Sept. 9, 1947. B. WANDEL 2,427,169

INSTRUMENT FOR APPLYING LIGATURES TO BLOOD VESSELS

Filed March 31, 1944 3 Sheets-Sheet 1

Fig. 1.

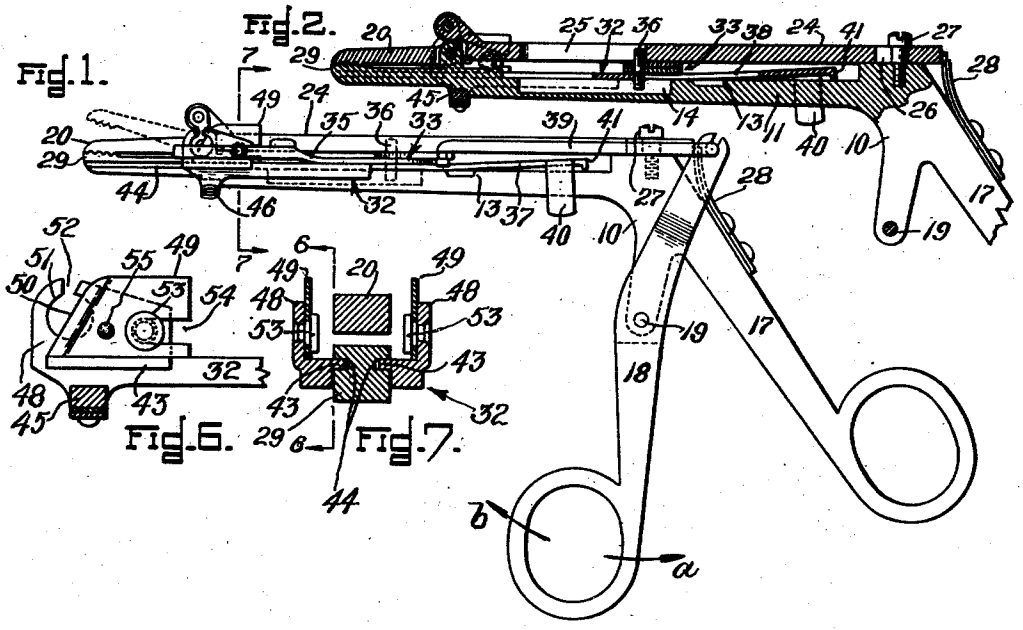


Fig. 2.

Fig. 6.

Fig. 7.

Fig. 3.

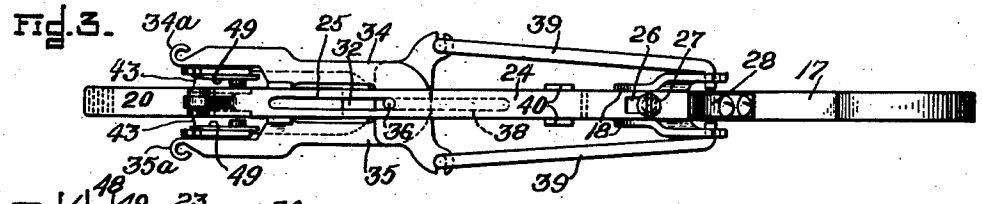


Fig. 4.

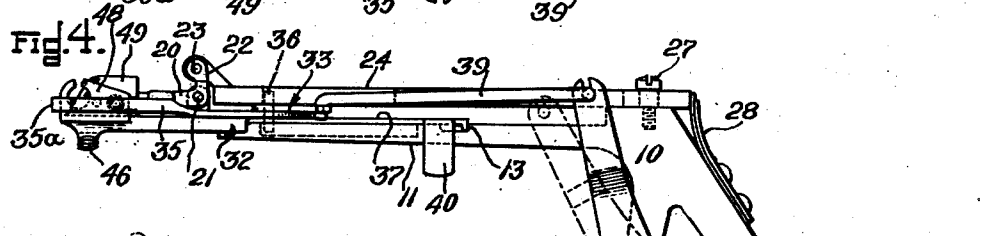
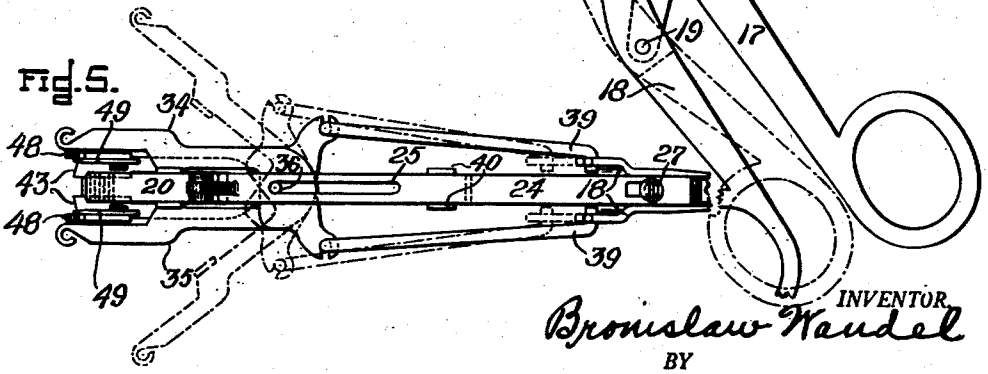


Fig. 5.



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INSTRUMENT FOR APPLYING LIGATURES TO BLOOD VESSELS

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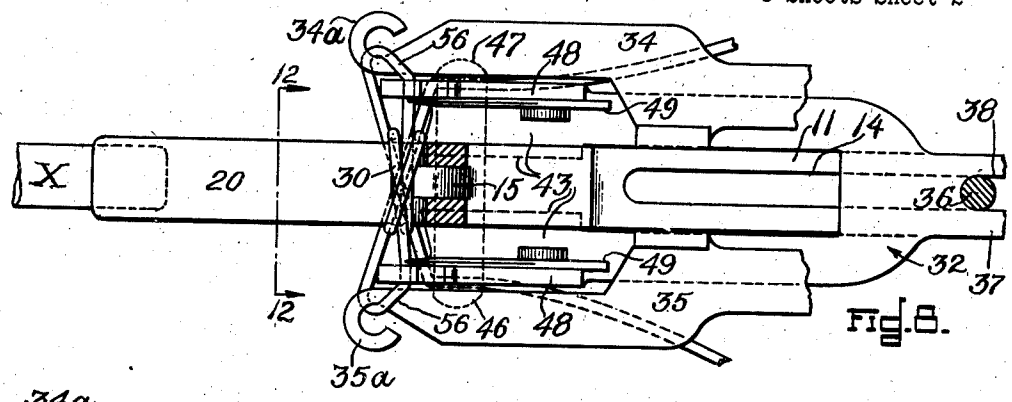


Fig. 8.

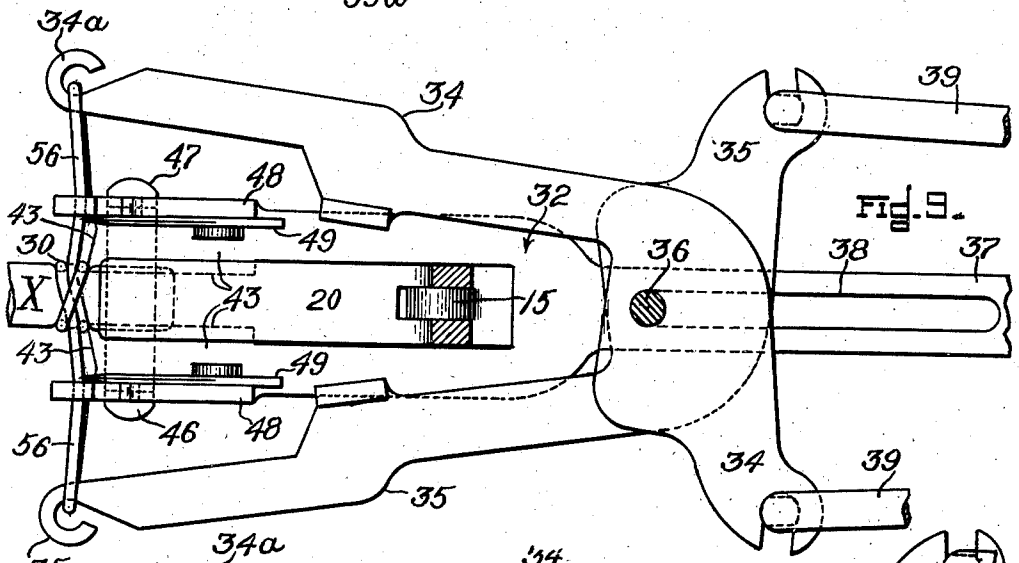


Fig. 9.

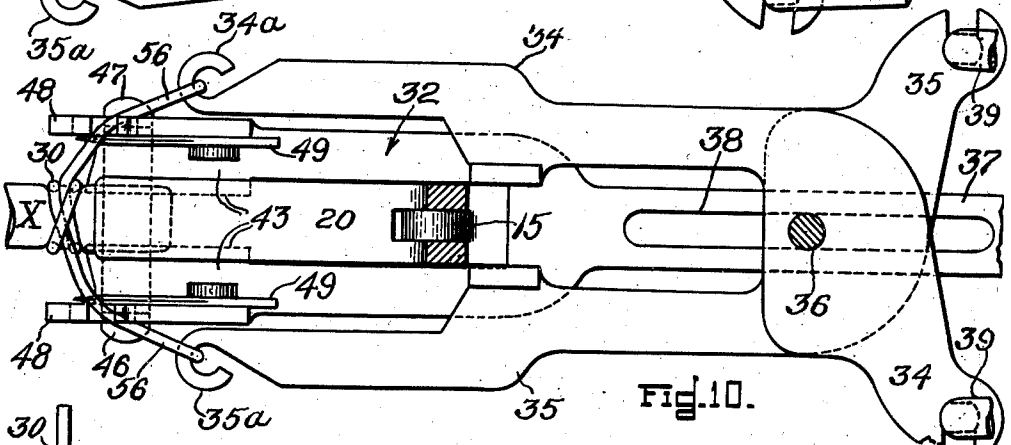


Fig. 10.

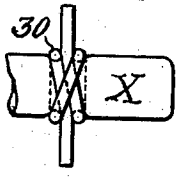


Fig. 11.

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INSTRUMENT FOR APPLYING LIGATURES TO BLOOD VESSELS

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Fig. 13.

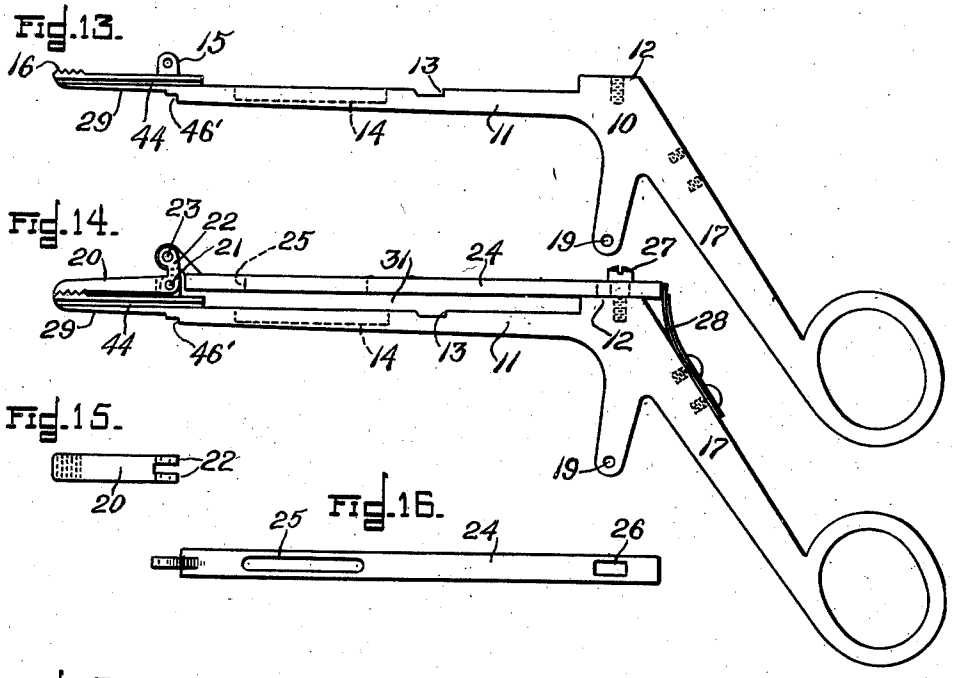


Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

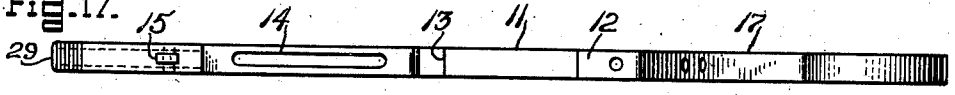


Fig. 18.

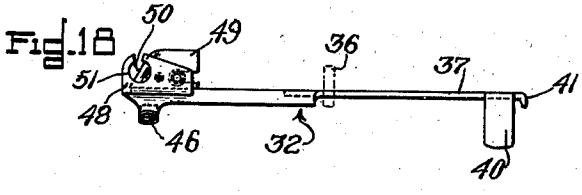


Fig. 19.

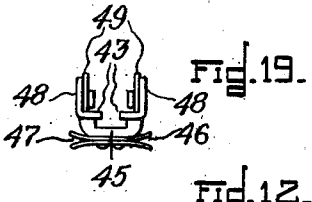


Fig. 20.

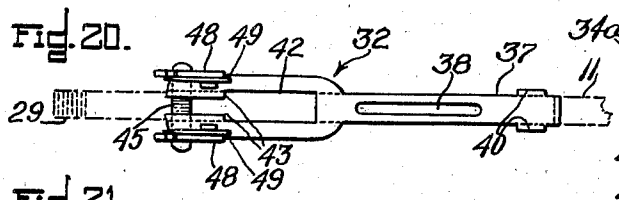


Fig. 12.

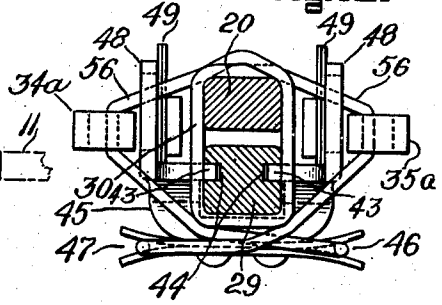
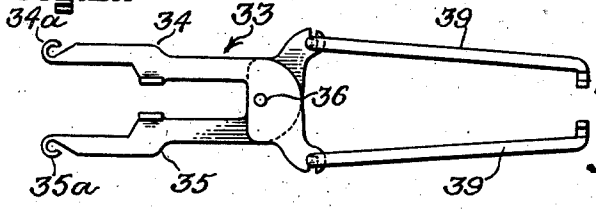


Fig. 21.



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UNITED STATES PATENT OFFICE

2,427,169

INSTRUMENT FOR APPLYING LIGATURES TO BLOOD VESSELS

Bronislaw Wandel, Boston, Mass.

Application March 31, 1944, Serial No. 528,939

5 Claims. (Cl. 128—326)

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This invention relates to an instrument for use by surgeons in applying ligatures to blood vessels to close the latter against bleeding during and after surgical operations.

The invention has for its object to provide an instrument of the character described which will be of simple and efficient construction and whose use will not only greatly reduce the time heretofore required in carrying out certain surgical operations, but will also render readily accessible for tying-up those blood vessels so situated as to be inaccessible or difficult to reach with the hands under the conditions heretofore prevailing.

To these ends I have provided an instrument of the character described which, in the preferred form thereof, may be constructed and operate as set forth in the following description, although it is to be understood that modifications thereof are intended to be included within the scope of the appended claims wherein the several novel features of the invention are separately pointed out and defined.

In the accompanying drawings:

Figure 1 is a side elevation of an instrument for use in tying-up blood vessels, said instrument being constructed in accordance with this invention.

Figure 2 is a longitudinal vertical sectional view of a portion of the instrument shown in Fig. 1.

Figure 3 is a top plan view of the instrument shown in Figs. 1 and 2.

Figure 4 is a side elevation like Fig. 1 but showing some of the parts in the positions they occupy at the completion of their knot-shedding stroke.

Figure 5 is a top plan view of a portion of Fig. 4.

Figure 6 is a sectional detail taken on the line 6—6 of Fig. 7.

Figure 7 is a sectional detail taken on the line 7—7 of Fig. 1.

Figures 8, 9 and 10 are enlarged views, in plan, of a portion of the instrument shown in Figs. 1 to 7, inclusive, and illustrate the manner in which a knot is applied to the instrument, transferred from the instrument to a blood vessel, tightened, and trimmed.

Figure 11 shows the completed knot tightened on the blood vessel.

Figure 12, sheet 3, is a section on line 12—12 of Fig. 8.

Figure 13 is a detail, in side elevation, of the frame hereinafter described.

Figure 14 is a view like Fig. 13 but with the addition of the movable jaw of the clamp hereinafter described and its actuating element.

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Figure 15 is a plan view of the movable jaw of the clamp.

Figure 16 is a plan view of the actuating element for the movable jaw shown in Figs. 14 and 15.

Figure 17 is a top plan view of the frame shown in Fig. 13.

Figure 18 is a side elevation of the slide, hereinafter described, for holding the ends of the knotted ligature, transferring the prefabricated knot from the snout of the instrument to the blood vessel, and for cutting off the ends of the knot adjacent to the latter after said knot has been tightened.

Figure 19 is an end view of the slide shown in Fig. 18.

Figure 20 is a top plan view of the slide shown in Fig. 18.

Figure 21 is a top plan view of the tongs, hereinafter described, which is operable to adjust the slide of Fig. 18 in a direction to transfer the prefabricated knot from the snout of the instrument to the blood vessel, to tighten the knot on the blood vessel and thereafter to effect the trimming off of the superfluous end portions of the ligature.

The illustrated embodiment of this invention comprises a frame 10 (Figs. 1 and 13) including as part thereof a straight stem 11 formed upon its top side and near its rear end with an elevated pad 12 in which is provided a tapped hole, and an abutment shoulder 13 facing the forward end of said stem, with a longitudinal slot 14 (Figs. 13 and 17), with an apertured upstanding lug adjacent to the forward end of the stem 11, and with transverse gripping teeth or serrations 16 immediately adjacent to the forward extremity of said stem.

At its rear end the stem 11 is made with a laterally and obliquely extending handle arm 17 made at its lower extremity with a finger hole as shown. The frame 10 of the instrument is embraced by a forked lever 18 that is fulcrumed at 19 on said frame and also made at its lower free end with a finger hole as shown.

Immediately above the forward end of the stem 11 there is provided a clamping jaw 20 (Figs. 1, 14 and 15) whose rear end is bifurcated and embraces the apertured lug 15 to which it is pivotally connected by a pintle 21. This jaw 20 is made at its rear end with a pair of upwardly extending arms 22 whose upper ends are pivotally connected at 23 with the forward end of a jaw-actuating element 24 whose rear end is slidably supported by the pad 12 of frame 10 as shown in Fig. 14. The intermediate portion

of this jaw-actuating element or slide 24 is formed with a longitudinal slot 25 as shown in Fig. 16 while the rear end portion thereof is formed with another longitudinal slot 26 that is loosely occupied by a screw 27 by which said element is held in position upon the pad 12. Springs 28 (Fig. 14) fastened to handle 17 exert their pressure against the rear end of element 24 to normally hold the jaw 20 firmly in its closed position against a lower fixed jaw 29 that is an integral part of the stem 11 of the frame 10. The two jaws 20 and 29 provide a beak or snout around which a ligature is loosely knotted as shown at 30 in Figs. 8 and 12, preparatory to the transfer of said knot to the blood vessel.

The pintle 23 and pad 12 (Fig. 14) support the jaw-actuating element 24 in spaced apart relationship with respect to the intermediate portion of stem 11 thereby providing a longitudinal slot 31 within which are slidably mounted a knife-carrying, end-holding and knot-transferring slide that is indicated generally at 32 (Figs. 1, 2, 3, 18, 19 and 20) and a pair of tongs that is indicated generally at 33 (Figs. 1, 3, 4 and 21) by which the slide 32 is actuated to transfer the knot from the snout or beak 20—29 of the instrument to the blood vessel X by which the knot is tightened on the blood vessel, and by which the knives 49 (Figs. 1, 8, 9 and 10) of slide 32 (Figs. 18–20) are caused to remove the superfluous end portions of the knot close to the latter.

The two lever-members 34 and 35 of the tongs are pivotally connected together by a pintle 36 (Figs. 2 and 21) which is a rigid part of one of said lever-members. The slide 32 (Figs. 18–20) is mounted within the slot 31 beneath the tongs 33 and its rear end portion consists of a resilient tang 37 formed with a longitudinal slot 38 which is of the same length as that of the slot 25 of the jaw-actuating element 24 (Figs. 2 and 16). The lower end portion of the pintle 36 of the tongs extends through the slot 38 of slide 32 into the slot 14 (Figs. 2 and 13) of stem 11, while the upper end portion of said pintle 36 occupies the slot 25 (Figs. 2 and 16) of the jaw-actuating element 24 and co-operates with the rear end of said slot to open jaw 20 as presently to be described.

Each lever 34 and 35 of the tongs 33 (Figs. 1, 3 and 21) is made at its free end with an outwardly facing hook and has pivotally connected with its rear end one end of a link 39 whose opposite end is pivotally connected with one of the branches of the forked lever 18. It will thus be clear that if lever 18 is swung slightly in the direction of the arrow b in Fig. 1 it will act through the links 39, tongs 33 and pintle 36 to force the element 24 rearwardly against the pressure of springs 28 (Fig. 2) and cause said element to swing jaw 20 into its open dotted line position indicated in Fig. 1 thereby to permit the end of a blood vessel X to be placed in position between the two jaws 20 and 29 whereupon release of lever 18 permits springs 28 to shift element 24 back toward its normal position thereby causing the jaws 20 and 29 to firmly grip the end of the blood vessel.

Adjacent to its rear end the tang 37 of slide 32 (Figs. 1 and 18) is made at opposite sides thereof with finger pieces or lugs 40 by means of which slide 32 is manually set at the limit of its rearward movement with the forward end of its slot 38 abutting the lower end portion of pintle 36 and the upper end portion of the latter abutting the rear end of the slot 25 of jaw-actuating element 24 as shown in Fig. 2. It will therefore be clear that when lever 18 is adjusted slightly in the direction of arrow b (Fig. 1) to open jaw 20 the lower end portion of pintle 36 moves lengthwise of slot 38 of slide 32 and does not disturb the position of the latter. Also the rear end of the tang 37 provides an abutment shoulder 41 (Fig. 18) to at times co-operate with the shoulder 13 upon the top side of stem 11 as shown in Fig. 4.

The forward end portion of slide 32 (Figs. 18, 19 and 20) is made with a longitudinal slot 42 provided at opposite sides thereof with runners 43 slidably mounted in longitudinal ways 44 (Figs. 6, 7, 12 and 14) formed in the opposite sides of the fixed jaw 29 of the snout or beak of the instrument. Below these runners 43 the slide 32 is provided with a cross-bar 45 (Figs. 6, 19 and 20) which at times engages an abutment shoulder 46′ provided upon the under side of stem 11, to positively limit the rearward movement of the slide when the latter is unlocked from shoulder 13 (Fig. 13) and manually returned to its normal position shown in Fig. 1 at the completion of the tying-up operation of the instrument. During this manual return of slide 32 to its normally retracted position the forward end of the slot 38 (Figs. 2 and 20) may engage the lower portion of pintle 36 and thereby return the tongs 33 to its normally retracted position, although it will be clear that the tongs may be first returned to its normally retracted position by means of lever 18 after which the slide 32 may be manually restored to its normally retracted position.

Fastened to the under side of cross-bar 45 (Figs. 19 and 12) are two leaf springs which provide two oppositely disposed end-holding spring clamps 46 and 47, one at each side of the slide. Also, upon its top side the forward end of the slide 32 is made at its opposite sides with longitudinally disposed perpendicular side walls 48 to the inner face of each of which is removably secured a blade 49 having an obliquely disposed cutting edge 50 (Fig. 18) disposed between apertures 51 provided through said side walls. Each of these apertures 51 is made at its top (Fig. 6) with a gateway or entrance through which the ligature is passed into the aperture in preparing the instrument for use.

Each cutting blade 49 is held in position against the inner face of its side wall by a headed stud 53 projecting from and forming a rigid part of the side wall, the shank of said stud occupying a slot 54 formed in said blade that is open at one end, and by a dowel 55 projecting from said side wall. In this way each blade is removably fastened to its side wall so that it can be readily applied thereto or removed. In applying each blade to its side wall it is slid edgewise and rearwardly on the slide 32 under the head of stud 53 while bent slightly away from dowel 55 and until the dowel registers with and enters an aperture formed in the blade whereupon the blade is locked in operative position against its side wall.

The instrument is prepared for use by first clamping the lower end of the handle 17 within a fixed vise with the stem 11 disposed in a vertical position and while thus supported a ligature is applied thereto as follows, reference being had particularly to Figs. 8 and 12. One end portion of the ligature is forced tightly into the spring clamp 46 of slide 32 from which it is stretched transversely across the front end of slide 32 to and through the open hook 34a of the tongs lever 34 thence through the aperture 51 of the adjacent

side wall 48 to the snout or beak 20—29 where the loose knot 30 is formed upon the latter. From the knot 30 the ligature is continued through the aperture 51 of the other side wall 48, through the open hook 35*a* of tong lever 35 and thence transversely beneath the snout and knot to the spring clamp 47 into which its opposite end portion is tightly wedged. A suitable form of knot is the clove hitch shown disposed on the snout as close to the pivot 21 (Fig. 14) as possible.

To apply the instrument 30 to a blood vessel which is the first step in the use of the device, the procedure is as follows: The instrument is removed from the fixed vise and held by one hand grasping handle 17 and lever 18 and while holding the snout close to the end of the blood vessel the lever 18 is shifted slightly in the direction of the arrow *b* of Fig. 1 which displaces the tongs rearwardly slightly causing pintle 36 (Fig. 2) to push slide element 24 rearwardly thereby opening the upper jaw 20 of the snout and permitting the end of the blood vessel to occupy a position between the two jaws. Removal of forward finger pressure on lever 18 permits springs 28 to return element 24 toward its normal position thereby clamping the end of the blood vessel tightly between the two jaws of the snout.

To transfer the knot 30 to the blood vessel the procedure is as follows: After attaching the instrument to the blood vessel as above described the lever 18 is swung rearwardly in the direction of the arrow *a* of Fig. 1 from the position shown in said Figure 1 into the full line position shown in Figs. 4 and 5. This brings the pintle 36 into position against the forward end of slot 25 of slide element 24 which at this time serves as a stop to limit the rearward swing of lever 18 and the forward movements of tongs 33 and slide 32, whereupon the abutment end 41 (Fig. 2) of the resilient tang or rear end portion of slide 32 snaps into position in front of the abutment shoulder 13 of stem 11 as shown in Fig. 4. During this forward movement of the tongs and slide 32 the levers 34 and 35 of the tongs are prevented from spreading apart into the positions shown by dotted lines in Fig. 5 by the ligature which, as shown in Fig. 8, holds said levers in positions against the opposite sides of jaw-actuating element 24. It will also be clear that during this forward movement of the slide 32 and tongs the forward ends of the runners 43 (Fig. 20) engage the knot 30 at opposite sides of the snout 20—29 and slide the same forward off from the latter and onto the end of the blood vessel as shown in Fig. 9.

To tighten the knot on the blood vessel the lever 18 is again swung farther rearwardly in the direction of the arrow *a* of Fig. 1 so that it acts through the links 39 to swing the levers 34 and 35 of the tongs outwardly into the positions shown in Fig. 9 thereby tightening the knot since pivot 36 is held against forward movement by the end of slot 25, the tightness of the knot depending upon the force applied to the lever 18.

To sever the knot from the opposite end portions of the ligature which are gripped by the clamps 46 and 47 (Fig. 12), the lever 18 is now swung forwardly slightly in the direction of the arrow *b* of Fig. 1 which again closes the tong levers 34 and 35 against the opposite sides of the jaw-actuating element 24 and shifts said levers rearwardly into the positions shown in Fig. 10. This pulls the upper stretches of loops 56 of the ligature rearwardly against the forward cutting edges of the blades 49, while the shoulder 13 of

stem 11 (Fig. 4) holds the slide 32 and its blades 49 in a fixed position with the result that the upper stretch of each ligature loop 56 is severed.

By continuing the movement of lever 18 in the direction of the arrow *b* of Fig. 1 after cutting the ligature, the pintle 36 is brought into engagement with the rear end of the slot 25 of jaw-actuating element 24 thereby shifting the latter rearwardly which opens the vessel-gripping jaw 20 and frees the tied-up blood vessel.

Thereafter finger pressure is applied to the finger-holds 40 to free the rear end of slide 32 from abutment shoulder 13 and said slide is manually returned to its normal retracted position shown in Fig. 1 where the forward end of slot 38 is against pintle 36, after which the severed ends of the ligature are removed from the spring clamps 46 and 47 (Figure 12), and the instrument is in condition to receive another ligature.

In practice the surgeon would be provided with a plurality of instruments such as above described and with a rack for supporting a plurality of instruments each with its stem portion 11 disposed vertically in an accessible position and with a ligature applied thereto as above described. Thus during the surgical operation each "bleeder" encountered can be quickly tied up through the use of one of the instruments and the employment of one hand only to operate the same regardless of the position in which it is necessary to hold the instrument. From my experience as a surgeon I believe that the time required in connection with tying-up operations can be reduced fifty or sixty per cent by the use of a set of instruments as described. In surgical operations many "bleeders" are encountered which are located in very close quarters and practically inaccessible for tying up as heretofore, but it will be obvious that such "bleeders" may be quickly reached and tied up by the use of my new instrument.

As shown in Figs. 1 and 6 each blade 49 is made with a straight bottom edge bearing against the runner 43 that is disposed upon its side of slide 32 and with an obliquely disposed front cutting edge 50 that is disposed at an acute angle relatively to the bottom edge of the blade. It will thus be clear that when the tongs 33 are moved rearwardly after slide 32 has been locked in its forward position through the engagement of tang 37 with shoulder 13, the upper stretch of each loop 56 (Fig. 12) is moved rearwardly in a direction approximately parallel with the bottom edge of the adjacent blade thereby causing the latter to sever said upper stretch by a shearing or slicing action. It will also be clear that the engagement of stud 53 and dowel 55 with the apertures of the blade, together with the engagement of the bottom edge of the blade with its runner 43, act to rigidly hold the blade in place but so that it can be readily removed and a new blade substituted when desired.

What I claim is:

1. In an instrument for use in ligating blood vessels, the combination of a frame made at one end thereof with a vessel-gripping and knot-holding snout comprising a fixed jaw and a movable jaw and provided adjacent to its opposite end with a handle, said snout being adapted to receive upon it a knot formed in a ligature and also adapted to grip between its jaws the end of the blood vessel to which said knot is to be transferred; a finger-operated lever pivotally mounted upon said frame adjacent to said handle and in a position for operation by a finger of one hand

by which said handle is grasped; a jaw-actuating member slidably mounted on said frame and having one end thereof pivotally connected with said movable jaw; spring means yieldingly urging said jaw-actuating member in a direction to hold said movable jaw in its closed position; a pair of knot-tightening tongs slidably confined between said jaw-actuating member and said frame, said tongs being disposed longitudinally with respect to said frame, at opposite sides of the latter and pivotally connected intermediate their ends by a pintle whereof one end portion occupies a slot of predetermined length formed longitudinally in said jaw-actuating member, and links connecting the rear ends of said tongs with said finger-operated lever so that movement of the latter in one direction acts through said links to shift said tongs and their pintle bodily in a direction to cause the latter to engage one end of said slot and thereby adjust said jaw-actuating member in a direction to open said movable jaw against the pressure of said spring means.

2. In an instrument for use in ligating blood vessels, the combination with a frame made at one end thereof with a vessel-gripping and knot-holding snout and provided adjacent to its opposite end with a handle and a manually operated lever pivotally mounted on said frame adjacent to said handle, of a pair of longitudinally disposed knot-tightening tongs slidably supported by said frame for movement toward and from said snout and pivotally connected together intermediate their opposite ends, means connecting the rear arms of said tongs with said lever through which the latter acts to operate said tongs, a slide supported by said frame in proximity to said tongs for movement lengthwise of said snout toward and from a normally retracted position on said frame, said slide having means for gripping the opposite end portions of a knotted ligature while the knot of the latter occupies a position upon said snout and also being equipped with a pair of cutting blades, one at each side thereof; means through which said slide is moved forwardly by and with said tongs to transfer said knot to and tighten it upon the gripped blood vessel when said lever is operated in one direction and means for holding said slide in its forward position while said lever is operated in another direction to retract said tongs thereby to cause said blades to sever the opposite end portions of the ligature adjacent to said knot.

3. The combination of claim 2 and wherein said slide is provided with a resilient tang and said frame is provided with an abutment shoulder that is automatically engaged by said tang when said slide occupies its forward position thereby to lock said slide in said position while said tongs are being retracted to sever the opposite end portions of the ligature.

4. The combination of claim 2 and wherein said slide is made with a longitudinal slot occupied by one end portion of a pintle by which the members of said tongs are pivotally connected so that when said tongs are moved forwardly said end portion acts against one end of said slot to move said slide forwardly with said tongs, said slot providing for retracting movement of the tongs independently of the slide after the latter has been secured in its projected position.

5. In an instrument of the class described, in combination, a frame having a handle and a stem extending forwardly therefrom provided at its forward end with a knot-holding and vessel-clamping snout; a finger-operated lever fulcrumed on said frame; mechanism operated by said lever comprising a slide mounted in longitudinal ways provided upon said stem and provided adjacent to its forward end with means for pushing the knot off from said snout when said slide is moved in the direction of the latter and also provided adjacent to its rear end with a resilient longitudinally slotted latch tang for automatically engaging a shoulder on said stem thereby to lock said slide at the limit of its movement toward said snout; a pair of knife blades both of which are fixedly mounted upon said slide at opposite sides of said stem; means on said slide for gripping the opposite end portions of a knotted ligature mounted on said snout and for supporting said end portions in positions in front of the cutting edges of said blades; a pair of knot-tightening tongs slidably supported by said tang, said tongs having forwardly extending arms disposed upon opposite sides of said stem made at their free ends with hooks engaging the end portions of the ligature between the knot thereof and the gripping means of the slide, and said tongs also having rearwardly extending arms each connected by a link with said lever, the pivot pintle of said tongs occupying the slot of said tang and serving through abutting engagement with one end thereof to move said slide forwardly when said tongs are moved forwardly by said lever, and said slot permitting said tongs to be moved rearwardly independently of said slide and its blades after the slide has been locked in its forward position by said tang thereby to cause said blades to sever said end portions from the knot.

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