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[54] **SURGICAL CLAMP**

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[52] **U.S. Cl.** ..... **128/346,** 81/5.1 R, 81/342

[51] **Int. Cl.** **A61b 17/08**

[58] **Field of Search** 81/5.1, 342, 348, 81/367, 385, 393, 418; 128/321, 322, 346

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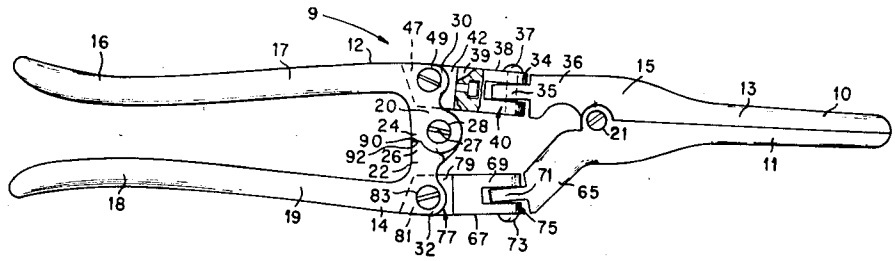
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[57] **ABSTRACT**

A clamp particularly useful in surgical procedures including handle means and jaws, the jaws being adjustable with respect to the handle means.

5 Claims, 8 Drawing Figures



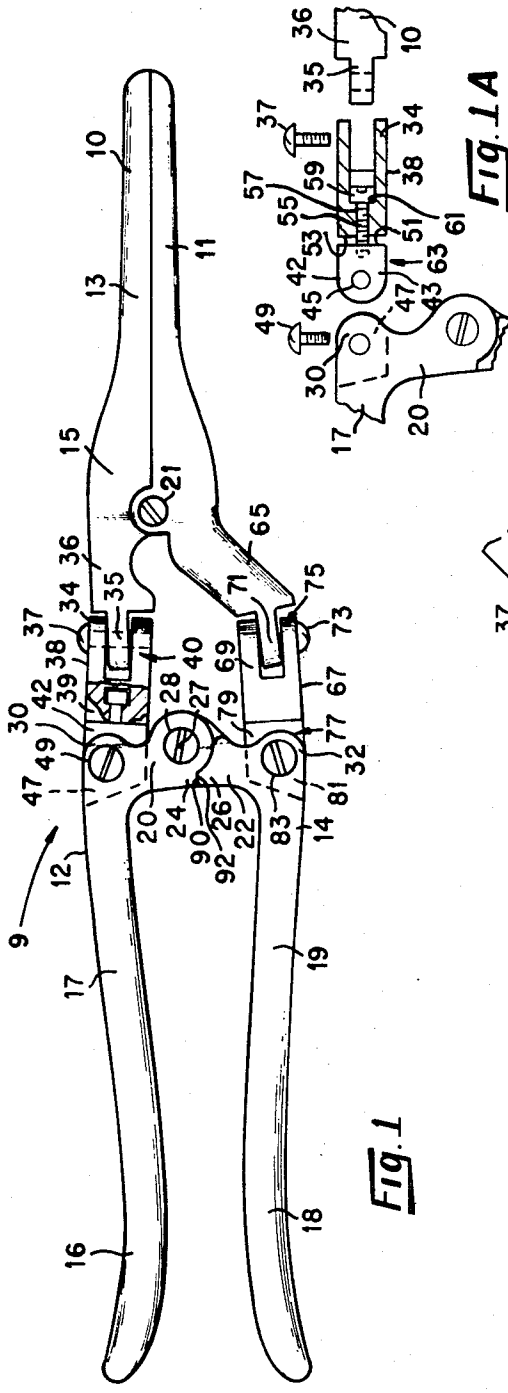


Fig. 1

Fig. 1A

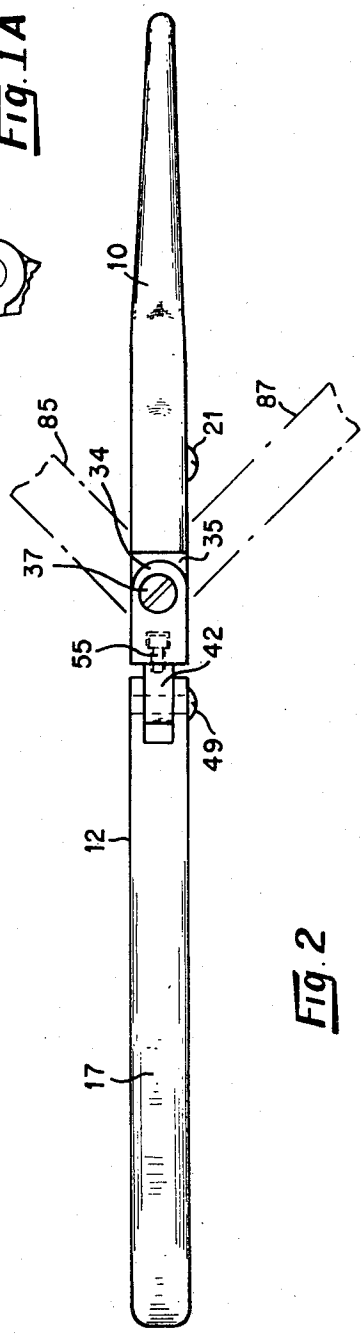


Fig. 2

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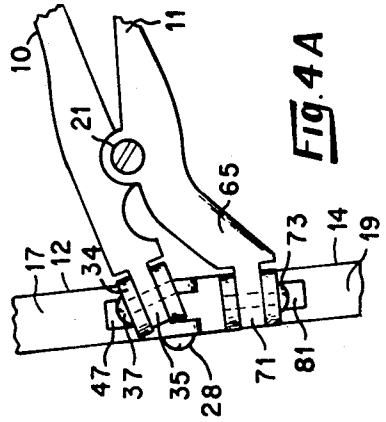


Fig. 4A

Fig. 4

Fig. 4B

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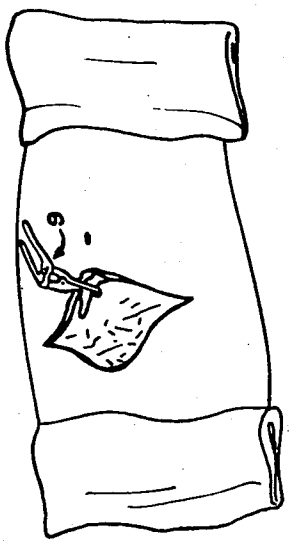


Fig. 5

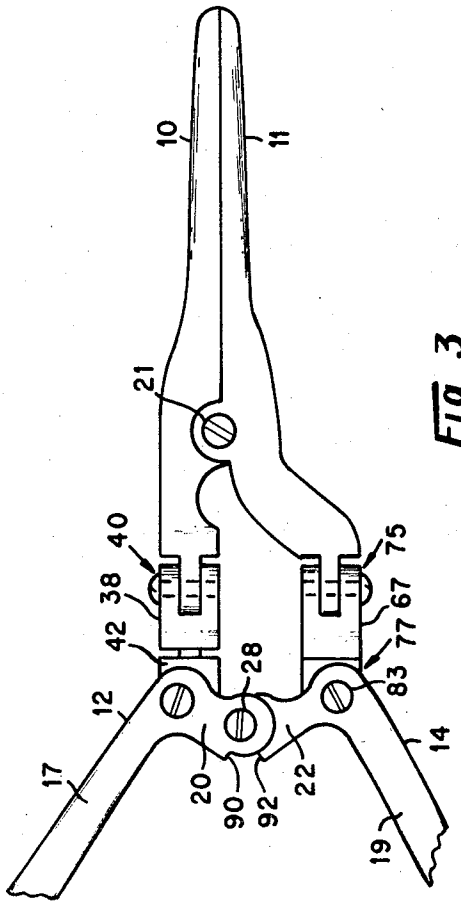


Fig. 3

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SURGICAL CLAMP

This invention relates to surgical and like clamps.

In certain surgical procedures, particularly those involving the opening of the body cavity and securing one or more body parts away from the operating area, surgeons have heretofore employed clamps whose jaws were permanently formed at an angle with respect to the handles so that the handles would lie flat against the patient's body and not project from the cavity and hamper the surgeon's movements. A number of clamps having different angles were required to accommodate the many different clamping functions encountered during an operation. Such a large inventory of differently-angled clamps was expensive and presented problems of communication between the surgeon and his assistant in selecting an appropriately angled clamp.

It is therefore the object of this invention to provide a clamp which is particularly useful in surgical procedures and whose jaws are adjustable to various angular positions with respect to the handles. It is a further object to provide a clamp of the type described which locks in the closed position.

FIG. 1 is a side view of a clamp having its jaws in the closed position and embodying various features of the invention;

FIG. 1A is a fragmentary, partly exploded view of the clamp of FIG. 1;

FIG. 2 is a top view of the clamp shown in FIG. 1;

FIG. 3 is a side view of the clamp of FIG. 1 with the crank arms shown fragmentarily and in a partly open position;

FIG. 4 is a side view of the clamp of FIG. 1 in a substantially fully open position;

FIG. 4A is a front end view of the open clamp of FIG. 4;

FIG. 4B is a fragmentary view of a gripping surface of a jaw; and

FIG. 5 is a representation of the clamp as employed in a surgical procedure.

Stated briefly, the clamp includes a set of jaws including a gripping portion, an actuating portion and pin means pivotally connecting the jaws for movement between open and closed positions within a first plane. A set of crank arms disposed and operable between open and closed positions within a second plane which is mutually intersecting with the first plane are connected at the junctures of the respective leg portions of the crank arms, to the actuating portion of the jaws. This connection comprises a hinge for infinite angular positioning of the first plane containing the jaws with respect to the second plane containing the crank arms within the design limits of the clamp. The effective distance between the junctures of the crank arms when in the closed position is greater than the effective distance therebetween when said crank arms are in their open position, thereby jamming the hinge connection and locking the planes in a preselected angular relationship.

By reason of the connection between the crank arms and jaws, opening and closing movements of the crank arms within their plane are transmitted to the jaws to similarly open and close the jaws within their plane. Universal means associated with the hinge connection between the jaws and crank arms accommodates rotational motion within the hinge connection which arises when transmitting the opening and closing force occurring in one plane to the second plane when the two planes are disposed at an angle one to the other.

With reference to the Figures, the clamp **9** includes a set of jaws **10** and **11** including a gripping portion **13** and an actuating portion **15.** The jaws are pivotally joined as by a screw **21** for opening and closing movement within a first plane (the plane of the drawing in FIG. 1). The actuating portion **15** of the set of jaws is connected to a set of handles **12** and **14** comprising crank arms **17** and **19,** each of which includes an elongated leg portion **16** and **18** adapted to be hand held, and a base leg portion **20** and **22,** respectively. The ends **24** and **26** of the base leg portions **20** and **22** of the two crank arms **17** and **19,** respectively, are pivotally joined as by a pin, which in the illustrated embodiment comprises a screw **28,** to provide for opening and closing movement of the handles within the plane of FIG. **1.** As will appear more fully hereinafter, the connection between the jaws and handles forms an operative relationship therebetween so that movement of the handles **12** and **14** between their open (see FIG. **4**) and their closed (see FIG. **1**) positions within the plane containing the handles (i.e., the plane of the drawing in FIGS. **1** and **4**), moves the jaws **10** and **11** between their open (see FIG. **4**) and closed (see FIG. **1**) positions within a further plane which, in FIGS. **1, 2** and **4,** is coincident with the plane containing the handles **12** and **14** (i.e., the plane of the drawing in FIGS. **1, 2** and **4**). As will also be further described, the connection between the jaws and handles comprises a hinge which permits the plane containing the jaws to be repositioned at an angle with respect to the plane containing the handles (see the angular positions of the jaws indicated in phantom in FIG. **2**). Still further, the connection between the jaws and handles provides an effective distance between the junctures **30** and **32** of the crank arms **17** and **19,** respectively, which is greater when the crank arms are in their closed position than when they are in their open position thereby to jam the hinge connection and lock the jaws in a preselected angular relationship with the handles.

As illustrated, the jaws **10** and **11** are pivotally joined at a point intermediate their respective ends by a pin means such as a screw **21** for pivotal movement of the jaws with respect to each other within their plane in a clamping action. The inward end **36** of the jaw **10** is connected to the juncture **30** of the crank arm **17** by link means **38** including a clevis portion **34** receiving a flat sided projection **35** extending from the inward end **36** of the jaw **10** which is secured in the clevis by a pin **37** to define a hinge **40** having its hinge axis within the plane which contains the jaws. The opposite end **39** of the link means **38** is connected to the juncture **30** of the crank arm **17** by means of a D-shaped flat-sided transition link **42** having a body portion **43** provided with an opening **45** and received in a mating slot **47** in the juncture **30** of the crank arm **17** and hingedly pinned therein by a screw **49.** The hinge axis of this latter connection is disposed at generally a right angle to the plane which contains the handles. The face **51** of the transition link **42** is held in near abutting relation to the flat end **53** of the link **38** by a screw **55** which passes through an internal opening **57** in the link **38** to threadably engage the transition link **42.** The diameter of the screw **55** is slightly less than the diameter of the opening **57** so as to be freely movable therein with the head **59** of the screw **55** engaging a shoulder **61** of the open-

ing, thereby defining a universal or swivel connection **63** between the crank arm **17** and the link **38** to accommodate relative rotational movement between the transition link **42**, hence the crank arm **17** and the link **38** (and a jaw **10**) when opening and closing the crank arms when the jaws are disposed at an angle with respect to the handles (as shown in FIG. **4A** and in phantom in FIG. **2**).

The inward end **65** of jaw **11** is similarly connected to the crank arm **19** through a link means **67** including a clevis portion **69** which receives a flat-sided projection **71** on the end **65** of the jaw **11**. A screw **73** pins the projection **71** in the clevis position **69** to form a hinge connection **75** between the jaw **11** and the link **67**. The hinge axis of this latter hinge connection **75** also lies within the plane which contains the jaws. A further and like hinge connection **77** is formed between the crank arm **19** and the link **67** wherein a flat-sided projection **79** on the link **67** is received in a slot **81** in the juncture **32** of the crank arm **19** and held by a screw **83**. The hinge axis of this connection is disposed at a substantially right angle to the plane which contains the handles.

The frictional hinge connections **40** and **75** between the links **38** and **67** and the jaws **10** and **11**, having their hinge axes within the plane which contains the jaws, provide for swinging of the jaws about the hinge connections to position the jaws at an angle with respect to the links **38** and **67**, hence at angle to the handles **12** and **14**. Several angular positions **85** and **87** of the jaws are shown in phantom in FIG. **2**. By reason of the hinge joint designs referred to above, the jaws are held against movement with respect to the links **38** and **67** other than the aforedescribed angular movement thus providing a rigid connection between the links and the jaws such as transmits opening and closing forces from the handles through the links to the jaws.

As described hereinbefore, each of the hinge connections **40** and **75** between the links **38** and **67** and the jaws **10** and **11** includes a projection **35** and **71**, respectively, extending from the jaws and hingedly received in clevis portions **34** and **69** of the links **38** and **67**. Screws **37** and **73** extend through the respective clevis portions of the links, hence through the projections **35** and **71** of the jaws to define a hinge connection between the jaws and the links. The screws **37** and **73** fit relatively loosely within the first leg of their respective clevis and also within the projection which each screw pins. Each screw is threadably received in the second leg of its respective clevis so that by tightening the screw, the legs of its clevis may be pulled into increased frictional engagement with the projection received by such clevis. The friction in each of the hinge connections **40** and **75** is selected initially to permit the jaws to swing freely about the hinge connections **40** and **75** such that the jaws can be swung about the hinge connections with a small positively applied force, as by a force applied by a surgeon's fingers, and be positioned at an angle with respect to the handles **12** and **14**.

The degree of frictional engagement in the hinge connections **40** and **75** is increased by the action of closing the handles to thereby retain the jaws in a selected angular position with respect to the handles. As illustrated in FIG. **3**, the flat faces of the projections **35** and **71** which abut the inner walls of their respective clevis portions of the links **38** and **67** are substantially parallel when the crank arms **17** and **19** are partly opened. Movement of the arms toward a fully open position (FIG. **4**) functions to open the jaws without substantially changing the parallelism of the abutting faces in the hinge connections **40** and **75**. Movement of the handles from the position illustrated in FIG. **3** toward the closed position (FIG. **1**) however, increases the effective distance between the junctures **30** and **32** of the crank arms and moves the abutting faces out of parallelism thereby increasing the force of contact between the faces and increasing the frictional engagement therebetween. Such increased friction serves to lock and hold the selected angular position of the jaws. Simultaneously, this closing of the arms moves the jaws closed to effect the desired clamping action. The nonparallelism in the hinge connections **40** and **75** is slightly exaggerated in FIG. **1** for purposes of illustration.

As the crank arms are moved closed, the pivot axis (represented by screw **28**) of the pivotally joined base legs **20** and **22** of the crank arms moves through a center point, thence past center in a toggle action to pull and lock the handles closed. The closing movement of the crank arms is halted by the coming together of a pair of stops **90** and **92**, one on each of the legs **20** and **22** of the handles, respectively, which limits the closing of the handles at a point where the pivot axis **27** has slightly passed center.

The aforedescribed opening and closing of the crank arms when the plane containing the arms is angularly disposed with respect to the plane containing the jaws requires a rotational movement within the means connecting the jaws to the crank arms. In the illustrated embodiment, this rotational motion is achieved through the swivel joint **63** referred to hereinbefore. FIG. **4A** depicts the rotational position of the link **38** when the jaws are disposed at angle to the open handles. With reference also to FIGS. **1** and **4**, when the handles are opened, transition link **42** in the swivel joint is held parallel to the plane containing the handles. The link **38** swivels with respect to the transition link **42**, however, by reason of the loose fit of the screw **55** disposed within the opening **57** in the link **38** and which joins the link **38** to the transition link **42**, thereby accommodating rotational movement between the transition link **42** and the link **38**. Longitudinal axial rigidity between the transition link **42** and the link **38** is maintained at all times by reason of the abutting flat faces **51** and **53** of the transition link **42** and the link **38**, respectively, thereby causing the movement of the crank arm **17** as it opens and closes to be transmitted to the jaw **10**. The other jaw **11** is connected to the crank arm **19** by the rigid link **67** as described hereinbefore so that as the crank arms open and close, the jaws also open and close.

When employed in a surgical procedure, the jaws of the clamp are positioned about an object to be grasped, such as a blood vessel. The angle of the jaws with respect to the handles is selected such as will position the handles out of the surgeon's field of movement and the clamp is closed. As shown in FIG. **5**, after closing the clamp **9** on vessel **94**, the handles **12** and **14** may be laid on the patient's body and not be an obstruction to the surgeon. As depicted in FIG. **4B**, the gripping ability of a jaw **11** is enhanced by providing a series of elongated grooves **96** in the gripping surface of one or both jaws.

Whereas a specific embodiment has been described herein, it is not intended that the invention be limited

to the specific embodiment, but rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A clamp comprising a set of jaws including a gripping portion, an actuating portion and pin means pivotally connecting said jaws for movement thereof between open and closed positions within a first plane,

a set of crank arms, each of said crank arms including a first leg portion adapted to be hand held, a second leg portion adapted to be hingedly connected to a mating crank arm, and a juncture between said leg portions, said crank arms being disposed and operable within a second plane,

means connecting said junctures of said crank arms to said actuating portion of said jaws for hinge movement of said jaws in said first plane containing said jaws with respect to said crank arms in said second plane containing said crank arms, and for transmission of opening and closing force from said crank arms to said jaws, wherein the effective distance between the junctures of said crank arms in their closed position is greater than the effective distance therebetween when said crank arms are in their open position to jam said means connecting said crank arms to said jaws and restrict angular movement of said first plane with respect to said second plane.

2. The clamp of claim 1 and including universal means associated with said means connecting said jaws and said crank arms and adapted to provide rotational freedom within said connecting means when said crank arms are operated to open and close said jaws when said plane containing said jaws is disposed at an angle to said plane containing said crank arms.

3. The clamp of claim 1 wherein said means connecting said junctures of said crank arms to said jaws comprises a first rigid link means hingedly connecting one of said crank arms to one of said jaws by means of plural hinge connections, said hinge connections being operable at generally right angles to each other, and a second link means including universal means hingedly connecting the other of said crank arms to the other of said jaws, said hinge connections being operable at generally right angles to each other, the hinge axes of said hinge connections with said jaws lying within a first common plane, and the hinge axes of said hinge connections with said handles lying in a second common plane, said planes being at substantially right angles to each other.

4. The clamp of claim 3 wherein said universal means included with said second link means comprises a swivel joint.

5. In a clamp useful in surgical procedures the combination comprising a set of jaws, a set of handles, and a plurality of connecting means joining said jaws to said handles for transmission of opening and closing force from said handles to said jaws to open and close said jaws, said connecting means including first and second link means hingedly connected to respective ends of said jaws wherein the hinge axes of said hinge connections between said jaws and said connecting means lie within a plane containing said jaws to provide for angular adjustment of said jaws about said hinge axes with respect to said connecting means, and transition means associated with one of said connecting means to provide for relative rotational movement between such connecting means and its respective connected handle as said handles are opened and closed while said jaws are disposed at an angle with respect to said handles.

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