Dec. 24, 1957 N. M. SULLIVAN 2,817,339

RIGID FASCIAL SUTURE

Filed Aug. 10, 1953 2 Sheets-Sheet 1

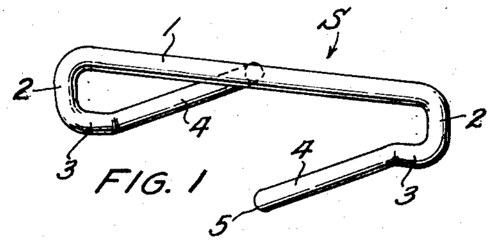

FIG. 1

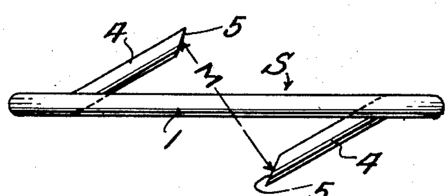

FIG. 2

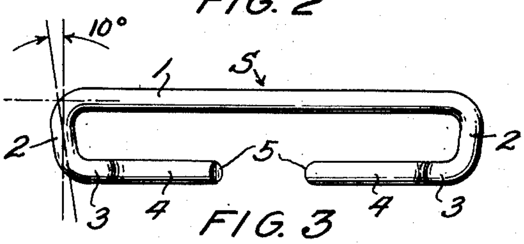

FIG. 3

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RIGID FASCIAL SUTURE

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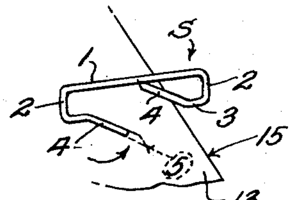

FIG. 4

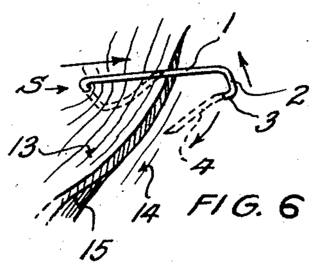

FIG. 6

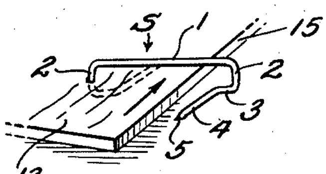

FIG. 5

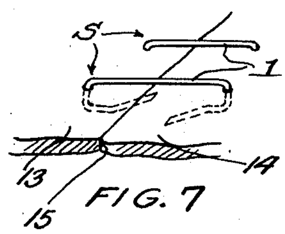

FIG. 7

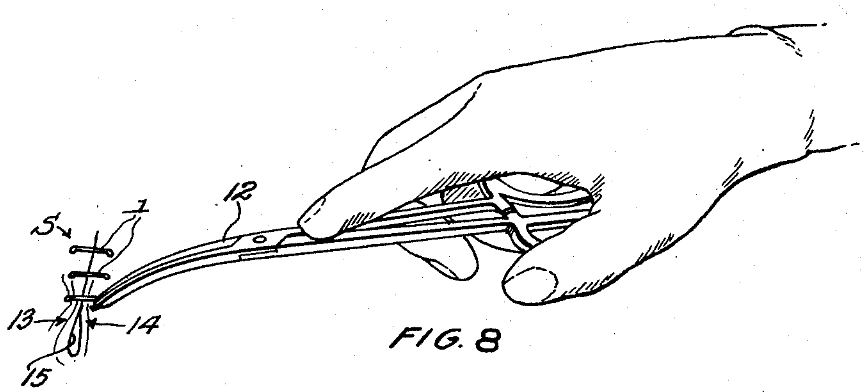

FIG. 8

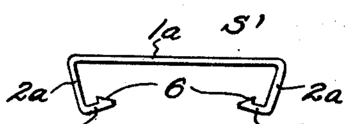

FIG. 9

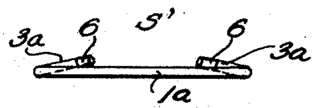

FIG. 10

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RIGID FASCIAL SUTURE

Norman M. Sullivan, Cincinnati, Ohio

Application August 10, 1953, Serial No. 373,168

7 Claims. (Cl. 128—334)

This invention relates to surgical sutures and, more particularly, to an improved preformed metallic suture adapted for employment by surgeons and others in the closure of incisions and other wounds.

Various freely flexible materials are now and have been used by surgeons in the closing of wounds and incisions, such materials consisting commonly of silk, cotton, catgut, and metal. All these sutures have required the use of tissue-penetrating needles to draw the freely flexible lengths thereof through tissue or fascia undergoing suturing, together with the tying or knotting thereof following application.

Annealed stainless steel wire is considered by certain authorities to qualify as a better fascial suture material. The improved results arising from the use of stainless steel wire are attributable in part to its tensile strength, inertness, non-irritating qualities, and smooth surface formation, although the material is not so widely used as the older forms of sutures. This condition is deemed to be attributable in large part to the difficulties encountered by surgeons in handling, tying, and cutting steel wire, and to the erroneous belief that the wire tends to tear or cut through tissue more readily than other types of suture material and cause a wound to disrupt.

However, when the edges of a wound are pulled together, whether by silk ties or wire, certain forces or stresses are created which require consideration. In analyzing these forces and stresses, I have proceeded under the accepted engineering principle that, ignoring weight and friction, the tension at any point in a flexible loop applied over a smooth body is constant; also, that the force against the body at any point, and the reaction to this force, is at right angles to the tangent at the point of contact with the surface of the body. Further, the reaction is inversely proportional to the radius of curvature of the body.

Utilizing these principles, I have found that a more uniform distribution of forces and stresses in minimizing wound disruption is obtainable in a relatively rigid suture than is possible in a suture of the freely flexible type of common usage. Also, such rigidity can be obtained with the employment of a suture composed of a non-corroding metal, such as the chrome and nickel type of alloyed steel known commercially as stainless steel. Such a relatively rigid metallic suture, in accordance with the present invention, is formed with angularly flaring prongs which provide the suture with its own tissue-penetrating needles. Further, the rigid suture of the present invention eliminates the usual knotting, tying, and cutting operations involved in the use of ordinary flexible sutures. Thus the regions of the tissue lying on opposite sides of a wound or incision are held in edge approximation by the untensioned span of the body of the suture and its hook-shaped ends, providing a suture which is substantially rectangular when viewed from its front. With such a formation, adequate mechanical strength is provided without any substantial tendency on the part of the

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suture to apply cutting or shearing stresses to adjacent regions of the fascia.

Among its objects, the present invention aims to provide a metallic suture composed of relatively rigid and inflexible parts which, when the suture is inserted in its applied position, will provide a uniform and equalized distribution of stresses or forces upon or within the tissue held or engaged thereby, avoiding the development of forces tending to compress or rigidify fascia held by the suture to prevent or minimize disruption in whole or in part of such a suture-closed wound or incision; to provide a rigid suture composed of a length of stiff metallic wire bent to provide a body possessing generally a rectangular configuration; to provide a metallic suture of this type having outwardly and laterally projecting angular prongs adapted for tissue penetration; to provide a metallic suture which may be operatively and conveniently inserted in an applied position through manipulation by an associated surgical clamp or other form of hand-wielded applicator; to provide a preformed suture wherein the various parts thereof are relatively rigid, inflexibly related, and of integral metallic formation; and to provide a suture which constitutes an improvement generally upon suturing appliances and methods heretofore generally applied in the closing of wounds or incisions.

This application constitutes a continuation-in-part of my prior copending application Serial No. 185,716, filed September 20, 1950, now U. S. Patent No. 2,707,783 issued May 10, 1955, and entitled Applicator for Inserting Preformed Metallic Sutures.

Further objects, advantages and various novel constructional features of my invention will be readily understood through consideration of the following specification and the accompanying drawings, wherein has been illustrated, by way of example, certain preferred embodiments of the invention.

In said drawings:

Fig. 1 is a perspective view of a wound-closing suture formed in accordance with the present invention;

Fig. 2 is an enlarged top plan view thereof;

Fig. 3 is a front elevational view of the same;

Fig. 4 is a perspective view showing the rigid suture of the present invention. In this figure one of the angularly directed needle or prong-forming extremities of the suture is shown when initially inserted in a fascia leaf;

Fig. 5 is a similar view disclosing the condition of the suture after the initially inserted prong-forming extremity thereof has been fully engaged with the fascia leaf of Fig. 4;

Fig. 6 is a perspective view disclosing the second prong-forming extremity of the suture of Figs. 11 and 12 when initially inserted in an adjoining second fascia leaf in producing edge approximation of the leaves of the fascia;

Fig. 7 is a similar view disclosing a pair of sutures when fully inserted and the leaves of the fascia held thereby in their finally secured position of edge approximation and incision closure;

Fig. 8 is a perspective view disclosing the manipulation of a suture of the present invention with the use of a surgeon's clamp;

Fig. 9 is a front elevational view of a modified form of suture when the same is of a form adapting it for employment in an applicator of the type disclosed in my aforesaid patent application; and

Fig. 10 is a top plan view of the suture of Fig. 9.

As shown in Figs. 1, 2 and 3 of the drawings, a steel wire suture S, formed in accordance with the present invention and adapted for hand insertion, is set forth. The suture comprises preferably a substantially rectangular body formed from stainless steel wire, such as spring tempered wire having a diameter of approximately .025

inch, and identified commercially as No. 302 stainless steel wire. Ordinarily, the suture possesses a length of approximately ½ of an inch; however, it will be understood that these specific conditions as to the preferred physical properties of my improved suture are given by way of example and are subject to certain variation in practice. Therefore, I do not desire to be limited to the precise details and specifications as herein set forth.

In this instance, the suture comprises an elongated upper tension-absorbing bar **1** which in the forms of the suture illustrated comprises a straight horizontally extending linear section. The bar has its opposite ends terminated in downwardly extending side or end bars **2**, the axes of which may be disposed advantageously at an angle of approximately ten degrees with respect to a perpendicular established by the longitudinal axis of the bar **1** as shown in Fig. 3. The lower end portions of the side or end bars **2** terminate in a pair of lower bars **3**. These lower bars contiguous to their positions of juncture with the end bars **2** are disposed in the same vertical plane as the upper bar **1** and end bars **2**, forming hooks at the opposite ends of the suture. However, these vertically registering hook-forming outer portions of the bars **3** terminate inwardly of the suture in outwardly and angularly flaring prong-forming extensions **4**, the latter having their outer ends tapered or beveled to provide tissue-penetrating needle-forming terminals **5**. It will thus be seen that the side bars **2** provide return bends of approximately 180° between the upper bar **1** and the lower bars **3**. It will be noted, upon reference to Fig. 2, that the longitudinal axes of the extensions **4** are disposed in relatively parallel order, and that one of said extensions lies on one side of a vertical plane passing through the upper bar **1**, while the opposite extension **4** is disposed on the other side of such a vertical plane. This arrangement provides a wide mouth M, as shown in Fig. 2, between the terminals **5** to enable the suture to be readily manipulated in inserting the same in materials to be joined thereby.

In the form of the suture disclosed in Figs. 9 and 10, the same is adapted to be inserted into fascia by machine operation, as defined in my aforesaid parent patent application, the latter being directed to an improved applicator for inserting the suture S' of Figs. 9 and 10. In the preferred form of my invention, as illustrated in Figs. 1 through 3, as later defined, a suture is provided which may readily be positioned through manipulation of a surgical clamp in which the suture is held while undergoing fascial insertion.

The suture clip of Fig. 9, as in the preferred form of Fig. 1, is formed from a stiff spring-tempered stainless steel wire to provide a body of generally rectangular configuration, the same being formed with an upper tension-absorbing bar **1***a*, side or end bars **2***a* and inturned angularly extending lower bars **3***a* constituting angularly flaring extensions which at the ends thereof may be barbed or pronged as at **6**. By the use of a mechanical applicator, such as that set forth and claimed in my aforesaid application, a suture of the type indicated in Figs. 9 and 10 may be inserted in the tissue on the opposite sides of a wound or incision therein to close and maintain closed the approximate edges of the incision.

In both the hand-inserted sutures of Fig. 1 and the machine-inserted suture of Fig. 9, rigid steel wire constructions are provided which are preformed and possess their final configuration at the time of insertion for the use thereof. Further, these sutures are not placed under tension at the time of or following insertion corresponding to pulling forces usually applied to a flexible suture when the latter is being knotted.

The flared extremities **4** of the suture and the wide span M formed therebetween facilitate its placement because they provide a better vision, easier insertion and because not so much supination and pronation of the operator's hand when using the clamp **12** is required. The method for placement of the suture is shown particularly in Figs. 4 through 8 of the drawings. By reference to these figures, it will be noted that in Fig. 4 one extremity **4** of the suture is hooked into the leaf **13** of fascia farthest from the operator. The suture is then pulled or dragged toward the operator and partially rotated by full pronation of the operator's hand, embedding the suture, as disclosed in Fig. 5. The proximal leaf **14** of fascia is penetrated by pushing the suture, as disclosed in Fig. 6. After a little practice, accurate approximation of the edges **15** of the wound or incision in the fascia can be obtained.

In addition to the theoretical advantages of spring-tempered or relatively rigid stainless steel wire over more flexible suture materials in accordance with the principles discussed, the rigid preformed suture has the advantage of ease of insertion and the saving of time as compared to the inconvenience in the cutting and handling of spools of steel wire, threading of needles, and the tying of knots. While the caliber is greater than that of the conventional steel suture material, the actual surface is less. The increased caliber produces less cutting, both by shearing and by failure in tensile strength of fascia when a given force is applied, than does ordinary flexible suture wire having a smaller diameter. The rectangular hook-like extremities of the suture should, by maintaining their form, minimize unequal distribution and stresses or concentration of forces upon the edges of the fascia to be held. The tissue incorporated in the suture is not completely encompassed and the aperture in the suture provides a route or path for decompression if the fascia becomes edematous.

The angular upwardly directed divergence of the bars or legs, as shown at **2** in Fig. 3, is employed so that the pull of the fascia on the legs **2** will tend to cause the fascia to press upwardly toward the straight unbroken bar **1** of the suture. This arrangement results in imparting the forces on the suture at its strongest point where the tendency of the suture to open is at a minimum. If the side legs **2** were substantially parallel, for example, slight resiliency on their part might reverse this condition, crowding the fascia toward the prongs **4** where the tendency to open or spread the suture would be the greatest and where the upper bar **1** does not function at its best in holding the edges of the fascia properly in the same plane.

I claim:

1. A suture comprising a relatively rigid body generally rectangular in configuration, said body including a substantially horizontally extending upper bar terminating at the ends thereof in downturned substantially vertical side bars, the lower portions of said side bars terminating in a pair of inwardly directed lower bars, the latter having the outer portions thereof joined with said side bars and disposed in parallel relation to the upper bar, said lower bars including outwardly and laterally directed angular extensions forming tissue-penetrating prongs.

2. A suture comprising a relatively rigid body generally rectangular in configuration, said body including a substantially horizontally extending upper bar terminating at the ends thereof in downturned substantially vertical side bars, the lower portions of said side bars terminating in a pair of inwardly directed lower bars, the latter having the outer portions thereof joined with said side bars and disposed in parallel relation to the upper bar, said lower bars including outwardly and laterally directed angular extensions forming tissue-penetrating prongs, said extensions being disposed in relatively parallel order with one extension arranged on one side of the body of said suture and the other extension on the opposite side of said body.

3. A suture consisting of an integral, one-piece, rigid body formed from a continuous length of wire having a substantially uniform cross-sectional area throughout its length, said body being preformed with an elongated, substantially straight, tension-absorbing crossbar terminating

at the ends thereof in integral, relatively shorter, downturned, linear, side bars and a pair of opposed, inwardly directed, tissue-penetrating prongs forming integral extensions of said side bars, said prongs terminating in a pair of sharpened end extremities disposed in laterally offset angular relation to said crossbar and in relatively spaced relation to each other, the relative spacing between the sharpened end extremities of said prongs permitting the application of said suture to tissue layers to be joined thereby without distortion of said suture from its preformed shape.

4. A suture as defined in claim 3, wherein said prongs are parallel to each other and project, respectively, laterally outwardly on opposite sides of said crossbar.

5. A suture consisting of a one-piece body formed to include an elongated, substantially straight, tension-absorbing bar terminating at the ends thereof in integral, angularly related, relatively shorter, linear side bars, and a pair of opposed, inwardly directed, tissue-penetrating prongs forming integral extensions of said side bars, said prongs terminating in relatively spaced, sharpened end extremities disposed in laterally offset, angular relation to said tension-absorbing bar, said body being inflexible under normal conditions of application and use.

6. A suture consisting of a one-piece body formed to include an elongated, tension-absorbing bar terminating at the ends thereof in integral, angularly related, relatively shorter, and substantially linear side bars, and a pair of opposed, inwardly directed, tissue-penetrating prongs forming integral angular extensions of said side

bars, said prongs terminating in relatively spaced end extremities, the relative spacing between the end extremities of said prongs permitting the application of said suture to tissue layers to be joined thereby without distortion of said suture from its preformed shape, said body being inflexible under normal conditions of application and use.

7. A rigid fascial suture consisting of a one-piece body formed with an elongated, tension-absorbing bar, a pair of opposed, generally inwardly directed, tissue-penetrating prongs disposed in definite spaced relation to said tension-absorbing bar and terminating in relatively spaced, sharpened end extremities, and relatively short side bars connecting said prongs with the ends of said tension-absorbing bar and providing return bends of approximately 180° therebetween, the relative spacing between the end extremities of said prongs permitting the application of said suture to tissue layers to be joined thereby without distortion of said suture from its preformed shape, and said body being inflexible under normal conditions of application and use.

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