

[54] **SURGICAL APPARATUS FOR SUTURING SOFT TISSUES**

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**FOREIGN PATENTS OR APPLICATIONS**

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[22] Filed: May 20, 1974

[21] Appl. No.: 471,687

[57] **ABSTRACT**

A suturing apparatus provided with two guides interhinged with an axle with, one guide carrying a magazine for storing a plurality of suturing staples therein, a staple pusher, a magazine displacement lever and a pusher-actuating lever, while the other guide carries a movable knife of a means for cutting the vessels and ducts of the tissue being sutured between the staples applied. Also there is provided needle-shaped dies and a member for detaching unsutured vessels and ducts.

[30] **Foreign Application Priority Data**

Sept. 28, 1973 U.S.S.R. .... 1974605

[52] U.S. Cl. .... 128/305; 128/334 R

[51] Int. Cl. .... A61b 17/32; A61b 17/04

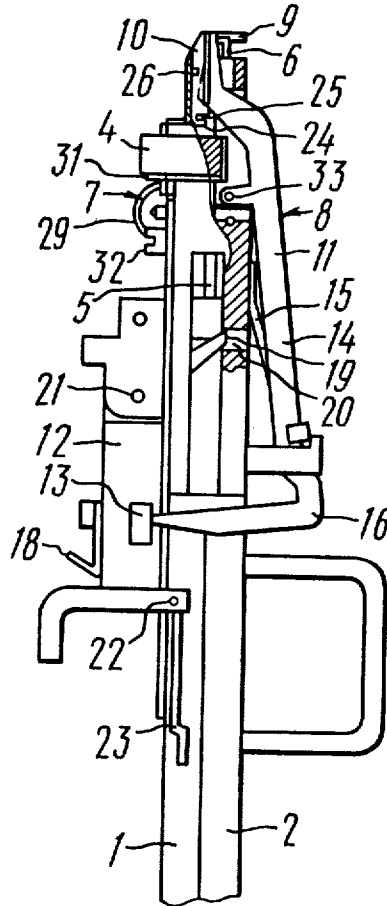
[58] Field of Search ..... 128/305, 334 R

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**5 Claims, 14 Drawing Figures**



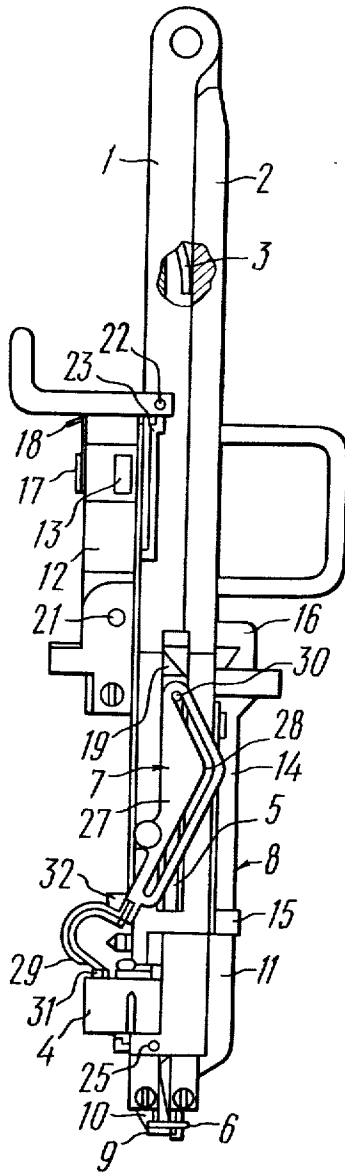


FIG. 1

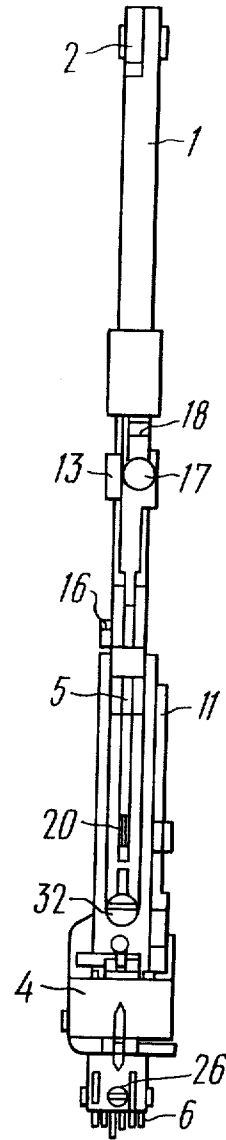


FIG. 2

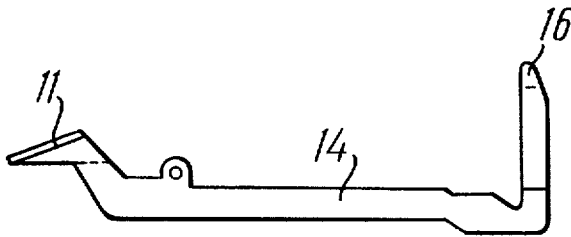


FIG. 3

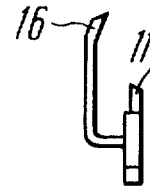


FIG. 4

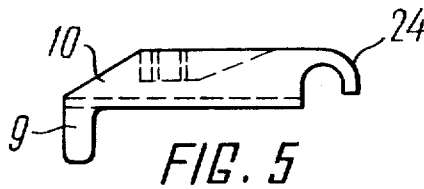


FIG. 5



FIG. 6

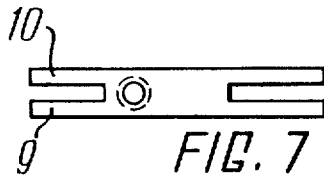


FIG. 7

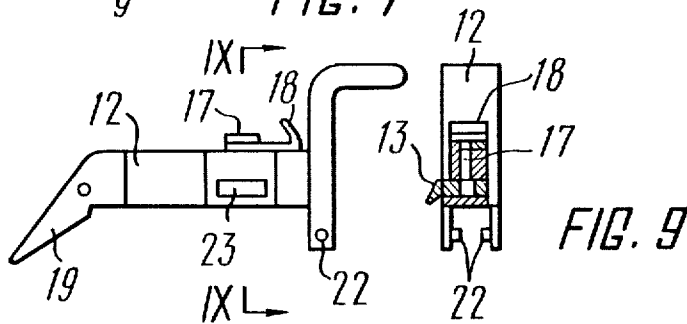


FIG. 8

FIG. 9

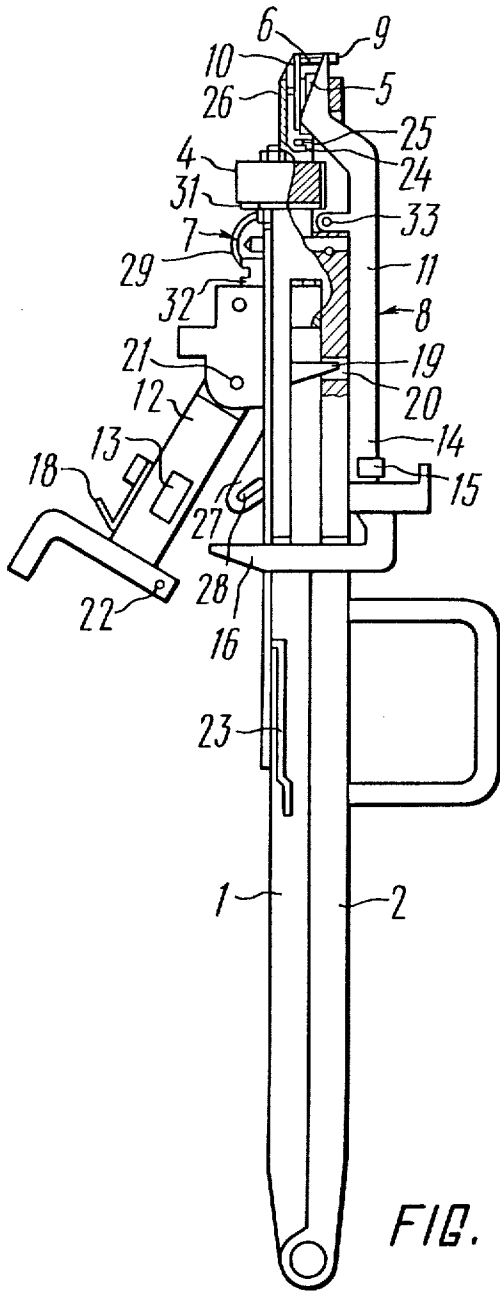


FIG. 10

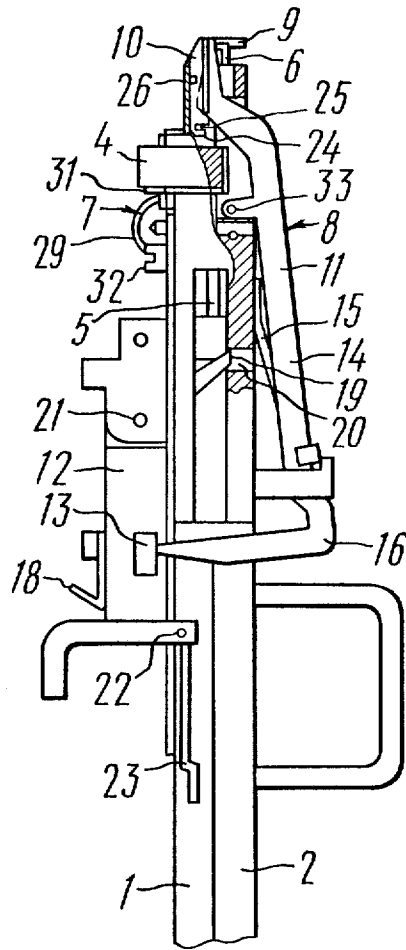


FIG. 11

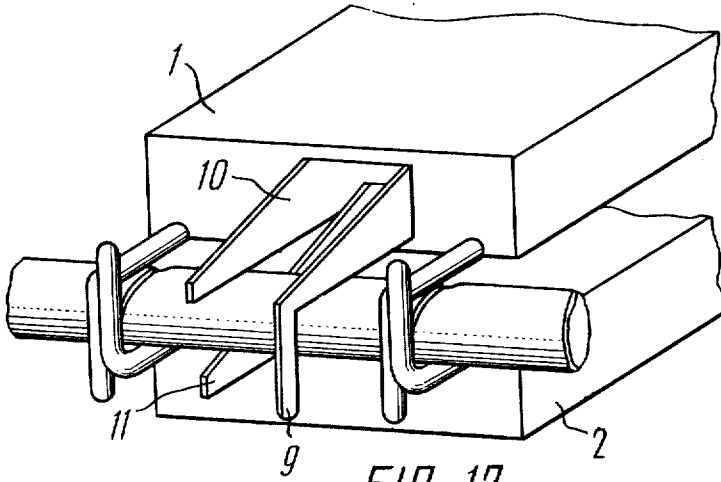


FIG. 12

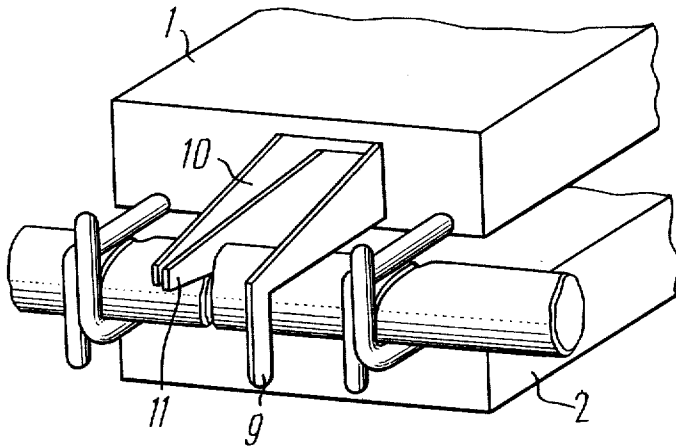


FIG. 13

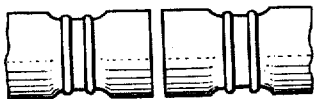


FIG. 14

## SURGICAL APPARATUS FOR SUTURING SOFT TISSUES

### BACKGROUND OF THE INVENTION

The present invention relates to surgical suturing apparatus employed in surgery and, more specifically to apparatus for a bloodless resection of soft tissues, e.g. hepatic soft tissues.

### PRIOR ART

It is known in the art to employ a surgical apparatus for suturing tissues with metal staples (U.S. Pat. No. 2,482,428), which comprises a casing shaped as pincers defined by two guides interhinged with an axle and connected by a spring placed therebetween which drives the guides apart. The free end of each guide mounts a die shaped as a curvilinear needle. On the inside of each guide and each die there is formed a groove extending to a staple magazine secured on one of the guides, and the groove serves for passing and bending the staples. The magazine is of a rectangular box-section shape and is provided with a through longitudinal hole to allow the passage of a pusher. There are slots defining staple seats which are formed, with a certain spacing, in the inner surfaces of the magazine walls disposed in the guide planes. Said magazine slots receive the staple ends so that one staple end is disposed in the slot of one magazine wall, while the other staple end is disposed in the slot of the opposite wall, whereas the staple back edge faces toward the axle interconnecting the guides. With the guides brought together, the slots of one of the magazine staple seats are aligned with said grooves formed in the guides. With the guides moved apart, the magazine remains on one of the guides.

The pusher displaces along the guides of the apparatus. The cross-sectional dimension of the pusher is such that the pusher is able to pass in the through hole of the magazine, ejecting just one staple therefrom. The extent of displacement of the pusher is limited by an eccentric stop.

The magazine is adapted to displace relative to the pusher by a distance corresponding to the spacing of the magazine staples.

The guides are immobilized in their working positions by means of projections on the pusher.

The apparatus is handled as follows.

The surgeon moves the pusher to its extreme position toward the axle interconnecting the guides. The spring moves the operating ends of the guides apart. The surgeon drives the die needles through the edges of the tissue to be sutured, brings the guides together and moves the pusher in the direction toward the dies. This causes the cams disposed on the pusher to actuate spring-loaded levers which move the magazine a distance corresponding to the staple spacing in the magazine, whereupon the pusher projections immobilize the guides in their working positions. As the pusher moves further, the pusher end comes to rest against the back edge of a staple, driving the same in the direction toward the die.

One end of the staple slides in the groove of one guide, while the other staple end slides in the groove of the other guide. The points of the staple transfix the tissue, reach the curved portion of the die, and are clinched thereon, binding the tissue so that each shank

of the staple forms a ring. The height of the ring is adjusted by the eccentric stop against which the pusher abuts in its extreme working position.

In order that the apparatus may be detached from the sutured tissue, the pusher must be driven back to the extreme position toward the axle interconnecting the guides. This causes the guides to open so that the needles are withdrawn from the tissue. To apply the next suture, the whole sequence is repeated.

Also known is a surgical apparatus for suturing soft tissues with U-shaped metal staples (U.S.S.R. Inventor's Certificate No. 240,171), which comprises two guides interhinged with an axle and having a tie spring therebetween, a detachable magazine for storing a plurality of staples, a pusher, a bearing member formed as twin needle-shaped dies, and a magazine displacement mechanism disposed on the guides.

The prior art apparatus have a common disadvantage, viz. a lack of provision for bloodless cutting of the sutured vessels and ducts. Another disadvantage of the known systems is that the curvilinear needles have pointed ends which pierce vessels and ducts while crushing the parenchyma of the liver.

### OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a surgical apparatus for suturing soft tissues, in which provision is made for a simultaneous suturing of soft tissue at two sites at a certain distance one from the other, as well as for cutting the sutured tissue between the sutures so that the tissue outside of the suturing zone is left intact.

Another object of the present invention is to provide a surgical apparatus for suturing soft tissues, in which provision is made for seizing vessels and ducts without causing injury thereto, e.g. in crushing the parenchyma of the liver, with the sequence of operations being suturing of the tissue followed by cutting thereof, with these operation requiring no additional efforts on the part of the surgeon.

A further object of the present invention is to provide a surgical apparatus for suturing soft tissues, in which provision is made for a simultaneous suturing with two staples, with the surgeon's effort exerted on the apparatus for suturing not exceeding the effort mounted by one finger of the surgeon's hand.

Yet another object of the present invention is to provide a surgical apparatus for suturing soft tissues, in which provision is made for suturing the tissue of organs, e.g. the liver, with an abundance of closely spaced blood vessels, and for so seizing the tissue to be sutured that the blood vessels or bile ductules thereof are not pierced.

Finally another object of the present invention is to provide a surgical apparatus for suturing soft tissues, in which provision is made for tissue suturing without cutting the tissue between the sutures.

These and other objects are attained by the provision of a surgical apparatus for suturing soft tissues which, in accordance with the present invention, comprises two guides interhinged with an axle and having a tie spring therebetween, a magazine for storing a plurality of U-shaped suturing staples which is disposed at the free end of one of the guides, a pusher displaced along said guide to thereby eject staples ends first from the magazine for suturing the tissue seized between twin needle-shaped dies mounted on the free ends of the

guides, and a mechanism displacing the magazine for feeding new staples to the working positions, in which there is provided a device for cutting the vessels and ducts of the tissue being sutured between the staples applied, and the free end of one of the guides mounting a member for detaching vessels and ducts remaining outside of the suturing and cutting zone.

Said improvement permits suturing hepatic vessels and ducts together with the parenchyma on the remaining portion of the liver as well as on the portion being resected in hepatectomy, with only those vessels and ducts being cut which fall into the suturing zone, leaving non-sutured vessels and ducts intact.

Due to this improvement, hepatectomy can be performed with a minimal blood loss.

The surgical apparatus in accordance with one embodiment of the invention is characterized in that the device for tissue dissection is formed as two cooperating knives with, one formed as a plate immovably secured on the end of the guide which mounts the member for detaching vessels and ducts, and the other formed as a lever with a cutting edge movably mounted on the other guide, said movable knife being normally spring-loaded so that the cutting edge is withdrawn from the immovable knife, and the distal end of the lever is provided with a projection cooperating with the staple pusher in such a manner that while the pusher is executing its backward stroke, the knife turns against the action of the spring, thus causing the two knives to be brought together and dissect the tissue.

Due to said improvements, hepatic vessels and duct can be exposed by crushing the parenchyma so that the vessels and ducts are not impaired by the knives, and then the suturing operation can be performed by first suturing the tissue and then cutting it between the sutures, the tissue dissection being executed by using the pusher movement required for the suturing operation.

The surgical apparatus in accordance with an alternative embodiment of the invention is characterized in that the staple pusher is provided with a lever booster which operates at the instant of staple bending, with the lever booster formed as an L-shaped lever interhinged with the rear end of the pusher so that one comparatively long, arm of the lever is adapted to be hand-actuated to move together with the pusher along one of the guides of the apparatus, while the other guide is provided with a stop which, when the longer arm of the lever is completing its movement, cooperates with the other arm, whereupon the lever turns, further passing upon the pusher.

Said improvement permits suturing simultaneously with two staples, and the effort of a surgeon's finger being quite sufficient to cause the lever to be moved forward and turned during the suturing operation.

Further, the surgical apparatus in accordance with the invention is characterized in that the member for detaching vessels and ducts is formed as an L-shaped plate mounted flush with the plate of the immovable knife between the protruding points of the needle-shaped dies which are rounded at their tips, just as said L-shaped plate, lest vessels and ducts should be pierced thereby.

Due to said improvement, vessels and ducts can be exposed for suturing, e.g. in hepatectomy, without sustaining any damage.

Lastly, in accordance with yet another embodiment of the present invention, the surgical apparatus is char-

acterized in that the pusher portion which engages the projection on the distal end of the movable knife to turn the same, is formed as an independent counter-sinking stop which sinks, barring the pusher from cooperating with the knife.

Said improvement permits turning off the knives of an operating apparatus with a view to performing the suturing operation alone, should the same be required.

The invention will be better understood by reference to the following detailed description of several preferred embodiments thereof, taken in conjunction with the accompanying drawings, wherein:

#### THE DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general view of an apparatus in accordance with the invention;

FIG. 2 is a side view of the apparatus shown in FIG. 1;

FIG. 3 illustrates a movable knife in the apparatus of FIGS. 1 and 2;

FIG. 4 is a side view of the knife of FIG. 3;

FIG. 5 illustrates an immovable knife in the apparatus in accordance with the invention;

FIG. 6 is a side elevation of the immovable knife of FIG. 5;

FIG. 7 is a plan view of the immovable knife of FIG. 5;

FIG. 8 illustrates a staple pusher lever in the apparatus in accordance with the invention;

FIG. 9 is a sectional view taken on line IX—IX of FIG. 8 the view looking in the direction of the arrows;

FIG. 10 is a general view of the apparatus in accordance with the invention, partially cutaway at the site of attachment of the knives, with the pusher shown in the extreme position of suturing and the pusher-actuating lever turned as far as it will go;

FIG. 11 is a general view of the apparatus in accordance with the invention, partially cutaway at the site of attachment of the knives, with the pusher actuating lever shown forced against the guide and withdrawing the pusher from the needle-shaped dies and the movable knife shown in the extreme position of cutting;

FIG. 12 illustrates the position of a vessel in the apparatus after having been staple-sutured and prior to being cut;

FIG. 13 illustrates the position of a vessel in the apparatus after the operations of suturing and cutting; and

FIG. 14 illustrates a vessel sutured in two places and cut between the sutures.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

Referring now to the drawings, there is illustrated therein a surgical apparatus for suturing soft tissues which is shaped as pincers and comprises two interhinged guides 1 and 2 provided with a tie spring 3, a detachable staple magazine 4, two pushers 5, a bearing portion in the form of twin needle-shaped dies 6, a mechanism 7 for displacing the magazine 4, means 8 for cutting vessels and ducts, and an L-shaped plate or gib 9 for detaching vessels and ducts.

The means 8 for cutting vessels and ducts comprises two detachable knives 10 and 11, with the knife 10 being immovably coupled with the guide 1 while the knife 11 is movably connected with the guide 2, and a movable lever 12 with a stop 13 is mounted on the pusher 5. The knife 11 is formed as a lever 14 forced

against the guide 2 by a spring 15. The operating tip of the knife 11 is appropriately shaped to ensure effective cutting action. The distal end of the lever 14 is provided with a projection 16 which cooperates with the stop 13. The stop 13 can be displaced by an eccentric 17 rigidly coupled with a handle 18. The lever 12 has a projection 19 cooperating with the walls of a hole 20 in the guide 2, an axle 21 and projections 22 cooperating with grooves 23 formed in the guide 1. The knife 10 is fashioned as a plate which mounts the gib 9 for detaching vessels and ducts. The knife 10 is interlinked with an axle 25 by a hook 24 and secured by a screw 26. The mechanism 7 for displacing the magazine 4 comprises a lever 27 with a slot 28 and a spring 29, as well as a projection 30 on the pusher 5 and a projection 31 on the magazine 4. The guide 1 mounts an eccentric movement limiter 32 limiting the extent of displacement of the pusher 5.

In order to prevent piercing of blood vessels and bile ductules in the course of hepatectomy (parenchyma crushing), the protruding ends of the needle-shaped dies 6 and of the L-shaped gib 9 for detaching vessels and ducts are rounded at the tips.

The apparatus of this invention operates as follows:

First, the magazine 4 charged with staples is mounted on the apparatus. Then, holding the apparatus with one hand, the surgeon crushes the parenchyma of the liver over a small area, with all the vessels and ducts in this area seized with the points of the guides 1 and 2. As the pushers 5 are displacing in the direction toward the needle-shaped dies 6, the guides 1 and 2 are brought together, the projection 30 turns the lever 27, the spring 29 of the lever 27 presses upon the projection 31, thereby turning the magazine 4. The projections 22 slide in the groove 23.

As soon as the end of the staple reaches the curved portion of the needle-shaped die 6, the projections 22 come out of engagement with the grooves 23, the lever 12 turns on the axle 21, its projection 19 enters the hole 20 in the guide 2 and, pushing against the wall on the side of the axle, boosts the effort driving the pushers 5 forward. The pushers 5 are thus moved as far the movement limiter 32 (FIG. 10).

As the pushers 5 are moving back, the lever 12 turns on the axle 21 and presses with its projection 13 upon the projection 16 of the lever 14 which turns, causing the seized vessels and ducts to be cut (FIG. 11). As the lever 12 is moving further, the projections 22 engage the grooves 23, and, when the pushers 5 reach their extreme right-hand position, the guides 1 and 2 are moved apart, so that the apparatus is ready for a repeated sequence.

To provide for the back movement of the pushers 5, the surgeon presses his finger on the lever 12 so as to induce its back rotation, i.e. in a direction opposite to its working direction, which causes the projection 19 of the lever 12 to push against the wall of the hole 20 on the side of the needle-shaped dies.

The projection 13 of the lever 12 bears upon the projection 16 of the lever 14, turning the same on an axle 33 (FIG. 11). As the lever 14 is turning, the knives 10 and 11 cut the seized and sutured tissue. As the lever 12 is rotating, the projections 22 engage the grooves 23 and stop the rotation of the lever 12.

As the lever 12 is progressing toward the axle, the projection 13 comes out of engagement with the projection 16, and the knife 11 is driven by the spring 15

to its initial position. At the end of its movement, the lever 12 moves aside the plate which brings the two guides together, and the spring 3 turns the guides 1 and 2 one relative to the other.

The operating ends of the guides are moved apart, rendering the apparatus ready for a repeated sequence.

If it not be required to cut the tissue being sutured, the knife 11 can be turned off. To this end, the handle 18 is turned through 180°C. This will cause the eccentric 17 to drive the projection 13 inside the lever 12, so that no cutting will take place while the pushers 5 are executing their backward movement.

What is claimed is:

1. A surgical apparatus for suturing soft tissues, comprising: two guides interhinged at one end; a tie spring between the guides which normally maintains the guides at the other end in a spaced-apart position; a magazine for storing a plurality of U-shaped suturing staples therein disposed at the free end of one of the guides; a pusher adapted to slide along said latter guide for ejecting the staples from said magazine points first; twin needleshaped dies disposed on the free ends of said guides for seizing therebetween, as the guides are brought together, the tissue to be staple-sutured; a means for controlling said magazine by displacing the magazine and feeding new staples to the working position; a means for cutting the vessels and ducts of said tissue being sutured in the area between said applied staples, said vessel-cutting means being disposed on the free ends of said guides; and a member for detaching the vessels and ducts located outside of the suturing and cutting zone, said member being disposed on the free end of one of the guides.

2. The apparatus as claimed in claim 1, wherein the tissue-cutting means is provided by two cooperating knives, one of which, defined by a plate, is fixed on the end of the guide which carries the member for detaching vessels and ducts, while the other knife, a movable member, is defined by a lever with a cutting edge mounted on the other guide and normally spring-loaded so that the cutting edge is withdrawn from the immovable cutting edge, and the distal end of the lever is provided with a projection which cooperates with the staple pusher so that, as the pusher is executing a backward movement, the knife lever turns against the action of the spring, thus causing the two knives to be brought together and cut the tissue.

3. The surgical apparatus as claimed in claim 1, wherein the staple pusher is provided with a lever member boosting the pushing action at the instant staples are bent, which member is defined by an L-shaped lever interhinged with the rear end of the pusher so that one comparatively long arm of the lever is adapted to be hand-moved along one guide together with the pusher, while the other guide includes a stop cooperating with the other arm of the lever, when the long arm of the lever is completing the movement thereof, whereupon the lever turns, exerting an additional pushing effort on the pusher.

4. The surgical apparatus as claimed in claim 1, wherein the member for detaching vessels and ducts is defined by an L-shaped plate or gib secured flush with plate of the immovable knife between the protruding ends of the needle-shaped dies which are rounded at the tips, just as the latter L-shaped plate or gib, lest vessels and ducts be pierced thereby.

5. The surgical apparatus as claimed in claim 2, wherein the pusher portion which cooperates with the projection on the distal end of the movable knife for turning the same, is defined by a separate countersinking stop, so that with the latter stop in a sunk position the pusher is barred from cooperating with the knife.

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