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(71) Applicant *(for all designated States except US)*: SURGICRAFT LIMITED [GB/GB]; Fishing Line Road, Redditch B97 6HF (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : BEVAN, David, Robin [GB/GB]; Bremmel Cottage, Llangennith, Gower, West Glamorgan SA3 1HU (GB). PORTER, Richard, William [GB/GB]; 34 Bawtry Road, Doncaster DN4 7AZ (GB). SHEPPERD, John, Anthony, Norman [GB/GB]; "Hemmingfold", Telham, Nr. Battle, East Sussex TN33 0SH (GB). PHILLIPS, Peter, William [GB/GB]; 16 Field Close, Badsey, Evesham, Worcestershire WR11 5JN (GB).

(74) Agents: HULSE, Thomas, Arnold et al.; Hulse & Co., Eagle Star House, Carver Street, Sheffield S1 4FP (GB).

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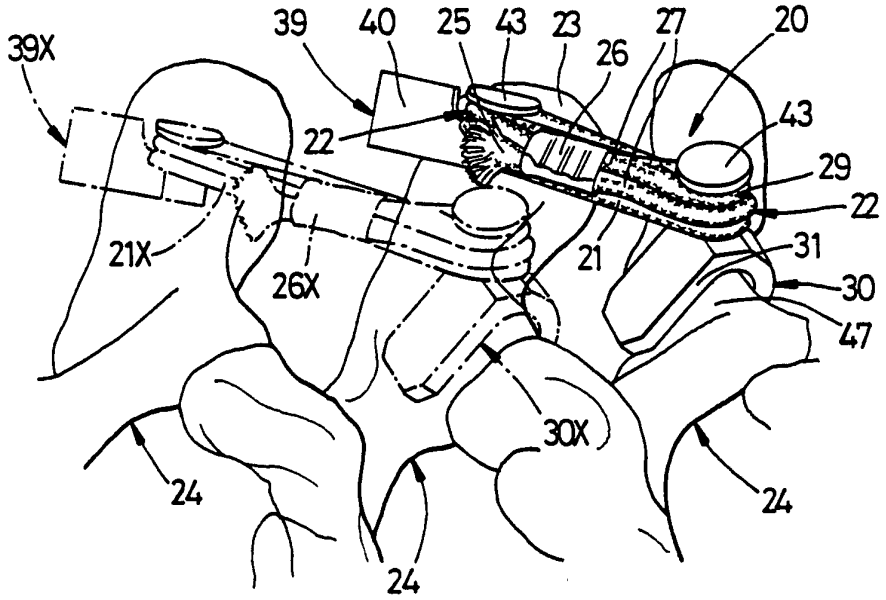

(57) Abstract

A surgical implant (20) comprises a hank formed from a single strand (21) of flexible biocompatible material (such as polyester) with at least one bight (22) at each end of the hank and a tail (25) extending from one end, and a crimpable sleeve-like element (26) encircling the overlapping end lengths (27) of the strand. The implant (20) is shown in use for the stabilisation of the spine, the bights (22) being applied to hooking members (30, 39) engaged respectively with the lamina (47) of one vertebra (24) and the spinous process (23) of an adjacent vertebra, the strand material (21) being tensioned by pulling the tail (25) before crimping the sleeve-like element (26).

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SURGICAL IMPLANTS, ETC.

This invention relates to surgical implants, etc., more particularly - but not exclusively - for the stabilization of the spine, but also applicable to other indications, such as the replacement or augmentation of knee or ankle ligaments, and also possibly applicable to the reduction of fractured bones.

Various forms of spinal stabilization are in use, including fixation devices such as Harrington, Hartshill (see EP-A-0 146 347 and EP-A-0 269 268), Luque, and Knodt, which comprise solid rods hooked on to the vertebrae or held thereto by wires.

More recently there have been introduced flexible stabilisation systems, such as inextensible strips between pedicle screws (See Burton US-A-4 743 260 and Graf et al EP-A-0 381 588) or inextensible bands of predetermined lengths round pedicle screws (see also EP-A-0 381 588).

However, in order to avoid failure of these anchorages in pedicles it has been proposed (in EP-A-0 381 588) to loop inextensible flexible members directly round the spinous processes; Senegas has an inextensible member wound in a figure of eight or multiples thereof round the spinous processes and through spacers therebetween, while Cremascoli (see EP-A-0 322 334) has semi-elastic flat lacing looped round the spinous processes and in between passed through small tubular cushions of the same material.

The winding or looping of flexible members, whether inextensible or semi-elastic, round the spinous processes and

through spacers or cushions is a time-consuming operation, and it is also difficult to tension the flexible members to adjust the load between vertebrae spanned by the flexible members, because of friction of the flexible members with themselves and with the bones and spacers or cushions.

One object of the present invention is to provide a surgical implant that can be quickly and surely applied, particularly for spinal stabilization but also for ligament augmentation or replacement or for reduction of fractured bones, and that can be easily tensioned to adjust the load between vertebrae spanned.

A secondary object of the invention is to adapt the surgical implant for alternative methods of engagement with the spine or with other bones in the body.

According to one aspect of the present invention, a surgical implant comprises a hank formed from a single strand of flexible biocompatible material with at least one bight at each end of the hank and a tail extending from at least one end, and at least one crimpable sleeve-like element encircling at least the overlapping end lengths of the strand.

With this simplest form, the two bights can be quickly and surely applied one over each of two spinous processes (or anchoring means such as pedicle screws secured in two vertebrae), any slack being taken up by pulling the tail, further pulling of which makes use of the purchase of the looped strand material to adjust the load between the vertebrae, then the crimpable sleeve-like element is squeezed (using any suitable, e.g., proprietary crimping tool) on to

the lengths of strand passing therethrough to secure the strand in its tensioned state.

The at least one crimpable sleeve-like element may encircle all the strands of the hank intermediate its ends, or only all the lengths of strand at one side of the hank, and more than one crimpable sleeve-like element may be applied to the hank.

For other indications, such as ligament augmentation or replacement, the bights are simply applied over suitable heads of anchorages in the relevant bones.

Conveniently, the at least one bight at one end of the hank comprises an eye formed at the end of the strand material remote from the tail, while the at least one bight at the other end of the hank is formed by the strand material looping from the corresponding end of the crimpable sleeve-like element. It will be evident that the eye will be of a size adequate to fit over a spinous process or the head of a pedicle screw or other anchorage.

The hank may consist of a plurality of loops of the single strand of flexible biocompatible material, so as to increase the purchase when pulling the tail to adjust the load between vertebrae or other bone parts. Thus the hank will have at each end a corresponding plurality of coincident bights.

In order to adapt the surgical implant for alternative engagement with the lamina or transverse processes on either side of the spine and/or to distribute the load over a greater edge area of the spinous processes (or the lamina or

transverse processes) than is afforded to the strand material when applied directly thereto, the surgical implant according to another aspect of the present invention also comprises a pair of hooking members, each having a broad flat hook portion for engaging one part of the spinal column, integrated with an oppositely directed and reverse facing round hook portion engageable with the bight or bights at one end of the hank. For symmetrical loading of vertebrae, two implants in accordance with the invention and each comprising a hank, a crimpable sleeve-like element, and two hooking members, all as defined above, may be applied to the lamina or transverse processes at both sides of the spine. Alternatively, two hooking members, each in the form of a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke, are combined with two hanks and two crimpable sleeve-like elements as defined above, the yokes being hooked on to spinous processes and the hanks lying one to each side of the spinous processes. Again, one yoke may be applied to the spinous process of one vertebra, and two hooking members, as defined above, may be applied to the lamina at both sides of the spinous process of other vertebra, and combined with two hanks and two crimpable sleeve-like elements as defined above, the bights of the hanks being applied to respective round hook portions on the yoke and the corresponding hooking members.

At least one of the hooking members preferably has abutment means for a tensioning tool for pulling the tail of the strand material, which abutment means may take the form of

a hole (or a spigot) located between the flat and round hook portions (or between the yoke and the round hook portions).

Each round hook portion is preferably formed by a bollard having a cylindrical body and a flat circular head, which aids retention of an eye at one end of the strand material. The bollard is also conveniently engageable by a forked end of an applicator tool having a striking portion at the other end; and the flat circular head of the bollard may also serve as a spigot for engagement by a socket in a tensioning tool.

A selection of hooking members is preferably made available with a variety of widths and radii of the broad flat hook portions and/or of the yoke portion, so that the surgeon can select hooking members appropriate to the size and shape of parts of the spinal column.

The hooking members, when used on the spine, may be attached to the cranial or caudal border of the lamina, the cranial base of the transverse processes, or the caudal edge of the sacral foramen.

The insides of the broad flat hook portions and/or of the broad flat yokes are preferably provided with sharp-ridged ribs extending in the direction of application of the hooking members, to enhance the grip on engaged bone parts; and a leading end of each broad flat hook portion is preferably provided with a chisel edge, to effect some shaving of an engaged bone part, if necessary, to achieve a good fit.

The strand material may be made of polyester or any other suitably strong flexible inert or biocompatible

material, and the crimpable sleeve-like element may be made from any suitably ductile inert material.

The inside of the crimpable sleeve-like element is preferably provided with circumferentially extending ribs, to enhance the grip on the strand material; thus, this element may be conveniently manufactured as an initially cylindrical and, preferably, internally screwthreaded sleeve, which is then flattened slightly, so as to accommodate a pair of overlapping end lengths of strand material in an element having minimal cross-sectional dimensions.

The hooking members may be made from any suitable implant material (e.g., stainless steel, titanium, ceramic) and may be coated with hydroxyapatite to encourage ingrowth of bone tissue, which will assist in reducing edge loading, while a plurality of turns of strand material in the hank will encourage ingrowth of body tissue.

According to a further aspect of the present invention, of independent significance, a capstan for tensioning a flexible surgical strand comprises a shank with a co-axial spigot or socket at one end for engagement with a hole in or spigot on a surgical implant, handgrip means at the other end of the shank for rotating the capstan after engagement with the spinal implant, and means on the shank (such as a cleat thereon or a notch or aperture therein), for securing a flexible surgical strand to the shank for winding thereon upon rotation of the capstan.

The handgrip means may comprise a crossbar secured to the shank, or it may comprise a knurled knob, which may be

coupled to the shank through a torque-setting device, for indicating or limiting the load applied to a flexible surgical strand secured to the shank as aforesaid.

According to yet another aspect of the present invention, of independent significance, a method of spinal stabilisation comprises securing to two parts of the spinal column respective bights at the ends of a hank formed from a single strand of flexible biocompatible material having at least its overlapping end lengths encircled by at least one crimpable sleeve-like element, with a tail of the strand extending from an end of the hank, pulling the tail to take up slack in the hank and tension the strand, squeezing the crimpable sleeve-like element on to the lengths of strand passing therethrough to secure the strand in its tensioned state, and cutting off excess strand material.

The bights may be secured to two vertebrae by applying them one over each of the respective spinous processes, or they may be applied over the heads of pedicle screws screwed into the vertebrae or other parts of the spinal column.

Alternatively, hooking members, each having a broad flat hook portion integrated with an oppositely directed and reverse facing round hook portion, are applied one to each of two vertebrae, with the respective flat hook portion engaged with the spinous process or to the lamina or transverse process at one side of the spine, then engaging the bights of the hank with the respective round hook portions of the hooking members, whereafter the tail of the strand can be pulled, the crimpable sleeve-like element squeezed, and excess

strand material cut off, as described above.

A similar combination of hooking members, hank and crimpable sleeve-like element may be applied similarly at the other side of the spine to achieve symmetrical loading of the vertebrae.

Again, hooking members, each having a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke, are applied one to each of two spinous processes, with the respective yoke portion engaged with a spinous process, the round hook portions then being engaged by respective bights of a pair of hanks each of which is formed from a single strand of material, as aforesaid, with a tail and an encircling crimpable sleeve-like element, the tails being pulled, the crimpable sleeve-like elements squeezed, and excess strand material cut off, as described above, to achieve symmetrical loading.

Yet again, a hooking member having a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke may be applied to the spinous process of one vertebra, and two hooking members each having a broad flat hook portion integrated with an oppositely directed and reverse facing round hook portion are applied to the lamina at both sides of the spinous process of another vertebra, the respective round hook portions of the yoke and the corresponding hooking members engaged with the lamina then being engaged by respective bights of a pair of hanks each of which is formed from a single strand of material, as aforesaid, with a tail and an encircling crimpable sleeve-like

element, the tails being pulled, the crimpable sleeve-like elements squeezed, and excess strand material cut off as described above, to achieve symmetrical loading.

A tensioning tool, such as the capstan described above, may be applied to one of the hooking members, engaged with the tail (or each of the tails) and operated (e.g., rotated) to tension the strand (or each strand) before squeezing of the (or each) crimpable sleeve-like element.

Embodiments of the invention and manner of application thereof will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a plan view of one of the simplest forms of surgical implant in accordance with the invention shown applied to the spinous processes of adjacent vertebrae;

Figure 2 is a side elevation of parts of Figure 1, as seen from the lower side of Figure 1;

Figure 3 corresponds to Figure 1 but shows two of the simplest forms of implant applied to pairs of pedicle screws secured in both sides of a pair of adjacent vertebrae;

Figure 4 is a side elevation of one of the implants of Figure 3 and its associated pedicle screws, with an indication (in chain-dotted lines) of the pair of adjacent vertebrae, and with an indication how further similar implants can extend from those pedicle screws;

Figure 5 is a perspective view of a basic concept for a surgical implant in accordance with the invention provided with hooking members, one of which is engaged by a tensioning tool;

Figure 6 is a fragmentary perspective view showing the crimpable sleeve-like element of Figure 5 after crimping on to the lengths of strand passing through it;

Figure 7 is a perspective view of alternative form of hooking member to those shown in Figure 5;

Figure 8 is a plan view of components of a preferred form of surgical implant in accordance with the invention;

Figure 9 is an end view of the crimpable sleeve-like element of Figure 8;

Figure 10 is an enlarged section taken from the line X-X of Figure 9;

Figure 11 is a plan view showing the two sets of components as in Figures 8 to 10, together with a preferred form of yoke and a pair of other hooking members of preferred form applied to adjacent vertebrae;

Figure 12 is a side elevation of parts of Figure 11, with an indication of similar surgical implants, yoke and other hooking members extending from one of the vertebrae to the next;

Figures 13 (a), (b), (c) and (d) are respective plan, side, underneath and end views of one of the hooking members shown in Figures 11 and 12;

Figure 14 is a side elevation of a tool for use in driving into place a hooking member as in Figures 13 (a) to (d) and shown engaged therewith;

Figure 15 is a fragmentary underneath view of the lower end of the tool of Figure 14, without the hooking member;

Figures 16 (a), (b), (c) and (d) are respective plan, side, underneath and end views of the other hooking member shown in Figures 11 and 12;

Figure 17 is a side elevation of a tensioning tool for engagement with one of the hooking members shown in Figures 11 and 12; and

Figure 18 is an underneath view of the tensioning tool shown in Figure 17.

In Figures 1 and 2, a surgical implant 20 comprises a hank formed from a single strand 21 of flexible biocompatible material with bights 22 at both ends, applied over each of two spinous processes 23 on adjacent vertebrae 24 with tails 25 projecting from a crimpable sleeve-like element 26 encircling the overlapping end lengths 27 of the strand, the element 26 being shown as having been crimped to secure the strand 21 after tensioning by pulling the tails 25 in opposite directions.

In Figure 3, two similar implants 20 are applied to pairs of pedicle screws 28 secured in both sides of a pair of adjacent vertebrae 24, the crimpable sleeve-like elements 26 being shown as having been crimped after tensioning the strands 21 to provide symmetrical loading of the vertebrae. In Figure 4, strands 21X, 21Y of further implants 20X, 20Y are indicated as extending to further adjacent vertebrae which are not shown or indicated.

The strand 21 shown in Figure 5 has one bight at one end of the hank comprising an eye 29 formed at the end of the strand material remote from the tail 25, and the hank consists

of a plurality of loops with all the lengths of strand between the bights 22 encircled by the crimpable sleeve-like element 26. Hooking members 30 each have a broad flat hook portion 31 for engaging one part of the spinal columnm, e.g., the lamina or transverse processes (not shown) on one side of the spine and to distribute the load over a greater edge area thereof, and an oppositely directed and reverse facing round hook portion 32 engaged by the bights 22 at one end of the hank of flexible biocompatible material 21. Abutment means for a tensioning tool 33, for pulling the tail 25 of the strand material, takes the form of a hole 34 located between the flat and round hook portions 31, 32, which hole is engaged by a spigot 35 at one end of a shank 36 of the tensioning tool. This tool 33 is in the form of a capstan with handgrip means 37 at the other end of the shank for rotating the capstan, a cleat 38 being provided on one side of the shank for securing the tail 25 of the strand material 21 to the shank for winding thereon upon rotation of the capstan. Figure 6 shows the crimpable sleeve-like element 26 crimped on to the hank.

Figure 7 shows a hooking member 39 having a broad flat yoke 40 with a round hook portion 32 integrated with and oppositely directed to each end of the yoke. Two such hooking members may have their yokes hooked on to spinous processes (not shown) of adjacent vertebrae, and two hanks and two crimpable sleeve-like elements combined therewith by hooking the bights 22 of the hanks on the round hook portions 32, with one hank on each side of the spinous processes, and

the elements 26 crimped on to the hanks after they have been tensioned. Alternatively, one such hooking member 39 may have its yoke hooked on a spinous process of one vertebra while two hooking members 30 have their broad flat hook portions hooked on the lamina of an adjacent vertebra, and combined with two hanks and two crimpable sleeve-like elements by hooking the bights of the hanks on respective round hook portions on the hooking members 30, 39.

It will be appreciated that because the crimpable sleeve-like element 26 in Figures 5 and 6 encircles four lengths of the strand material 21, its bore must be of an adequate diameter for easy feeding of the tail 25 repeatedly therethrough, and - in consequence - the outside diameter will be commensurately larger. Preferably, therefore, as shown in Figures 1 and 2, Figures 3 and 4, and Figures 11 and 12, the crimpable sleeve-like element 26 encircles only the overlapping end lengths 27 of the strand 21, thus minimising the cross-sectional dimensions of the element 26. Thus the element 26 may be manufactured as an initially cylindrical and, preferably, internally screwthreaded sleeve, which is then flattened slightly to give the preferred form shown in Figures 8 to 10 with the turns of the internal screwthread 41 constituting circumferentially extending ribs, to enhance the grip on the strand material 21 upon crimping of the element 26 thereon.

The preferred forms of crimpable sleeve-like element 26 and strand material 21 with eye 29 are shown in Figures 11 and 12 in use in combination with preferred forms of hooking

members, details of which will be described with reference to Figures 13(a) to (d) and 16(a) to (d). In these preferred forms of hooking members the round hook portions 32 are formed by bollards having cylindrical bodies 42 and flat circular heads 43, and the heads on the hooking members 30 are shown in Figures 11 and 12 aiding retention of the eyes 29 of hanks of strand material hooked on the bollards.

In Figure 14 the bollard 32 of one of the hooking members 30 is shown engaged by a forked end 44 of an applicator tool 45 having a striking portion 46 at the other end, which enables the hooking member 30 to be hammered into place on the lamina 47 at one side of the spinous process 23 of one vertebra 24, and - as shown in Figure 11 - another hooking member 30 is hammered into place on the lamina 47 at the other side of that spinous process 23. As can be seen in Figures 13(a) to (d), the inside of each broad flat hook portion 31 is provided with a sharp-ridged rib 48 extending in the direction of application of the hooking member 30, to enhance the grip on the engaged bone part. A leading end 49 of each broad flat hook portion 31 is provided with a chisel edge, to effect some shaving of the engaged bone part, if necessary, to achieve a good fit.

In Figures 16(a) to (d) a hooking member 39 can be seen to be provided with sharp-ridged ribs 50 extending along the insides of the arms of the yoke portion 40 in the direction of application to the spinous process 23 of an adjacent vertebra 24 in Figures 11 and 12, to enhance the grip on this engaged bone part.

Referring again to Figures 11 and 12 the bights 22 of the hanks are applied to respective bollard type round hook portions on the yoke 39, 40, with the crimpable sleeve-like elements 26 encircling the overlapping end lengths 27 of the strands, and after tensioning of the strands (as by means of the tool shown in Figures 17 and 18, and which will be described presently) the elements 26 are crimped on to the lengths of strand passing therethrough to secure the strands in their tensioned state.

Any suitable one of the heads 43 of the bollard type round hook portions of the hooking members 30, 39 may serve as a spigot engageable by a socket 51 in one end of the tensioning tool 52 shown in Figures 17 and 18, the other end of which has a handgrip 53 enabling the tool to be rotated with the socket 51 thus engaged with a head 43. The tool 52 has a notch 54 into which the tail 25 of a hank can be jammed, and a neck 55 round which the strand material 21 can be wound as the tool is rotated to tension the strand material.

Further hooking members 30X, 39X, a hank of strand material 21X and crimped element 26X are indicated in chain dotted lines Figure 12 providing further stabilisation between the vertebra carrying the hooking member 39 and the next adjacent vertebra.

CLAIMS

1. A surgical implant comprising a hank formed from a single strand of flexible biocompatible material with at least one bight at each end of the hank and a tail extending from at least one end, and at least one crimpable sleeve-like element encircling at least the overlapping end lengths of the strand.

2. A surgical implant as in Claim 1, wherein the at least one crimpable sleeve-like element encircles all the strands of the hank intermediate its ends.

3. A surgical implant as in Claim 1, wherein the at least one crimpable sleeve-like element encircles all the lengths of strand at one side of the hank.

4. A surgical implant as in any one of Claims 1 to 3, wherein more than one crimpable sleeve-like element is applied to the hank.

5. A surgical implant as in any one of Claims 1 to 4, wherein the at least one bight at one end of the hank comprises an eye formed at the end of the strand material remote from the tail, while the at least one bight at the other end of the hank is formed by the strand material looping from the corresponding end of the crimpable sleeve-like element.

6. A surgical implant as in any one of Claims 1 to 5, wherein the hank consists of a plurality of loops of the single strand of flexible biocompatible material.

7. A surgical implant as in any one of Claims 1 to 6, also comprising a pair of hooking members, each having a

broad flat hook portion for engaging one part of the spinal column, integrated with an oppositely directed and reverse facing round hook portion engageable with the bight or bights at one end of the hank.

8. A surgical implant as in any one of Claims 1 to 6, also comprising two hooking members, each in the form of a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke, combined with two hanks and two crimpable sleeve-like elements as defined above.

9. A surgical implant as in any one of Claims 1 to 6, also comprising one hooking member in the form of a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke and a pair of hooking members, each having a broad flat hook portion for engaging one part of the spinal column, integrated with an oppositely directed and reverse facing round hook portion engageable with the bight or bights at one end of the hank.

10. A surgical implant as in any one of Claims 7 to 9, wherein at least one of the hooking members has abutment means for a tensioning tool for pulling the tail of the strand material.

11. A surgical implant as in Claim 10, wherein the abutment means takes the form of a hole located between the flat and round hook portions.

12. A surgical implant as in any one of Claims 7 to 10, wherein each round hook portion is formed by a bollard having a cylindrical body and a flat circular head.

13. A surgical implant as in any one of Claims 7 to

12, wherein a selection of hooking members is made available with a variety of widths and radii of the broad flat hook portions and/or of the yoke portion.

14. A surgical implant as in any one of Claims 7 to 13, wherein the insides of the broad flat hook portions and/or of the broad flat yokes are provided with sharp-ridged ribs extending in the direction of application of the hooking members, to enhance the grip on engaged bone parts.

15. A surgical implant as in Claim 7 or Claim 9, wherein a leading end of each broad flat hook portion is provided with a chisel edge, to effect some shaving of an engaged bone part.

16. A surgical implant as in any one of Claims 1 to 15, wherein the strand material is made of polyester

17. A surgical implant as in any one of Claims 1 to 16, wherein the inside of the crimpable sleeve-like element is provided with circumferentially extending ribs, to enhance the grip on the strand material.

18. A surgical implant as in Claim 17, wherein the crimpable sleeve-like element is manufactured as an initially cylindrical and internally screwthreaded sleeve, which is then flattened slightly, so as to accommodate a pair of overlapping end lengths of strand material in an element having minimal cross-sectional dimensions.

19. A surgical implant as in any one of Claims 7 to 9, wherein the hooking members are coated with hydroxyapatite to encourage ingrowth of bone tissue.

20. A capstan for tensioning a flexible surgical

strand comprising a shank with a co-axial spigot or socket at one end for engagement with a hole in or spigot on a surgical implant, handgrip means at the other end of the shank for rotating the capstan after engagement with the spinal implant, and means on the shank for securing a flexible surgical strand to the shank for winding thereon upon rotation of the capstan.

21. A capstan as in Claim 20, wherein the means on the shank for securing a flexible strand thereto is a cleat on the shank.

22. A capstan as in Claim 20, wherein the means on the shank for securing a flexible strand thereto is a notch in the shank.

23. A capstan as in any one of Claims 20 to 22, wherein the handgrip means comprises a crossbar secured to the shank.

24. A capstan as in any one of Claims 20 to 22, wherein the handgrip means comprises a knurled knob.

25. A capstan as in Claim 23 or Claim 24, wherein the crossbar or knurled knob is coupled to the shank through a torque-setting device, for indicating or limiting the load applied to a flexible surgical strand secured to the shank as aforesaid.

26. A tool for applying a hooking member as defined in Claim 7 in combination with Claim 12, the tool comprising a forked end engageable with the bollard of the hooking member and a striking portion at the other end.

27. A method of spinal stabilisation comprising securing to two parts of the spinal column respective bights

at the ends of a hank formed from a single strand of flexible biocompatible material having at least its overlapping end lengths encircled by at least one crimpable sleeve-like element, with a tail of the strand extending from an end of the hank, pulling the tail to take up slack in the hank and tension the strand, squeezing the crimpable sleeve-like element on to the lengths of strand passing therethrough to secure the strand in its tensioned state, and cutting off excess strand material.

28. A method as in Claim 27, wherein the bights are secured to two vertebrae by applying them one over each of the respective spinous processes.

29. A method as in Claim 27, wherein the bights are applied over the heads of pedicle screws screwed into the vertebrae or other parts of the spinal column.

30. A method as in Claim 27, wherein hooking members, each having a broad flat hook portion integrated with an oppositely directed and reverse facing round hook portion, are applied one to each of two vertebrae, with the respective flat hook portion engaged with the spinous process or to the lamina or transverse process at one side of the spine, then engaging the bights of the hank with the respective round hook portions of the hooking members, whereafter the tail of the strand can be pulled, the crimpable sleeve-like element squeezed, and excess strand material cut off.

31. A method as in Claim 30, wherein a similar combination of hooking members, hank and crimpable sleeve-like element may be applied similarly at the other side of the

spine to achieve symmetrical loading of the vertebrae.

32. a method as in Claim 27, wherein hooking members, each having a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke, are applied one to each of two spinous processes, with the respective yoke portion engaged with a spinous process, the round hook portions then being engaged by respective bights of a pair of hanks each of which is formed from a single strand of material, with a tail and an encircling crimpable sleeve-like element, the tails being pulled, the crimpable sleeve-like elements squeezed, and excess strand material cut off, as described above, to achieve symmetrical loading.

33. A method as in Claim 27, wherein a hooking member having a broad flat yoke with a round hook portion integrated with and oppositely directed to each end of the yoke may be applied to the spinous process of one vertebra, and two hooking members each having a broad flat hook portion integrated with an oppositely directed and reverse facing round hook portion are applied to the lamina at both sides of the spinous process of another vertebra, the respective round hook portions of the yoke and the corresponding hooking members engaged with the lamina then being engaged by respective bights of a pair of hanks each of which is formed from a single strand of material, with a tail and an encircling crimpable sleeve-like element, the tails being pulled, the crimpable sleeve-like elements squeezed, and excess strand material cut off, to achieve symmetrical

loading.

34. A method as in any one of Claims 30 to 33, wherein a tensioning tool is applied to one of the hooking members, engaged with the tail of the respective hank and operated to tension the strand before squeezing of the crimpable sleeve-like element.

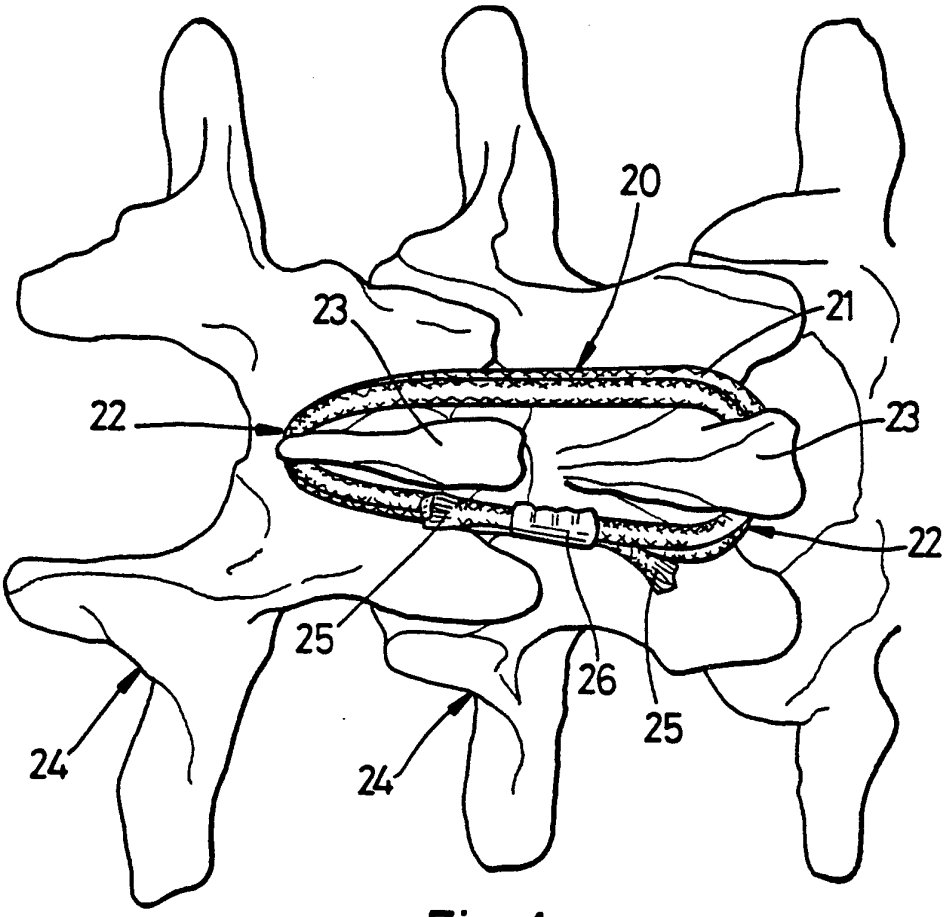

Fig. 1

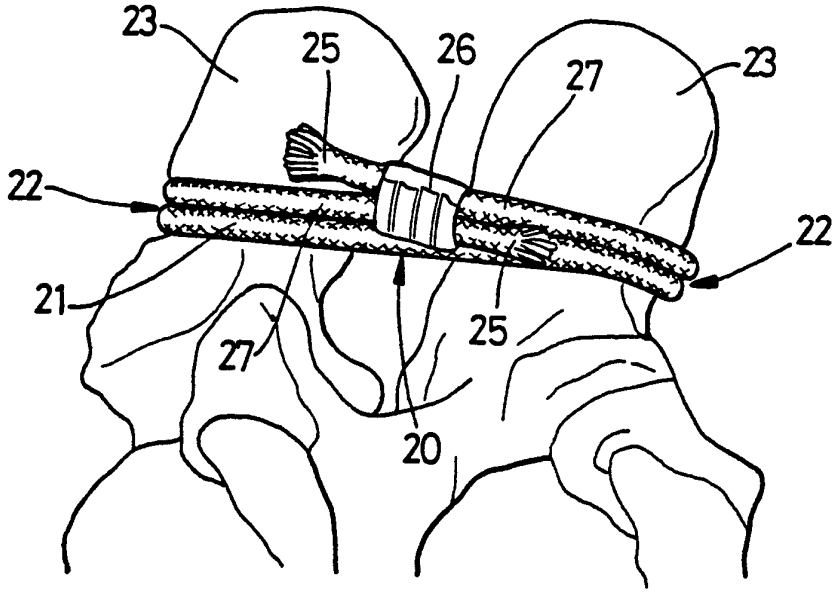

Fig. 2

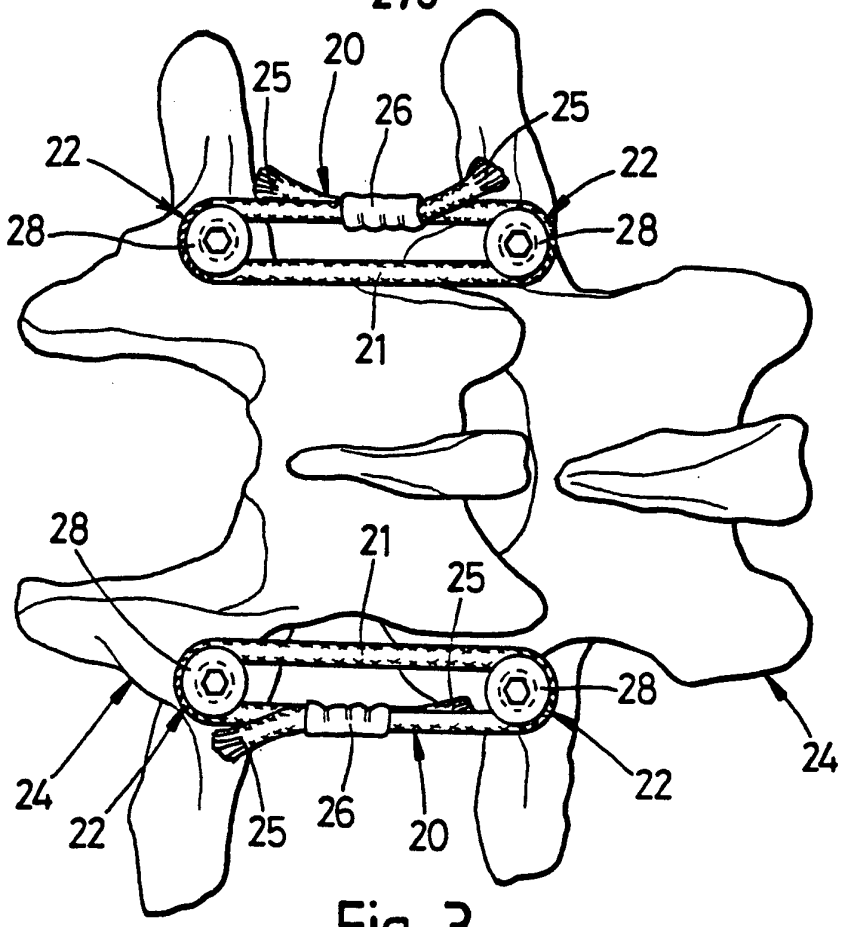
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Fig. 3

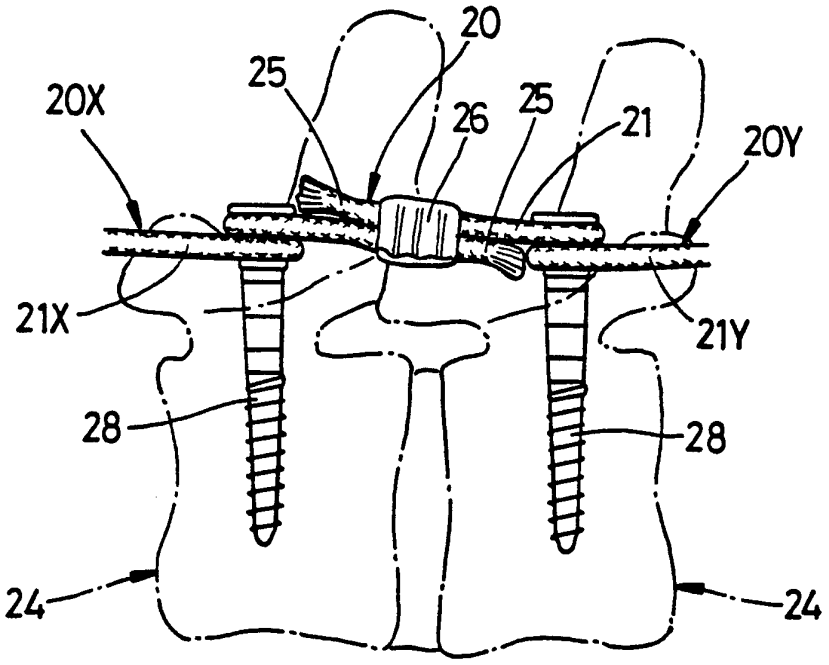
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Fig. 4

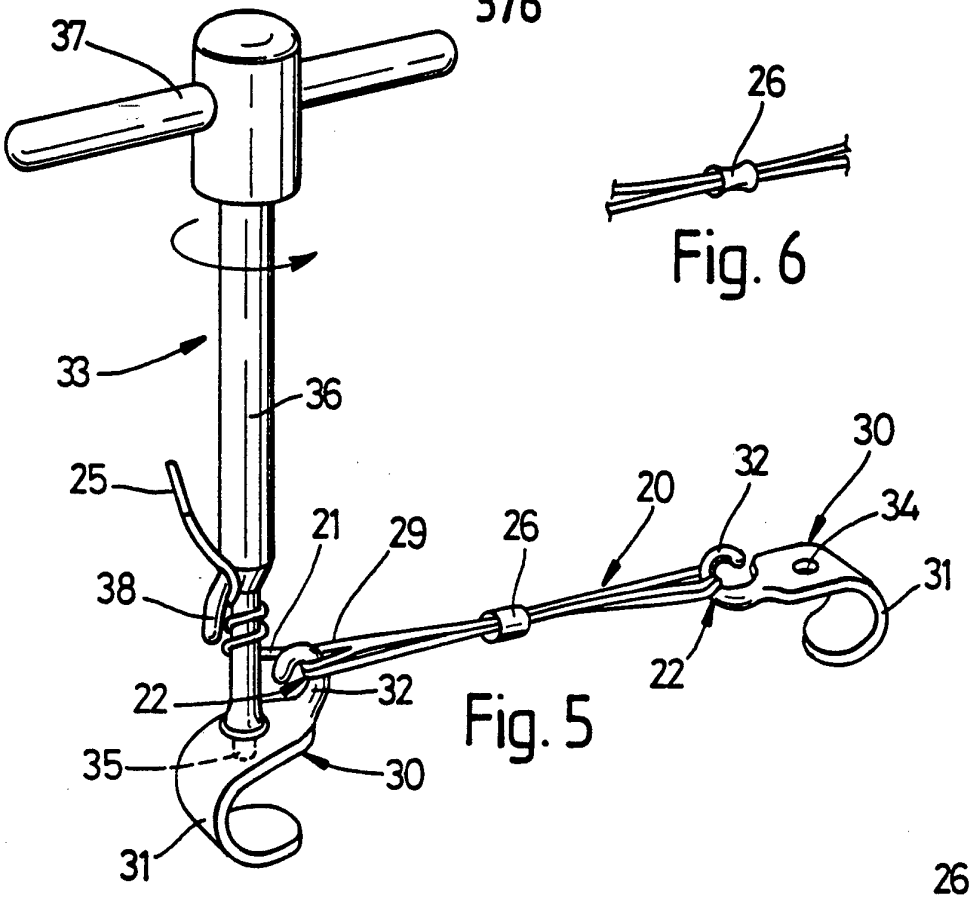

Fig. 5

Fig. 6

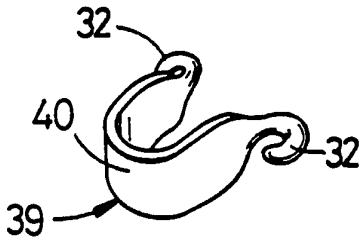

Fig. 7

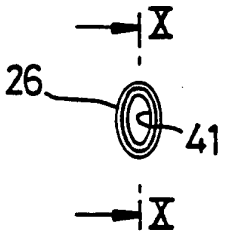

Fig. 9

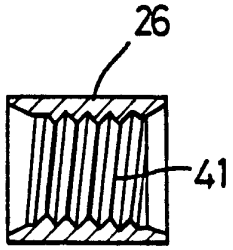

Fig. 10

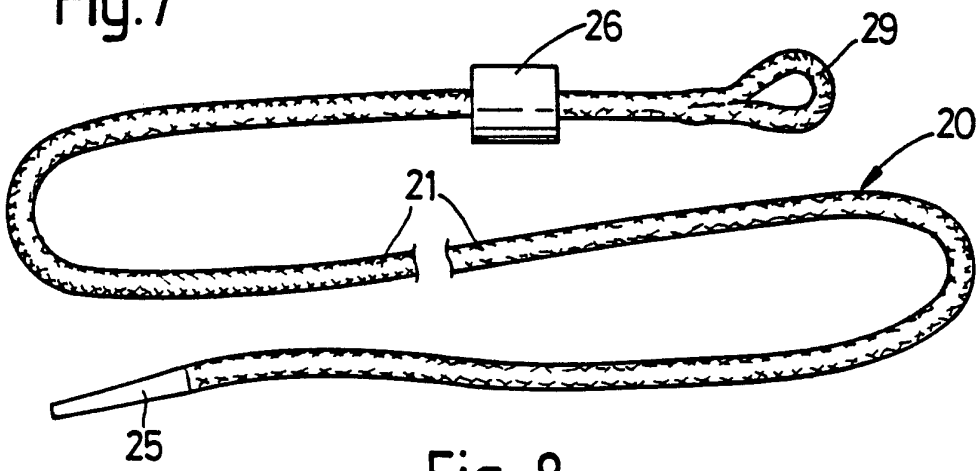

Fig. 8

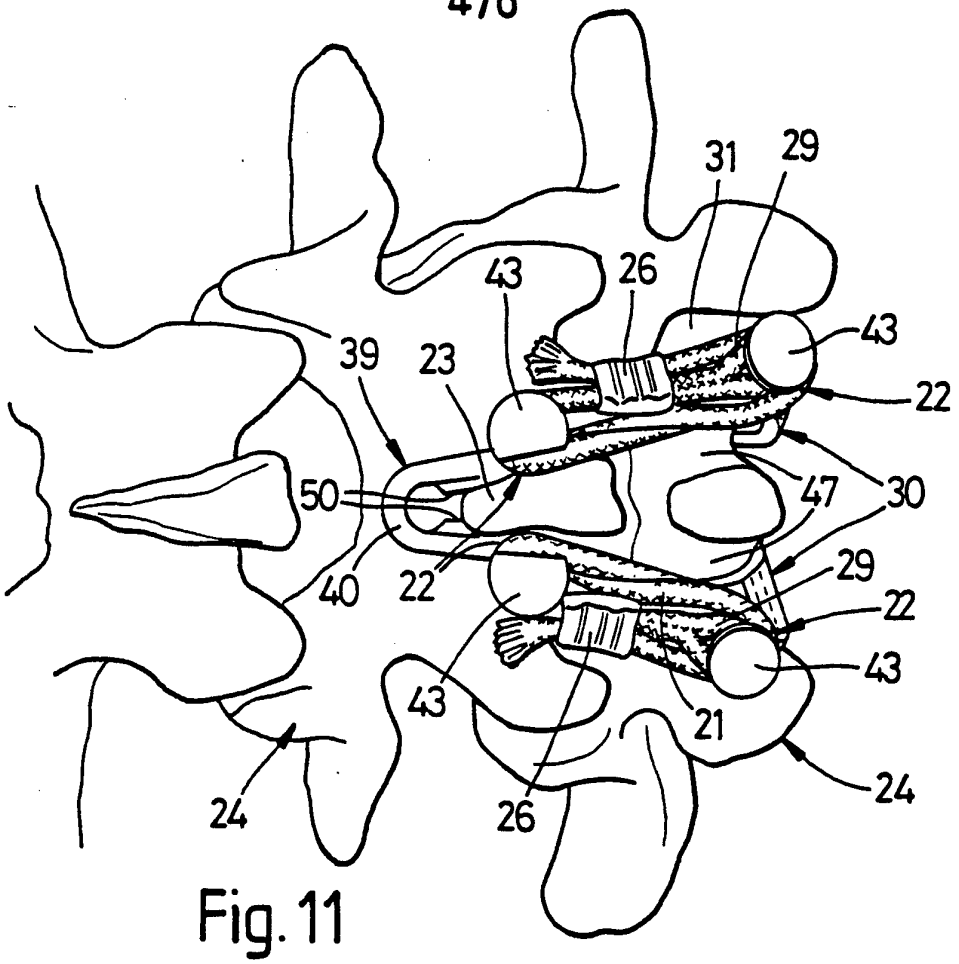
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Fig. 11

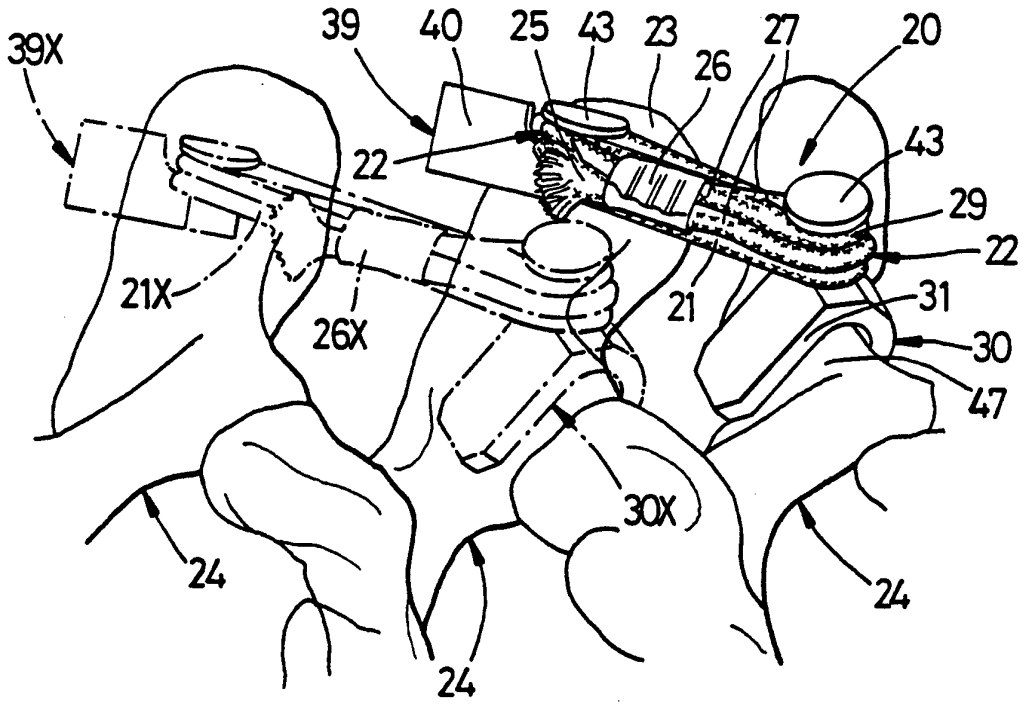
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Fig. 12

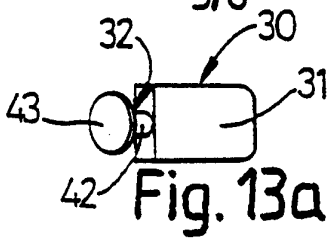

Fig. 13a

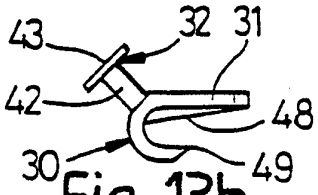

Fig. 13b

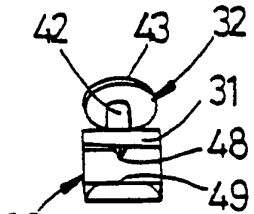

Fig. 13d

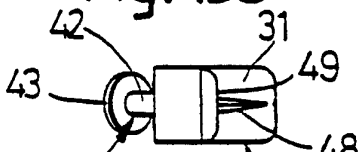

Fig. 13c

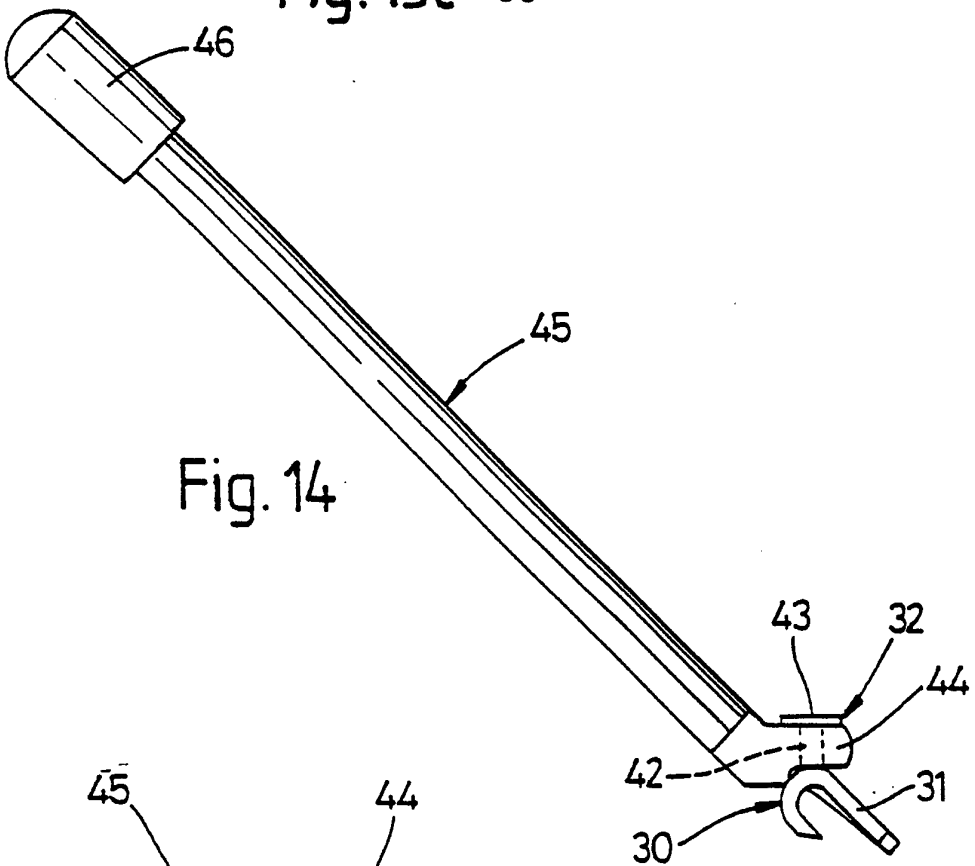

Fig. 14

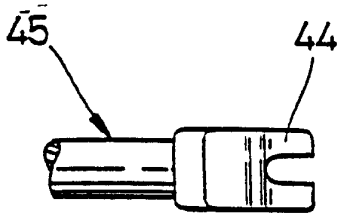

Fig. 15

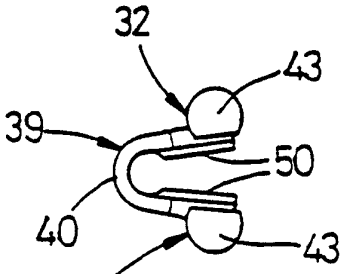

Fig. 16a

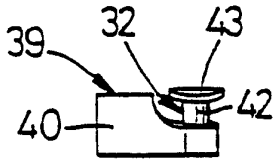

Fig. 16b

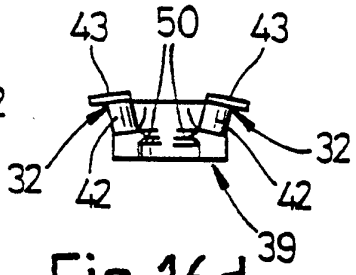

Fig. 16d

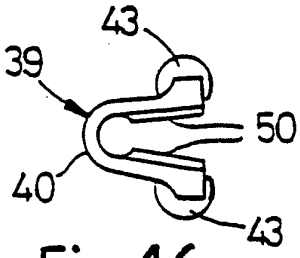

Fig. 16c

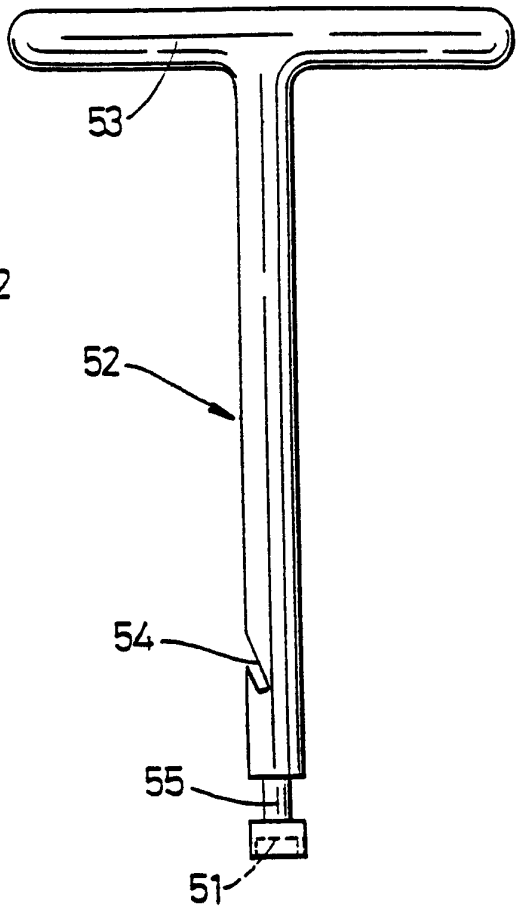

Fig. 17

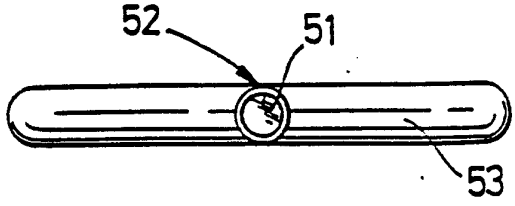

Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 93/01746

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: A61B 17/60, A61F 2/44
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)

IPC5: A61B, A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A1, 0322334 (COTE S.A.R.L.), 28 June 1989 (28.06.89) --	1-6,16
A	EP, A1, 0381588 (BREARD, F.H.), 8 August 1990 (08.08.90), figures 2,2b, abstract --	1-6
A	US, A, 4570618 (K.K. WU), 18 February 1986 (18.02.86), column 2, line 23 - line 25 -- --------	17-18

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" 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)
"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
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 1993	30. 11. 93
Name and mailing address of the International Searching Authority: European Patent Office, P.B. 5818 Patentlaan 2, NL-2280 HV Rijswijk, Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer: Hans Presto

INTERNATIONAL SEARCH REPORT

Int. ..tional application No.

PCT/GB 93/01746

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 27-34
because they relate to subject matter not required to be searched by this Authority, namely:

Methods for treatment of the human or animal body by surgery or therapy. (PCT, Article 17(2)(a)(i), Rule 39(iv)).

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/10/93

International application No.
PCT/GB 93/01746

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0322334	28/06/89	DE-A- 3868611	02/04/92
		FR-A,B- 2625097	30/06/89
EP-A1- 0381588	08/08/90	CA-A- 2009219	03/08/90
		FR-A,B- 2642645	10/08/90
		US-A- 5092866	03/03/92
		WO-A- 9116018	31/10/91
US-A- 4570618	18/02/86	NONE	