Feb. 14, 1956 J. NICHOLS ET AL 2,734,507

COTTON SUTURES AND LIGATURES

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Fig. 1.

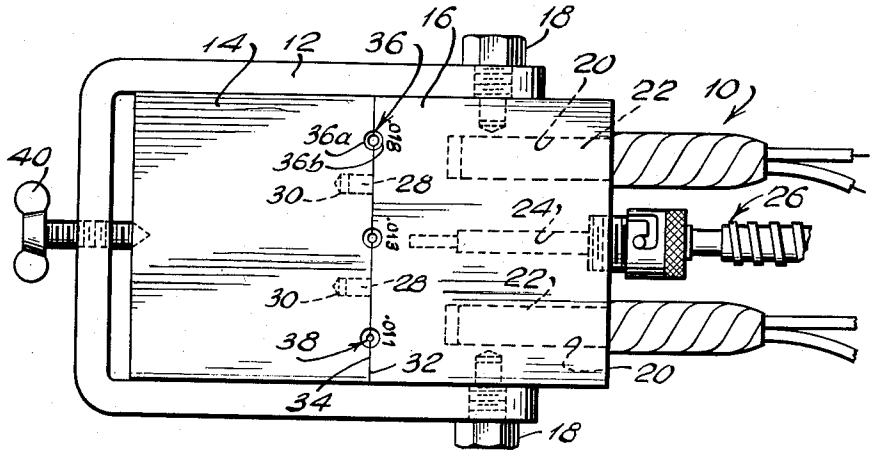


Fig. 2.

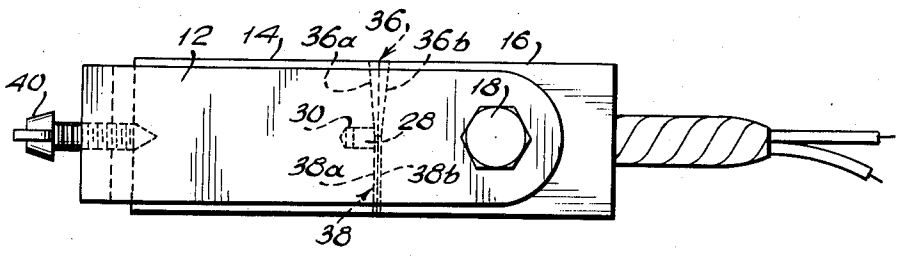
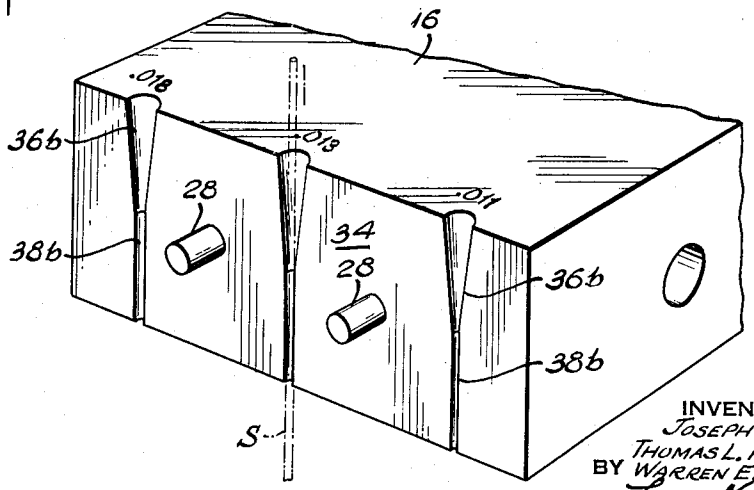


Fig. 3.



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COTTON SUTURES AND LIGATURES

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13 Claims. (Cl. 128—335.5)

The present invention relates to impregnated cotton suture strands for surgical purposes and to a method of impregnating cotton threads or strands with a polymeric substance.

Cotton threads, made by twisting four cord strands and treating with a mixture of an oil and starch, have been used as suturing and ligating material for many years. The coating of cotton strands with a mixture of an oil and starch provides improved fiber-bonding and renders the strands superior to untreated cotton in properties of hand, stiffness, and appearance. Untreated strands have the undesirable properties of fuzzing and brooming of the ends to a marked degree and this makes needle threading difficult; whereas, coating of cotton strands with a mixture of oil and starch somewhat reduces the properties of fuzzing and brooming. Although cotton suture strands treated with a mixture of an oil and starch have been used for many years and have achieved acceptance by the surgical profession, it has been recognized that there are inherent and serious disadvantages in such cotton sutures. Aside from the still present fuzzing and brooming of the conventional cotton suture strands, a further disadvantage is that such strands become extremely limp when wet and knot-tying by the surgeon is very difficult. Cotton suture strands treated with a mixture of an oil and starch still have the tendency to fuzz and broom to such an extent that the attachment of such strands to channel or drilled surgical needles is impractical on a commercial basis. When an untreated cotton suture strand which has been imbedded in tissue comes in contact with bacteria the strand may become a nidus of infection. The exposed end of an imbedded cotton suture may act as a wick to carry the infection to the tissue because of its capillarity. The practice of treating cotton suture strands with a mixture of an oil and starch has also been adopted as a means of reducing capillarity.

It is a general object of the invention to provide cotton sutures and ligatures which are impregnated with a polymeric substance and do not have the disadvantages and shortcomings inherent in untreated cotton sutures or cotton sutures treated with a mixture of oil and starch.

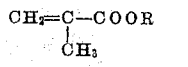
It is a specific object of this invention to reduce the capillarity of cotton sutures by impregnation with a polymeric substance.

A more specific object of this invention is to provide cotton sutures and ligatures which are impregnated with a polymeric substance, that are non-brooming, have high tensile strength, sufficient stiffness to facilitate the tying of knots, particularly when the strands are wet, and good knot-holding properties.

It has now been discovered that the object of this invention may be accomplished, in general, by the impregnation of cotton threads with a polymeric substance belonging to the class of polymers of methacrylic acid esters and copolymers of at least two different esters of methacrylic acid. More specifically, in the practice of

this invention, cotton thread consisting of a twisted four cord strand, wound loosely on an open spindle type spool, is placed in a chamber which is then evacuated and preferably evacuated to a pressure of not greater than 1 mm. of mercury. A solution of the impregnating resin is then introduced into the chamber in an amount sufficient to completely immerse the spool. After a short period of immersion under vacuum conditions, the vacuum is released and pressure in the chamber is allowed to come to atmospheric. The thread is stripped of excess impregnating solution and drawn through a pre-heat chamber and then through an aperture in a die maintained at a temperature of about 250° C. to 300° C. It is preferred that the aperture in the die have a diameter not exceeding by two mils the diameter of the cotton thread or strand. Passage of the heated impregnated cotton strand through the aperture of the heated die forces the melted resin into the taut strand and removes substantially all of any solvent still remaining. The strand is finally heated to set the resin and remove all traces of residual solvent by passing it, as it comes through the aperture of the heated die, through baking chambers in which the temperature is preferably maintained at 130° C. to 150° C.

Polymers of methacrylic acid esters having the following formula



in which R is an alkyl radical having from three to six carbon atoms and copolymers of at least two different esters of methacrylic acid in which R in each ester is an alkyl radical having not more than 12 carbon atoms and in which the average number of carbon atoms in the R groups of the copolymers is within the range of three to six, have been found suitable for use as impregnants for surgical cotton. The preferred polymeric substance is a copolymer of normal butyl methacrylate and normal hexyl methacrylate in which the ratio of the butyl to the hexyl ester is approximately three to one.

The amount of the polymeric substance impregnating the cotton thread or strand may be from five to twenty per cent by weight but it is preferred that the amount be twelve to sixteen per cent by weight.

An advantage of the surgical cotton threads or strands prepared according to this invention is that they may be repeatedly flexed without cracking and have a slight tackiness which facilitates knotting and provides good knot-holding properties to the strand. A decided advantage of the surgical cotton threads or strands prepared according to this invention is that the wetted strands have sufficient stiffness to enable the surgeon to tie knots with facility and rapidity. The method of this invention for impregnating the cotton strands or threads provides for an even distribution of the polymeric substance around the fibers of the thread and the polymeric substance is not stripped off or exuded when the thread is knotted. The thread treated with the polymeric substance does not broom when cut with a reasonably sharp instrument because the cotton fibers are firmly fixed together and the strand may be cut to a point to facilitate needle threading. Impregnation of surgical cotton threads or strands with the polymeric substance effects bonding of the cotton fibers and at the same time imparts strength to the fibers and results in improved tensile strength of the cotton threads or strands in general. Surgical cotton strands or threads impregnated with the polymeric substance have increased resistance to wetting and water penetration and a minimum of capillary action when the strand is imbedded in body tissue and in contact with tissue fluids.

Any conventional method of polymerization may be used in the preparation of the polymers or copolymers of an ester or esters of methacrylic acid but emulsion polymerization has been found particularly suitable. The following example is given to illustrate the preparation of a polymeric substance by emulsion polymerization.

Example I

Four thousand grams of distilled water, 50 grams of sodium lauryl sulfate and 40 grams of benzoyl peroxide were thoroughly agitated in a 12-liter round bottom flask fitted with a stirrer, dropping funnel, thermometer, heating mantle, reflux condenser, and nitrogen inlet tube. The mixture was purged of oxygen and maintained under an oxygen-free atmosphere by means of a continuous flow of nitrogen during the course of the reaction. A mixture of 1500 grams of monomeric n-butyl methacrylate and 500 grams of monomeric n-hexyl methacrylate, from which any hydroquinone present as an inhibitor had been removed by washing with a 25 per cent sodium carbonate—1 per cent sodium hydroxide aqueous solution, was slowly introduced into the reaction flask from the delivery cylinder with a simultaneous application of heat to the reaction flask. By the time of completion of addition of the mixture of monomers the temperature of the reaction flask was 50° C. and agitation of the reaction mixture was continued for five hours while the temperature was maintained at 50° C. After completion of the copolymerization, the entire reaction mixture was poured into twice its volume of methanol at room temperature and this resulted in the coagulation of the copolymer. The spongy coagulated copolymer was squeezed dry and extracted three times in boiling methanol. The copolymer was then thoroughly dried, pulverized and dissolved in an amount of hot toluene such that the solution contained seven per cent of solids. The solution has a kinetic viscosity as measured by the method of Gardner-Holdt at 25° C. of 4.8 stokes.

A solution of the polymeric substance in an organic solvent is used for the impregnation of surgical cotton strands. Any organic solvent in which the polymeric substance is sufficiently soluble to provide a solution having a kinetic viscosity in the range of 0.005 to 10 stokes is suitable and such organic solvents, in addition to toluene, include xylene, acetone, ethyl acetate, methyl ethyl ketone and a liquid hydrocarbon such as high flash naphtha and mixtures thereof. It is preferred that the concentration of polymeric substance in the organic solvent be about seven per cent by weight and that the absolute viscosity of the solution, as determined by the Gardner Bubble viscometer at 25° C., be about 4.80 poises.

An impregnating solution containing the polymeric substance having a kinetic viscosity in the range of 0.005 to 10 stokes may be used in the impregnation of surgical cotton strands or threads according to the method of this invention, but it is preferred that the kinetic viscosity be within the range of from 2 to 6 stokes.

The following specific example illustrates the preferred method of impregnating surgical cotton strands or threads but it is not intended that the invention be construed as strictly limited to the method of the following example.

Example II

A twisted four cord surgical cotton strand having a diameter of 11.4 mils was wound loosely on an open spindle type of spool and placed in a two-piece resin flask fitted with a long-stem separatory funnel and a vacuum take-off in such a manner that the tip of the separatory funnel extended down into the open core of the spool. The impregnating chamber was evacuated to a pressure of 0.1 to 0.5 mm. of mercury and then

the vacuum take-off was closed and the seven per cent toluene solution of the polymeric substance, prepared according to Example I, was introduced into the chamber. The vacuum take-off was released to the atmosphere a few seconds after the introduction of the impregnating solution into the chamber. The impregnated cotton strand was drawn from the flask and passed through a wire loop to remove excess impregnating solution and to prevent the impregnating solution from beading along the strand, and then drawn through a vertical pre-heating column open at both ends and heated to a temperature of 200° C. During the passage of the cotton strand through the pre-heating column, the polymeric substance became semi-fluid and a substantial amount of the toluene was removed. Immediately after the impregnated strand had passed through the pre-heating column, it was drawn through a funnel-shaped aperture in a stainless steel block about one inch in thickness, which was maintained at a temperature of 270° C. The strand entered the aperture at the side having the larger diameter, 38 mils and emerged from the aperture at the side having the smaller diameter, 13.0 mils.

The die block illustrated in the drawing has been found suitable for use in the impregnation of cotton suture strands and in the drawing:

Figure 1 is a top view of the die block;

Figure 2 is a side view of the die block; and

Figure 3 is an enlarged drawing of a portion of one-half of the die block showing the shape of the apertures and the passage of a cotton suture strand through an aperture.

The die block, generally shown at **10**, is composed of two halves, a front half **14** and a rear half **16**; which are held together by a U-shaped holding member **12** attached to the rear half of die block **16** by bolts **18**. The front half of die block **14** is firmly held against the rear half of die block **16** by screw **40** and the two halves of the die block are maintained in proper position by centering and locking pegs **28** which are integral with the rear half of the die block **16**. The pegs are set into holes **30** in the front half of the die block **14**. By these means, the two halves of the die block are held tightly together such that edge **32** of the rear half of die block **16** and edge **34** of the front half of die block **14** are pressed firmly together. The die block is heated by two heating units **22**, which are inserted in heating unit wells **20** in the rear half of die block **16**. The temperature of the die block is determined by means of thermo-couple **26**, which is inserted in thermo-couple well **24** in the rear half of the die block. As shown in the drawing, and particularly in Figure 3, the die block contains three apertures having a funnel shape for about one-half of their length **36**. The measurements .018, .013, and .011 on Figures 1 and 3 represent the diameters of adjacent apertures at their narrowest part **38**. The narrow part extends about one-half the length of the apertures and begins where the funnel part ends. As illustrated in Figure 3, the cotton suture strand S, is pulled in the direction of the arrow so that it emerges from the aperture at its narrowest part, that is, the part represented by the diameters shown in the figures. The die block illustrated in the figures is constructed so that one-half of the aperture is in each half of the die block; the one-half of the aperture **36***a* is in the front half of die block **14**, and the other half of the aperture **36***b* is in the rear half of die block **16**, the corresponding half of the aperture **38***a* is in the front half of the die block **14**, and the other half of the aperture **38***b* is in the rear half of the die block **16**.

An aperture having the shape of a funnel for about one-half its length has been found particularly effective in impregnating a cotton suture strand because when a cotton suture strand is passed through the funnel shaped portion and then through the narrowest portion, the impregnating polymeric substance has been found to more thoroughly

permeate and intimately contact the individual fibers of the strand.

Passage through the heated die block had the effect of more thoroughly impregnating the cotton strand by forcing the resin uniformly throughout the body of the strand and giving a smooth surface and a uniform diameter to the impregnated strand. It is preferred that the aperture in the die block be wider at the intake side than at the outgoing side and be funnel shaped over at least part of its length and that the diameter of the aperture at its narrowest point be about one mil greater than the average diameter of the cotton strand before impregnation.

After the impregnated strand was passed through the aperture in the die block, it was passed through a baking column maintained at 130° C. to 150° C. and wound on a spool. After passage through the baking columns the impregnated strand was completely free from solvent. The speed with which the cotton was passed through the preheating columns, the aperture in the die block, and the baking column was six feet per minute. The speed with which a cotton strand may be impregnated varies for different sizes or strands or threads and with the temperature of the baking column. Smaller sizes of cotton strands may be processed at a faster rate than larger sizes because solvent evaporation from the former is faster.

The impregnated strand contained 15.1 per cent by weight of the polymeric substance and had a diameter of 12.9 mils, a dry knot tensile strength of 4.34 pounds and a wet knot tensile strength of 4.92 pounds. The impregnated strand had a good hand and stiffness when wet or dry and did not broom when cut with a sharp instrument. A twisted four knot cotton strand of the same diameter as the strand treated according to the above process but treated with a mixture of an oil and starch had a dry knot tensile strength of 4.06 pounds and a wet knot tensile strength of 4.82 pounds.

The linear speed with which the cotton strand is passed through the pre-heating column, the die block aperture and the baking column is related to the temperature to which the strand is subjected therein. At higher temperatures the speed is greater and if the temperatures are reduced the speed is reduced correspondingly.

Examples III to VIII illustrate the preparation of six different polymeric substances. In these examples the method of polymerization was that of Example I except for the materials and amount used and specific reaction conditions which are given for each example.

Example III

	Grams
Methyl ester of methacrylic acid	33.3
Normal-hexyl ester of methacrylic acid	66.7
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for four hours at 70° C. Six, nine, and twelve per cent solutions of the polymeric substance in toluene had kinetic viscosities at 25° C. of 0.03, 0.18, and 0.41 stoke, respectively.

Example IV

	Grams
Ethyl ester of methacrylic acid	40.0
Normal-hexyl ester of methacrylic acid	60.0
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for two hours at 75° C. Six, nine, and twelve per cent solutions of the polymeric substances in toluene had kinetic viscosities at 25° C. of 0.10, 0.18, and 0.27 stoke, respectively.

Example V

	Grams
Methyl ester of methacrylic acid	50.0
Normal-octyl ester of methacrylic acid	50.0
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for two hours at 80° C. Six, nine, and twelve per cent solutions of the polymeric substance in toluene had kinetic viscosities at 25° C. of 0.27, 1.12, and 3.1 stokes, respectively.

Example VI

	Grams
Methyl ester of methacrylic acid	66.7
Normal-lauryl ester of methacrylic acid	33.3
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for three hours at 80° C. Six, nine, and twelve per cent solutions of the polymeric substance in toluene had kinetic viscosities at 25° C. of 0.03, 0.10, and 0.18 stoke, respectively.

Example VII

	Grams
Ethyl ester of methacrylic acid	60.0
Normal-octyl ester of methacrylic acid	40.0
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for three hours at 75° C. Six, nine, and twelve per cent solutions of the polymeric substances in toluene had kinetic viscosities at 25° C. of 0.18, 0.41, and 0.92 stoke, respectively.

Example VIII

	Grams
Normal-hexyl ester of methacrylic acid	100.0
Water	200.0
Sodium lauryl sulfate	2.5
Benzoyl peroxide	1.0

The reaction was continued for two hours at 75° C. Six, nine, and twelve per cent solutions of the polymeric substance in toluene had kinetic viscosities at 25° C. of 0.41, 1.32, and 3.30 stokes respectively.

Example IX

A twisted four cord strand having a diameter of 11.4 mils was impregnated with a nine per cent toluene solution of the polymeric substances prepared according to Examples III, IV, VI, and VII by the impregnation method of Example II. The following table gives the characteristics of the impregnated cotton suture strands:

Polymeric Substance From Example	Percent Wt. Polymeric Substance	Tensile Strength		Tensile Strength after autoclaving	
		Dry Knot (lbs.)	Wet Knot (lbs.)	Dry Knot (lbs.)	Wet Knot (lbs.)
III	11.8	4.29	4.58	4.60	4.26
IV	15.2	4.38	4.44	4.28	4.71
VI	17.7	4.33	4.35	4.34	4.89
VII	11.1	4.55	4.48	4.39	4.96

A twisted four knot cotton strand of the same diameter as the strand treated according to the above process but treated with a mixture of an oil and starch had dry knot and wet knot tensile strengths of 4.06 and 4.83 pounds, respectively, and after autoclaving, dry knot and wet knot tensile strengths of 4.34 and 4.50 pounds, respectively.

All of the impregnated suture strands prepared according to this example had good hand, and stiffness both when wet and dry, and did not broom when cut with a sharp instrument.

Example X

A four cord twisted cotton strand having a diameter of 8.2 mils was impregnated with a seven per cent toluene solution of the resin prepared according to Example I and was impregnated according to the process of Example II. The impregnated strand had a diameter of 10.9 mils, and a resin content of 16.5 per cent by weight. The dry knot and wet knot strength of the impregnated strand was 3.48 pounds and 3.79 pounds, respectively. A twisted four cord strand of the same diameter and treated with a mixture of an oil and starch had dry knot and wet knot strengths of 3.20 pounds and 3.68 pounds, respectively.

The impregnated cotton strand had a good hand and stiffness, both when wet and dry, and did not broom when cut with a sharp instrument. The wet impregnated strand had excellent knot-tying properties.

Although in the practice of this invention, it is preferred that cotton suture strands be impregnated according to the method illustrated in Example II, it has been found that satisfactory impregnated cotton suture strands may be generally made by contacting the strand with a solution of the polymeric substances listed above as suitable impregnating materials, followed by the removal of excess solution and air-drying at elevated temperatures and for a sufficient period of time to remove all of the volatile solvent. Such a means of impregnation may be repeated as many times as necessary in order that a sufficient amount of the polymeric substance may be impregnated into the strand.

After the cotton suture strands have been impregnated they may be cut into required lengths, wound onto reels or into small coils and placed in glass tubes or other suitable receptacles which may then be sealed and heat sterilized at 155° C. for one hour. The autoclave method of sterilizing strands not hermetically sealed in containers may also be employed. Repeated sterilization by the autoclave method of impregnating cotton surgical strands prepared according to the above examples significantly decreases the wet and dry knot-tying strengths.

Although the invention has been described with a certain degree of particularity and with specific reference to certain embodiments with respect to methods of impregnation, sterilization and so forth, it is understood that it is not to be limited thereto, but it is to be construed broadly and restricted solely by the scope of the claims.

What is claimed is:

1. A substantially noncapillary cotton suture comprising a cotton suture strand coated with polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six.

2. A substantially noncapillary cotton suture comprising a cotton suture strand coated with five to twenty per cent by weight of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six.

3. A substantially noncapillary cotton suture comprising a cotton suture strand coated with twelve to sixteen per cent by weight of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six.

4. A substantially noncapillary cotton suture comprising a cotton suture strand coated with a copolymer of butyl methacrylate and hexyl methacrylate in which the ratio of the normal butyl to the normal hexyl ester is approximately three to one.

5. A substantially noncapillary cotton suture comprising a cotton suture strand coated with five to twenty per cent by weight of a copolymer of normal butyl methacrylate and normal hexyl methacrylate in which the ratio of the normal butyl to the normal hexyl ester is approximately three to one.

6. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at reduced pressure with a solution in an organic solvent of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent; and passing the strand through a heated die, whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed.

7. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at reduced pressure with a solution in an organic solvent of a polymeric substance, the solution having a kinetic viscosity within the range of 0.005 to 10 stokes, the polymeric substance being selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent; and passing the strand through a heated die, whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed.

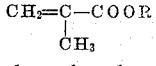
8. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton suture strand at a pressure not greater than 1 mm. of mercury with a solution in an organic solvent of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula

$$CH_2=C(CH_3)-COOR$$

in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms,

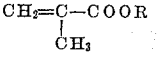
and when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent; and passing the strand through a heated die, whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed.

9. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at reduced pressure with a toluene solution of the polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula



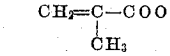
in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent, and passing the strand through a die maintained at a temperature of from 250° C. to 300° C. whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all solvent is removed.

10. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at reduced pressure with a solution in an organic solvent of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula



in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent; passing the strand through a heated die, whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed; and heating the strand to a temperature of from 130° C. to 150° C. whereby the solvent is completely removed from the strand.

11. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at reduced pressure with a solution in an organic solvent of a polymeric substance selected from the class consisting of polymers and copolymers of methacrylic acid esters of the general formula



in which, when the polymeric substance is a polymer, R is an alkyl radical having three to six carbon atoms and, when the polymeric substance is a copolymer, R is an alkyl radical having not more than twelve carbon atoms and an average number of carbon atoms within the range of three to six; heating the strand to remove a major amount of the solvent; passing the strand through a die maintained at a temperature of about 250° C. to 300° C. whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed; and heating the strand to a temperature of from 130° C. to 150° C. whereby all the remaining solvent is removed from the strand.

12. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at a pressure not greater than 1 mm. of mercury with a solution in an organic solvent, of a copolymer of normal butyl methacrylate and normal hexyl methacrylate in which the ratio of normal butyl to normal hexyl ester is approximately three to one, heating the strand to remove a major amount of the solvent; and passing the strand through a die maintained at a temperature of about 250° C. to 300° C., whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed.

13. A method of making a substantially noncapillary cotton suture which includes the following steps: contacting a cotton strand at a pressure not greater than 1 mm. of mercury with a toluene solution of a copolymer of normal butyl methacrylate and normal hexyl methacrylate in which the ratio of normal butyl to normal hexyl ester is approximately three to one and in which the kinetic viscosity of the toluene solution is within the range of 0.005 to 10 stokes; heating the strand to remove a major amount of the solvent; passing the strand through a die maintained at a temperature of from 250° C. to 300° C., whereby the polymeric substance is made fluid and becomes evenly distributed throughout and coated on the strand and substantially all the solvent is removed; and heating the strand to a temperature within the range of 130° C. to 150° C. whereby all remaining solvent is removed from the strand.

No references cited.