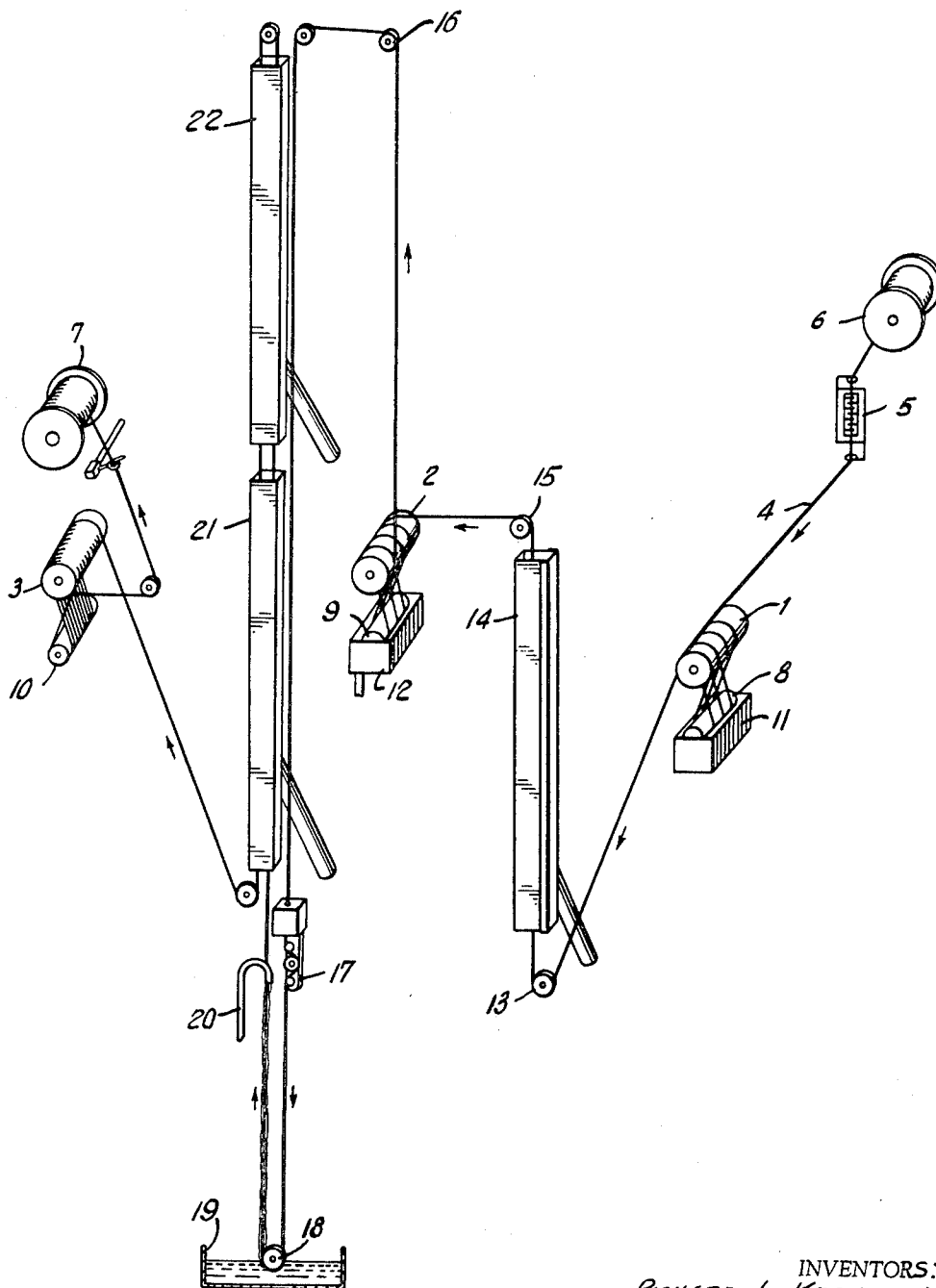


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PROCESS FOR IMPROVING THE KNOT STRENGTH OF AN
EXTRUDED COLLAGEN STRAND
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PROCESS FOR IMPROVING THE KNOT STRENGTH OF AN EXTRUDED COLLAGEN STRAND

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3 Claims

ABSTRACT OF THE DISCLOSURE

The knot strength and fray characteristics of an extruded collagen strand are improved by treating the collagen strand with dehydrated castor oil.

This invention relates to new and useful methods for improving the knot strength of extruded absorbable sutures and ligatures.

Absorbable sutures may be made by acid-swelling, extruding and reconstituting collagen in accordance with the procedure described in U.S. Patent No. 3,114,593. In this process a strand of the desired diameter is produced by combining a plurality of smaller collagen filaments which are twisted together while in the wet state and dried under tension. When wet, the individual lengths of collagen cohere to form a unitary structure that, in the dry state, remains bonded together by forces of cohesion.

Extruded collagen sutures of the type described above are extremely uniform in diameter and have a dry tensile strength (sterile) of about 2 to 4 grams per denier, and a wet tensile strength (sterile) of about 2 to 2.5 grams per denier. These values far exceed the minimum requirements of the U.S. Pharmacopeia. The knot strength of such extruded sutures is also excellent, averaging about 1.5 grams per denier for size 1/0 through 6/0.

Because an extruded suture is subjected to extreme tension and deformation at the knot, this is the area in which breakage is most likely to occur under the rigorous conditions of use. The knot, therefore, is the "weakest link" in a properly placed collagen suture as the tensile strength is lowest at that point.

It is an object of this invention, therefore, to treat collagen that has been acid-swollen, extruded and reconstituted to form a strand, whereby the fray characteristics and knot strength of the strand is improved.

It has now been discovered that the knot strength of an extruded collagen strand can be greatly improved by treating the collagen strand with dehydrated castor oil. When a solution containing from about 2% to 4% of dehydrated castor oil is used to surface coat the reconstituted collagen strand the finished suture is smoother, ties down better and has improved fray characteristics and knot strength.

Dehydrated castor oil may be applied from solution in an organic solvent such as hexane. Preferably, however, the dehydrated castor oil is applied as an oil in water emulsion. Such emulsions avoid the hazards of flammability and toxicity associated with volatile organic solvents.

The invention will be readily understood from the following detailed description when taken in connection with the drawing which illustrates apparatus that may be used for continuously treating a reconstituted collagen strand with dehydrated castor oil. Throughout the specification and claims all quantities are expressed in parts by weight unless otherwise indicated.

EXAMPLE I

A collagen tape containing 195 individual filaments, obtained by the indirect spinning process as described at

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column 20 of U.S. Patent No. 3,114,593 is treated with a solution of dehydrated castor oil to improve the knot strength of the final strand. The general sequence of operations is illustrated by the drawing.

The apparatus illustrated has three driven godets 1, 2 and 3 which transport the collagen tape 4 under the tension applied by the tensioning device 5 from the creel 6 to the take-up reel 7. Below each driven godet are auxiliary rollers 8, 9 and 10. The time that the moving collagen strand is in contact with the treating solutions 11 and 12 may be controlled by the speed of the driven godets 1 and 2 and the number of times the strand passes around these driven godets and their associated auxiliary rollers.

The moving collagen tape from the creel 6 is passed through an aqueous tanning solution 11 containing 1.2% of Cr_2O_3 , 0.3% pyrogallol, and 0.2% formaldehyde. The pH of this bath is 3.2 and the contact time is one minute.

The tape from the godet 1 passes around the idler pulley 13 and through the drying tube 14. While moving through this tube the tanned tape is subjected to a temperature of 100° F. for 50 seconds.

The tanned and dried tape passes over the idler pulley 15 and is immersed in an aqueous solution containing a surface active agent, i.e. an alkyl aryl polyether alcohol and water. The wet tape next passes over the idler pulley 16 and is twisted by the false twister 17 which rotates at 450 r.p.m. The twist backs up to the pulley 23, and as the wet collagen tape emerges from it, a gradual tapering effect takes place which rounds out the strand. The false twister is positioned at such a distance from the idler pulley 23 that the twist remains in the tape for two minutes. During this time the wringing action caused during the formation of the twist effectively dries the strand and bonds together the tape surfaces.

The twist is cancelled from the round and bonded strand as it passes between the false twister 17 and the idler pulley 18 which is immersed in the bath 19. This bath contains a solution of 4% dehydrated castor oil and 0.02% cobalt octoate in hexane. This solution contacts the moving collagen strand and is continuously added to the bath from the jet 20, flowing downwardly in a direction opposite to the direction in which the collagen strand is moving.

The collagen strand after it has been treated with dehydrated castor oil passes twice through the tubes 21 and 22 where it is dried under tension. The temperature within these drying tubes is maintained at 175°–195° F. and the dwell time of the moving collagen strand within the tubes is one minute and 40 seconds. The finished strand is taken up on the godet 3 and collected on the take-up reel 7. The speed of the driven godets 1, 2 and 3 is so adjusted that there is a 10% stretch between the godet 1 and the godet 3.

The dry knot strength of the collagen strand so obtained (size 2/0) is 5.3 pounds. This value may be compared with a dry knot strength of 3.8 pounds that is obtained when a collagen strand is prepared under the conditions described above omitting the treatment with dehydrated castor oil in the container 19.

Example II

Reconstituted collagen strands can be coated with dehydrated castor oil emulsions prepared from a variety of materials to obtain the improved knot strength described above. Stable dehydrated castor oil in water emulsions may be prepared with such emulsifying agents as polyvinyl alcohol (partly acetylated), gelatin, casein or carboxymethyl cellulose.

The improvement in the knot strength of the size 2/0 extruded collagen strand obtained by the process described in Example I above using aqueous emulsions of dehy-

drated castor oil is apparent from the following table which summarizes the data from a number of experiments in which only the emulsion added to the container 19 through the jet 20 is changed.

TABLE 1

Coating emulsion composition in container 19			Dry knot tensile strength, pounds
Dehydrated castor oil	Cobalt octoate	Continuous aqueous phase	
4%	0.03%	0.5% gelatin.....	5.61
4%	0.03%	1.0% gelatin.....	5.61
4%	0.03%	2.0% gelatin.....	4.9
4%	0.03%	0.5% polyvinyl alcohol.....	5.51
4%	0.03%	1.5% polyvinyl alcohol.....	4.90
4%	0.03%	0.5% gelatin plus 0.5% carboxymethyl cellulose.	5.3
None	None	None.....	4.3

From the experiments summarized in the above table, it will be apparent that the knot strength of an extruded collagen strand may be improved by treating the strand with dehydrated castor oil. The surface coating of dried dehydrated castor oil, by analysis, amounts to about 0.1% to about 0.2% of the weight of the collagen suture.

What is claimed is:

1. In the manufacture of collagen sutures by extruding a dispersion of acid-swollen collagen fibrils into a coagulating bath, the improvement which comprises immersing the collagen strand so obtained in a solution of dehydrated castor oil and drying the coated collagen strand under tensions; whereby the knot strength of the strand is improved.

2. In the manufacture of collagen sutures by extruding a dispersion of acid-swollen collagen fibrils into a coagulating bath, the improvement which comprises continuously moving the collagen strand so obtained through a solution of dehydrated castor oil and continuously drying the coated collagen strand under tension; whereby the knot strength of the strand is improved.

3. In the manufacture of collagen sutures by extruding a dispersion of acid-swollen collagen fibrils into a coagulating bath, the improvement which comprises continuously moving the collagen strand through an aqueous emulsion of dehydrated castor oil and drying the coated collagen strand under tension; whereby the knot strength is improved.

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8—94.22, 127.5; 106—252; 117—141, 167; 128—335.5;
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