June 20, 1967 E. C. WOOD 3,326,216

HEMOSTATIC CLIP CONSTRUCTIONS

Filed March 30, 1964 2 Sheets-Sheet 1

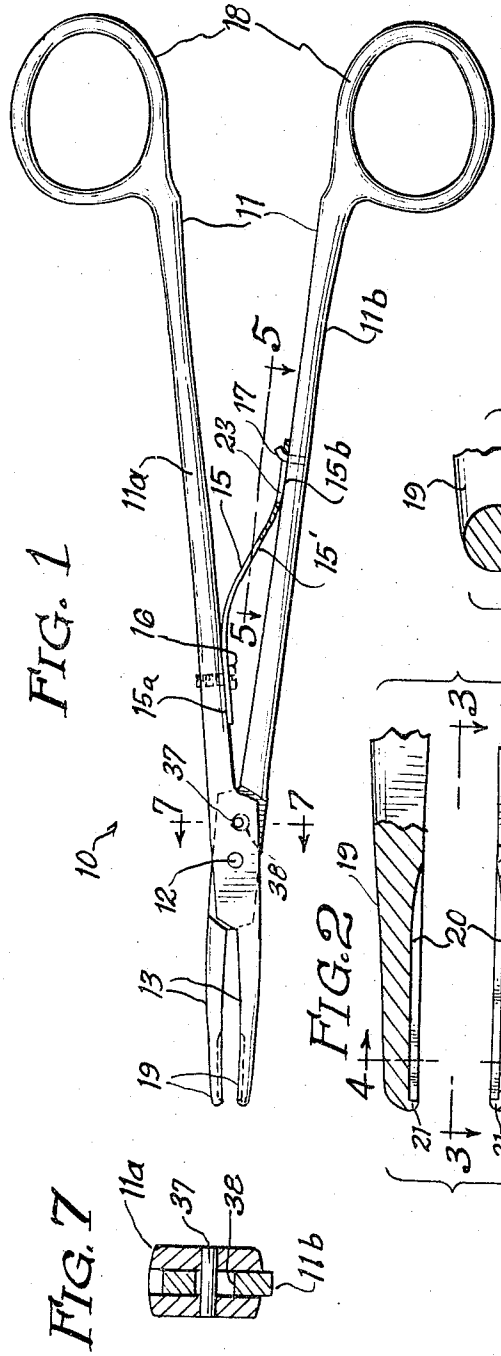

FIG. 1

FIG. 2

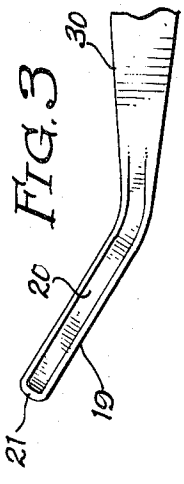

FIG. 3

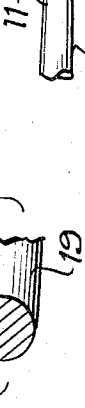

FIG. 4

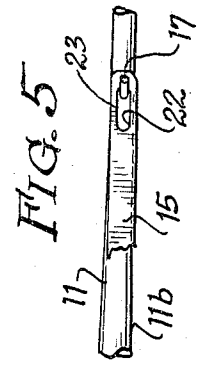

FIG. 5

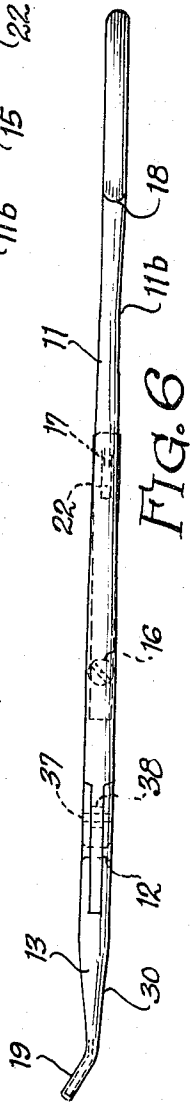

FIG. 6

FIG. 7

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HEMOSTATIC CLIP CONSTRUCTIONS

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FIG. 9

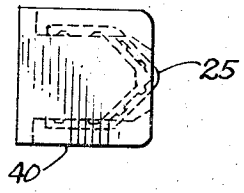


FIG. 10

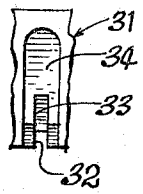


FIG. 11

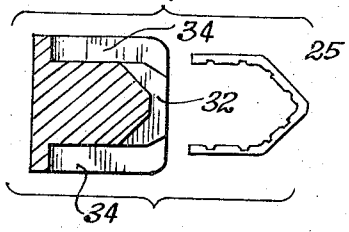


FIG. 12

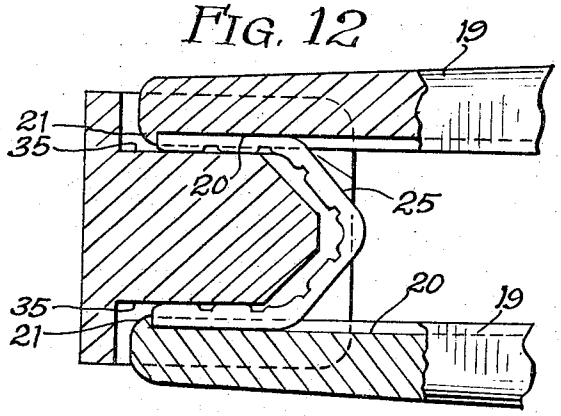


FIG. 13

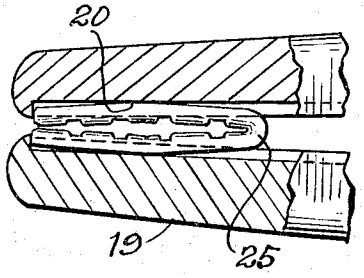


FIG. 14

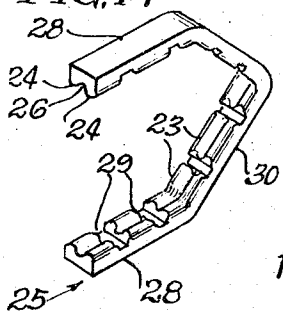


FIG. 15

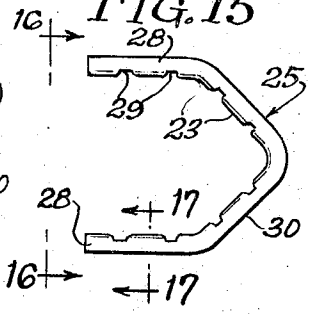


FIG. 16

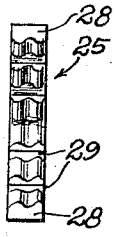


FIG. 17

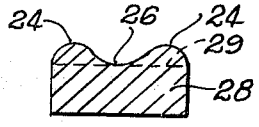
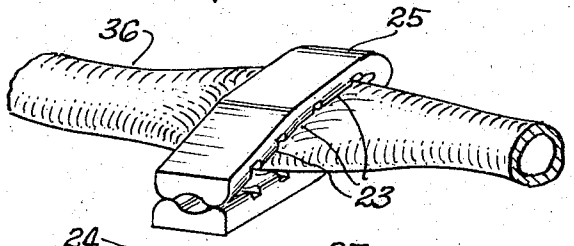


FIG. 18



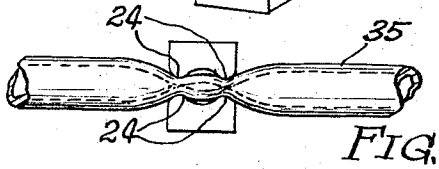


FIG. 19

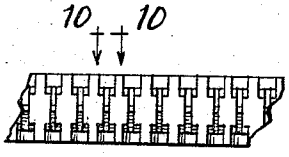


FIG. 8

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3,326,216

HEMOSTATIC CLIP CONSTRUCTIONS

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Filed Mar. 30, 1964, Ser. No. 355,810
9 Claims. (Cl. 128—325)

This invention relates to mechanisms useful in the strangulation of tubular members. Specifically, it is directed toward devices including hemostatic clips useful in the strangulation of blood vessels and other fluid ducts in the human body.

The particular application of this invention to the strangulation of blood vessels will serve as an illustration of the inventive concepts enclosed herein. It will be appreciated, however, that the mechanisms embodying the concepts of this invention can be adapted for the closing of other tubular structures at intermediate points as well as near their open ends.

In the course of a surgical operation, a surgeon must often sever one or more blood vessels. It is desirable to provide means for closing the ends of the severed vessels, at least until the end of the operation, to stop bleeding that could interfere with the performance of the operation as well as present unnecessary risks to the patient.

Conventional means for closure consist of ligatures or the like tied about the individual vessels at the desired point of strangulation. The customary technique provides for the separate clamping of each vessel after the incision has been made. After clamping the vessels, a ligature is secured about each vessel providing closure and permitting the removal of the clamps. In some instances a great number of vessels must be severed after requiring one or more hours for proper closure at which point the operation may proceed. It will be apparent that an improved technique for closure will not only obviate the excessive expenditures of time by the surgeon and his assistants under conventional practice but also the dangers to the patient inherent in any delay.

It is an object of this invention to provide mechanisms for use in the strangulation of blood vessels whereby the time required for closure is materially reduced and whereby bleeding can be terminated without the use of the excessive combination of clamping and tying operations.

It is a more particular object of this invention to provide improved mechanisms for the strangulation of blood vessels and the like whereby the blood vessels may be sealed off in a highly efficient manner to prevent bleeding during an operation and whereby the operation can proceed with a minimum loss of time as well as blood thereby to maintain conditions most favorable to the patient.

It is a specific object of this invention to provide an improved design for a hemostatic clip, which is adapted to meet the foregoing objects.

These and other objects of this invention will hereinafter appear and for purposes of illustration, but not of limitation, specific embodiments of the invention are shown in the accompanying drawings, in which—

FIG. 1 is a plan view of the hemostatic clip applicator structure;

FIG. 2 is an enlarged sectional elevational view of the jaws of the applicator structure;

FIG. 3 is an enlarged top view of one jaw of the applicator, taken about line 3—3 of FIG. 2;

FIG. 4 is an enlarged cross-sectional view of the jaws taken about line 4—4 of FIG. 2;

FIG. 5 is a view of the applicator along line 5—5 of FIG. 1;

FIG. 6 is an elevational view of the applicator;

FIG. 7 is a view of the applicator taken about line 7—7 of FIG. 1.

FIG. 8 is a front elevational view of a magazine construction adapted to hold a plurality of the clips of this invention;

FIG. 9 is an end elevational view of the holding means suitable for hemostatic clips made in accordance with this invention shown in FIG. 8.

FIG. 10 is a view of the holding means taken about line 10—10 of FIG. 8;

FIG. 11 is a sectional elevational view showing the spatial relation of the clip and magazine;

FIG. 12 comprises an enlarged cross-sectional view illustrating the relative positions of clip, applicator and magazine during loading of the applicator with a clip from the magazine;

FIG. 13 is an enlarged sectional view illustrating the manner in which the jaw portions of the applicator provide for closing the clip;

FIG. 14 is a perspective view of a hemostatic clip construction designed in accordance with the concepts of this invention.

FIG. 15 is an elevational view of the clip shown in FIG. 14;

FIG. 16 is a view of the clip taken about line 16—16 of FIG. 15.

FIG. 17 is a cross-sectional view of the clip taken about line 17—17 of FIG. 15.

FIG. 18 is a perspective view of a blood vessel with a clip clamped thereon; and

FIG. 19 illustrates the strangulation of a blood vessel effected by having a clip clamped thereon.

The hemostatic clip of this invention is adapted to be formed from a strip of deformable non-toxic material whereby it can be safely used in an operation. The clip to be fully described hereinafter defines a pair of arm portions with interfaces in opposed relationship. These interfaces, when clamped by means to be described, engage the outer surface of a blood vessel to effect the strangulation desired.

The applicator of this invention includes jaw portions with defining means for receiving the outer faces of the arm portion of the clip. When so received the clip will be firmly held and there will be little tendency for the clip to be dislodged therefrom before being clamped to a blood vessel.

In order to further increase the efficiency of this invention, a suitable magazine or holding means is provided for mounting a plurality of clips in position to be loaded between the jaws of the applicator for use. The holding means and associated clips can be sterilized and packaged whereby they can be stored indefinitely and will be ready for use at any time. The slots defined in the holding means are dimensioned to receive therein the end portion of the jaws of the applicator means, to permit the jaws to grasp the clip contained therein and extract it from the holding means thereby eliminating the necessity of handling the clip at any time between sterilization and use in the strangulation of a blood vessel.

The accompanying drawings illustrate the structures that embody the concepts of this invention. As illustrated in FIGS. 14 through 17, the hemostatic clip of this invention comprises an elongate strip 25 of deformable material having its end portions arranged in arms 28 in spaced apart parallel relation with the facing inner surfaces of the arms being formed intermediate their lateral edges with a valley or recessed portion 26 extending lengthwise through at least the end portion of the arms and preferably through the entire length thereof.

In the preferred practice, as illustrated, the clip is formed with but a single recessed portion which extends continuously through the central portion of the strip but it will be understood that the inner face of the strip may be formed with more than one such recessed portion in

side by side parallel relation. The ridges **24** formed alongside the recessed portion are preferably formed to curvilinear shape and the inner surfaces are preferably, but not necessarily, formed with longitudinally spaced apart, crosswise extending serrations **29** which extend continuously crosswise of the strip from edge to edge.

The strip is formed of non-toxic material, such as stainless steel, plastics and like materials, which are capable of being deformed and which retain the amount of deformation for fixedly clamping the blood vessels therebetween.

In the illustarted modification, the bail portion **30** of the strip intermediate the spaced arms **28** is bent to substantially V-shape but it will be apparent that the portion intermediate the arms may be formed to other contours, such as U-shape, rounded shape, or other polygonal shape.

The depth and width of the recess **26** is not sufficient to noticeably weaken the clip, yet adequate to leave ridges **24** that will impress a circumferential band of compression about the blood vessel whereon the clip is attached.

The crosswise extending serrations are dimensioned to have a depth and width substantially equal to the depth and width of the recess **26**, and spaced to permit at least one and preferably more than one such serration to be in contact with the surface of the blood vessel upon which the clip is attached, yet not so close as to permit the distance between the center lines of the serrations to be less than twice the width of recess **26**.

FIGS. 1 through 6 illustrate an applicator **10** and details of various portions thereof. The applicator structure comprises two pivotally joined elongate members **11**^{a} and **11**^{b}, each providing a cooperating jaw member **13** on one side of the pivot **12**, and cooperating handle portions **11** on the other side of the pivot. Means are provided between the handle portions resiliently to urge the handle portions in the direction away from each other and correspondingly to urge the jaw portions **19** in the direction away from each other but between certain limits, as will hereinafter be defined. For these purposes, there is provided a leaf spring **15** which is formed **15'** intermediate its ends to offset the end portions **15**^{a} and **15**^{b} in normal position, fastened to one handle portion **11** at **16** and slidably connected to the other handle portion.

As best shown in FIG. 5, the movable end **23** of the curvilinear leaf spring **15** defines as lot **22** which is adapted to receive a hook **17** fixed to the handle portion **11**. It will be apparent that pressure exerted in the finger holes **18** directed to bring the handles together will cause the movable end portion of the spring **15** to slide relative to its associated handle portion. Similarly, removal of the pressure from the finger holes will permit the spring **15** to urge apart the handle portions and their associated jaw portions, the movable end of the spring sliding relative to its associated handle portion until the end of the slot **22** engages the hook **17** as shown in FIG. 5, thereby limiting the separation of the handle portion **11** and hence the separation of the jaws **13**.

Further limiting the separation of the jaws and associated handle portions is the interaction of pin **37**, shown in FIG. 1, firmly secured to one of the elongate members **11**^{a} or **11**^{b} and the edges of hole **38** in the other elongate member through which the pin **37** passes. Both the pin and the hole are preferably located on the handle side of the pivot **12** in a position close to the pivot on portions of the elongate members having mutually sliding interfaces. The hole and pin are dimensioned to permit the pin to move freely in the hole, its motion defining an arc about pivot **12**, the hole dimensioned as to limit the separation of the handle portion **11** to that separation to which the handles are limited by the hook **17** engaging the end of the slot **22**.

FIG. 3 provides an illustration of the preferred construction of the jaws of the applicator. Each jaw defines a body portion **30** and a lip portion **19** with said lip being

angularly offset from the body portion. The contact surface of each lip portion is in a coplanar relationship to the surface of the body portion of its associated jaw, the lip and body of each jaw being formed with a blind groove **20** extending continuously throughout the length of the body portion and terminating just short of the end of the jaw thereby to form a ridge **21** on the outer end of the lip portion **19**. In the preferred practice, it is desirable to have the recessed portions located centrally along the inner face of the jaw members and to extend continuously about the bend and to terminate in the body portions as illustrated in FIG. 3. The ridge **21** is formed to provide an abrupt abutment at the end of the recessed groove. The straight portion of the blind groove within the lip portion of the jaw is dimensioned to have a length slightly greater than the length of a closed hemostatic clip, a width dimensioned comfortably to receive said clip, and a depth sufficient to provide a firm hold thereon. As will hereinafter appear, the said ridges and grooves provide for the extracting of the clip **25** from a clip magazine as well as the firm gripping of the clips when held by the jaws.

FIG. 8 illustrates a magazine designed to hold a plurality of clips and FIGS. 9 and 10 the internal features thereof.

As illustrated in the drawings, the clip holder **31** comprises a rigid body in the form of a substantially rectangular block **40** having a recessed portion across the top and down the sides with the recessed portion **32** across the top being formed of V-shape or other shape corresponding to the bail of the clip and dimensioned to have a length corresponding to the length of the clip and a width slightly greater than the width of the clip. The recessed portion **34**, which extend downwardly along the sides of the body from the opposite end of the top recess, are dimensioned to have a width slightly greater than the width of the clip and the jaw portions of the applicator with the bail seated firmly on the saddle portion **32** of the recess and with the arms extending downwardly in the recessed portion **34** with the ends of the clip terminating short of the ends of the recessed portions by an amount which corresponds to the spaced relation between the end of the recessed portion **20** and the end of the jaw portion or slightly greater.

In the use of this invention for the strangulation of blood vessels as shown in FIG. 18, the hook **17** on the handle portion **11** of the applicator is normally positioned relative to the extreme end of the slot **22** in leaf spring **15** as to limit the separation of the lip portions **19** of the jaws **13** to slightly less than the spread of the outer faces of the parallel arm portions **28** of clip **25**. It will be appreciated that on inserting the applicator lips **19** into the defined slot **32** in the clip holder **31** to engage the clip **25**, the ridges **21** on the ends of the lips may not easily pass over outer faces of the parallel arm portions **28**. Rather, it is necessary to forcefully push the lips **19** into the holder thereby causing a sufficient separation of the lips to permit the ridges **21** to slide along the parallel arms of the clip. As illustrated in FIG. 12, after sliding the entire length of the arm portions of the clip, the ridges **21**, it will be appreciated, snap into the gap **35** resulting from the proper dimensioning of the clip relative to the depth of the recess **32**. Moreover, it will be noted that the width of the grooves **20** in the applicator lips are dimensioned approximately equal to the thickness of the clips **25**. These two features in combination permit the clip to be received in fitting relation within the recessed portion **20**. As the jaws of the applicator are withdrawn upwardly from the holder, the clip will tend to remain in the holder until the abutment **21**, formed at the end of the slot, comes into contact with the ends of the clip arms, preferably to position the clip in the jaw members. Continued withdrawal of the applicator jaws will effect displacement of the clip from the holder with the clip properly positioned between the jaw members. The clip will

be firmly held thereby, with little tendency for the clip to fall away from the lips and, in this connection, there is no necessity for pressing the jaws together to hold the clips.

The open ends of a clip can be placed on opposite sides of the severed end of a blood vessel and, when pressure is applied through the finger holes **18** and handles **11** of the applicator to urge the jaw members in the direction towards each other, the clip held by the jaws will be clamped as shown in FIG. 13. The interfaces on the ends of the clip arms being the first portions to come in contact, the remainder of the interfaces encircling the blood vessel and pressing together, strangulating the vessel as shown in FIG. 18.

The clips are designed to tightly seal the blood vessel when clamped thereon and, therefore, the use of ligatures in an operation can be greatly diminished. As illustrated in FIG. 19, the ridges of the opposed interfaces of the clip engage the surface of the blood vessel at multiple locations **24** whereby more than one tight seal is formed. The advantage of several separate sealing rings in a given length of blood vessel over one single seal is that the clamping force exerted by the clip is concentrated in the circumferential compression band impressed by the ridges on the clip's interfaces rather than distributed over the enclosed length of the vessel clamped. To adequately seal the vessel less clamping pressure need be applied than is necessary with the clip with small interfaces. Such reduces the danger of crushing the vessel walls. The multiple crosswise serrations on the clip interfaces insure a firm hold on the blood vessel even with the light clamping pressure necessary to effect strangulation thereby preventing bleeding and providing an additional safety feature insuring that if the clamping pressure used to close the clip is excessive, part of the vessel upon which the clamp is fixed will remain uncrushed.

The design of the clip construction **25**, which represents the preferred design, is particularly important. Thus, the provisions of the parallel portions **28** serves to insure a firm gripping action by the applicator. These straight sections of the clip are readily seated in the grooves **20** in the lips **19**, the ridges **21** preventing the clip from sliding from the groove.

The clip of this invention is preferably formed of surgical metals which are non-toxic and which therefore can be tolerated within the body for indefinite periods of time. Representative of such metals are stainless steel, platinum and tantalum. It is also contemplated that the clips be formed of less expensive non-toxic non-metallic materials such as plastic, or materials which are slowly absorbable in body fluids, such as collagen, gelatin, albumin, dried blood, synthetic materials, and the like.

It will be understood that various changes can be made in the above described hemostatic clip and applicator constructions which provide the characteristics of this invention without departing from the spirit thereof, particularly as defined in the following claims.

I claim:

1. A hemostatic clip formed of elongate strips of non-toxic material comprising a pair of arms interconnected at one end and open at the other with the arms arranged in laterally spaced apart relation, at least one longitudinal valley and at least one crosswise serration in the interior surfaces of the arms facing one another.

2. A clip construction in accordance with claim **1** wherein said strip defines a V-shaped configuration and comprises a thin, essentially rectangular cross-section, one long side of the rectangle indented to conform to the longitudinal valley on the clip's interface, the depth and width of the valley sufficient to allow the ridges alongside to define multiple circumferential lines of contact upon the tubular member to which it is to be clamped without materially weakening the clip.

3. A clip construction in accordance with claim **1** wherein said strip defines a V-shaped configuration which includes a central fold, the arm portions of said V extending angularly from said fold and bending toward each other into an approximately parallel relationship, said longitudinal valley disposed on the mutually opposed interfaces.

4. A hemostatic clip as described in claim **1** having multiple longitudinal valleys in side by side relation on the interior face of the clip arms.

5. A hemostatic clip as defined in claim **2** having multiple longitudinal valleys.

6. A clip construction in accordance with claim **1** in which said strip is formed of a surgical metal which retains the shape to which it is deformed.

7. A clip construction in accordance with claim **1** in which said strip is formed of a material slowly absorbable in body fluids and selected from the group consisting of collagen, gelatin, albumin, dried blood and synthetic materials.

8. A clip construction in accordance with claim **1** in which said strip is formed from a non-metallic, deformable, sterile material.

9. A clip construction in accordance with claim **1** wherein the depth and the width of the serrations is approximately equal to that of the longitudinal valley.

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