United States Patent [19]

LeVeen

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[54] **WOUND SPLINTS**

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[21] Appl. No.: **158,687**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 813,478, April 4, 1969, abandoned.

[52] **U.S. Cl.** **128/335**
[51] **Int. Cl.** **A61b 17/04**
[58] **Field of Search** ..... 128/334 R, 335, 335.5

[56] **References Cited**

UNITED STATES PATENTS

3,541,591	11/1970	Hoegerman	128/335
3,014,483	12/1961	McCarthy	128/334 R
815,264	3/1906	Chambers	128/334 R
1,852,098	4/1932	Anderson	128/335
3,473,528	10/1969	Miskin et al.	128/335 X

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[57] **ABSTRACT**

Semi-rigid resilient bars or bar-like materials of slightly pliable elastomeric plastics are provided for use in post-surgical procedures in connection with sutures for closing incisions. The bars may be of various cross-sectional configurations, such as a flat or semi-circular bar, with a downwardly converging slot or groove for the reception, guiding and gripping of the sutures. Alternatively, the bar-like element may be bowed or bridge-like with expanded terminal foot portions slotted for the reception and passage of sutures or provided with a central hinge portion.

3 Claims, 7 Drawing Figures

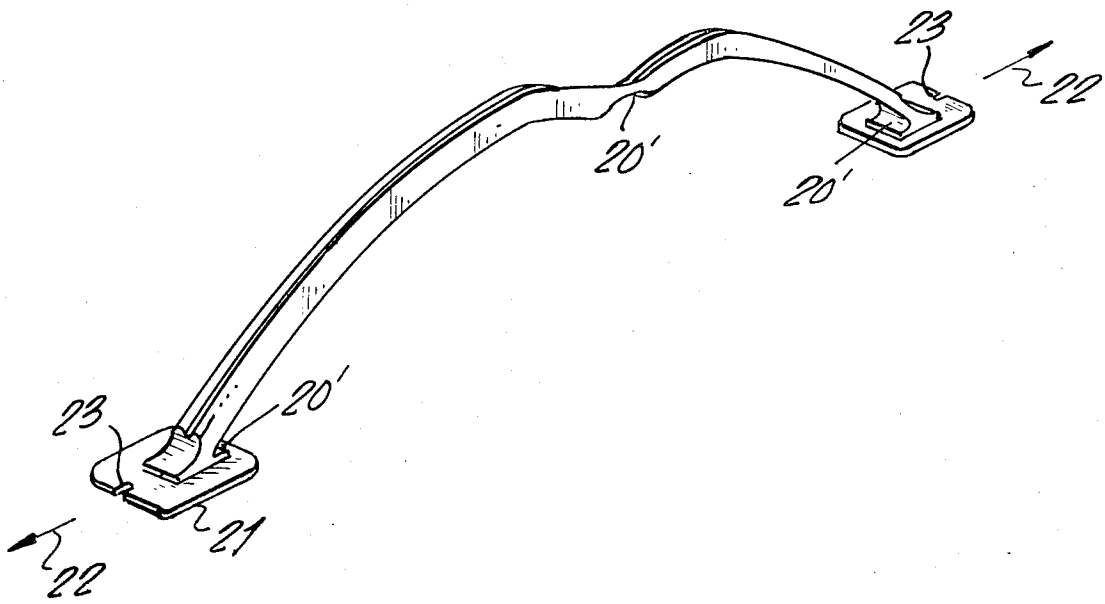


FIG. 1

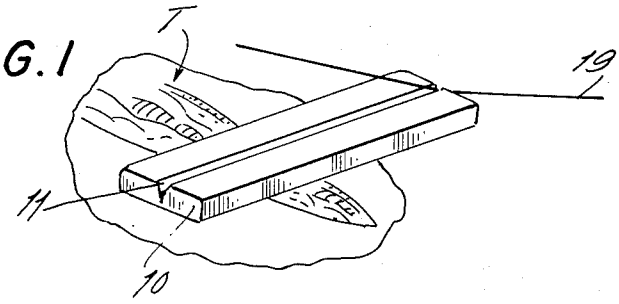


FIG. 1A

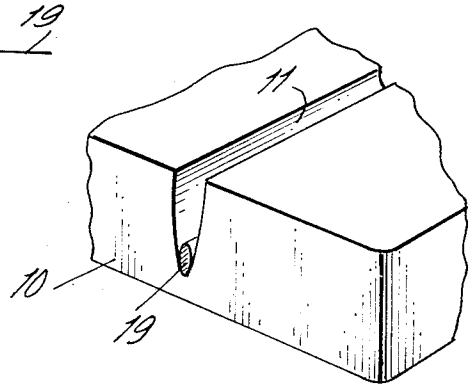
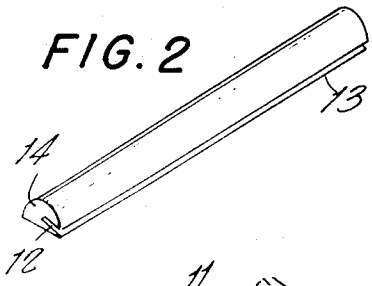


FIG. 2



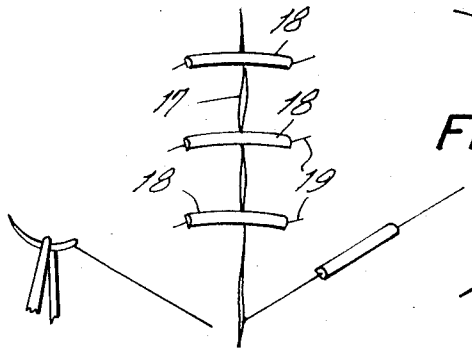


FIG. 4

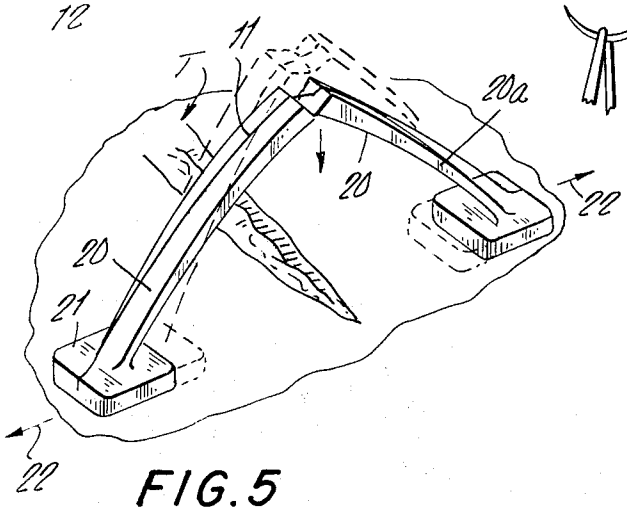


FIG. 5

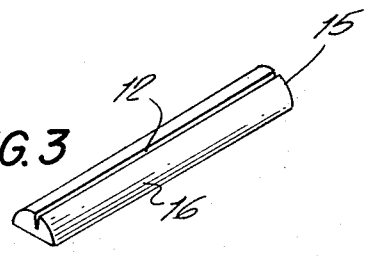


FIG. 3

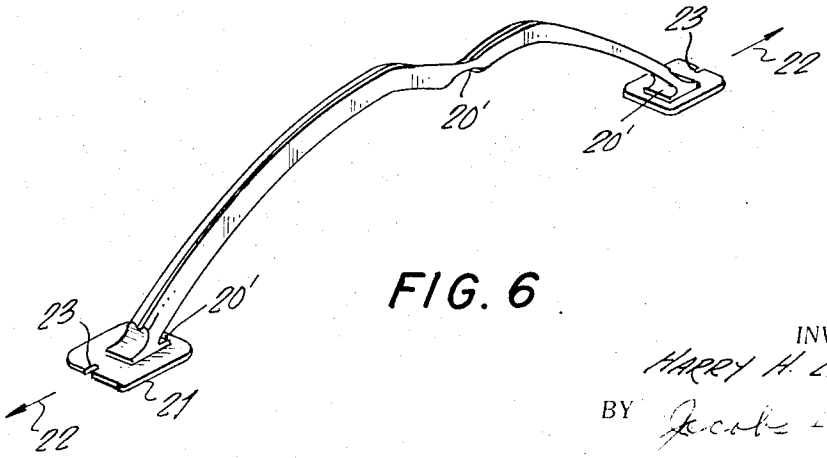


FIG. 6

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WOUND SPLINTS

This application is a continuation-in-part of copending application Ser. No. 813,478 filed Apr. 4, 1969, and now abandoned.

In the performance of abdominal surgery, retention sutures are assuming increased importance because of the demonstration that wound disruption is less frequent with mass wound closure than it is with approximation of the facial edges as in a layer to layer closure. (McCallum, G.T., Link, R.F. The Effect of Closure Technique on Abdominal Disruption. Surg. Gyn. & Obst. 119:74, 1964). When retention sutures are used alone, as indicated as aforementioned by McCallum et al., or combined with layer by layer closure, as advocated by Lehman et al. (Lehman, J.A., Cross, F.S. and Partington, P.F., Prevention of Abdominal Wound Disruption. Surg. Gyn. & Obst. 126:1,235, 1968), the danger of wound disruption is almost eliminated. Yet, mass closure of abdominal wounds has not received popular acceptance. The chief disadvantage to retention sutures and mass abdominal closure is the inclusion of a large volume of tissue in the ligature loop. Such tissue is compressed and devitalized when the tension is applied to close the wound; and, even when minimal tension is applied, the wound swells and the sutures cut the tissue. Hoerr (Hoerr, S.O. A New Single Layer Technique for Closing the Disrupted Wound. Surg. Gyn. & Obst. 126:119, 1968) maintains that the suture should ideally elongate with the swelling of the wound but such an ideal suture is not available. It is evident that two factors should be avoided, compression of tissue and resiliency in the loop which allows for maintenance of constant tension.

Various types of splints or bridges have been proposed to reduce this tissue compression. The most commonly employed device is to place the ligature through a circular tube of rubber which lies on the skin and serves as a stiffener to prevent some of the compression of the skin and cutting where the suture enters the tissue. Rubber tubes have the disadvantage in that they are not stiff enough and fall off the end of the suture and a hemostatic forceps or other device must be applied to the end of the suture to prevent this. Also, tubes are difficult to thread. Since it is the usual practice to place all the sutures before tying them, it is apparent that this extra procedure of placing clamps on the end of the sutures is time-consuming and cumbersome. The great disadvantage from this type of rubber tube lies in the fact that it is too flexible and does not avoid compression of the tissue. (Taylor, F.W., Jontz, J.G., Figure 8-type Retention Sutures. Surg. Gyn. & Obst. 109:378, 1959).

The ideal situation as has been pointed out by Price (Price, P.B., Stress, Strain and Sutures. Ann. Surg. 128:408, 1948) is to pull the divided abdominal wall toward the midline by sutures placed at either end of a rigid bar, the bar serving to absorb the compressive forces. Dennis (Dennis, C., Nelson, C.A., Anker, F.J., Utilization of Wound Splints and Through and Through Figure 8 Sutures of Stainless Steel Wire for Abdominal Closure in the Presence of Poor Wound Expectancy. Surg. Forum 4:601, Oct. 1953) has advocated a figure of 8-closure utilizing a rigid straight bar over which the suture is tied. This bar takes up the compressing force rather than have the forces applied to the tissues. This bar is a loose piece of apparatus which must be held under the suture during tying. It has the disadvantage in that the suture does not grip the bar tightly and that, as a rigid bar, predetermined sizes must be made and the bar cannot be easily shortened at the time of surgery. It has an added disadvantage since a rigid bar cannot exert constant tension on the suture but utilizes the elasticity of the tissue for this purpose which, of course, implies that the tissue must be compressed.

McCarthy (McCarthy, H.F., Tension (Stay) Suture Bridge, J. Int. Col. Surg. 34:613, 1960) has advised the use of a bar with a central elevation which holds the suture off the wound. This product has been used in three different sizes. It has the disadvantage of being cumbersome, is not attached to the suture, and the fixed sizes are not always adaptable to the patient's needs. As described in U.S. Pat. No. 3,014,483, it does not maintain constant tension on the suture.

The invention is illustrated in the accompanying drawing wherein:

FIG. **1** is a perspective view of a bar with a downwardly converging suture-receiving and gripping groove positioned over a wound.

FIG. **1A** is a fragmentary perspective view, partly enlarged, of a bar with a downwardly converging suture-receiving and gripping groove having a suture-wedged therein;

FIG. **2** is a perspective view of a semi-circular bar having its suture-receiving groove along one edge;

FIG. **3** is a modified form of semi-circular bar wherein the suture-receiving groove is in the convex top of the bar;

FIG. **4** is a fragmentary diagrammatic view of a surgical incision partly sutured and partly in the process of being sutured; and

FIGS. **5** and **6** are variant forms of the invention wherein the bar is bowed or "hinged" with expanded terminal foot portions.

The present invention relates to a semi-rigid flat resilient bar of a slightly pliable elastomeric plastic material which allows the bar to take up a certain amount of increased tension by shortening and distorting. The simplest and preferred form of the device is shown in FIG. **1** in the shape of a flat bar **10** of greater width than height with a central groove **11** converging downwardly from the surface so that the suture **19** displaces the sides of the elastomeric material which firmly holds the suture so that the suture can be packaged with the retention suture attached to the bar and the bar can be inserted without the danger of the retention suture bar dropping off during the act of suture placement. The groove holds the suture firmly but the frictional forces can be overcome and it is relatively easy to slide the bar along the long axis of the suture for proper placement and tying. In addition, the bar can readily be reduced in size by trimming with a scissor or knife as indicated in FIG. **1**.

The invention is further illustrated in FIG. **2** which shows a form of the invention in which the groove **12** of the same shape as groove **11** is illustrated as coming from a free edge **13** of a half cylinder **14** but the groove **12** could also extend down from the convex upper surface **15** of the cylinder **16** as illustrated in FIG. **3** as well as from the upper surface of flat bar **10** as described above with respect to FIG. **1**. It is evident that the actual shape or configuration of the extrusion need not be a half cylinder or a flat bar but can also be a trapezoid or other desired geometric configuration which pro-

vides a suitable cross-sectional area. FIG. 4 shows a wound or incision 17 closed with a number of already placed sutures 19 in bars 18 and a suture 19 in the act of being placed and to which a bar 10 is attached. The bar grips the suture and does not fall off.

The bar need not necessarily have a flat side or surface as shown in FIGS. 1 to 4 but may have a hinge-like form 20 as shown in FIG. 5 which lifts it off the skin surface and the wound. This is accomplished by giving the bar a bridge-like shape such that it is raised away from the skin and is highest at its central bridge portion. Since the bar material is resilient there will be a tendency to pull the center down and push out the ends of the bar where the suture 20*a* leaves and tends to keep continuous outward traction on the suture. This configuration has been found advantageous in some cases since it helps to keep the suture from cutting or abrading the skin. The resiliency of the wound splint tends to make it self-adjusting in size. This modified form of the invention is shown in FIG. 5. Since the bar is made of elastomeric material, it grips the suture firmly. The downward compressive force of the suture tends to push on the expanded areas or pods 21 (FIG. 6) at each end of the bar which serve to transmit the compressive force to the skin in an outward direction as indicated by the arrows 22. This tends to take the tension off the suture and prevents it from cutting the skin. The center central bridge portion which is away from the abdominal skin may also be thinned to form an integral hinge 20′ (FIG. 6) which further makes it resilient and self-adjusting. The ends of the bars may also be flared to form the expanded. enlarged or rectangular areas 21 which distribute the pressure on the skin more evenly. These ends are notched at 23 so that the suture passes through the notch. Each of the designs of FIGS. 5 and 6 is moulded from a resilient plastic and has a suture slot or groove 11 therealong as shown.

The mechanics of the resilient plastic can also be simulated with rigid plastic by utilizing the tension of the suture used to hold the wound closed to reduce the compressive force. In such a design, the bar is slightly curved away from the abdominal skin as in FIG. 6 and has an integral hinge 20′ in its center and at the center of the two rectangular surfaces contracting the skin. A portion of the cross-sectional area contains a slot to grip the suture as aforedescribed. Since the central portion of the bridge has an integral hinge, the change in the angle of this hinge forces the two feet outward. The suture is brought over the top of the bridge and pushes down on the bridge causing the central integral hinge to bend and force the legs outward. This tends to push the sutures outward instead of compressing the tissue inward as will be appreciated from FIG. 6. The constructions of FIGS. 5 and 6 also facilitate knot-tying when it is necessary or desirable to form a knot in the suture.

The main advantage of the resilient bridge design is that it allows for what may be considered elongation of the loop of suture during swelling of the tissues, a point which is important in some types of wounds. As the tissues swell, the expansion tends to put greater tension on the suture. Thus the downward compressive force on the bridge increases and the bridge tends to straighten. This means that the area under the bridge is now incorporated in the tissues rather than on the outside of the body. This tends to enlarge the size of the loop in the tissues. The cross-sectional area of tissue included in the loop of suture is thus enlarged which allows the loop to accommodate to tissue swelling. These essential features cannot be obtained by a rigid bar. The flattening of the bridge also tends to push the ends of the wound splint outward which prevents cutting of the skin. The resilient flat bar also possesses these desirable features but to a somewhat lesser extent. The flat bar is satisfactory in most cases but secondary wound closure is often best accomplished with the bridge type wound splint.

A variety of materials having the requisite and above-described properties are suitable for use in the present invention. Examples are polypropylene or thermoplastic polyurethane formed to desired shape by injection molding or extrusion. Two suitable polyurethane elastomers for this purpose are Texin manufactured by Mobay Chemical and Estane manufactured by B. F. Goodrich Chemical Company.

What is claimed is:

1. An elongated, bar-like, wound splint of pliable resilient material having opposite end portions and an intermediate portion extending between said end portions, said intermediate portion including an upwardly bowed arcuate member forming a central bridge portion, an integral hinge means in said bridge portion adjacent the mid-point area thereof to permit bending of said bridge portion, means defining a suture receiving and retaining groove extending lengthwise of said splint through the location of said hinge means, said groove being open on the upper side of said bridge portion, and means defining a notch in each of said end portions of said splint whereby said hinge means permits flattening of the splint during tissue swelling to accomodate elongation of a suture loop.

2. A splint according to claim 1 wherein the said end portions of said splint are enlarged to define terminal foot portions.

3. A splint according to claim 1 in which said hinge means includes a notched portion in the upper side of said bridge portion.

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