

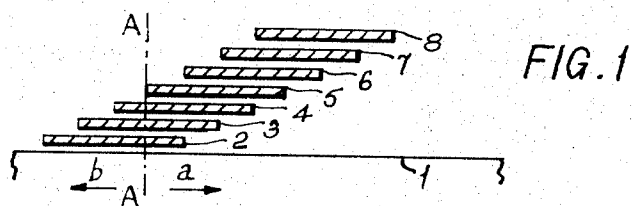
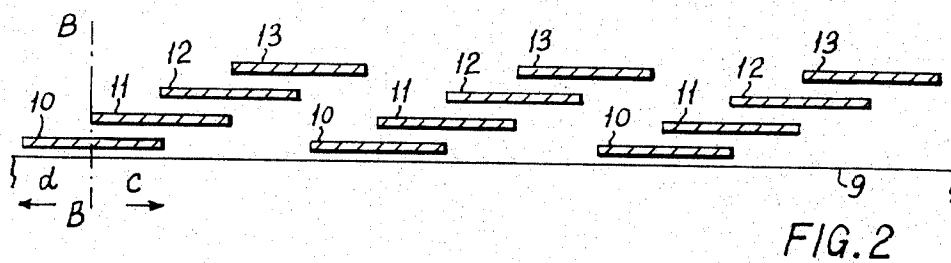
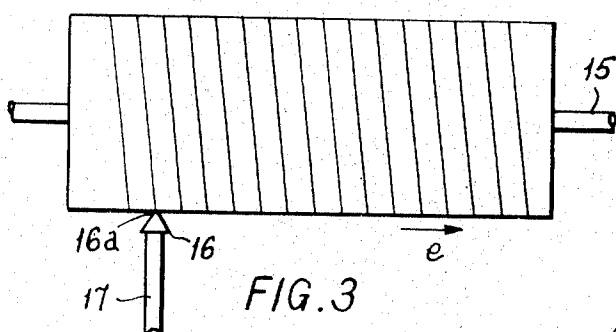
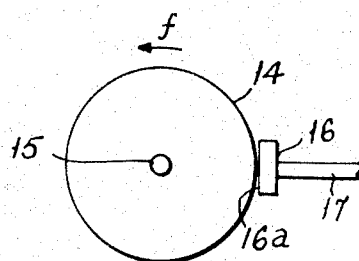
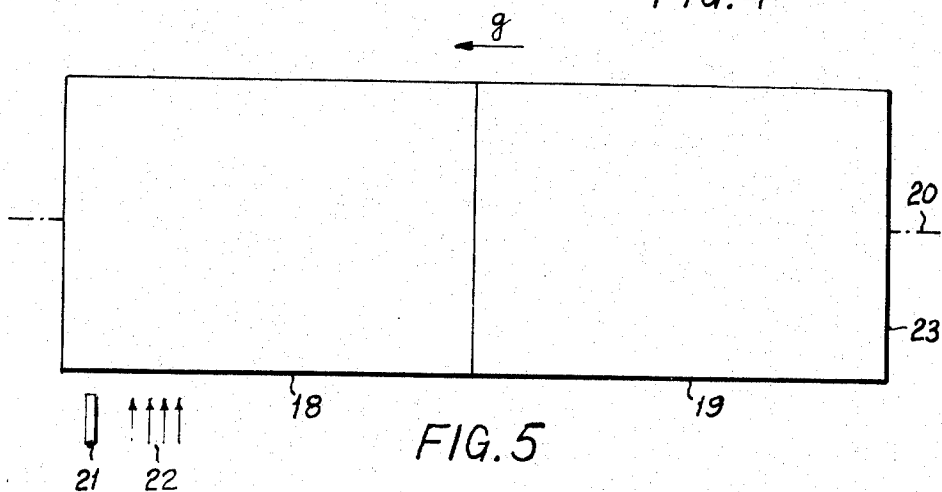
[54]	METHOD FOR MAKING CARBON FILAMENT TAPES	1,287,515	12/1918	Tew	156/174
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[58]	Field of Search	156/173, 181, 174			
[56]	References Cited				
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[57] ABSTRACT

A process for making a tape of filaments which comprises winding at least one bundle of filaments, for example carbon filaments, helically on a mandrel to produce a multilayer structure of filaments of even thickness, and helically cutting the filaments in the same sense as they are wound to produce a tape of filaments. Apparatus for performing the process is also described.

4 Claims, 5 Drawing Figures



METHOD FOR MAKING CARBON FILAMENT TAPES

This invention relates to a process and apparatus for making a tape of filaments.

The use of filaments to strengthen matrices is known, as exemplified by the use of carbon filaments to strengthen resin matrices. The accurate laying of filaments to make reinforced matrices is facilitated when the filaments are gathered together into a band of known width, which is usually referred to as a tape. Such a tape may have a width of from 1 cm. to 8 cm. or more and may comprise more than one bundle of filaments. It is desirable that the tape contains as few slits as possible, is of precise width, and has carefully machined edges. This is to facilitate the accurate laying up of tapes in making a reinforced matrix.

According to this invention, a process for making a tape of filaments comprises winding at least one bundle of filaments helically on a mandrel to produce a multilayer structure of filaments of even thickness, and helically cutting the filaments in the same sense as they are wound to produce a tape of filaments.

This process enables a tape to be made which is coherent and in which the edges are substantially straight. This is of particular advantage for making a tape of carbon filaments, which may be used to make precision engineering components.

Even thickness may be obtained by winding a bundle at a pitch such that the filaments in each circuit of the mandrel by the bundle partly overlap the filaments in the immediately preceding circuit. Or, it may be obtained by providing a first layer of filaments, by winding a bundle of filaments at a pitch so that there is no such overlap and winding one or more additional bundles in similar manner to provide one or more additional layers, so that the filaments in a particular layer overlap the filaments in the layer wound immediately preceding said particular layer.

In the wound, multilayer structure of filaments, it is preferred that the filaments are parallel to one another. However, the filaments in one layer may be aligned at an angle to the filaments in another layer; the tape produced from filaments so-wound is called a cross-ply tape.

An interfilament adhesive may be applied to the filaments and, if so, is preferably applied before the filaments are wound on the mandrel. The adhesive is to assist the handling of the tape.

The process may be used or the continuous production of tape in which case it is necessary to present the mandrel continuously to the bundles of filaments.

The invention also includes an apparatus for making a tape of filaments which comprises a rotatable mandrel, a cutter for helically cutting filaments wound on the mandrel, means for rotating the mandrel and means for causing relative movement in the direction of the longitudinal axis of the mandrel between the mandrel and the cutter.

The apparatus may be provided with a feed for supplying filaments for winding on the mandrel.

The mandrel may be movable relative to the cutter and may be adapted to be presented continuously to the cutter. For example, the mandrel may comprise a plurality of cylindrical drums mounted on a common axis, each drum, having been presented to the cutter, being relocatable relative to the other drum or drums

for further presentation to the cutter. This is to enable the apparatus to be used for making tape continuously.

The invention will now be described, by way of example only, with reference to the accompanying drawing, in which:

FIG. 1 is a diagrammatic representation of filaments wound in a first way,

FIG. 2 is a diagrammatic representation of filaments wound in a second way,

FIG. 3 is a diagrammatic plan of a first embodiment of apparatus according to the invention,

FIG. 4 is a side elevation corresponding to FIG. 3, and

FIG. 5 is a diagrammatic representation of an apparatus according to the invention for making tapes continuously.

Referring to FIG. 1, a continuous bundle of filaments is wound helically onto the surface 1 of a rotatable drum. Each circuit of the surface 1 by the filaments is indicated by a separate number, 2, 3, 4, 5, 6, 7, and 8, respectively. It can be seen that the filaments in each circuit overlap those in the immediately preceding circuit. Thus, those in the circuit 3 overlap those in the circuit 2 and so on.

Also, an even thickness of filaments is achieved after the circuit 4, i.e. to the side of the line A—A shown by the arrow *a*. Thus, in producing tape from filaments wound as illustrated, the filaments to the side of the line A—A shown by the arrow *b* are discarded.

It will, of course, be appreciated that FIG. 1 merely shows schematically the relative positions of the filaments and how even thickness is obtained. It does not illustrate the actual positions of the filaments on the drum surface which will evidently be different from those shown as the filaments settle on the drum surface.

Referring to FIG. 2, (which again is a purely schematic representation as in the case of FIG. 1), a continuous bundle 10 of filaments is wound helically onto the surface 9 of a rotatable drum so that each circuit does not overlap the immediately preceding circuit. A second continuous bundle 11 of filaments is wound over the first bundle 10 at the same pitch but commencing from a different point longitudinally of the drum surface 9. The procedure is repeated for each of two further bundles 12 and 13.

An even thickness of filaments is achieved to the side of the line B—B shown by the arrow *c*. Thus, in producing tape from filaments wound as illustrated, the filaments to the side of the line B—B shown by the arrow *d* are discarded.

Referring to FIGS. 3 and 4, a cylindrical drum 14 is mounted for rotation about its longitudinal axis on a shaft 15. The shaft 15 and drum 14 are rotatable together and are driven by a motor (not shown). A knife 16 having a straight cutting edge 16*a* is mounted adjacent the surface of the drum 14 so that the edge 16*a* is in near touching contact with the surface. The knife 16 is rigidly mounted on an arm 17 which has a drive (not shown) for causing it to effect a traversing motion in the direction of the longitudinal axis of the drum 14, i.e. a motion in the direction indicated by the arrow *e*.

In operation of the apparatus shown in FIGS. 3 and 4, a spread tow of carbon filaments, which have been impregnated with resin, is wound on the surface of the

drum 14 in the way described above with reference to FIG. 1. The cutting edge 16a of the knife 16 is aligned along the line of the filaments and the drum 14 is rotated in the direction indicated by the arrows f. Simultaneously, the arm 17 is caused to traverse in the direction indicated by the arrow e. Thus, the knife 16 follows a helical path over the surface of the drum 14 by virtue of the combination of its own traversing motion and the rotation of the drum 14. The cutting edge 16a cuts the wound filaments into tape which is collected on a spool (not shown). The speed of rotation of the drum 14 and the speed of traverse of the arm 17 are selected so that the filaments are cut at the same angle as they were wound.

Referring to FIG. 5, a first cylindrical drum 18 is mounted on a common axis 20 in relation to a second cylindrical drum 19 of similar dimensions so that their peripheral surfaces are substantially continuous. The two drums 18 and 19 are mounted so that they can be rotated together and so that they can be driven along their common axis 20 in the direction indicated by the arrow g. Positioned adjacent the first drum 18 are a tow cutting knife 21 and four tow feed heads 22. The knife 21 and the feed heads 22 are all stationary.

In operation of the apparatus illustrated in FIG. 5, the drums 18 and 19 are rotated about their common axis 20 and are simultaneously moved in the direction indicated by the arrow g. Parallel filaments obtained by spreading tow in an air spreader and to which an inter-filament adhesive has been applied are supplied to the surface of the drum 18 from each of the tow feed heads 22. Because of the motion and rotation of the drum 18, the filaments are wound helically. The speeds of motion and of rotation are selected to provide windings of such pitch that each circuit of the filaments about the drum 18 partly overlaps the immediately preceding circuit. The filaments which have been wound onto the drum 18 move with the drum 18 in the direction indicated by the arrow g and are then helically cut at the same pitch as they were wound by the knife 21. The cutting gives rise to a tape which may be collected, for

example, on a spool.

When the drum 18 has moved past the knife 21, it is relocated relative to the drum 19 so that it is positioned at the end 23 of the drum 19 opposite the end at which it was previously positioned. Meanwhile, the winding and cutting process described above is continued on the drum 19. When the second drum 19 has moved past the knife 21, it is relocated in a like manner. The process of relocation may be repeated for as many times as is desired, there being no break in the continuity of the winding and cutting operation.

What is claimed is:

1. A process for making a tape of carbon filaments comprising providing at least one bundle of carbon filaments, applying an inter-filament adhesive to the bundle of carbon filaments, winding the bundle of carbon filaments helically on a mandrel to produce a multi-layer structure of even thickness, and helically cutting the multi-layer structure parallel to the wound carbon filaments to produce a tape of carbon filaments.

2. A process according to claim 1 wherein the filaments are wound by winding a bundle of filaments at a pitch such that the filaments in each circuit of the mandrel by the bundle partly overlap the filaments in the immediately preceding circuit.

3. A process according to claim 1 wherein the filaments are wound by providing a first layer of filaments by winding a first bundle of filaments at a pitch such that there is no overlap between the filaments in each circuit of the mandrel by the bundle and the filaments in the immediately preceding circuit, and by providing one or more additional layers by winding one or more additional bundles of filaments at the same pitch as the first bundle, so that the filaments of a particular layer overlap the filaments in the layer wound immediately preceding said particular layer.

4. A process according to claim 1 wherein the mandrel is continuously presented to the bundles of filaments.

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