



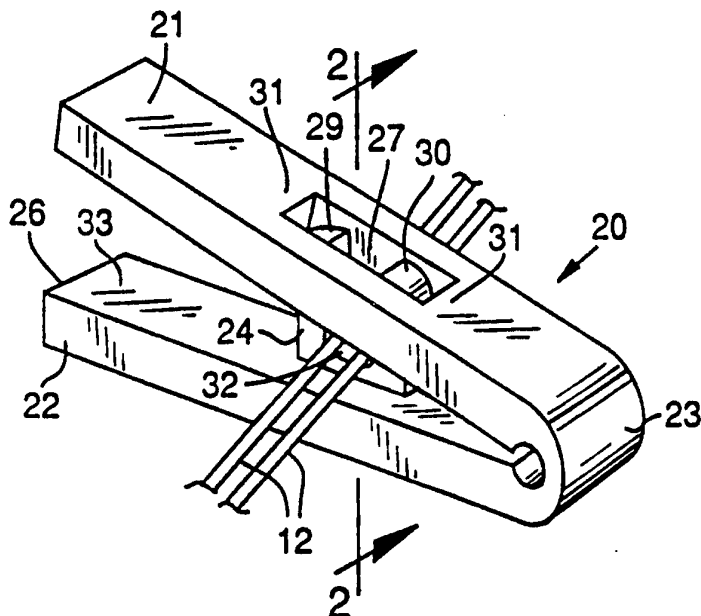
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>5</sup> : A61B 17/00</p>	A1	<p>(11) International Publication Number: <b>WO 94/15535</b> (43) International Publication Date: 21 July 1994 (21.07.94)</p>
<p>(21) International Application Number: PCT/US93/12654 (22) International Filing Date: 30 December 1993 (30.12.93) (30) Priority Data: 001,268 7 January 1993 (07.01.93) US (71) Applicant: HAYHURST, John, O. [US/US]; 14751 S.E. Wanda Drive, Milwaukie, OR 97267 (US). (74) Agents: HUGHEY, Patrick, W. et al.; Klarquist, Sparkman, Campbell, Leigh &amp; Whinston, One World Trade Center, Suite 1600, 121 S.W. Salmon Street, Portland, OR 97204 (US).</p>	<p>(81) Designated States: AU, CA, FI, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i></p>	

(54) Title: CLIP FOR SUTURE

(57) Abstract

Eliminates the need for tying knots in sutures. The clip (20) is slidable in an open position along sutures (12) that extend from a suturing site. With the clip (20) at the suturing site, the sutures (12) are tensed and the clip is forced into a closed position that fixes the position of the clip (20) relative to the sutures (12).



*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

-1-

**CLIP FOR SUTURE****TECHNICAL FIELD**

This invention relates to clips used in surgical procedures and particularly to clips for securing the free ends of sutures.

**BACKGROUND INFORMATION**

Sutures are commonly used to close incisions and to reunite damaged tissue. Typically, the sutures are passed through the tissue and the free ends of the sutures are tied together. In many instances, the suturing site is exposed to an extent that is sufficient to permit the surgeon to quickly tie the suture by hand. However, in some procedures, such as arthroscopic surgery, the suturing site is inaccessible by hand. As a result, the surgeon must tie the suture ends into a knot at a location remote from the suture site, and then manipulate suitably configured instruments for sliding the knot to the site.

For example, an arthroscopic surgical procedure usually employs a small-diameter cannula that extends through a small incision made in a joint. The sutures extend from the suturing site through the cannula. The exposed free ends of the sutures are tied by the surgeon and the knot is slid through the cannula to the suturing site. Such a suturing procedure is time consuming and can result in knots that do not hold the suture ends with sufficient tension to securely reunite the tissue.

**SUMMARY OF THE INVENTION**

This invention relates to a suture clip that eliminates the need for tying knots in suture ends. The clip is slidable along a suture or pair of sutures from a remote location to a suturing site. With the clip at the suturing site, the suture is tensed and the clip is closed against the suture to securely fasten the suture at the site.

The suture clip of the present invention comprises a pair of legs attached together at one end by a hinge. The clip is made of resilient material, such

as plastic. The clip is configured so that the elasticity of the plastic biases the legs toward a generally V-shaped orientation that defines the open position of the clip. Prongs are attached to one leg  
5 for holding both legs together in a closed position.

The prongs and clip legs define a passageway whenever the clip is in an open position. The free ends of a suture are threaded through the passageway. With the sutures threaded through the passageway, the open  
10 suture clip may be slid along the sutures without passing laterally away from the sutures because the passageway surrounds the sutures. The clip is slid down the sutures and passed through the arthroscopic incision until it reaches a position adjacent to the tissue where  
15 the suture is to be secured. An appropriate surgical instrument is used for sliding the clip along the sutures and for closing the clip. When the clip is forced into the closed position, the legs pinch the sutures to fasten the clip and sutures together. In one  
20 embodiment, the sutures are captured between the legs of the clip in a serpentine path, thereby increasing the resistance to slippage of the clip along the sutures.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one embodiment of a suture clip of the present invention, showing the clip in an open position.  
25

FIG. 2 is a cross-sectional side view, taken along line 2-2 of FIG. 1, showing sutures passing through the open clip.

FIG. 3 is a side view of the clip of FIG. 1, showing the clip in a closed position with sutures pinched between the legs of the clip.  
30

FIG. 4 is a perspective view of another embodiment of the present invention, showing the clip in an open position.  
35

FIG. 5 is a side view of the suture clip of FIG. 4.

-3-

FIG. 6 is a side view of the suture clip of FIG. 4, showing the clip in a closed position with sutures pinched between the legs of the clip.

FIG. 7 is a perspective view of another embodiment of the present invention, showing the clip in an open position.

FIG. 8 is a side view of the embodiment of FIG. 7.

FIG. 9 is a cross-sectional view, taken along line 9-9 of FIG. 8.

FIG. 10 is a side view of the embodiment of FIG. 7, showing the clip in a closed position with sutures pinched between the legs of the clip.

FIG. 11 is a cross-sectional view, taken along line 11-11 of FIG. 10.

FIG. 12 is a side view of another embodiment of the present invention, showing the clip in an open position.

FIG. 13 is a side view of the embodiment of FIG. 12, showing the clip in the closed position.

FIG. 14 is a cross-sectional view, taken along line 14-14 of Fig. 13.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1, 2 and 3 show one embodiment of a suture clip 20 formed in accordance with the present invention. The suture clip 20 includes an upper leg 21 and a lower leg 22, joined at a flexible hinge 23. The legs 21, 22 move about the hinge 23 between an open position (FIG. 1) and a closed position (FIG. 3). The clip 20 is formed of resilient material that normally biases the clip toward the open position, wherein the legs 21, 22 assume a V-shaped orientation.

A first prong 24 and a second prong 25 are attached to the lower leg 22 and extend toward the upper leg 21. The prongs 24, 25 are attached between the hinge 23 and the free end 26 of the lower leg 22.

The upper leg 21 has an opening 27 that is located to receive the prongs 24 and 25 whenever the

-4-

clip 20 is moved to the closed position, as described more fully below. Whenever the clip is in the open position, the prongs 24, 25 extend partly into the opening 27 (FIG. 2). A passageway 28 is defined between  
5 the first prong 24 and second prong 25, and between the lower leg 22 and the upper leg 21. The passageway 28 has no lateral opening. Consequently, one or more sutures 12 may be threaded through the passageway 28, and the open clip 20 may be slid along the length of the  
10 sutures 12 without moving laterally away from the sutures.

For example, an open clip 20 may be slid along the sutures that extend from a suturing site that is located inside a joint that is accessible only by  
15 surgical instruments. As used herein, the term suturing site means the location adjacent to the tissue to which the suture is connected. The free ends of the sutures 12 that are exposed outside of the joint are threaded through the passageway 28 of the clip, and the clip is  
20 slid down the sutures 12. The clip 20 will remain in contact with the sutures as it is slid to the suturing site because, as noted earlier, the passageway 28 in the open clip 20 has no lateral opening. In this regard, the sutures act as a guide for moving the clip to the  
25 suturing site. Once in position at the suturing site, the suture is tensed and the clip is closed (FIG. 3) by an appropriate surgical instrument, such as a clamp.

The prongs 24, 25 serve to lock the clip 20 in a closed position. To this end, a hook 29 is formed on  
30 the end of the first prong 24 and a correspondingly shaped hook 30 is formed on the second prong 25. The hooks 29 and 30 extend apart a distance that is greater than the length of the opening 27 in the upper leg 21. Consequently, as the upper leg 21 is forced toward the  
35 lower leg 22, the first prong 24 and second prong 25 are deflected toward one another as the opening 27 is slid over the curved tops of the hooks. Once the hooks 29 and 30 extend through the opening 27, the prongs 24

and 25 snap apart so that the hooks 29 and 30 extend partly over the outer surface 31 of leg 21 near the opening 27, thereby locking the clip 20 in the closed position. With the clip locked in the closed position, 5 the sutures 12 are firmly pinched between the legs 21, 22 (FIG. 3) so that the clip is unable to slide along the sutures 12.

As best shown in FIG. 2, a curved platform 32 is formed between the prongs 24, 25. The platform 32 10 provides a surface that is raised slightly above the inner surface 33 of the lower leg 22. The platform 32 effectively carries the sutures 12 above the inner surface 33 of the lower leg 21 to ensure the sutures 12 will be tightly pinched between the legs 21, 22 when the 15 clip is closed.

The clip 20 is of unitary construction and is preferably made of plastic. The plastic material provides the resiliency for urging the clip 20 into the open position and for permitting deflection of the 20 prongs 24, 25 as described above. Preferably, the clip 20 is made of material that is gradually absorbed. Such materials are polyglycolic acid, polylactic acid and trimethylene carbonate copolymers. Alternatively, the clip may be formed of permanent or non-absorbable 25 materials, such as acetal homopolymers or copolymers, polyethylene, polypropylene, and copolymers thereof.

FIGS. 4, 5, and 6 show another embodiment of the invention wherein the passageway 128 of the clip 120 is defined by a single prong 124 attached to the end of the 30 lower leg 122. The hinge 123 biases the clip 120 into a V-shaped open position (FIG. 5).

In the embodiment of FIG. 4, the single prong 124 is attached to the distal end of lower leg 122 and extends toward the upper leg 121. When the clip is 35 in the open position, the prong 124 is in contact with the free end 126 of upper leg 121, thereby forming a passageway 128 surrounded by the prong 124, the lower leg 122, and the upper leg 121. The passageway 128 has

no lateral opening. Any sutures 12 that are threaded through the passageway 128 are, therefore, substantially surrounded. As a result, the open clip 120 may be slid along the sutures 12 without moving laterally away from the sutures.

The prong 124 serves to lock the clip 120 in a closed position. A hook 131 is formed on the end of the prong 124. As the upper leg 121 is forced toward the lower leg 122, the prong 124 is deflected away from the upper leg 121 as the free end 126 of the upper leg 121 slides over the angled top of the hook. Once the hook 131 extends over the upper surface 133 of upper leg 121, the prong snaps back so that the hook 124 extends partly over the upper surface 133 of leg 121 near the free end 126, thereby locking the clip 120 in the closed position. When the clip is locked in the closed position, the sutures 12 are firmly pinched between the legs 121, 122.

FIGS. 7-11 show another embodiment of the suture clip 220 of the present invention. This embodiment includes an upper leg 221 and a lower leg 222, connected together at a flexible hinge 223. As with the other embodiments, this clip is formed of a resilient material that biases the clip toward the open position, wherein the legs 221, 222 assume a V-shaped orientation.

A first prong 224 and a second prong 225 are attached to the lower leg 222 and extend toward the upper leg 221. The prongs 224, 225 are attached between the hinge 223 and the free end 226 of lower leg 222. Each prong 224, 225 includes an inwardly protruding hook 230, 231.

The upper leg 221 has a first notch 227 located to receive the prong 224, and a second notch 228 located to receive prong 225 when the clip is forced into the closed and locked position (FIG. 10). When the clip 220 is in the open position (FIG. 8), the hook 230 on prong 224 contacts the leg 221 at one notch 227, and the hook



231 on prong 225 contacts the leg 221 at the other notch 228.

A passageway 229 is defined between the first prong 224 and the second prong 225, and between the lower leg 222 and the upper leg 221. One side 232 of the first prong 224 and the corresponding side 233 of the second prong 225 are curved such that the passageway 229 is essentially circular (FIG. 8) when the clip is in the open position. The passageway 229 has no lateral opening and, as with the other embodiments, the open clip 220 may be slid along the sutures 12 without laterally moving away from them.

With the sutures 12 threaded through the passageway 229, and the clip 220 adjacent to the suturing site, the clip 220 is locked in the closed position. In this regard, the hooks 230, 231 formed on the end of the first and second prongs 224, 225 have inclined facing surfaces that permit the upper leg 221 to be forced between the prongs 224, 225 as the clip 220 is moved into the closed position. As the upper leg 221 is forced toward the lower leg 222, the first prong 224 and second prong 225 are deflected away from one another as the portions of the upper leg 221 within the notches 227 and 228 push against the inclined surfaces of the hooks 230, 231. Once the hooks 230, 231 extend past the notches 227 and 228, the prongs 224 and 225 snap together so that the hooks 230, 231 extend partly over the top surface 234 of upper leg 221, thereby locking the clip 220 in the closed position. With the clip locked in the closed position, the sutures 12 are firmly pinched between the legs 221, 222 (FIG. 10) so that the clip is unable to slide along the sutures 12.

Another embodiment of the present invention is shown in FIGS. 12-14. In this embodiment the legs of the clip in the closed position capture the sutures in a serpentine path that is transverse to the longitudinal axis of the legs, thereby increasing the resistance to slippage of the clip along the suture, and providing a

more positive connection between the clip and the sutures. The configuration of this embodiment also decreases the possibility of misalignment of the legs when the clip is moved into the closed position.

5           The clip 308 includes an upper leg 312 that has an inner surface 310 that defines a serpentine shape in cross-section (FIG. 14). The inner surface 314 of lower leg 316 is configured with a complementary serpentine cross-sectional shape.

10           As shown in FIGS. 12 and 14, the surface 310 of upper leg 312 is defined by two downwardly projecting, generally convex (in cross-section) ridge portions 318 and 320, which are separated by a generally concave valley portion 322. The surface 314 of lower leg 316 is  
15 defined by an upwardly projecting, generally convex ridge portion 324 that separates two adjacent concave valley portions 326 and 328.

          With clip 308 in the open position (FIG. 12), a passageway 330 is defined, having no lateral opening.  
20 Consequently, one or more sutures 12 may be threaded through passageway 330, and the open clip 308 may be slid along the length of the suture without moving laterally away from the suture.

          Once the clip is moved adjacent the suturing  
25 site, it is locked into the closed position (FIG. 13) in the manner detailed above. In the closed position, the ridge portions and the valley on upper leg 312 mate with the valley portions and the ridge on lower leg 316, as illustrated, to define a transverse serpentine path  
30 along which pass the sutures that are threaded through the clip. In this position, the sutures contact surface 310 of upper leg 312 and surface 314 of lower leg 316, along the entire length of the path.

          Because the sutures follow a serpentine path,  
35 the contact length between sutures 12 and clip 308 is substantially greater than the length of contact between the generally flat inner surfaces of the legs illustrated in the embodiment shown in FIG. 4. Put

another way, the length of the path (FIG. 14) and, therefore, the length of contact between the sutures and the legs, is greater than the width of the legs in the direction transverse to the longitudinal axis of the legs (distance "X" in FIG. 14). Accordingly, the curves in the path increase the length of the sutures that is compressed between the legs of the closed clip. The increased contact length between the suture and the legs increases the resistance of clip 308 to sliding laterally along the sutures as a result of the increased frictional resistance between the sutures and the legs.

The serpentine or curved path for capturing the suture also has the effect of increasing frictional resistance to suture slipping when the suture is tensed. More particularly, tension imparted in the sutures (which tension would arise, for example, in instances where the clip is sited firmly against tissue with the suture held taut as the clip is closed) will, throughout most of the length of the serpentine path, transfer a component of that tension force in a direction normal to the leg surfaces 310, 314, thereby supplementing the frictional resistance attributable to the sutures being compressed within the elongated serpentine path.

In the preferred embodiment, the legs are formed to define a very narrow gap between the upper surface 310 and lower surface 314 when the clip is closed. To this end, the clip is formed with the cross-sectional width of the ridge portions 318, 320 and 324 being slightly narrower than the cross-sectional width of the complementary valley portions 326, 328 and 322. The gap, which is formed to be less than the width of the sutures, reduces the shear stress on the captured suture, thereby reducing the possibility of breaking the suture. This configuration also reduces the amount to which the sutures are stretched over the serpentine portions of the legs when the clip is closed, to further decrease the possibility of breaking the suture.

Neither the number of ridges and valleys on the upper and lower legs, nor the respective height of the ridges and valleys is critical. Thus, the clip may be formed with greater or fewer ridges and valleys than are  
5 illustrated in FIGS. 12-14, and the size of the ridges and valleys may be varied. The position of the ridges and valleys relative to one another on the legs, and the cross-sectional shape of the ridges and valleys is also not critical.

10 Other complementary mating configurations between the upper and lower legs will also suffice to increase the length of contact and the forces between the sutures and the clip, thereby increasing frictional resistance. Alternatively, frictional resistance  
15 between the sutures and the clip may be increased by roughening the mating surfaces of the legs. For example, with any of the embodiments illustrated, the resilient material used to form the clip may be unpolished on the inner surfaces of the legs. The  
20 surfaces also may be deliberately roughened after the clip is molded.

While the present invention has been described in accordance with several embodiments, it is recognized that variations and changes may be made therein without  
25 departing from the scope of the invention as set forth in the claims.

-11-

CLAIMS:

1. A clip for a suture comprising:  
a first leg;  
a second leg attached to the first leg, the  
5 first and second leg being movable relative to one  
another; and  
the clip being constructed of a resilient  
material that normally urges the first and second legs  
toward a first position that defines a passageway that  
10 completely surrounds a suture that may be threaded  
through the passageway, the first and second legs being  
movable from the first to a closed position for  
preventing movement of the clip relative to a suture  
threaded through the passageway, the clip in the closed  
15 position defining a curved path along which a suture  
threaded through the passageway is held between the  
legs.
2. The clip according to claim 1, wherein the  
closed clip has a width through which the suture passes  
20 and wherein the curved path length is greater than the  
width.
3. The clip according to claim 1, wherein the  
length of the curved path is greater than the transverse  
width of either of the legs.
- 25 4. The clip of claim 1 wherein part of the  
curved path is roughened.
5. A one-piece suture clip made from a  
resilient material and comprising:  
a first and second leg attached by a hinge and  
30 movable relative to each other between a first position  
and a second position;  
a prong attached to one leg, the prong and the  
legs defining a passageway that is configured for  
substantially surrounding a suture that may be threaded  
35 through the passageway, the prong being configured for  
securing the legs in the second position for holding the  
clip immovable relative to the suture, the suture

following a serpentine path through the clip and defined by the closed clip.

6. The suture clip according to claim 4,  
wherein the length of the path is greater than the  
5 transverse width of either of the legs.

7. The suture clip according to claim 5,  
wherein the clip contacts along the entire length of the  
path a suture that may be threaded through the  
passageway.

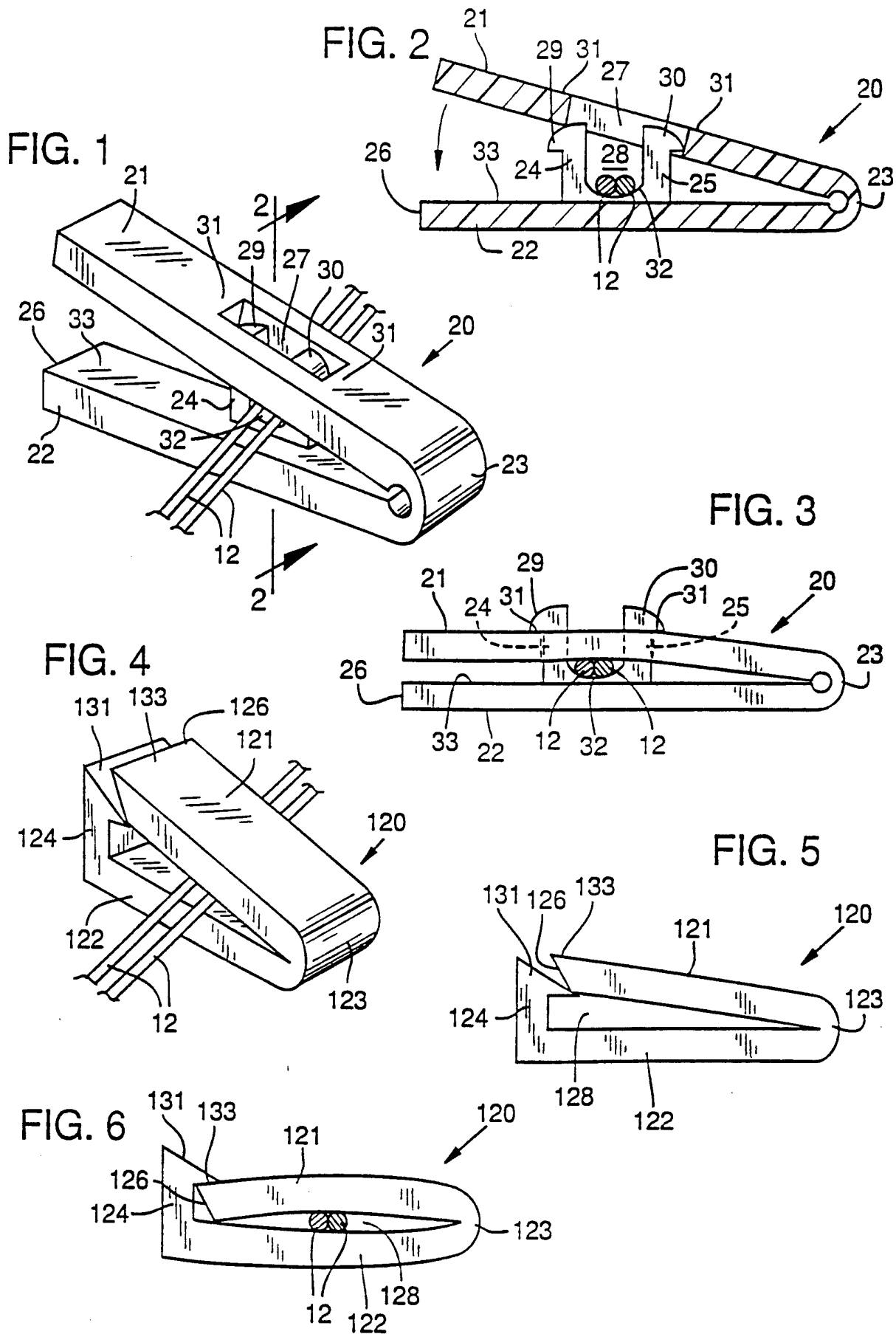


FIG. 7

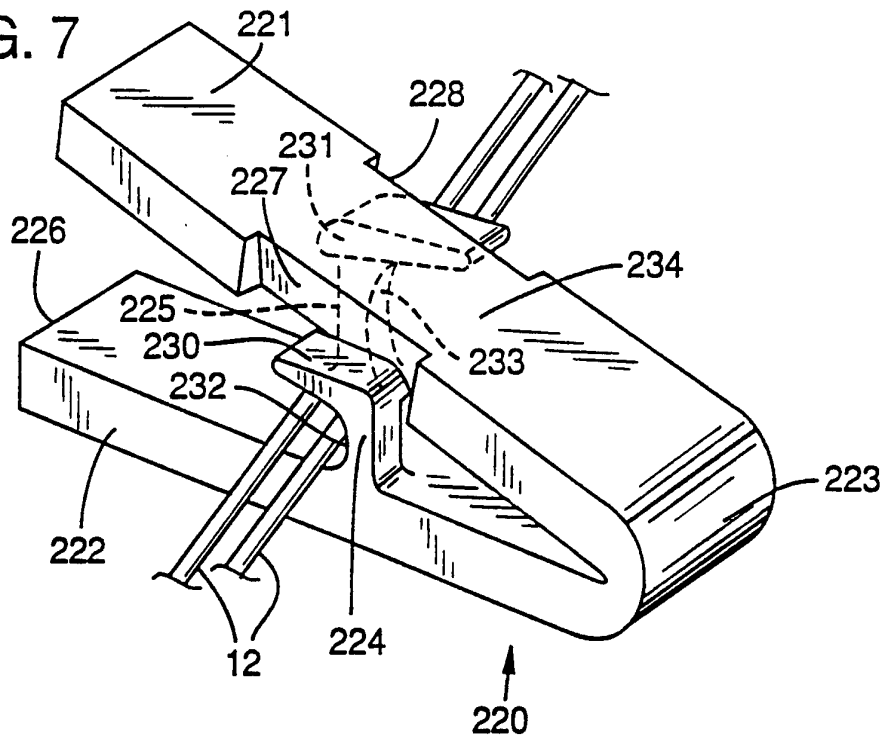


FIG. 8

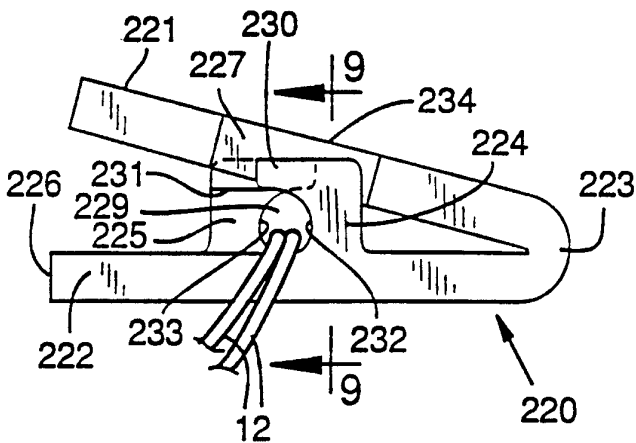


FIG. 9

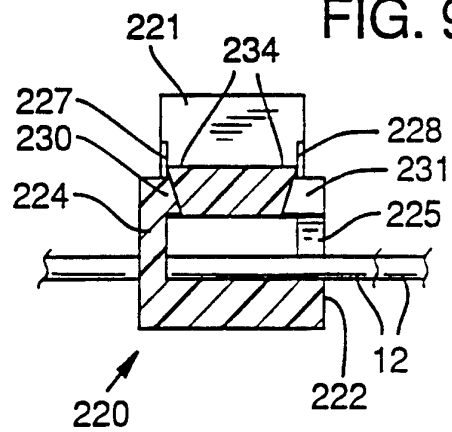


FIG. 10

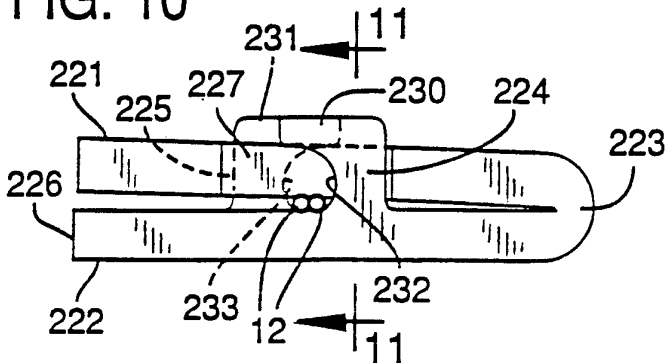


FIG. 11

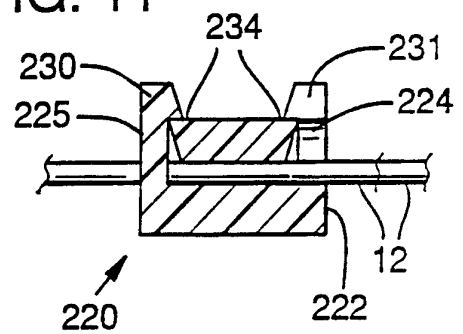




FIG. 12

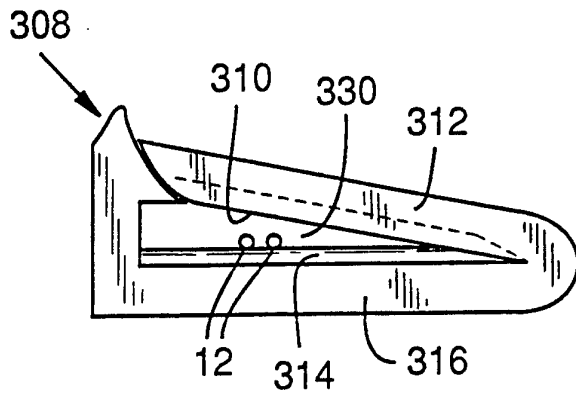


FIG. 13

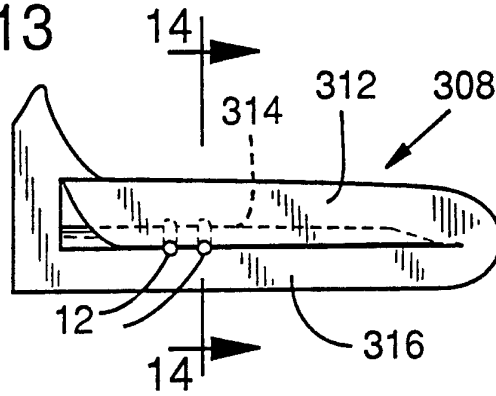
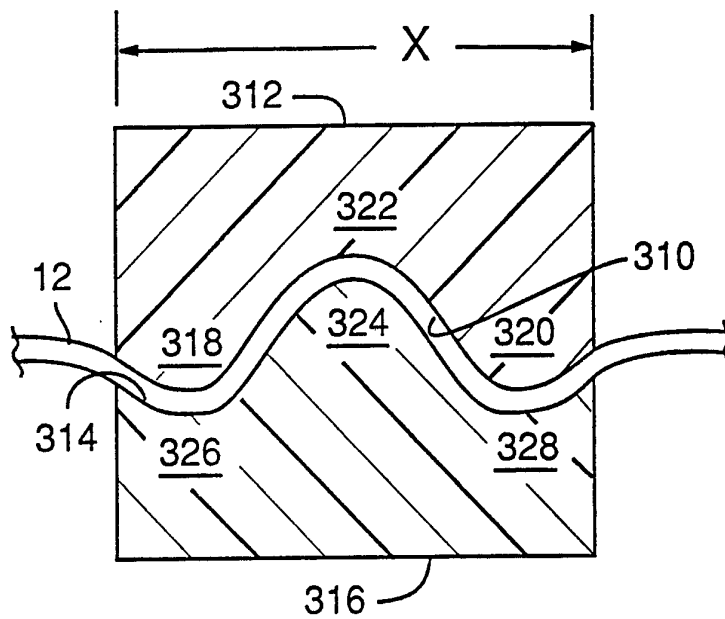


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US93/12654

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A61B 17/00

US CL :606/151, 158, 232

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/120, 151, 157, 158, 232; 24/129R 132R, 134R, 543

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,291,698, (Fuchs, deceased et al.), 29 September 1981. See column 1, lines 1-61.	1, 4
Y	US, A, 4,623,102, (Hough, Jr.), 18 November 1986. See Abstract of Disclosure.	1, 4
A	US, A, 4,750,492, (Jacobs), 14 June 1988. See Abstract of Disclosure	1, 4

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

16 MARCH 1994

Date of mailing of the international search report

25 APR 1994

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

*Gary Jackson*  
FOR  
GARY JACKSON

Telephone No. (703) 308-4302