This invention relates to the anastomosis or hemostasis of bleeding vessels and also to the closing of arterial wounds. It relates more particularly to a surgical instrument for use in effecting same and elements used therefor and apparatus used therewith for loading the applicator with such elements.

To the present, anastomosis or hemostasis of bleeding vessels has been achieved by the laborious and time consuming techniques of stitching the separated segments of the bleeding vessel together wherein the stitches are allowed to rove uninfluenced until spontaneously complete epithelization. The use of such stitches has been employed in surgical operations to bring the separated segments together in closing longitudinal arterial wounds.

The use of stitches for anastomosis or the closing of vessels to stop bleeding and the like requires the complete separation and isolation of the bleeding vessel with respect to the surrounding tissue, etc., so that proper access can be had all around for stitching purposes. Such access is sometimes most difficult to achieve and the separation to acquire access sometimes causes displacement and stresses which are not only painful to the person on whom the operation is being performed, but such displacements may also have harmful effects.

The sewing of stitches is a time consuming operation which delays the stoppage of bleeding and thus exposes the patient to dangers from the standpoint of loss of life, excessive loss of blood, and interference with the rapid and effective cure of the wound.

Stitching techniques in anastomosis require the use of at least both of the hands of the physician and often the help of one or more assistants thereby to crowd an area where greater accessibility and freedom of movement is desired while also confining the physician to the slow and tedious job of a single anastomosis at a time when it may be desirable to have greater freedom in the use of one's hands and one's assistants in the various operative functions.

It is an object of this invention to provide a new and improved technique for anastomosis or hemostasis of bleeding blood vessels, etc. and for the closing of longitudinal arterial wounds, and it is a related object to provide elements for use in same.

Another object is to provide a clip means for use in surgical operations and more particularly for use in the closing of wounds or in the anastomosis or hemostasis of bleeding blood vessels and it is a related object to provide a new and improved applicator for use with clip means of the type described.

A further object is to produce a clip applicator which can be used in surgical operations and the like for closing bleeding blood vessels and in the anastomosis of bleeding blood vessels; which can be used to reach into otherwise relatively inaccessible areas for clip application; which is shaped for most efficient use in reaching various parts to be clipped in surgical techniques; which is capable of use easily, quickly and effectively to apply clip elements in the closing of wounds or in the anastomosis of vessels, and it is a related object to provide a means for loading the applicator with clips for use in the foregoing surgical functions.

A still further object is to produce a magazine loading device for loading individual clips in an applicator, which loading device is simple in construction and easy in operation for displacement of separated clips into the desired operative relation within the applicator and which operates simply and efficiently, without the necessity for skilled labor, excessive help, and without requiring the use of both of the hands of the surgeon, and it is a related object to provide a cartridge or magazine having a plurality of clip elements for use in the loading device.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings, in which:

FIG. 1 is a top plan view of a clip loading device embodying the features of this invention;
FIG. 2 is a sectional view taken substantially along the line 2—2 of FIG. 1;
FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 1;
FIG. 4 is a sectional view taken along the line 4—4 of FIG. 2;
FIG. 5 is a sectional view taken along the line 5—5 of FIG. 3;
FIG. 6 is a top plan view of a segment of the loading device, with portions cut away to illustrate various features of this invention;
FIG. 7 is an elevational view partially in section of the upper right hand portion of the device shown in FIG. 6;
FIG. 8 is a sectional view taken substantially along the line 8—8 of FIG. 7;
FIG. 9 is a top plan view of a clip applicator embodying the features of this invention;
FIG. 10 is a side elevational view of the applicator shown in FIG. 9;
FIG. 11 is a perspective view of an anastomosis clip embodying the features of this invention;
FIG. 12 is a fragmentary sectional elevational view illustrating the arrangement of elements for the insertion of a clip in a clip applicator with a loading device of the type shown in FIGS. 1 to 6;
FIG. 13 is a sectional view taken substantially along the line 13—13 of FIG. 12;
FIG. 14 is an elevational view partially in section illustrating the use of the applicator and clip in anastomosis of blood vessels;
FIG. 15 is a perspective view of the closing of a blood vessel in accordance with the practice of this invention;
FIG. 16 is a detailed elevational view showing the loading of the applicator with a cartridge embodying the features of this invention; and
FIG. 17 is a perspective view of the arrangement of parts to effect reloading of the applicator.

Concepts of this invention will hereinafter be described by reference to use of clips 10 in the anastomosis of blood vessels 12 to join the free edges 14 and 16 of the blood vessels to stop bleeding and until epithelization takes place to make the joiner permanent. It will be understood that the concepts described will have application to the use of clips in the joiner of other separated segments of blood vessels or tissues, either for joiner or for grafting or in hemostasis of bleeding blood vessels, or in closing of arterial longitudinal wounds, and the like.

The clip member 10 which is employed in the practice of this invention may be supplied in the form of a strip of material of small dimension having a central body portion 18 and end portions 20 and 24 which are turned in the same direction to extend at an angle up to about 90 degrees from the body portion 18 and at an angle between 60 to about 90 degrees. The outer edges of the turned end portions 20 and 24 are formed
with teeth 26, serrations or other configurations adapted to establish a better gripping relationship with the portion of the tissue or vessel adapted to be clamped between the edges when the clip 10 is bent into position of use, as shown at the bottom of FIG. 14 and in FIG. 15. The body portion 38 is designed to define the area of bend when the end portions of the clip are subjected to a squeezing action or compression to bring the turned end portions together for gripping the desired portion of tissue therebetween. For this purpose, the body portion can be formed with mid-portions 28 of lesser width than the remainder or other lines of weakness can be introduced wherein the applied longitudinal squeezing forces will be effective to cause the desired bend in the body portion.

The clip members should be of a character which can be allowed to remain in the body for an extended period of time without undesirable side effect. For this purpose, it is desirable to make use of clips of minimum dimension and formed of metals ordinarily used in surgery, such as stainless steel, tantalum, Vitalium, etc. Instead of forming the clips of metal which can be allowed to remain in the system at least until epithelialization has taken place, considerable benefit can be derived from the use of clips formed of materials which are slowly absorbed by the body fluids but have exerted their intended function of retaining the joint edges of the vessels in contact one with another until the wound has healed or until epithelialization has progressed sufficiently that the additional clamping power of the clips is no longer needed. Such absorbable materials for clips may be fabricated of chromo-tized gelatin, albumens, various slightly water soluble resinsous materials, and the like.

The clips may be formed to various dimensions depending upon the use to be made of the clips and the character of the vessels or tissues to be anastomozied. They may be formed of various other shapes and constructions both in the body portion and in the gripping end portion. For example, the body portion may be formed of uniform width or cross-section but with a slight bend or curvature in the same direction as the bend in the ends of the clips so that the body portion will collapse in response to compressive squeezing at the ends to bring the inturnd ends 20 and 24 in clamping relation, as illustrated in FIGS. 14 and 15.

The clip applicator 30 comprises a forceps or tong formed of a pair of elongate rods 32 and 34 having a longitudinal alignment on the same line to be received on the pin 66 in the case of clampers and a pair of clamping jaws 38 and 40 at the opposite end of the rods. The clip applicator is formed as a pair of clamping jaws with a pivot pin 42 so that displacement of the handle portion in the direction away from each other will increase the spaced relationship between the clamping jaws 38 and 40 while the jaws will close towards each other another in response to gripping the handle portion to bring the ends in the direction towards each other. The handle and the clamping jaws are constantly urged towards their spread or open position by means of a resilient member, such as a leaf spring 48, and a pivot pin 42. So that displacement of the jaw members beyond the position 42 will cause the jaw members to return to the spread or open position 42, the clamping jaws 38 and 40 are held by an inner surface of one of the rod members beyond the pivot 42 while the free end portion 50 of the leaf spring bears against the adjacent wall of the other rod member 32. To maintain the resilient means in proper engagement between the adjacents end portions of the applicator may be employed.

Having defined the clip and clip applicator, illustration will now be made of the use thereof in joining the adjacent ends 14 and 16 of blood vessel 12. In practice, the adjacent ends are gripped by calipers or other suitable surgical tool and brought together with the end portions extending of the vessel portions being placed in contact as illustrated in FIG. 14. While so retained, the open end of the clip applicator with the clip 10 in position of use is brought into endwise alignment with the abutting ends of the vessel and with the inturnd portions more or less overlapping the edges of the vessels. Thereafter, when the handle portion is brought to the body portion is adapted to clamping and the portions are rocked about their pivot in the direction towards each other to apply compression onto the ends of the
clip located therebetween. This will cause the clip to collapse by bending about the mid-section whereby the turned in end portions 20 and 24 are displaced towards each other with a rolling motion within the retaining recesses to bring the clamping ends together and engage the vessels in gripping relationship therebetween. While the gripping relationship will exist substantially throughout the length of the bent clip, a more effective clamping action is achieved at the intumed end portions spaced a short distance inwardly from the outer edge of the flange formed by the joined vessels. Additional clips are applied in the same manner to circumferentially spaced apart portions of the joined ends of the vessels until a sealing relationship is established all around.

When completed, the edge portions of the joined vessels will extend outwardly in abutting relationship to form an annular flange having a plurality of clips circumferentially spaced to hold the abutting end portions together. The described flange arrangement enables the clips more effectively to secure the elements together and it further provides an increased surface area for more effectively achieving a sealing relationship between the vessels to stop bleeding and to accelerate epithelialization.

It will be apparent from the foregoing that the clip apparatus has been adapted for use for clip application at the site of the rupture or wound which may at times be located at innermost or remote portions of the body where access is difficult without displacement for separation or isolation of the blood vessels. It will be further apparent that the clip applicator should be capable of use for clip application at various angles in order completely to close the joined vessels all around. It has been found that this can be achieved by the construction of the clip applicator with a slight bend 74 in an intermediate portion of the rods and with a rather sharp downwardly turned portion 76 immediately beyond the clamping end portion and more preferably between the clamping end portion and the pivot.

Thus a physician can reach to areas to which access is difficult without obstructing the view of the physician in carrying out the exacting operation.

It has been found difficult to handle the tiny clips found for insertion manually into position of use between clamping jaws of the clip applicator and it has been found difficult manually to insert the clips while maintaining the desired degree of sterilization. Thus, it is a further concept of this invention to provide a means for supplying clips in sterilized condition and for loading the clips into the clip applicator in a simple and efficient manner without contamination of the clips and without requiring the use of excessive time or skills.

In the figures, illustration is made of a loading device 80 to provide two clip loading mechanisms which are the same in construction and operation but different in dimension whereby one is adapted for use in loading clips of one size while the other is adapted for loading clips of another size for which the clip applicator has been designed.

It will be understood that the loading device can have but one loading mechanism for use with clips of one dimension or a number of loading mechanisms for use with clips of different dimensions. Since the construction and operation is the same, it will suffice hereafter specifically to define but a single loading mechanism.

The loading device comprises a base plate 82 having a housing 84 secured onto the top side thereof means of hold-down bolts 86. An elongate slot 88 is provided in the surface of the base plate beneath the housing slidably to accommodate to a width corresponding to the width of the slot and a length less than the length of the slot to enable reciprocal movement of the actuator bar between a forwardly operated position and a retracted or normal position within the assembly. The actuator is constantly urged towards its retracted position by a coil spring 92 having one end 94 anchored onto a stud rigid with the rearward end portion of the actuator bar while the other end 96 is anchored onto a stud 98 extending forwardly from the base plate into a rearward end portion of the slot.

Means are provided externally of the base plate and housing for displacement of the actuator from retracted to operated position. Such means, illustrated as a bell crank lever 100 having a horizontally disposed operating arm 102 which is located outwardly of the base plate and the housing assembly, has an operating handle which is accessible for manipulation. The other arm 104 extends downwardly through a slot 106 in the housing in vertical alignment with a pivot pin 108 extending laterally from the actuator onto which the end portion of the lever arm is pivotally connected to effect lengthwise displacement of the actuator in response to rocking movement of the lever arm. The lever arm can be pivoted for rocking movement about a portion of the housing through which it extends and it is preferred pivotally to mount the lever arm a greater distance from the pivot to increase the length of stroke. Thus, as illustrated in FIG. 2, an adaptor 110 is secured by hold-down bolts 112 onto the top side of the housing in vertical alignment with the actuator and the adaptor is provided with a slot 114 vertically aligned with the slot 106 to enable the arm of the bell crank lever to extend continuously downwardly therethrough. The adaptor 110 is provided with a pivot pin 116 about which the intermediate portion of the bell crank lever is pivoted to cause lengthwise displacement of the downwardly extending end portion 104 in response to upward and downward displacement of the operating arm 102.

The actuator is dimensioned also to have a height slightly less than the height of the slot to enable a slight amount of play in the vertical direction, at least in the leading end portion. It is desirable constantly to urge the actuator towards its raised position for purposes which will hereinafter appear. This can be effected by resilient means, such as a leaf spring 118, which is confined within an opening 120 in the bottom side of the actuator with one end of the leaf spring secured to the top wall of the actuator at the top side of the slot by the stud 122 while the other end slightly bears on the portion of the base plate defining the bottom wall of the slot. Alongside the slot 88, the housing 84 is provided with an elongate slot 124 in the bottom side thereof which extends lengthwise from an inlet at the rear to an outlet at the front. The slot 124 is dimensioned to correspond in cross-section with the cross-section of an elongate cartridge 126 having a rib 128 extending upwardly from the top side dimensioned to have a width corresponding to the spaced relationship to the intumed end portions 20 and 24 of the clip members but less than the width of the base 130 of the cartridge. The top surface of the rib is provided with a plurality of longitudinally spaced apart, crosswise extending grooves 132 having a length corresponding to the width of the body portion of the clip members releasably to seat the clips in fitting relationship therein.

It is desirable that the movement of the actuator from retracted to operated position be transmitted to the cartridge for forward displacement of the cartridge by an increment corresponding to the spaced relationship between the clip members so that each clip member will be placed to the position previously occupied by the previous clip member in response to the operation of the actuator from retracted to operated position.

For this purpose, the underside of the cartridge is provided with longitudinally spaced apart, crosswise extending rack teeth 134 having an abrupt vertically disposed back wall and a downwardly inclined front wall. The rack teeth are spaced to correspond with the spacing between the receiving grooves 132 on the ribs or multiple thereof. Forward movement of the actuator from retracted to operated position is transmitted to the cartridge by means of an extension 136 on the forward end
of the actuator which projects crosswise and forwardly through a contiguous slot 138 in the top side of the base plate to the position underlying the rack on the bottom side of the cartridge. The end portion of the extension 136 underlying the rack is provided with an upstanding pawl 149 having an abrupt vertically disposed front wall and a downwardly inclined or tapered back wall. Means are provided to adjust the amount of lengthwise displacement of the actuator per stroke to effect displacement of the cartridge by an amount corresponding to the distance between the centers of the spaced clip holders or grooves 132 formed thereon. In the illustrated modification, such stop means comprises a pin 142 spaced forwardly from the end of the extension by an amount corresponding to the length of stroke whereby when the actuator is displaced from normal to operated position, the recessed forward end portion of the extension engages the stop pin 142.

It is also desirable to block return movement of the cartridge responsive to return of the actuator and pawl from operated to retracted position. One such blocking means, illustrated in FIG. 3, comprises a spring arm 144 having its rearward end portion 146 anchored to the base of a recess 148 in the top wall of the base plate by a holding pin 150 while the forward end portion of the spring arm is turned upwardly by an amount to provide a plane beyond the surface of the base plate and into the path of the rack teeth 134 on the underside of the cartridge so that the spring arm can be cammed downwardly by the engaged inclined cam surfaces of the rack teeth to clear the rack teeth during forward displacement of the cartridge but which confronts the abrupt back wall of said teeth upon clearance to block movement of the cartridge in the rearward direction.

The housing is provided with a vertically disposed applicator slot 152 extending downwardly through the housing in vertical alignment with the rib 128 on the cartridge whereby the clips are brought into registry with the slot 152 responsive to operation of the actuator from normal to operated position. The slot 152 is dimensioned to have a length slightly greater than the width of the clamping end portions of the applicator and a width which is slightly greater than the width of the clips plus the width of the clamping end portions of the applicator so that when the clamping end portions of the applicator are inserted through the slot, the concave recessed portions 54 will be in crosswise alignment with the groove portion 132 of the rib 128 to receive a clip therebetween as the clip is advanced by the slotter into the slotter.

The cartridge 126 is formed with a rounded nose 154 to facilitate entrance of the cartridge into the passage 124 through the housing. The cartridge is adapted to be assembled with a removable cover 156 which encloses the sides and the top wall, including the rib, there by effectively to hold the clips in position of use on the crosswise seats and to protect the sterilized clips against contamination. The cover 156 is formed with a slot 158 in the underside conforming to the contour of the cartridge completely to enclose the side and top walls of the cartridge. It can be dimensioned to have a length corresponding to the length of the cartridge but it is preferred to form the cover to a length slightly less than the cartridge so that the leading end portion of the cartridge can be free for insertion into the passage for displacement therethrough in feeding relation. Because the clips do not extend to the end of the leading edge of the cartridge, it will be apparent that even if the cartridge is displaced through the passage into a position to be engaged by the actuator pawl, a number of actuation cycles will be required for displacement of the cartridge until a clip comes into registry with the applicator opening 152, the cover is left on the cartridge to protect the clips. The cartridge is displaced from within the cover stepwise as the cartridge is actuated stepwise through the housing.

In practice, the cartridge with the cover is brought into endwise alignment with the passage 124 through the housing. The operating lever arm 102 is depressed to advance the applicator whereby the pawl engages the back side of the rack teeth to effect corresponding displacement of the cartridge until the actuator is stopped by the pin 142. This may be repeated as many times as there are rack teeth in advance of the clip seats or until the next actuation will bring a clip into registry with the applicator opening 152.

Thereafter, the clamping end portion of the applicator is inserted into the cases and the desirable jaws the cartridge are displaced 38 and 40 in spread position. This will place one clamping end portion on each side of the rib 128 with the concave portions 154 aligned with the turned down ends 20 and 24 of the clips. The operating lever 102 is then depressed to advance the cartridge one increment.

This will advance the clip sidewise into the recessed portion of the clamping ends of the applicator. Thus, when the applicator is raised for removal of the clamping end portions from the applicator opening, the clip will be retained between the clamping ends in position of use to engage segments of tissue, vessels, etc. for joining, as previously described. Then the handles portions 36 of the applicator are squeezed and the clamping end portions are brought together to deform the clip clamping portion, removal of the clamping end portions to spread position responsive to actuation by the spring 44 will enable the clamping end portions of the applicator to clear the applied clip for separation so that the clipping member can be re-inserted into the clamping opening for reloading. Thus when the clip has been used, the operations are repeated by re-insertion of the clamping end portions into the applicator opening and again advancing the cartridge to bring the next clip into engagement between the clamping members.

Upon release of the operating lever arm 102, the spring 92 becomes effective to cause return of the actuator bar 90 to retracted position whereby the operating lever arm is rocked about its pivot for return to raised position. Upon return of the actuator bar 90 to retracted position, the spring 140 is cammed downwardly against the force of the spring 118 by the cam edge of the rearwardly rack tooth until the back wall of said following tooth is cleared whereupon the leaf spring 118 will cause the actuator and pawl 140 to snap upwardly behind the vertical wall in position for the next cycle of operation for displacement of the cartridge and its supported clips into the waiting jaws of the applicator. This operation can be repeated until the clip is free of clips after which it can be displaced forwardly manually for removal from the housing while a new cartridge is introduced from the back side of the housing.

It will be apparent that the clips, cartridge, applicator, and loading device will have uses in addition to the applications described for anastomosis, etc., and that they can have uses separate and apart from each other thereby to define subject matters for separate inventions. The clips may be used in other operational techniques adapted to hold or connect tissues or other elements in the body as well as on the skin surface whereby the applicator, loading device, cartridges, etc. will have utility in combinations therewith.

It will be further apparent that in the utilization of the elements embodying the features of this invention in anastomosis, etc., it is desirable to have used tissues or vessels in a suitable edge-to-edge or surface-to-surface relation for use of the clips in maintaining such relationship until anastomosis or healing has been sufficiently advanced. Thus the edge portions of the blood vessel to be joined are arranged with the inner surfaces abutting relationship as in FIGS. 14 and 15. However, other arrangements for anastomosis can be effected.
It will be understood that changes may be made in the details of construction, arrangement and operation, as well as in the processing steps, without departing from the spirit of the invention, especially as defined in the following claims.

We claim:

1. An applicator for surgical clips having an elongate body portion with turned in ends comprising a pair of elongate arms pivoted on one another intermediate their ends, one end portion of said arms being formed with a handle portion and the other end portion comprising clamping end portions whereby the clamping end portions are displaced between open and clamping positions responsive to actuation of said handle end portions in the direction toward and away from each other, said clamping end portions being formed with recesses in the facing edges conforming substantially to the contour of the turned in end portions of the clips and lips extending inwardly substantially horizontally from the outer ends of said recessed portions in the direction towards each other, means for limiting pivotal movement of the arms to a predetermined open position in which the spaced relationship between the recesses in the clamping end portions of the arms correspond substantially to the length of the clips releasably to support the clips inserted therebetween, means for constantly urging the arms towards open position and whereby pressure on said handle means in opposition to said urging means operates to deform clips held between said clamp end portions.

2. An applicator as claimed in claim 1 which includes a slight bend in the intermediate portion of the handle portion and a relatively sharp bend in the same direction in the clamping end portion between the clip receiving end and the pivot.

3. An applicator for surgical clips having an elongate body portion with turned in end portions comprising a pair of elongate arms pivoted intermediate their ends for rocking movement between open and closed positions, handle members at one end of said arms and clamping members on the opposite ends of said arms, recesses in the facing edges of said clamping end portions conforming substantially to the contour of the turned in ends of the clips, adjustable means for varying the limits to which the arms can be rocked to open position, said adjustable means including a first portion adapted to provide for spacing of the recessed portions in the clamping end portions to correspond with the length of the clips of one size when in open position, said adjustable means including at least one additional position adapted to provide for spacing of the recessed portions in the clamping end portions to correspond with the length of clips of a second size when in open position, and means constantly urging said arms towards open position and in which the adjustable means for varying the open position of the clamping end portion comprises a plate pivotally mounted at one end on a side wall of one of said arms, spaced recesses in portions of said plates spaced from the pivot by variable distances, an opening communicating said recesses, and a stop pin extending from the same side of said other arm into said opening whereby selected ones of said recesses can be aligned therewith for entrance of the pin to define the open position.

4. An applicator as claimed in claim 3 which includes knob means integral with said plate for rocking said plate about its pivot to a desired position of adjustment.

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