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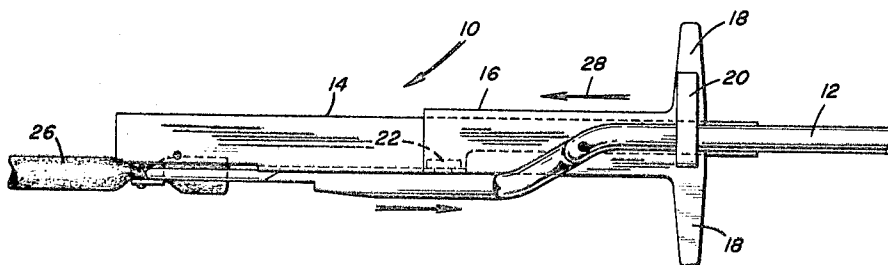
[54] **HEMOSTAT UNIT**
9 Claims, 10 Drawing Figs.

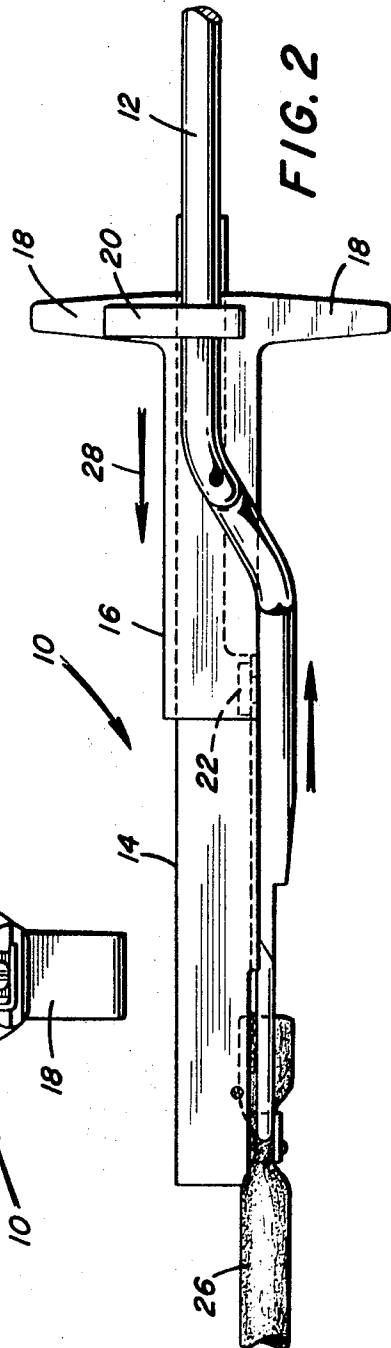
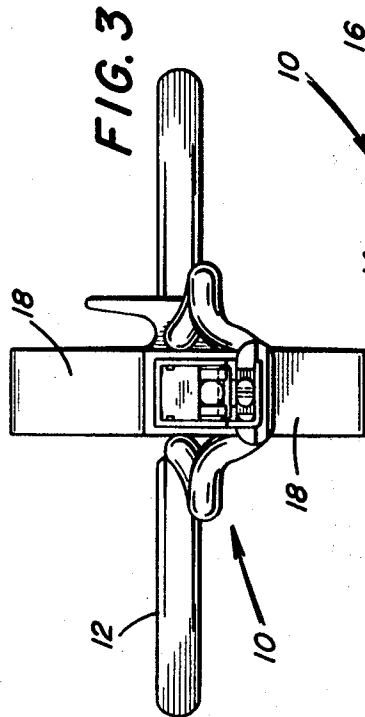
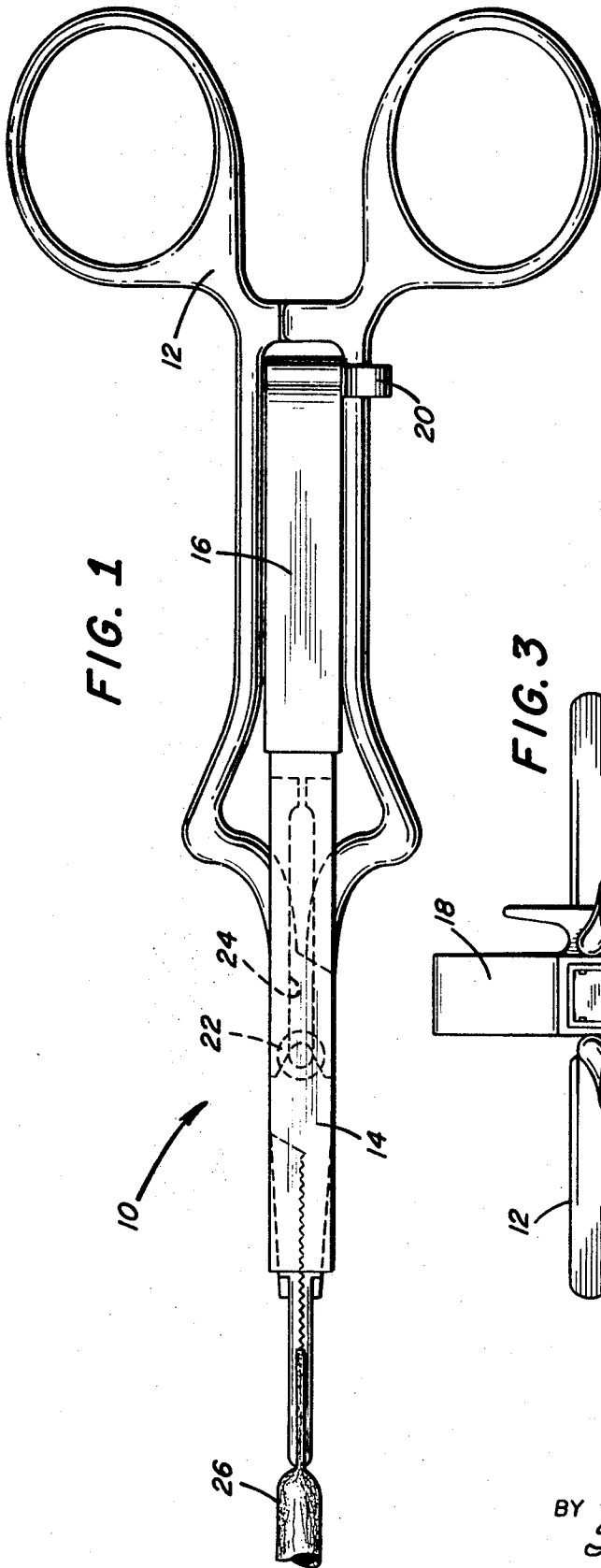
[52] U.S. Cl. **227/120,**
227/19
[51] Int. Cl. **B25c 5/02**
[50] Field of Search 227/19,
120, 143, 144

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ABSTRACT: A hemostat unit comprising, in combination, a hemostat and a staple carrying and ejecting system for clamping a fluid-carrying artery and stapling same so as to seal off the flow of fluid. A plurality of staples is positioned on respective threads of a screw, which screw is turned one revolution each time the unit is activated. A vertically oriented driver, slidably mounted in the forwardmost part of the stapling unit, serves to eject the staples one at a time and to force same against an anvil to shape the staples. The driver is moved in response to the movement of a rotatably mounted driver-activating member, which latter member is caused to pivot in response to the command of the operator.

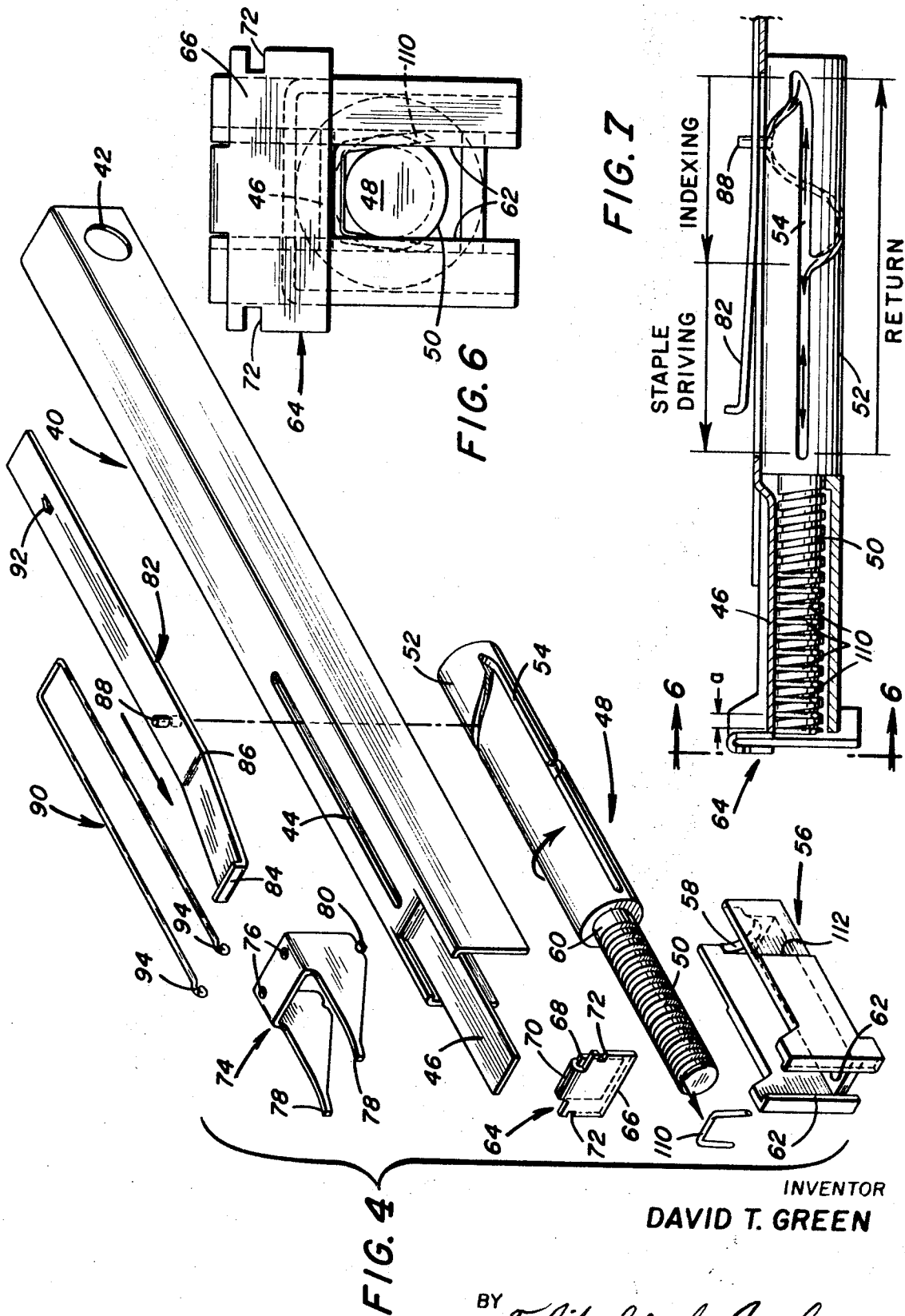




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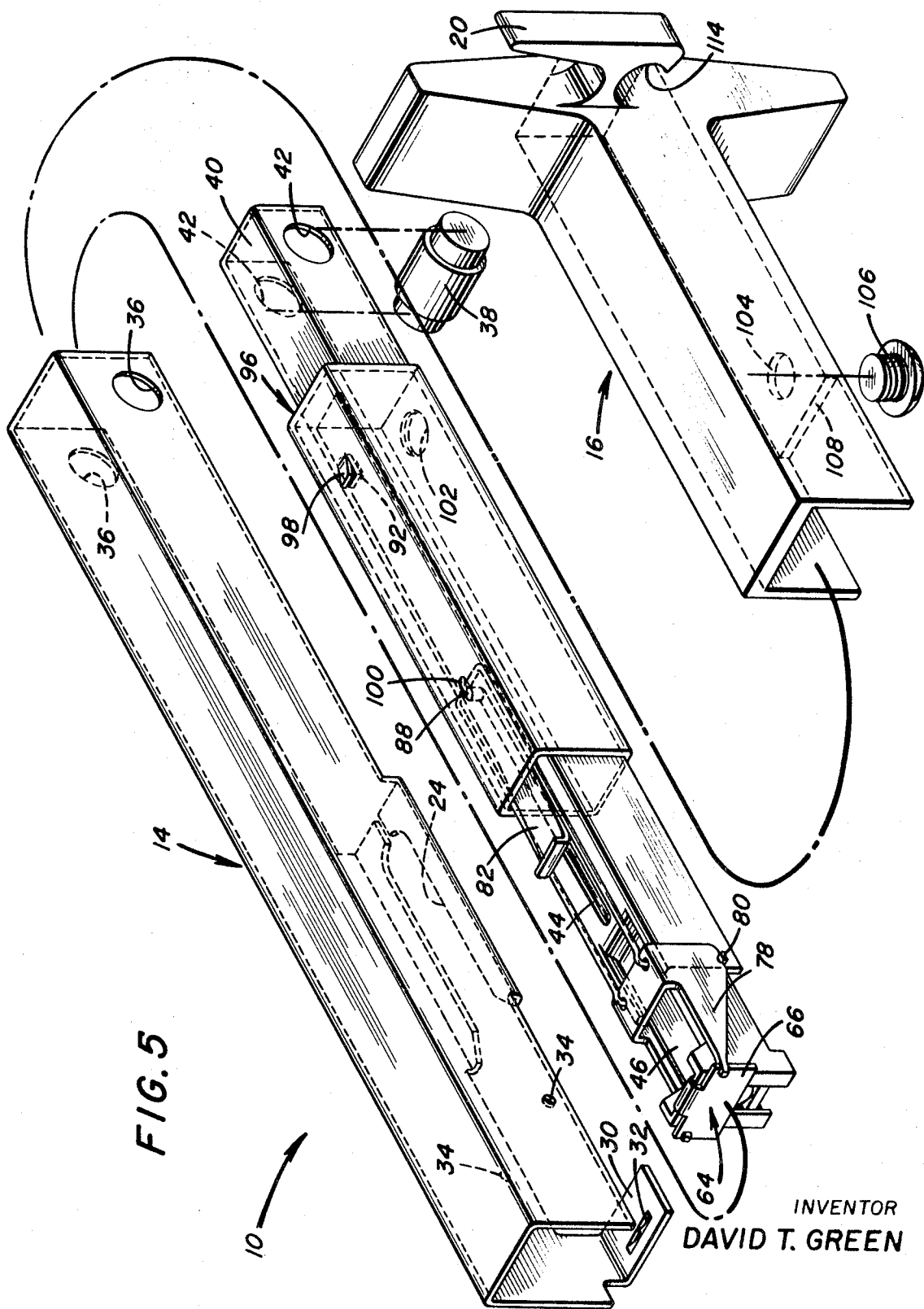


FIG. 5

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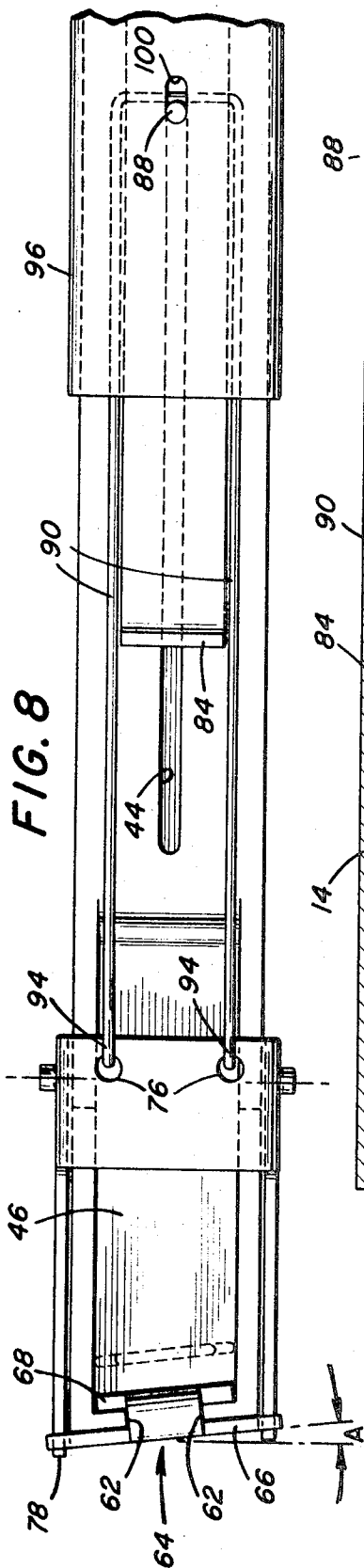


FIG. 8

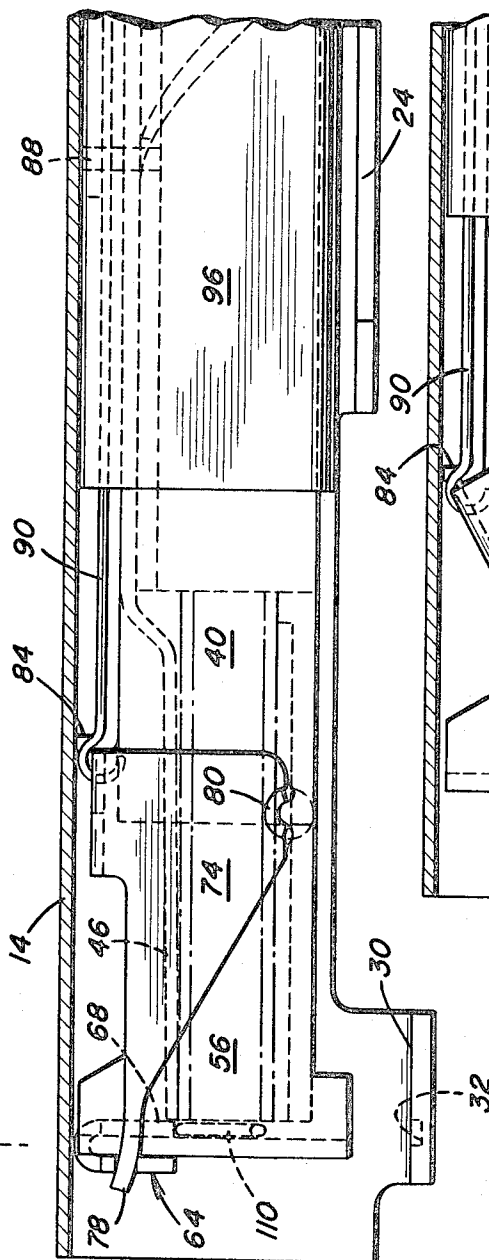


FIG. 9

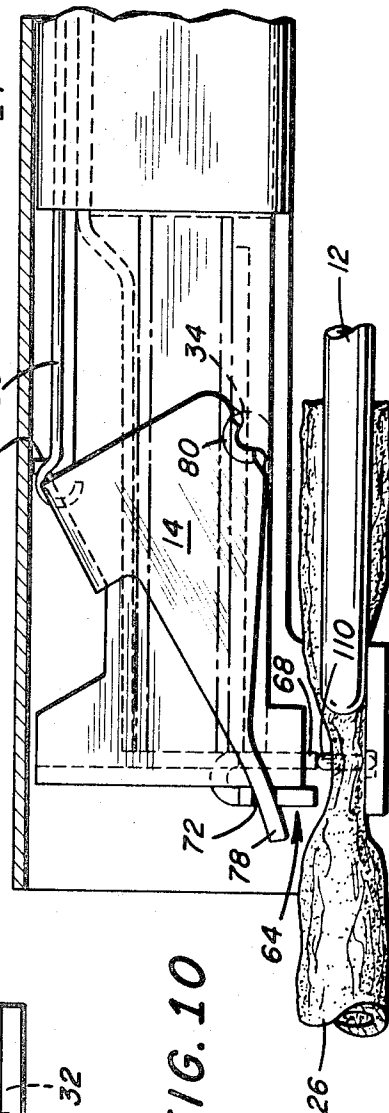


FIG. 10

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HEMOSTAT UNIT

BACKGROUND OF THE INVENTION

A hemostat with a detachably mounted stapling attachment is known. Such an instrument is described in copending U.S. Pat. application Ser. No. 766,544, filed on Oct. 10, 1968, entitled "Medical Instrument." In this copending application, the driver element is securely mounted on a long arm adapted to pivot about an axis remote from the driver element. This arm is acted upon and is caused to pivot through the action of a wedge-shaped member which slides along the arm and thereby forces the driver to eject and form a staple on an anvil assembly.

It has been found, due to the substantial length of the pivoting arm on which the driver element is mounted, that smooth operations are difficult to attain. This results since the tolerances of such an instrument are small and since the extreme length compounds the inaccuracies of the slide fit between individual members of the compound instrument. Therefore, the elements of the instrument disclosed in the above-noted copending patent application must be of extremely close tolerances and must be constructed with great care.

SUMMARY OF THE INVENTION

The present invention relates to a hemostat unit comprising a hemostat and a stapling assembly detachably mounted thereon. The stapling unit of the present invention avoids the problems of the prior art, particularly, the problems involving the alignment and the tolerance of the individual elements of the unit.

A vertically oriented driver is slidably mounted in the forwardmost portion of the stapling unit. The operation of the driver is controlled by a pivotally mounted driver activating member, which member, in turn, is caused to pivot in response to the position of a thin slidable member which moves in response to the command of the operator.

The driver, being slidably mounted and small in size, may eject a plurality of staples with great accuracy and dependability. This is the case since the movement of the driver is restricted to a small area and is carefully controlled.

Accordingly, it is the main object of the present invention to provide a stapling unit to be detachably mounted on a hemostat, which unit accurately effects the ejection of a large number of staples with great dependability.

It is another object of the invention to provide an efficient staple-ejecting unit which may be manufactured without the need for prohibitive tolerances.

Yet another object of the invention is the provision of a staple carrying cartridge adapted to fit on a hemostat, which cartridge is relatively inexpensive and which may therefore be discarded and replaced when exhausted.

These and other objects of the invention, as well as many more of the attendant advantages thereof, will become more readily apparent when reference is made to the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a hemostat adapted with the staple carrying and ejecting cartridge of the present invention;

FIG. 2 is an enlarged side view of the unit shown in FIG. 1;

FIG. 3 is a front view of the hemostat and cartridge assembly shown in FIG. 1;

FIG. 4 is an exploded perspective of the staple carrying and ejecting cartridge of the present invention, absent its cover and handle;

FIG. 5 is a perspective view, partially exploded, of the staple carrying and ejecting mechanism of the present invention;

FIG. 6 is a front view of the staple carrying assembly taken along lines 6-6 of FIG. 7;

FIG. 7 is a side view, partially in section, of the staple carrying screw with its associated camming surfaces showing the indexing, driving, and returning stages of operation;

FIG. 8 is a top view of the forward part of the carrying cartridge of the present invention, with the cover removed;

FIG. 9 is a side view of the unit shown in FIG. 8 after the staple-indexing operation, but immediately before the staple-driving operation; and

FIG. 10 is a view similar to FIG. 9 but showing the cartridge at the end of the staple-driving operation.

DETAILED DESCRIPTION OF THE DRAWINGS

With reference first to FIGS. 1 through 3, the inventive staple carrying and ejecting unit is shown generally at 10, mounted on a hemostat 12. The unit 10 comprises a main body portion enclosed by a cover 14 and a handle portion 16. The handle portion 16, at its rearwardmost region, defines a pair of extensions 18, which extensions serve to facilitate the operation of the unit. Integral with the handle 16 is a flange 20 serving to hold the unit 10 on the hemostat 12, and further serving to maintain the unit 10 on the hemostat 12 are a pin 22 integral with the hemostat 12 and a slot 24 carved into the bottom of the cover 14. The slot 24 is elongated, allowing the unit 10 to slide along the body of the hemostat 12.

As noted immediately above, the staple carrying and ejecting unit 10 is slidably mounted on the body of the hemostat 12. The reason for this is as follows. When the unit 10 is in its rearwardmost position, as illustrated in FIG. 1, the hemostat 12 is free to open and to grasp a fluid-carrying artery such as that shown at 26. Then, when it is desired to perfect the stapling of the artery 26, the unit 10 is slid along the body of the hemostat 12 into the position illustrated in FIG. 2, the unit 10 being free to slide until the rear portion of the slot 24 engages the pin 22. Then, as will be explained below, forces acting on the extensions 18 in the direction of arrow 28 cause a staple to be ejected and clinched in the artery 26.

With reference now to FIGS. 4 and 5, the construction of the staple carrying and ejecting unit 10 is described.

The cover 14 of the unit 10 is best shown in FIG. 5. But for the region of the cover 14 defining the slot 24, the cover is U-shaped and bottomless and has, at its forwardmost region, and anvil 30 provided with staple-clinching grooves 32. Near the forward region of the cover 14 are a pair of small bores 34 which, as will be explained below, serve as a pivot axis for a driver-activating member. And near the rear of the cover 14 are a pair of large bores 36 which serve to seat a pin 38 adapted to maintain a fixed relationship between certain of the elements of the staple carrying and ejecting unit 10.

Adapted to fit within the cover 14 is a U-shaped liner 40, best shown in FIG. 4. The liner 40 is provided with a pair of bores 42 similar in diameter to the bores 36 in the cover 14. Pin 38 is adapted to fit through the bores 36 and 42, respectively, and to maintain a fixed relationship between the cover 14 and the liner 40. The liner 40 is provided with a slot 44 on its upper surface, the function of the slot 44 being described below. The upper surface of the liner 40, forward of the slot 44, is cut and bent downwardly and defines an extension 46 for maintaining the staples in their proper position. This, too, is more fully explained below.

The cartridge of the present invention is further provided with a staple carrying screw 50 and a cylindrical cam 52, the total unit being shown generally at 48 in FIG. 4. The screw 50 is threaded and serves to maintain the proper positioning between staples, and further to guide the staples toward the anvil 32. The cam 52 is in the form of an enlarged-diameter cylinder having camming grooves 54, the functions of which grooves are explained below.

The assembly 48 is supported, at its forwardmost region, by a support element 56 provided with an arcuate surface 58 for supporting the assembly 48 at 60. The element 56 is U-shaped and is of a width sufficient to support the screw 50, loaded with staples, while restraining the staples which are resiliently

biased against its walls. The forwardmost region of the support element 56 is fitted with a pair of inwardly directed flanges 62 which serve as a guide for a driver element 64.

As best seen in FIG. 4, the driver element 64 has a front leaf 66, a rear leaf 68 and a connecting member 70. In the front leaf 66 there is provided a pair of aligned notches 72, the function of which is explained below.

As best seen in FIG. 5, the driver element 64 is positioned on the support element 56 so that the front and rear leaves of the driver sandwich the flanges 62 of the support element 56. In this manner, the driver 64 is able to slide vertically on the support element 56. As is evident from FIGS. 4, 5, and 6, the front leaf 66 of the driver element 64 is wider than the rear leaf 68. The dimension of the front leaf 66 is such that the notches 72 extend outwardly with respect to the outer surfaces of the support element 56; the rear leaf 68 is dimensioned so that it comfortably slides within the inner walls of the element 56.

Serving to control the motion of the driver element 64 is a driver-activating member 74. Member 74 has a U-shaped body, the top of which is provided with a pair of bores 76 and the sides of which are each provided with a forwardly projecting arm 78. Near the bottom of the driver-activating member 74 is a pair of outwardly extending projections 80, adapted to engage the holes 34 in the cover 14, and thus defining the pivotal axis about which the driver-activating member 74 pivots. As best seen in FIG. 5, the forwardmost part of each arm 78 is adapted to engage a respective slot 72 in the driver element 64.

Serving to control the operation of the driver-activating member 74, and therefore the operation of the driver element 64, is a thin elongated control element 82. The forwardmost part of the element 82 defines an upwardly extending flange 84 normally biased against the upper wall of the cover 14 as a result of a bend in the member 82 at 86. The control element 82 is fitted with a pin 88, extending both upwardly and downwardly from the plane of the element itself. The upper region of the pin 88 extends a distance sufficient to trap the rear surface of a U-shaped retracting wire 90 between the control element 82 and the upper wall of the cover 14. The lower region of the pin 88 is of a length sufficient to extend through the slot 44 in the liner 40 and into the camming grooves 54 in the cylindrical cam 52. At the rear of the control element 82 there is provided an upwardly extending flange 92, the function of which is fully explained below.

As best seen in FIG. 4, the U-shaped retracting wire 90 is fitted with a pair of hooks 94 at the forwardmost end thereof. These hooks are adapted to fit through holes 76 in the driver-activating member 74. In this manner, the pivoting of the member 74 in the clockwise direction may be controlled by pulling the retracting wire 90 toward the right.

As seen in FIG. 5, the staple carrying and ejecting unit 10 further comprises a sleeve 96 surrounding the liner 40, the sleeve 96 having an inner diameter greater than the outer diameter of the liner 40, thereby allowing relative motion therebetween. The rearward portion of the sleeve 96 is provided with a hole resulting from the provision of an upwardly extending flange 98. The flange 92 on the control element 82 is adapted to engage the hole in sleeve 96. The sleeve 96 is rectangular in cross section and has, on its top surface, a small slot 100 carved therein. On the bottom surface of the sleeve 96 is threaded bore 102, adapted, when in alignment with a similar bore 104 provided in the bottom surface of the handle portion 16, to accept a screw 106. When the screw 106 extends through the bore 104 and threads into the bore 102, relative motion is prevented between the handle portion 16 and the sleeve 96. A vertical wall 108 in the handle portion 16, defined where the handle portion transforms from a U-shaped cross section to a rectangular cross section, is provided to abut a corresponding vertical wall in the cover 14, thereby limiting the forward stroke of the handle portion 16 with respect to the cover 14.

The staple carrying and ejecting unit 10 is assembled as follows. The cylindrical assembly 48 is positioned in the support element 56 and a plurality of staples 110 is loaded therein. The staples 110 are positioned in the threads of the screw 50 so that the points thereof are directed toward the anvil 30 and are biased against the walls of the support element 56 so that they are prevented from falling out of the support element when in readiness for a stapling operation. The liner 40 is then positioned over the support element 56 so that the extension 46 maintains the staples 110 against the threads of the screw 50. It will be noted that the sidewalls of the support element 56 are stepped so as to define a ledge 112 adapted to abut the sidewalls of the liner 40 when these elements are in association with each other.

As best seen in FIG. 5, the driver element 64 is mounted on the flanges 62 provided on the support element 56, and the notches 72 in the front leaf 66 are engaged by the arms 78 of the driver-activating member 74. The elongated control element 82 is fitted atop the liner 40 so that the pin 88 extends downwardly through the slot 44 in the liner. The retracting wire 90 is looped around the upper portion of the pin 88, and the hooks 94 are made to engage the driver-activating member 74 at the holes 76. The sleeve 96 is then positioned over the liner 40 and control element 82 so that the pin 88 extends upwardly through the slot 100 in the sleeve 96. The cover 14 is then positioned over the entire unit and the pin 38 is placed in position, the pin passing through bores 36 in the cover 14 and bores 42 in the liner 40. Then, the handle 16 is positioned over the cover 14 and placed in alignment with the sleeve 96 so that the screw 106 may be passed through the bore 104 and screwed into the bore 102.

The staple carrying and ejecting unit 10, completed as described above, is then brought to the hemostat 12 and the pin 22 on the hemostat is aligned with the slot 24 in the cover 14. The flange 20 on the handle 16, at 114, is then made to engage the body of the hemostat 16. The handle 16 and the flange 20 are made of a pliable material so that the flange may snap about the body of the hemostat 16, thereby maintaining a close but slidable fit therebetween. The unit is then ready for a stapling operation.

Referring now to FIG. 7, the functions of the cam 52 and its grooves 54 are best explained in this FIG. As pictured, the lower part of pin 88 engages the groove 54. When the central element 82 is stroked in the forward direction, the pin 88 slides in the groove 54 in a manner which causes rotation of the staple carrier 50. After one complete revolution of the carrier 50, that amount necessary to advance a staple into a position ready for ejection, the pin 88 is allowed to slide forward in the groove 54 without rotating the carrier 50. The interval during which the staple carrier 50 rotates is termed the indexing period, the period during which the pin 66 slides forward without a corresponding rotation in the carrier 50 is termed the staple-driving period, and the period during which the instrument is reverting to its readiness position is termed the return period.

The relationship between the individual elements in the inventive unit 10 will now be described with particular reference to FIGS. 1, 2, 5 and 7.

The assembled staple carrying and ejecting unit 10 is first positioned on the hemostat 12, taking the position shown in FIG. 1. The clamping surfaces of the hemostat 12 are opened and the artery 16 is clamped therebetween. The unit 10 is then slid forwardly on the hemostat 12 until the rear surface of the slot 24 engages the pin 22, taking the position shown in FIG. 2. Then, when ready to staple the artery 26, the operator exerts a force on the extension 18 to urge the handle 16 in the direction of the arrow 28 shown in FIG. 2. Since the handle 16 is united with the sleeve 96, by screw 106, a forward motion of the handle 16 causes a corresponding forward motion in the sleeve 96.

As best shown in FIG. 5, when the sleeve 96 moves forward, its slot 100 moves forward with respect to the pin 88 integral with the control element 82. When the rear portion of the slot

100 engages the pin 88, the control element 82 is thrust forwardly. As is clearly shown in FIG. 7, the early stages of movement in the control element 82 cause the cam 52 to rotate. Therefore, the staple carrier 50 rotates, carrying forward each staple housed in the support element 56. It should be noted that with each forward stroke of the pin 88, the screw representing the staple carrier 50 is rotated one revolution and, therefore, each staple is moved forward one staple unit *a*. (See FIG. 7.) This is the indexing.

After the indexing operating is completed, the pin 88 associated with the control element 82 freely slides in the groove 54 without corresponding rotation in the staple carrier 50. Next, the upstanding flange 84 on the control element 82 engages the driver-activating member 74. This is shown in FIG. 9. While the cover 14 is not shown in FIG. 4 or in FIGS. 8 through 10, it should be remembered that the inner surface of the cover 14 maintains the upstanding flange 84 in the plane of the upper face of the driver-activating member 74, thereby ensuring positive engagement between the flange 84 and the member 74. Further motion in the control element 82 causes the driver-activating member 74 to rotate about its pivot axis defined by the members 80 and the bores 34 until the element 80 reaches the position shown in FIG. 10.

When the driver-activating member 74 pivots, the positive engagement between the arms 78 of the member 74 and the slots 72 in the driver element 64 causes the driver element 64 to move downwardly along the flanges 62 on the support member 56. The downward movement of the driver element 64 causes a staple 110 to be ejected from the support element 56 and to be forced against the staple-clinching grooves 32 of the anvil 30. As shown in FIGS. 9 and 10, it is the rear leaf 68 of the driver element 64 which engages the staple 110.

After the staple 110 has been clinched on the anvil 30, the operator exerts a rearwardly directed force on the extensions 18 of the handle 16. This pulls the sleeve 96 toward the rear of the unit 10 and, when the front surface of the slot 100 engages the pin 88, the control member 82 is urged rearwardly. During the return movement of the control member 82, the pin 88 engages the retracting wire 90 and, because of the interrelationship between the retracting wire 90, the driver-activating member 74 and the driver element 64, the driver element 64 is returned to its uppermost position. The next step in the operation of the assembly 10 occurs when the flange 92, integral with the control element 82, comes into engagement with the hole in the sleeve 96 beneath the flange 98. When this occurs, rearwardly directed forces acting on the extensions 18 serve to retract the staple carrying and ejecting unit 10 from the position shown in FIG. 2 and into the position shown in FIG. 1. Then, the stapled artery 26 can be released from the hemostat and the hemostat placed on another artery which is to be stapled.

With reference, now, to FIG. 8, it will be noted that the flanges 62 on the support element 56 are inclined at an angle *A* with respect to a line perpendicular to the longitudinal axis of the assembly 10. The rear face 68 of the driver element 64 is also inclined at an angle *A*. This is necessary since the staples 110 are guided at an angle *A*, which angle is the pitch angle of the thread serving to guide the staples. Naturally, the clinching grooves 32 are formed at an angle *A* to ensure positive engagement between the ejected staples 110 and the grooves of the anvil.

Above, there has been described a specific embodiment of the present invention. It should be understood, however, that many alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is the intent, therefore, that the present invention not be limited by the above but be limited only as defined in the appended claims.

What I claim is:

1. A staple attachment adapted for mounting on a clamping tool of the type having a pair of gripping jaws, the attachment comprising:

an elongated cover member;

staple carrying means in the form of a threaded screw mounted for rotation in said cover member, wherein the thread of said screw is adapted to carry a plurality of staples;

cylindrical cam means fixedly attached to said staple carrying means for causing the screw of said staple carrying means to rotate about its axis;

a support element fixedly mounted in said cover member, surrounding said staple carrying means and serving to provide a guide in which said staple carrying means can rotate;

a driver element slidably attached to said support element and capable of forcing out of said support element a staple which is positioned for ejection, said driver element mounted on said support element to slide in a plane parallel to the plane of said staple;

driver-activating means pivotally mounted in said cover member, associated with said driver element and adapted to move said driver element in the plane of said staple when pivoted;

a control element associating with said driver-activating means and said cam means for simultaneously controlling the action of said driver-activating means and said cam means;

anvil means integral with said cover member for clinching ejected staples in a predetermined shape; and means for mounting said staple attachment on said clamping tool.

2. The invention as set forth in claim 1, wherein said support element is fitted with a pair of guide flanges; wherein said driver element has a front face, a rear face and a connecting member; and wherein said driver element is slidably mounted so that said flanges are sandwiched between said front and said rear faces.

3. The invention of claim 1, wherein activation of said control element activates said driver-activating means and said cam means, wherein said driver-activating means causes the ejection of a staple upon the activation of said control element and wherein said driver-activating means returns the driver element to its readiness position upon the activation of said control element, acting through driver-retracting means.

4. The invention as recited in claim 1, and further comprising a camming pin fixedly attached to said control element and extending into a series of grooves in said cam means.

5. The invention as recited in claim 4, wherein said control element can be stroked in a forward or rearward direction and wherein said stroking causes said cam to rotate integral with said staple-carrying means, thereby advancing said plurality of staples.

6. The invention as recited in claim 5, wherein said series of grooves are of a configuration so that when said control element is stroked in a forward direction, said staple carrying means is caused to rotate until a single staple is advanced into a position ready for ejection.

7. The invention as recited in claim 1, wherein said control element is an elongated member which slides against an inside wall of a housing and which forces said driver-activating means to pivot in response to the forward stroke of said control element.

8. The invention as recited in claim 7, wherein said attachment has two basic positions with respect to said clamping tool, the first being one of readiness, wherein said clamping tool can function normally, and the second being adapted for stapling, wherein the clamping tool is in engagement with the object to be stapled, said first position being rearward of the gripping jaws of said tool and said second position being adjacent said gripping jaws.

9. The invention as recited in claim 1, wherein the pitch of the thread of said staple carrying means is such that a single staple is advanced into a position ready for ejection each time said control element undergoes a forward stroke.