METHOD OF PRODUCING CATGUT THREADS AND STRINGS

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The present invention relates to a new method of producing threads, strings, or cords from animal raw materials, to be used as surgical thread, for stringing musical instruments or tennis rackets, and various other purposes.

This application is a continuation-in-part of my copending application Serial No. 441,869, filed July 7, 1954, now abandoned for Catgut.

Heretofore, violin strings and catgut threads have been obtained solely by combining strips of intestines in wet condition, this being accomplished by twisting together a plurality of individual (and wet) strips into the form of a string or thread. The formation of this wet string or thread is followed immediately by the drying of the string or thread. The drying operation causes sticking or, technically expressed, adhesion of the wet intestine strips to form a homogeneous thread.

The present invention is based upon an entirely new concept. It proposes to combine the single intestine strips not by drying and attendant adhesion of the raw material, but rather by uniting extremely fine prefabricated threads as such, i.e., without any subsequent drying and adhering thereof in the form of dry threads by braiding, winding or spinning. The known drying procedure used in the manufacture of strings or catgut threads is only applied in the present invention for the preparation of the prefabricated threads.

According to the prior art methods, the drying of the surgical threads was invariably affected after the twisting thereof. This inherently produced a considerable reduction in the cross section of the finished product. Since the properties of the different intestinal sections used for the preparation of the strips always vary to some extent and can not be determined in advance, it is impossible with the prior art methods to manufacture threads or strings having a definitely predetermined final cross section. However, in most cases, the user is only able to utilize strings or threads that possess very definite diameters. This cannot be accomplished with the prior art methods without waste. For example, if, in accordance with the prior art methods, it were desirable to produce a final catgut thread of No. 3 size (0.55 mm. diameter), it would be necessary to select a certain number of strips of raw materials having a combined width in the wet state which would most likely yield, after drying, a resulting thread possessing a diameter of the order of 0.53 mm. However, at the same time, there would be produced a large number of threads of No. 4 size (0.61 mm. diameter), i.e., of a size that is seldom used. It follows that, as the need for No. 3 threads becomes greater, the stockpile of No. 4 threads will increase accordingly without the necessary outlet therefor. This, in turn, results in a higher cost for the product which is in greater demand.

The above drawbacks are completely removed by the use of the present method of operation. As already mentioned, the threads and strings are not produced by twisting of moistened, i.e., intestine strips in not-dried state, but rather, it is contemplated to first twist and then separate thin strips into single prefabricated thin threads. These thin prefabricated single threads have an accurately predetermined diameter. Due to the fineness of these threads, fluctuations in the thread diameter are confined to very narrow ranges. The prefabricated threads are now twisted or braided into structures of predetermined diameters, whereby the desired diameter is arrived at in the simplest way, twisting together in the dry state a corresponding number of single threads having accurately known and unchangeable diameter. The conventional after-treatment of the final product by abrading and polishing, which was necessary to meet certain requirements of thread size and smoothness of the surgical catgut, can be dispensed with in the exercise of the present invention.

The threads prepared in accordance with this new method distinguish over the known products by their considerably increased flexibility, tensile strength and, above all, by their even and uniform diameter extending over the entire length of the thread. Moreover, due to the looser structure of the new catgut thread, the resorption thereof is enhanced in case of clinical use.

In contrast to the prior art methods, the present invention makes it possible to produce surgical threads of any suitable length by the application of an extremely simple mode of operation, without the occurrence of an undesired thickening of the thread. This is accomplished by knotting together the prefabricated single threads before the twisting or braiding thereof into the final catgut product. The small knots at the connecting points are barely noticeable in the end product.

According to some of the prior art methods, it is proposed in the manufacture of endless threads to knot the wet intestine strips to each other. This is obviously made very difficult in view of the slipperiness and extensibility of the intestine strips. Moreover, undesirable thickening of the threads takes place at the knotting points. In order to avoid this drawback, it has already been suggested to fasten the intestine strips to one another by rolling, splicing and pressing. However, these operations are not only tedious and relatively expensive, but are also incapable of producing threads of predetermined diameter. This is now possible in accordance with the present invention by knotting together prefabricated threads of known thickness and by combining the endless threads thus prepared.

It is an important object of this invention to cut strips of very slight thickness, in the order of 0.005 mm., and of narrow width, in the order of about 6 mm., from sheep intestines or other animal substance, such as tendons, skins or the like. Since the thickness of the intestine, etc., is generally non-uniform, each narrow ribbon or strip of material cut therefrom is twisted about the longitudinal axis of the strip, so as to produce a single thread of uniform diameter, which thread will not be affected by the small differences in thickness of the intestine, etc., from which the strip was cut originally.

It is another object of the invention to devise a method of producing a catgut of any desired length and thickness with a uniformity far superior to any similar product previously made.

Another object is a method of making such thread which is superior, especially for surgical purposes, because of its high degree of flexibility, its thickness, high tensile strength, and high absorptive qualities, and the facility of sterilizing the same.

The principal feature of the invention consists in making the catgut from fine prefabricated threads so as to form a rope or braid which may either be used in such a state or be coated by a covering of similar threads so as to reinforce their structure.

Further objects and the entire scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be under-
stood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

In the drawings:

Figure 1 shows a narrow ribbon cut from animal intestines, sinews, tendons, skin or the like, from which the individual threads are made accessible to the invention; Figure 4a is a side view of the ribbon shown in Figure 1, illustrating that the ribbon is of very small thickness; Figure 2 shows the step of twisting the narrow ribbon of Figure 1 on a longitudinal axis so as to produce a resulting thread of constant diameter; Figure 3 shows the step of attaching together a plurality of threads of the type illustrated in Figure 2; Figure 4 shows a thin plaited rope or cable with a core formed by the thread as shown in Figure 3; Figure 5 shows a rope-like catgut in which the outer covering is made similarly to that shown in Figure 4, but containing a core similar to that shown in Figure 3; Figure 6 shows a catgut similar to that illustrated in Figure 5, but with a differently braided covering; Figure 7 shows still another form of making the outer covering; Figure 8 illustrates the knotting or tying together of the individual threads shown in Figure 2.

Referring in detail to the drawings, the strips or ribbons 1, shown in Figure 1, are cut from sheep intestines or other animal substance, such as tendons, skins, or the like. The sheep intestine, for example, is preconditioned in the conventional manner by soaking the same in alkaline solution until the wet intestine weighs approximately three times as much as it would weigh in the dry condition.

The strips or ribbons 1 are then cut from the wet intestine in an essentially conventional manner by means of suitable slitting devices; however, these strips are cut so as to be considerably narrower in width than any similar strips heretofore employed for the purpose of the present invention. For example, an intestine having a diameter of 8 mm. and a circumference of about 25 mm. was divided longitudinally into four parts, furnishing strips of about 6 mm. width. The thickness of the wall of the intestine was determined to be about 0.003-0.007 mm., preferably 0.005 mm. when the intestine was in the dried state; thus the wet strips would be about 3 to 9 mm., preferably 6 mm. in width and slightly greater than 0.005 mm. in thickness.

Each of the individual strips 1, after having been cut and while still moist, is twisted about a longitudinal axis (on itself), so as to produce a resulting thread 2 of uniform diameter, as shown in Figure 2. The threads of Figure 2 are dried (in the twisted state) and may then be used to produce the various forms illustrated in Figures 3 to 7. Depending upon the lengths of the strips 2, formed as indicated above, it may be desirable to tie two or more threads together, so as to form a longer continuous thread; therefore, after being assorted, the threads are joined together by forming small knots 12, as shown in Figure 8. The thin threads may be wound in any suitable length on spools or bobbins or may be placed in suitable machines of the type known for making textiles.

As indicated above, the conventional threads and strings, known as "catgut," are manufactured by cutting individual strips, twisting a plurality of strips together and then drying the same to produce the final product. Depending upon the twisting and drying steps in the course of the manufacture result in dimensional changes, the size of the final product cannot be predetermined with any degree of accuracy. Thus, if it were desired to produce a quantity of size 3 threads in accordance with the prior art methods, a large proportion of size 4 threads would be produced at the same time. Of course, if there were no similar demand for size 4 threads, then the process would be wasteful or, at best, very inefficient.

The present invention, on the other hand, involves the formation of individual small threads of uniform diameter which are combined to form the catgut only after the individual threads have been dried. Thus, after drying, the threads shown in Figure 2, having a possible size range of 0.004 to 0.009 inch in diameter, may be very accurately assured as to size, if necessary; then, since the size of the catgut is also known, and, since there is no drying step involved to cause a dimensional change at a later stage, the individual threads may be combined by twisting or braiding, etc., a given number of threads to produce a resulting catgut thread of accurately predetermined size.

Figure 3 illustrates the feature of twisting a plurality of threads 2 as shown in Figure 2 (after drying) together to form an accurately predetermined size of catgut 3. Figure 4 shows the feature of forming a braided covering 5, fashioned from dried strips 1 or dried threads 2, around a core 4, similar to the combined threads 3 of Figure 2 shown in Figure 2.

Figure 5 shows a modification wherein the core 6 is the same as the single thread 2 of Figure 2 and wherein the covering 7 is substantially the same as the covering 5 of Figure 4.

Figure 6 shows a modification similar to that of Figure 5, wherein the inner core 8 is a single strand of thread, such as shown in Figure 2, and wherein the outer covering 9 is woven from threads, such as shown in Figure 2.

Figure 7 shows a modification similar to that of Figure 5, wherein the inner core 10 is a single strand of thread, such as is shown in Figure 2, and wherein the outer covering 11 is formed merely by spining or twisting a single thread, such as a thread 2, around the core.

The threads, strings, or cords made according to the invention have the following advantages over the catgut previously made:

The catgut of any type made according to prior methods, either in the form of threads, strings, or cords, was so stiff and inelastic that, for surgical purposes, it had first to be treated with a softening agent, for example, a watery alcohol or alcohol to which a special softener was added. Such softening agent, however, loosens the thread to such an extent that it causes the tensile strength of the catgut. The thread, string, or cord, made according to the invention, on the other hand, is so flexible that it can be used directly, i.e., without any pretreatment by a softening agent. Therefore, for storing it, in a manner so as to protect it from drying out, aliphatic or aromatic hydrocarbons may be used rather than alcoholic or other softening agents.

The tensile strength of the threads, strings, or cords, according to the invention is considerably higher than that of the catgut as previously made, for the reason that, in the present case, it includes the sum total of the tensile strength of the individual threads which are woven, braided or spun together. Furthermore, it is a fact well known in the art that, when a catgut, made according to prior methods, has a lower tensile strength per square millimeter than thin catgut. Hence, it follows that the threads, strings, or cords made according to the invention, may be used for the same purposes as the prior products without, however, being required to be of such thick diameter. Such reduction in material, obviously, also reduces the cost of the final product to a large extent. One of the most important particularly when the catgut is to be used for tennis rackets, musical instruments, and other technical purposes.

The sterilization of the former products for surgical purposes also entailed various other difficulties. The new product, however, because of its structure of individual fine threads, allows the chemical sterilizing agents to enter the inside thereof very easily and quickly and, thus,
insures the sterilization to be completely successful in every case. Finally, due to their greater tensile strength and flexibility, the threads according to the invention, when used for surgical purposes, insure a firmer and more reliable hold of the tissues of ligatures and sutures than those made with previous products, in spite of the fact that the individual threads are thinner. Also, the new structure of individual fine threads with thinner diameter, facilitates the penetration of the catgut by the blood corpuscles, causing the threads, after accomplishing their purpose to disintegrate and to be easily absorbed by the body.

I claim:

1. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of 0.003 to 0.007 mm. thickness, and 3 to 9 mm. width, of a moistened raw animal intestine, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, and combining several threads so as to reinforce each other.

2. A method according to claim 1, wherein said ribbons have a thickness of 0.005 mm.

3. A method according to claim 1, wherein said ribbons have a width of 6 mm.

4. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of a raw animal intestine, said intestine being preconditioned by soaking the same in alkaline solution, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, and twisting together several threads so as to reinforce each other.

5. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of a raw animal intestine, said intestine being preconditioned by soaking the same in alkaline solution, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, and braiding together several threads so as to reinforce each other.

6. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of a raw animal intestine, said intestine being preconditioned by soaking the same in alkaline solution, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, tying together a plurality of said threads to extend their length, and coating said threads with a covering of additional threads of the same material.

8. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of about 0.005 mm. thickness, and about 6 mm. width, of a moistened raw animal intestine, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, tying together a plurality of said threads to extend their length and spinning an additional fine thread of the same material around said first threads so as to reinforce the same.

9. A method of producing catgut threads and strings comprising the steps of first cutting moist narrow ribbons of about 0.005 mm. thickness, and about 6 mm. width, of a moistened raw animal intestine, twisting said moist ribbons and drying said twisted moist ribbons thereafter so as to form thin threads, tying together a plurality of said threads to extend their length and braiding several fine threads of the same material around said first threads so as to reinforce the same.

10. A method of producing catgut strings which comprises the steps of cutting moist narrow ribbons of about 0.005 mm. thickness, and about 6 mm. width, of a moistened raw animal intestine, twisting each of said moist ribbons upon itself, drying each of the so twisted moist ribbons to form individual thin threads, and combining several of said threads to produce a resulting catgut string.

11. A method of producing catgut strings which comprises the steps of cutting moist narrow ribbons of about 0.005 mm. thickness, and about 6 mm. width, of a moistened raw animal intestine, twisting each of said moist ribbons upon itself, drying each of the so twisted moist ribbons to form individual thin threads and twisting together a plurality of said threads so as to produce a resulting catgut string.

12. A method of producing catgut strings which comprises the steps of cutting moist narrow ribbons of about 0.005 mm. thickness, and about 6 mm. width, of a moistened raw animal intestine, twisting each of said moist ribbons upon itself, drying each of the so twisted moist ribbons to form individual thin threads and braiding together a plurality of said threads so as to produce a resulting catgut string.

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