26 and substantially tangential thereto. The circumferential direction in which the passages 40 point is such as to induce a vortex rotating in the opposite direction to that in the conical passage 30. The yarn 21 emerging from the orifice 41 in the end of the twist control tube 26 proceeds to a stationary guide 42, and thence to a take up device 43 by means of which it is drawn away and collected at a constant linear speed.

In the operation of the device, the continuous filaments 1 are delivered at a constant rate, in terms of weight per unit time by the rotation of the package 2, the package 2 being of the kind described in U. S. Patent No. 2,224,923 in which the yarn varies in denier from the inside of the package to the outside so that by rotating the package at a constant annular speed the yarn is delivered therefrom at a constant rate in terms of weight. After passing over the electrifying roller 9 the filaments 1 are drawn through the ejector device 5 by means of which they receive a preliminary separation from one another, aided by the electrification induced by the roller 9. They then pass to the second ejector device 11 and emerge from the nozzle 14 thereof in the form of a flat wide band of separate filaments. The ends of the continuous filaments emerging from the nozzle 14 pass round the curved duct 23 and, when they reach an appropriate length, are severed by being deflected into the blades of the cutter 18 by one or other of the deflector pins 17. At the same time they are brought into contact with the rapidly rotating tail of the yarn 21 whereby the rear

ends of the fibers are entangled, while the leading ends are swept sideways through the V-sectioned passage 31 into the conical passage 30 to form a new tail to the yarn 21. The yarn 21 is being constantly drawn away by the take up device 43 so that the new tail, each time it is formed, is drawn forward into a position to receive further fibers to constitute a further new tail. The denier or count of the staple fiber yarn 21 produced depends directly on the constant rate of take-up imposed by the device 43, and the constant rate at which the delivery package 2 is rotated.

The apparatus described above is capable of working at very high speeds, and for this reason is suitable for the conversion into a staple fiber yarn of continuous artificial filaments continuously with their production. Figs. 7 and 8 show how the apparatus can be adapted for this purpose. The continuous filament yarns or bundles 1 are produced in a dry spinning apparatus indicated at 44, from which they are drawn by means of a series of constantly rotating godet rollers 45. From the rollers 45 the filaments proceed directly to the cutting devices, indicated at 12, which are driven by means of belts 46 from the rollers 45. Emerging from the twist control tubes 26 associated with the devices 12 the finished yarns 21 are collected on take-up devices 43 particularly adapted for high speed winding. The tail tubes 25 of the several devices 12 are all connected to a suction conduit 47 while the compressed air supply pipes 27, 28 and 29 feeding the devices 12 are connected to a header 48. As indicated in Fig. 8, the dry spinning apparatus 44 produces a number of bundles of filaments, each of which is dealt with by its own cutting device 12, the compactness of the whole device enabling the requisite number to be disposed side by side in front of the apparatus 44.

The apparatus shown in Figs. 9-11 is a modification of that described in U. S. Patent No. 2,258,661 for the production of a staple fiber product containing fibers cut from a bundle of continuous filaments in admixture with fibers from another source.

The continuous filaments 50 from which staple fibers are to be cut to form the basis of the staple fiber product 51 being produced are supplied from a large drum-like package 52 rotated at a constant angular speed, about a horizontal axis by two pairs of friction wheels 53 on which the flanges 54 of the package 52 rest. As in Fig. 1, the package 52, is of the kind formed by the method described in U. S. Patent No. 2,224,923 in which the yarn 50 varies in denier from the inside of the package to the outside so that by rotating the package at a constant angular speed the yarn is delivered therefrom at a constant rate in terms of weight per unit time. Leaving the package 52, the continuous filament yarn 50 is drawn in frictional contact with a roller 55 covered with a material such as rubber, gutta percha or the like, suitably removed in the electro-static series from the basic material of the filaments in the yarn 50. On leaving the roller 55 the yarn 50 passes in series through two ejector devices 56, 57, similar in form and function to the ejector devices 5, 11 of Fig 1 except that the device 57 is supplied with compressed air intermittently instead of continuously. Air is supplied by the pipes 58, 59 from the header 60, the pipe 59 passing through a valve 61 operated by means of a crank 62 and communicating with the ejector 57 by a pipe 63. The nozzles 64, 65 by which the

yarn 50 emerges from the ejector devices 56, 57 are of flat cross-section, so as to bring about the separation of the filaments into a flat wide band 66 this separation being assisted by the electrification of the filaments caused by drawing them in contact with the roller 55.

Emerging from the second ejector device 57 in the form of a flat and diverging band 66, the filaments pass over a constantly operated cutter 67 similar to the cutter 18 of Fig. 1, and driven by the band 68. The flat wide band of filaments 66 emerging from the second ejector device are pressed at uniform intervals into engagement with the cutter 67 by means of a deflector 69 operated by a rocker arm 70 whose other end is actuated by the crank 62, deflection occurring immediately after the opening of the valve 61.

Beyond the cutter 67 are disposed a pair of rollers 71, 72 disposed one above the other and carrying a band 73 of woven fabric, the left hand run of the band 73 engaging with a run of another band 74 mounted on rollers 76, 77, having a number of projecting "ribs" 75 formed on its surface and extending across its surface at intervals along its length. The bands 73, 74 are maintained close to one another by means of a cam plate 49 engaging the band 74. The rollers 71, 72, 76, 77 carrying the bands 73, 74 are driven so that the engaging runs of the two bands move upwards. Into the nip of the bands 73, 74 between the lower rollers 72, 77 is fed intermittently a sliver 78 of wool fibers, the sliver 78 being fed continuously by a high draft device 79, 80. The intermittent feed of the fibers between the bands 73, 74 is brought about by the intermittent firm contact of the ribs 75 of the band 74 against the band 73 at a point where the band 73 is firmly supported by its lower roller 72. As the result of this action, groups of wool fibers are pulled from the sliver 78 at intervals and pass up between the engaging runs of the two bands 73, 74.

The upper roller 71 carrying the fabric band 73 is perforated over the part of its periphery with which the band comes into contact, and suction is applied by means of a suction pipe 81 to a chamber 82 inside the band 73 and communicating with the roller 71. As a consequence of the suction, the wool fibers rising between two bands 73, 74 are caused to adhere, as the bands separate at the upper end of their run, to the fabric band 73. At the same time the leading ends, and subsequently the whole length of each group of fibers cut from the end 66 of the continuous filament yarn 50 are drawn down on the fabric band 73 over the wool fibers already adhering to the band. In this way the downward run of the fabric band 73 carries with it a distributed layer of mixed fibers, some of the fibers being wool fibers and the others being fibers cut from the continuous filament yarn. The wall 83 of the chamber 82 adjacent to the downward run of the band 73 is perforated, so that the suction applied within the chamber 82 prevents the fibers falling away from the downward run. A guard 84 is provided close to the downward run of the fabric band.

Close to the lower roller 72 carrying the fabric band 73, and parallel to the axis of the roller near the lower end of the downward run of the band, is the tail 85 of the staple fiber yarn 51 being produced, the end of the tail 85 extending as shown in Fig. 10 a short distance beyond the flat side, or end face, of the roller 72. The tail 85 protrudes into an assembly 86, 24, 25, 26, simi-

lar to the assembly 22, 23, 24, 25, 26 described with reference to Figs. 1-6. The vortex tube 86 differs from the vortex tube 22 of Fig. 3 in that, instead of the curved duct 23, a flat passage 87 is provided, open on the side adjacent to the band 73, and communicating with the V sectioned passage 88, which, as shown in Fig. 11, is narrower in section than the passage 31 of Figs. 3 and 6. In addition a curved gauze guard 89 is provided between the vortex tube 86 and the twist control tube 26. The suction applied to the wide end of the conical passage 30 in the vortex tube 86 is intermittent, being applied each time the leading ends of a group of cut fibers reach, and are taken up by, the tail 85 of the yarn 51, so that the trailing ends of said fibers are swept sideways through the flat passage 87 into the conical passage 30 and are held along its length by means of the suction. Small pipes 90 similar to the pipes 33 communicate tangentially with the conical passage 30, the pipes being inclined towards the wide end of the passage, and through these pipes compressed air is supplied by the pipe 91. Compressed air is supplied to the ejector device 24 by the pipe 92, the pipes 91 and 92 coming from a valve 93 intermittently opened by means of a crank 94 timed to open the valve each time the leading ends of a group of fibers reach the tail 85. Compressed air is also supplied from the header 60 by a pipe 95 to a chamber 96 adjacent to the chamber 82 and having a slit 97 through which blows a narrow stream of air, penetrating the fabric band 73 and causing the ends of each group of fibers to engage the tail 85. The yarn 51, as it is built up by the addition of successive groups of mixed fibers to its tail 85, is drawn away through the twist control tube 26 by means of nip rolls 98, and lead to a take up device 99 by means of which it is wound into a package 100.

The apparatus described above with reference to Figs. 9-11 may be used, in the manner described, for the production of yarn consisting throughout its length of a substantially uniform mixture of staple fibers cut from continuous filaments and other fibers, such as wool, or, by providing for an intermittent feed of either or both types of fiber, various effect yarns may be produced. Again, if desired, by discontinuing the feed of either type of fiber, a yarn consisting wholly of fibers of the other type may be produced.

In each of the forms of apparatus described above with reference to Figs. 1-11, the tail of the staple fiber yarn 21 or 51 being produced is held under tension against the pull of the take up devices by the axial components of the two vortices, and is rapidly rotated by the vortex in the twist control tube 26 near to the take-up device, the other vortex in the tube 22 or 86 acting to restrain the extreme end of the yarn from rotating in this direction, and even to rotate it, or at least the free fiber ends projecting from it, in the opposite direction. By reason of the fact that the fibers are twisted first in one direction and then in the other, any definite degree of twist in the resulting product is obscured. Nevertheless the fibers are securely interlaced with one another in a more complex fashion than a mere twisting together, and form a staple fiber product of great coherence. Moreover since the complex interlacing holds the fibers firmly into the yarn, the yarn may be given a loose structure rendering it suitable for the manufacture of fabrics such as blankets that are subjected to a raising or napping operation after weaving.

Having described my invention, what I desire to secure by Letters Patent is:

1. Process for the manufacture of staple fiber yarns and like products, said process comprising feeding a succession of flat wide groups of separated fibers to the tail of a staple fiber yarn being produced in a direction across the length of said tail, applying to said tail at a point close to the end thereof, and at a second point removed from the end thereof, frictional torques in opposite directions, to bring about rapid rotation of said tail, bringing an end of each group of fibers into engagement with said tail as said end reaches said tail, whereby said groups of fibers are successively taken up by said tail to form a new tail, and continuously drawing away said staple fiber yarn as it is formed by the successive taking up of said groups of fibers.

2. Process according to claim 1, comprising inducing a gaseous vortex about the tail of the staple fiber yarn being produced so as to apply a frictional torque to said tail near the end thereof.

3. Process according to claim 1, comprising momentarily inducing a gaseous vortex about the tail of the staple fiber yarn being produced each time a group of fibers is taken up by said tail so as to apply a frictional torque to said tail near the end thereof.

4. Process according to claim 1, comprising inducing two gaseous vortices rotating in opposite directions about the staple fiber yarn being produced, one near the end of said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail.

5. Process according to claim 1, comprising inducing two gaseous vortices, one intermittent and the other continuous, rotating in opposite directions about the staple fiber yarn being produced, the first of said vortices being applied near the end of said tail each time a group of fibers is taken up by said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail.

6. Process according to claim 1, comprising inducing a gaseous vortex about the tail of the staple fiber yarn being produced so as to apply a frictional torque to said tail near the end thereof, said vortex having an axial component in a direction contrary to that in which the staple fiber yarn being produced is drawn away.

7. Process according to claim 1, comprising inducing two gaseous vortices, one intermittent and the other continuous, rotating in opposite directions about the staple fiber yarn being produced, the first of said vortices being applied near the end of said tail each time a group of fibers is taken up by said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail, each of said gaseous vortices having an axial component in a direction contrary to that in which the staple fiber yarn being produced is drawn away.

8. Process according to claim 1, comprising feeding a bundle of continuous filaments in the form of a flat wide ribbon of separated filaments to the tail of the staple fiber yarn being produced, and repeatedly severing the filaments at the end of said bundle to form successive flat wide groups of separated fibers.

9. Process according to claim 1, comprising feeding a bundle of continuous filaments in the

form of a flat wide ribbon of separated filaments to the tail of the staple fiber yarn being produced, repeatedly severing the filaments at the end of said bundle to form successive flat wide groups of separated fibers and mixing, with said flat wide groups, preformed groups of fibers from another source.

10. Process according to claim 1, comprising feeding a bundle of continuous filaments in the form of a flat wide ribbon of separated filaments to the tail of the staple fiber yarn being produced and repeatedly severing the filaments at the end of said bundle to form successive flat wide groups of separated fibers, and inducing two gaseous vortices, one intermittent and the other continuous, rotating in opposite directions about the staple fiber yarn being produced, the first of said vortices being applied near the end of said tail each time a group of fibers is taken up by said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail, each of said gaseous vortices having an axial component in a direction contrary to that in which the staple fiber yarn being produced is drawn away.

11. Process according to claim 1, comprising feeding a bundle of continuous filaments in the form of a flat wide ribbon of separated filaments to the tail of the staple fiber yarn being produced, repeatedly severing the filaments at the end of said bundle to form successive flat wide groups of separated fibers mixing, with said flat wide groups, preformed groups of fibers from another source, inducing two gaseous vortices, one intermittent and the other continuous, rotating in opposite directions about the staple fiber yarn being produced, the first of said vortices being applied near the end of said tail each time a group of fibers is taken up by said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail, each of said gaseous vortices having an axial component in a direction contrary to that in which the staple fiber yarn being produced is drawn away.

12. Process according to claim 1, comprising feeding the fibers beyond the tail of the staple fiber yarn being produced and causing the trailing ends thereof to engage with said tail.

13. Process according to claim 1, wherein the leading ends of the groups of fibers are engaged with the tail of the staple fiber yarn being produced.

14. Process according to claim 1, comprising feeding a bundle of continuous filaments in the form of a flat wide ribbon of separated filaments to the tail of the staple fiber yarn being produced, repeatedly severing the filaments at the end of said bundle to form successive flat wide groups of separated fibers mixing, with said flat wide groups, preformed groups of fibers from another source, the ends of said flat wide groups and said preformed groups that are brought into engagement with said tail being the leading ends, inducing two gaseous vortices, one intermittent and the other continuous, rotating in opposite directions about the staple fiber yarn being produced, the first of said vortices being applied near the end of said tail each time a group of fibers is taken up by said tail and the other at a point removed from said end, so as to apply frictional torques in opposite directions to said tail each of said gaseous vortices having an axial component in a direction contrary to that in

which the staple fiber yarn being produced is drawn away.

15. Apparatus for the production of staple fiber yarn, said apparatus comprising means for feeding successive groups of fibers to the tail of a staple fiber yarn being produced in a direction across the length of said tail, means for applying to said tail, at a point close to the end thereof and a second point removed from the end thereof, frictional torques in opposite directions to bring about a rapid rotation of said tail, means for bringing an end of each group of fibers into engagement with said tail so that said groups of fibers are successively taken up on said tail by previously fed fibers, and means for continuously drawing away the staple fiber yarn as it is formed by the successive taking up of said groups of fibers.

16. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, and means for applying suction to the wide end of said conical passage so as to induce a gaseous vortex in said conical passage.

17. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said conical passage having a narrow slit communicating tangentially therewith over its whole length and narrow passages also communicating tangentially therewith, means for applying suction to the wide end of said conical passage so as to induce a gaseous vortex in said conical passage and means for supplying compressed air through said narrow passages to assist in inducing the vortex.

18. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, and means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage.

19. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said conical passage having a narrow slit communicating tangentially therewith over its whole length and narrow passages also communicating tangentially therewith, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage and means for intermittently supplying compressed air through said narrow passages to assist in inducing the vortex.

20. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for applying suction to the wide end of said conical passage so as to induce a gaseous vortex in said conical passage about the end of said tail, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages

pointing in such a direction as to induce in said tube a gaseous vortex rotating in the opposite direction to that in the conical passage of the vortex tube.

21. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex rotating in the opposite direction to that in the conical passage of the vortex tube.

22. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said conical passage having a narrow slit communicating tangentially therewith over its whole length and narrow passages also communicating tangentially therewith and pointing obliquely towards the wide end of said conical passage, means for applying suction to the wide end of said conical passage so as to induce a gaseous vortex in said conical passage and means for supplying compressed air through said narrow passages to assist in inducing the vortex.

23. Apparatus according to claim 15, comprising a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex having an axial component away from said conical passage and rotating in the opposite direction to that in the conical passage of the vortex tube.

24. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn and means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers.

25. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn, means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, and means for supplying a succession of preformed groups of fibers for admixture with the fibers cut from said continuous filament bundle.

26. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn, means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, a vortex tube having a conical passage into the narrow end of which the

tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex having an axial component away from said conical passage and rotating in the opposite direction to that in the conical passage of the vortex tube.

27. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn, means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, means for supplying a succession of preformed groups of fibers for admixture with the fibers cut from said continuous filament bundle, a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex having an axial component away from said conical passage and rotating in the opposite direction to that in the conical passage of the vortex tube.

28. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments beyond the tail of the staple fiber yarn, means in the neighborhood of said tail for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers and means for bringing the freshly cut ends of the fibers into engagement with said tail.

29. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments beyond the tail of the staple fiber yarn, means in the neighborhood of said tail for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, means for bringing the freshly cut ends of the fibers into engagement with said tail, a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex having an axial component away from said conical passage and rotating in the opposite direction to that in the conical passage of the vortex tube.

30. Apparatus according to claim 15, compris-

ing means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn, means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, said severing means being spaced from the said tail by at least a distance equal to the length of the staple fibers to be cut, and means for deflecting the leading ends of the cut staple fibers into engagement with said tail.

31. Apparatus according to claim 15, comprising means for feeding a bundle of continuous filaments to the tail of the staple fiber yarn, means for repeatedly severing the filaments at the end of said bundle to form a succession of groups of staple fibers, said severing means being spaced from the said tail by at least a distance equal to the length of the staple fibers to be cut, means for deflecting the leading ends of the cut staple fibers into engagement with said tail, means for supplying a succession of preformed

groups of fibers for admixture with the fibers cut from said continuous filament bundle, a vortex tube having a conical passage into the narrow end of which the tail of the staple fiber yarn may extend, said passage having a narrow slit communicating tangentially therewith over its whole length, means for intermittently applying suction to the wide end of said conical passage so as to induce an intermittent gaseous vortex in said conical passage, a tube adapted to surround the tail of the staple fiber yarn at a point removed from the end thereof and means for supplying compressed air through tangential passages in the wall of said tube, said passages pointing in such a direction as to induce in said tube a gaseous vortex having an axial component away from said conical passage and rotating in the opposite direction to that in the conical passage of the vortex tube.

WILLIAM POOL.