



## SPINAL FIXATION APPARATUS AND ITS APPLICATOR



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### FIELD OF INVENTION

The invention relates to bone prosthesis, parts, aids and accessories thereof and tools used to install them on patients.

### 5 BACKGROUND OF THE INVENTION

Internal spinal fixation apparatus is used to stabilize the position of adjacent vertebrae, transfer part of the load bear by the vertebrae to the fixation apparatus, correct abnormal spinal curvature such as scoliosis, kyphosis and lordosis among other functions. This is carried out by means of screws implanted into adjacent vertebrae  
10 and fastening said screws to a common rod. Usually such screws are driven into the pedicles of the vertebrae and are referred to as pedicle screws. Other screws may be driven into the cortex of the vertebra and are referred to as cortical screws, such as exemplified in United States Patent no. US 5,688,275. Throughout this specification, these different types of screws are generally referred to as implant screws.

15 Usually one implant screw is driven into each side of a vertebra. Implant screws on the same side of the vertebrae are further fastened to a common rod. Depending on the situation or the need of the patient, the common rods may be straight or bent at one or more corners and they may also be further fastened together into pairs by cross-link assemblies. Spinal fixation apparatus perform above-mentioned functions by means of  
20 fastening together the implant screws using the rods and if necessary by fastening together the rods in pairs using cross-link assemblies. The rods not only align the vertebrae but load from the vertebrae is transferred to it. Cross-link assemblies align both rods and thus align the vertebra further. Improvement on spinal fixation apparatus is therefore concentrated on how these different parts of the fixation are  
25 fastened together. Load transfer effectiveness from the vertebra to the rod depends on how the implant screws are fastened to the rod. Furthermore such improvements also make the improved fixation much easier to be applied by a surgeon.

European Patent no. EP 0,346,521 discloses a screw head of an implant screw that has a bight portion. A pair of resiliently deflectable legs extends from the screw head to form a bight portion. A rod is inserted in between the two resilient legs and a cap is fastened on the end of the legs. German Patent no. DE 2,649,042 referred therein  
5 discloses an implant screw with an intermediate portion and a pair of legs extends from the intermediate portion. The pair of legs receives a portion of the threaded rod. A pair of nuts on the threaded rod is screwed in oncoming directions to engage the pair of legs on each implant screw.

## 10 SUMMARY OF THE INVENTION

The present invention is a spinal column fixation device including implant screws and connecting rods. The implant screw has a threaded portion that is driven into the vertebra and a screw head. The screw head has a bight portion for receiving the connecting rod or loading bearing rod or simply referred to as rod. The inner surface  
15 of the bight portion have female interlocking feature which engages the outer surface of a plug inserted into the portion. The plug has divided portions on of its end and these divided portions are resiliently deflectable. The outer surface of these divided portions have male interlocking feature which engages the female interlocking feature on the surface of the bight portion so that the screw would not come out of the bight  
20 portion/ screw head. A lock screw is then fastened through a threaded through passage of the plug until its end engages the rod.

The surface of the bight portions also have features to engage the plug so as to prevent it from rotating in the bight portion when the lock screw is fastened into the plug. Such feature is embodied in grooves and matching protrusion. A pair of grooves runs  
25 in the same direction as the insertion of the plug. The plug must have protrusions on

the outside surface of its body corresponding to the dimensions of the groove, each of which will slide into the respective grooves when the plug is properly oriented and inserted into the bight portion. There are at least two possible embodiments of this groove-protrusion feature presented in this specification.

- The implant screw may have a third embodiment that is further simplified. A plug would not be used with the third embodiment of the implant screw. The lock screw will instead be directly fastened on the female screw thread on the bight portion of the screw head after a connecting rod is received in the bight portion. The lock screw is
- 5 fastened on the implant screw by means of an applicator which has two possible embodiments. The common features in both applicator is that they have an elongated through cylindrical body. A hollow cap to accommodate the head of the third embodiment of the implant screw is attached at one of the ends of the elongated through cylindrical body. There is a pair of stub located on the inside of the hollow
- 10 cap. The hollow cap on the first embodiment of the applicator has an end that is split into two portions, while the hollow cap on the second embodiment of the applicator is not split into two portions. The applicator is used to guide a lock screw to be fastened on the screw head of the implant screw to prevent cross-threading when a lock screw is fastened on the implant screw.
- 15 Cross-link assembly is also part of the invention and may be used as needed. Two possible embodiments of the cross-link assembly is disclose herein. Both configurations make use of a similar kind of hook that is hooked on to the rod. Each hook that is hooked on a rod on each side of the vertebrae is linked together by a cross-link member fastened thereon.

## 20 **BRIEF DESCRIPTION OF THE DRAWINGS**

- The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to be
- understood that in some instances various aspects of the invention may be extricated from the entire invention and shown alone by itself to facilitate an understanding of the
- 25 invention.

Figure 1 shows a spinal fixation apparatus using implant screws and cross-link assembly taught according to the invention.

Figure 2 shows the first embodiment of a uniaxial implant screw according to the invention and the uniaxial implant screw being assembled with the rod.

- 5    Figure 3 shows the second embodiment of the uniaxial implant screw according to the invention and the uniaxial implant screw being assembled with the rod.

Figure 4 shows the third embodiment of the uniaxial implant screw according to the invention.

Figure 5 shows another embodiment of the bone implement which is a lamina hook.

- 10   Figure 6a shows the implant screw head of the first embodiment of a multiaxial implant screw.

Figure 6b shows the first embodiment of the multiaxial implant screw according to the invention and the multiaxial implant screw being assembled with the rod.

- 15   Figure 7 shows the implant screw head of the second embodiment of a multiaxial implant screw.

Figure 8 shows the implant screw head of the third embodiment of the multiaxial implant screw.

Figure 9 shows a serrated washer, a threaded portion and a lock washer used with the first, second and third embodiment of the multiaxial implant screw.

Figure 10 shows the the applicator and the cross-section view of the applicator.

Figure 11a shows the the hook and rod assembly according to the invention.

Figure 11b shows the hook and plate assembly according to the invention.

Figure 12a are top and front views of a fixed cross-link.

5 Figure 12b are top and front views of an adjustable cross-link.

## **DETAILED DESCRIPTION OF THE INVENTION**

Detailed descriptions of the preferred embodiment which summarize all aspects of different embodiments of this invention are provided herein and it is appreciated that these aspects may be implemented individually or in any combination. It is also  
10 understood that the present invention may be embodied in various forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but rather as a basis for the claims and as a representative basis for teaching one skilled in the art to employ the present invention in virtually any appropriately detailed system, structure or manner. The details of the preferred embodiments of the invention and its different  
15 components are made clear in this section with the aid of all the figures briefly described in the preceding section.

As shown in Figure 1, a spinal fixation apparatus according to the invention comprises at least two pairs of bone implements which can be implant screws, such as the first

embodiment of the uniaxial implant screws (200a) shown in Figure 2, for stabilizing  
20 two adjacent vertebrae which are not shown (vertebrae are not shown through out the specifications). The bone implements can also be a lamina hook (200g) as shown in Figure 5 are pieces of the spinal fixation apparatus that holds a vertebrae to a rod (101)

used for aligning the vertebrae. By way of example, one implant screws according to the second embodiment (200a1, 200a2) is implanted into the pedicle on each side of a first vertebra. The dimensions of the implant screws may also be properly altered while maintaining all embodiments disclosed herein so that the implant screws can be  
5 implanted into other parts of a vertebra such as the cortex. A second pair of implant screws (200a3, 200a4) is also likewise implanted on the second vertebra that is adjacent to the first vertebra. If more vertebrae needs to be aligned or stabilized by the invention then more implant screws (which can be the first, second or third embodiment of a uniaxial implant screw or a multiaxial implant screw) are likewise  
10 implanted in every vertebrae involved. Stabilizing of the vertebra is carried out by fastening the heads of all the implant screws on the same side of the vertebrae to the rod (101) on that side of the vertebrae.

Generally, all the implant screws (200a, 200b, 200c, e.g. 200d) as shown in Figure 2, 3, 4, 6a, 6b, 7 and 8 respectively have a threaded portion (201) and a screw head  
15 (202a, 202d, 202e, 202f). The screw head (202a, 202d, 202e, 202f) has a bight portion (203) formed by a curve portion (206) and two similar leg portions (204a, 204b) extending upward from the screw head (202a, 202d, 202e, 202f). The implant screws can be a uniaxial implant screw (200a, 200b, 200c) or a multiaxial implant screw (e.g. 200d) as shown in the Figure 2, 3, 4 and 6b. The screw head of each uniaxial implant  
20 screw (200a, 200b, 200c) is integrally formed with the threaded portion (201) while the screw head of any multiaxial screw (200d, 200e, 200f) as shown in Figure 6a, 7 and 8 is rotatably joined with the threaded portion.

Each screw head (202d, 202e, 202f) of any of the multiaxial implant screw is rotatably joined with each threaded portion (201) by means of a rotatable joint such as a ball and  
25 socket joint. The rotatable joint of any said multiaxial implant screw is assembled according to the manner exemplified with the first embodiment of the multiaxial implant screw (200d) as shown in Figure 6b. Figure 9 shows a serrated washer (310), the threaded portion (201) and a lock washer (315) separately when they are not assembled with any of the screw heads (202d, 202e, 202f). They can be assembled  
30 with all the screw heads (202d, 202e, 202f) illustrated in Figure 6a, 7 and 8 to form the first (e.g. 200d), second and third embodiment of the implant screws respectively.

The serrated washer (310) is inserted into a designated first washer seat (hidden from view) found at the bottom of the screw heads (202d, 202e, 202f) for different embodiments of the multiaxial implant screw. The serrated washer (310) is inserted with the serrated surface (311) facing toward the screw heads (202d, 202e, 202f). The  
5 tooth edges (313) running along each axially extending groove (312) on the serrated surface (311) engages a rod (101) inserted in the bight portion (203) of the screw heads (202d, 202e, 202f). Then, the ball end (201a) of the threaded portion (201) is inserted into the curve surface (hidden from view) of the serrated washer (310) followed by inserting the lock washer (315) into a designated second washer seat  
10 (hidden from view) disposed below the first designated washer seat, nearer to the bottom exterior of the screw heads (202d, 202e, 202f). When the multiaxial implant screws are assembled, the serrated surface (311) is preferably slightly higher than the bottom most point of the curve portion (206) on each screw heads (202d, 202e, 202f) to ensure a rod (101) inserted into the multiaxial implant screws (e.g. 200d) sits on the  
15 serrated washer (310).

Once the lock washer (315) is inserted into its designated washer seat, it will engage the curve bottom (201c) of the ball end (201a) and it will be difficult to disassemble the threaded portion (201) from the screw heads (202d, 202e, 202f). The ball end (201b) is joined by the neck (201d) to the threaded portion (201). The curve top of  
20 ball end (201a) of the threaded portion (201) is preferably roughened with ring-like steps (201b) so that it will engage the curve surface of the serrated washer (310) when a lock screw (400a) is fastened on the screw heads (202d, 202e, 202f) in various means to be explained later to engage the rod (101) to the screw heads. When that happens, all screw heads (202d, 202e, 202f) of different embodiments of multiaxial  
25 implant screws (e.g. 200d) will not be able to swivel anymore relative to the threaded

portion (201). When the lock screw (400a, 400b) is not fastened on the screw heads (202d, 202e, 202f), there are minute gaps among the serrated washer (310), the ball end (201b) and the lock washer (315). In this condition the screw heads are able to swivel about smoothly relative to the threaded portion (201).

For the first embodiment of the uniaxial (200a) and multiaxial implant screw (200d) as shown in Figure 2 and 6a respectively, two features are found on the inner surface (207) of the bight portion (203) as one trace along the inner surface of the leg portions (204a, 204b) from the direction of the distal end to the curve portion (206). This direction is the direction in which a plug (300) as shown in Figure 2 and 5 respectively will be inserted. The first feature on the inner surface is a female interlocking feature (209) formed by a series of wedges disposed on one after the other in the direction of the insertion of the plug (300). Furthermore, the wedges are in upright orientation i.e. a plug (300) will come in contact first with the slanted surface of the wedges, not with the base surface of the wedges when the plug is inserted into the bight portion (203). The female interlocking features (209) allow the bight portion (203) to receive and engage the plug (300) in between the two leg portions (204a 204b). The second feature is a pair of dead end grooves (210) running on the inner surface along the direction of the insertion of the plug (300) that is also included to ensure that the inserted plug (300) do not rotate inside the bight portion (203).

The following common features are found in the plugs (300) as shown in Figure 2 and 6a respectively. The cylindrical body of the plugs (300) generally has a female threaded through passage (303) to receive a lock screw (400a). The plug (300) is split lengthwise and made of a material that is rigid yet resilient so that its body can deflect slightly when they are inserted into the implant screws (200a, 200d).

The outer surface of the plug (300) have male interlocking feature (304) that is made up of wedges. This male interlocking feature (304) is formed by a series of wedges disposed on one after the other. The wedges have the same dimension but in opposite orientation as those found on the female interlocking feature (209). When the plug (300) is inserted into the bight portion (203), the slanted surface of the wedges of the male interlocking feature (304) will meet first with the slanted surface of the wedges of the female interlocking feature (209). After the plug (300) is fully inserted into the bight portion (203), the base surfaces of the wedges of the male interlocking feature and those on the female interlocking feature is in contact with each other. In this manner, the male interlocking feature (304) of the plugs (300) will fully engage the female interlocking feature (209) on the first embodiment of the uniaxial (200a) and multiaxial implant screws (200d) respectively.

There are two protrusions (305a, 305b) on the plugs (300) that are aligned with the grooves (210) and slides therein exactly when the plug (300) is inserted into the first embodiments of the uniaxial (200a) and multiaxial implant screws (200d) respectively. Therefore the insertion of the plugs (300) into the implant screws (200a, 200b) is done by firstly aligning the protrusions (305a, 305b) to the grooves (210). Then the plug (300) is pushed down with sufficient force until the plug is fully received in the bight portion (203). By then the male interlocking feature (304) is already fully engaged with the female interlocking feature (209). Once the plug (300) is inserted into the implant screws (200a, 200b) it is obvious that the plug (300) cannot come out easily from the bight portion (203) unless considerable force deflects the resiliently deflectable plug body. When the lock screw (400a) is screwed into the plug, the threaded portion of the screw will also force the plug body to open up slightly, pressing the plug body against the leg portions (204a, 204b) of the implant screws (200a, 200d).

The second embodiment of the uniaxial (200b) as shown in Figure 3 and second embodiment of the multiaxial implant screws have all the features in respective first embodiment of the uniaxial (200a) and multiaxial implant (200d) screws except for the differences to be pointed out as follow. The second embodiment of multiaxial screw head (202e) as shown in Figure 6b is assembled with the same serrated washer (310), threaded portion (201) and lock washer (315) to form the second embodiment of the multiaxial implant screw as in the case of the first embodiment of the multiaxial screw head. The second embodiment of the uniaxial (200a) and multiaxial implant screws as shown in Figure 7 use a cap (320) instead of a plug (300) to receive the lock nut (400a).

The cap (320) has pair of hook members (322) integrally formed with and extending downwardly from the sides of the top member (321) of the cap. The hook members (322) are machined or molded to form the distal end (322b) and curve (322a) of the hook members. The lock nut (400a) is driven through a threaded hole (321a) in the top member (321) of the cap. The grooves (210) and the female interlocking features (209) on inner surface of the leg portions (204a, 204b) are replaced by a pair of bushes (210b) on the outer surface of the leg portions of the screw heads (202a, 202e) to allow the hook members (322) of the cap (320) to engage the screw heads (202a, 202e) by

the bushes. Preferably, the distal end (322b) on both the hook members (322) faces clockwise direction i.e. same as the lock screw (400a) screwing direction. There is a dimple (322c) on near to the tip of the the distal end (322b) to narrow down the opening (323) of the hook member but more portions of the hook member (322) is  
5 machine off so that the opening slightly widens near the vicinity of the curve (323a) of the hook member.

During assembly of the spinal fixation apparatus, the cap (320) engages the screw heads (202a, 202e) by the hook members (322) as illustrated with the uniaxial implant screw (200b) in Figure 3, the bushes (210b) just slip through the opening (323) and sit  
10 in the curve (322a) of the hook member (322). When the lock nut (400a) driven through the threaded hole (321a) on the cap (320) is tightened against a rod (101) inserted earlier into the bight portion (203) of the screw heads (202a, 202e), the cap is slightly lifted up and the bushes (210b) sits in the curve (322a) of the hook member (322).

15 The plug (310) and the cap (320) are advantageous because cross threading do not happen easily when the lock screw (400a) is fastened thereon respectively. This is because all the lock screws (400a, 400b) used are fabricated in certain manner so that their screw heads (400a1, 400b2) break away from the rest of the lock screw when enough torque is applied to the screw heads. Therefore, it is undesirable for any cross  
20 threading to occur which may result in the lock screw (400a, 400b) jammed up in any of the implant screws disclosed herein during the assembly of the spinal fixation apparatus in a surgery.

The third embodiment of the uniaxial (200c) and multiaxial implant screws are fabricated to receive lock screws (400b) directly. As explained earlier, the third design  
25 of multiaxial screw head (202f) as shown in Figure 8 is assembled with the same serrated washer (310), threaded portion (201) and lock washer (315) to form the third embodiment of the multiaxial implant screw. The third embodiment of the implant screws has screw threads (211) on the inner surface of the leg portions (204a, 204b) to receive the lock screw (400b) after the rod (101) was placed in the bight portion  
30 (203). The outer surface of the leg portion (204a, 204b) has a pair of bushes (210b)

for the implant screw (200c) to be engaged with an applicator (500) that helps to align the lock screw (400b) when it is being fastened. The applicator (500) is used to prevent incidence of cross threading and jammed lock screws (400b) explained earlier.

5 The applicator (500) as shown in Figure 10 guides the lock screw (400b) when it is being fastened on to the implant screws (e.g. 200c) to prevent cross-threading. A screw driver (not shown) is then inserted into the applicator (500a) to fasten the lock screw (400b) on to the implant screws (e.g. 200c) so that the lock screw (400b), the rod (101) and implant screws (200c) are fastened together.

10 The applicator (500) has a cylindrical body (505) with a taper circular through passage (504). The smallest diameter (504a) of this passage (504) is the same as the diameter of the lock screw head (400b1) so that the lock screw (400b) would slide straight down the circular passage (504) without any side-to-side movements. In this way, possibility of cross-threading while fastening the lock screw (400b) is eliminated. There is a hollow cap (501) attached to the end of the cylindrical body (505) that has  
15 the smallest opening. There is also a pair of slots (503) partially dividing the hollow cap (501) lengthwise into two attached portions (503a). During application the hollow cap (501) of the applicator will accommodate the rod (101) in the slot (503).

Another embodiment of the bone implement as shown in Figure 5 is the lamina hook (200g) used in place of all the implant screws disclosed earlier. The lamina hook  
20 (200g) is used on vertebra of the upper body such as upper thoracic vertebra or cervical vertebra that have smaller pedicle that cannot be implanted with implant screws or no pedicles for implant screws to be implanted thereon. Other situations in which the lamina hook (200g) is used includes vertebra which are too porous to firmly receive an implant screw implanted thereon.

25 The lamina hook (200g) has similar bight portion (203) formed by two leg portion (204a, 204b) extending upward from the body (202g) of the lamina hook. The rod (101) is inserted into the bight portion (203). There is also female thread (hidden from view) on the inner surface of the leg portion (204a, 204b) to receive the lock screw (not shown) for securing the rod (101) inserted into the bight portion (203). The

lamina hook is fixed to the lamina of a vertebrae by the hook (201e) extending downwardly from the lamina hook body (202g).

The assembly of the spinal fixation apparatus illustrated in Figure 1 is as follows: Firstly, all the implant screws used whether a uniaxial implant screw (200a, 200b, 200c) or a multiaxial implant screw (e.g. 200d) are implanted into the vertebrae to be stabilized. Secondly, the vertebrae of the spinal column are aligned and a rod (101) is inserted into bight portion (203) of the implant screws lining up on the same side of the vertebrae. The rod (101) will rest on the curve surface of the bight portion (203). Thirdly, the lock screws (400a, 400b) are applied on the implant screws to secure the rod to the implant screws. The lock screws are applied using either the plugs (300) or the cap (320) or are received directly in the bight portion (203) of the implant screws as described earlier to prevent the rod (101) from coming out from the implant screws (200b1, 200b2, 200b3, 200b4). Once the vertebrae are properly aligned and all the lock screws (400a, 400b) are tightened, the entire assembly (100) self-locks and the vertebrae involved are stabilized.

In certain situation such as twisting of the vertebra besides its misalignment, one or more cross-link assembly as shown in Figure 1 may be applied to keep assemblies of implant screws (200a1, 200a2, 200a3, 200a4) and rod (101) on both sides of the vertebra parallel. Several embodiments of the cross link assembly as explained later can be applied to the fasten to rods (101) on both sides of the vertebra together.

The first embodiment of the cross-link assembly (110) uses a hook (111) as shown in Figure 11a that has a male threaded stem (111a) attached to the top of the hook portion (111b). This stem is divided in two parts by a lengthwise slot (111c) to accommodate a cylindrical cross-link member (113a) therein. The diameter of the cross-link member (113a) is preferably the same as the width of the lengthwise slot (111c). The slot (111c) must oriented in such a way that two rods (101) on both sides of the vertebrae will be parallel to each other when a cross-link member (113a) is inserted into the slot on each hooks (111). Furthermore, the cross-link member (113a) is preferably simultaneously perpendicular to both rods (101) so that the force exerted by the nuts (114) is optimized to the full to hold a pair of rods (101) together.

During the application of the first embodiment of the cross-link assembly (110), the hook (111) will be hooked on the rod (101), the cross-link member (113a) is placed in the slot (111c) and a nut (114) is screwed on the stem (111a) to lock up the hook (111) to the rod (101) and the cross-link member (113a) to the rod (101). The slot (111c) extends into the top portion of the hook (111) so that the cross-link member (113a) rest on the rod (101) when the rod (101), the hook (111) and the cross-link member (113a) are locked up together.

The second embodiment of the cross-link assembly (110a) as shown in Figure 11b does not use the cross-link member (113a). Furthermore, the hook (111) used in this embodiment (110b) may be same as the one (111) used in the first embodiment (110a). Both hooks in used the first and second embodiment of the cross-link assembly has a circular horizontal cross-section. The second embodiment of the cross-link assembly uses a plate (113b) that has two loops (113c) attached together by a horizontal member (113d). The opening of the loop (113c) allow the top of the hook portion (111b) to be fit in it. Preferably, the width of the opening of the loop (113c) is just wide enough to accommodate the width of the hook portion (111b) so that the cross-link member can only rotate in the loop (113c). However the length of the opening of the loop (113c) is slightly larger than the width of the hook (111) to allow the hook to slide along the length of the loop. Furthermore, the loop (113c) should be thick enough so that the nut (114) can be fastened against it before the nut is touches the top of the hook portion. During its application, the hook (111) is hooked on to the rod (101). The stem (111a) of the hook (111) is passed through the loop (113c) of the the plate (113b) until the plate fits around the top of the hook portion (111b) and rest on the rod (101). Then a nut (114) is fastened on the stem (111a) to lock up the hook (111) and the plate (113b) to the rod (101).

The third embodiment of the cross link assembly as shown in Figure 12a is a fixed cross-link (120) which is a unitary piece comprising two hooks (121) joined together by a neck (122). There is a female threaded passage (123) in each hook (121) to receive screws for fastening the rod (101) placed within the curve (121a) to the hook (121).

The fourth embodiment of the cross link assembly as shown in Figure 12b is an adjustable cross-link (130) which is a two-piece assembly comprising a first hook (131) and a second hook (135). Each hook also has a female threaded passage (132, 136) to fasten the rod (101) placed in the curve (131a, 135a) of the hooks. One hook  
5 e.g. the second hook (135) has a body with a blind passage (137) formed therein to allow a stem (133) integrally formed with the other hook, e.g. the first hook (131) to be slid therein. A second female threaded passage (138) for engaging the stem (133) inserted into the blind passage (138) is disposed at one end of the second hook (135), adjacent to the opening to the blind passage. The stem (133) and blind passage (137)  
10 combination is an embodiment of the means for adjusting the spacing in between the pair of hooks (131, 135). The range of distance which the adjustable hook (130) can accommodate is defined in part by the lengths of the stem (133) and the blind passage (137).

Preferably, the both hooks (131, 135) only move apart or toward each other and does  
15 not rotate within relation to each other. Therefore cross section of the stem and blind passage can be polygonal or of any other shape which disallow movements. In the case where the cross-section of the stem (133) and the blind passage (137) is circular, a slot (139) that is in communication with the blind passage (137) is cut in part of the second hook (135) body that defines the blind passage. A pin (134) as wide as the slot  
20 (139) is driven into the distal end of the stem (133) that is farthest from the first hook (131) through the slot when the circular stem (133) is placed within the blind passage (137). The exposed end of the pin (134) will be located in the slot and prevents the rotation of one of the hook relative to the other. The pin (134) and the slot (139) combination also defines in part the range of distance that can be accommodated by the  
25 adjustable hook (130).

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention.

## CLAIMS

1. A spinal fixation apparatus comprising:
  - a rod;
  - a plurality of implant screws having a screw head and a threaded portion, said screw
  - 5 head head is attached to one end of said threaded portion, said screw head has inner surfaces having a female interlocking feature, and a bight portion to receive said rod;
  - a plug having two ends and an outer surface, said outer surface having a male interlocking feature to communicate with the female interlocking feature of the implant screw,
  - 10 said inner surface (207) of the bight portion (203) comprises one or more dead-end groove running on said inner surface in the direction of said plug to be received,
  - one or more protrusion on said outer surface of said plug, dimension and relative position of said protrusion on said plug corresponds to dimension and relative position of said dead-end groove on said inner surfaces whereby all said protrusions are
  - 15 inserted into said dead-end grooves, and
  - said male interlocking feature comprises one or more wedges disposed one after the other in an orientation opposite to said wedges of said female interlocking feature and said wedges on both female interlocking feature and male interlocking feature have corresponding dimensions to form a locked unit; and
  - 20 a lock screw.
2. An apparatus claimed in claim 1, wherein said dead-end groove cuts through said leg portion and divides said leg portion into two parts.

3. A spinal fixation apparatus comprising;

a rod;

a lock-screw;

an implant screw, said implant screw has a head and a threaded portion, said threaded  
5 portion is in connection with a vertebra of a spinal column, said head is attached to one  
end of said threaded portion, said head has inner surfaces for receiving said rod, said  
inner surfaces have a female thread for receiving said lock screw, said lock screw is  
fastened in said female thread and engages said rod; and

a female means for engaging on the outer surface of each said leg portion, said female  
10 engaging means is one or more blind end L-shaped grooves on the outer surface of  
each said leg portion.

4. A spinal fixation apparatus claimed in claims 1 or 2, wherein said implant screws  
are in connection with vertebra adjacent to each other that are located at certain part of  
the spinal column, with one said implant screw in connection with each left and right  
15 side of each said vertebrae, said implant screws on right and left side of the vertebrae  
is lines up with other said implant screws on the same side; and

said rod is held in said lined up implant screws on the same side of the vertebrae.

5. A spinal fixation apparatus claimed in claim 3, wherein said implant screws are in  
connection with vertebra adjacent to each other that are located at certain part of the  
20 spinal column, with one said implant screw in connection with each left and right side  
of each said vertebrae, said implant screws on right and left side of the vertebrae is

lines up with other said implant screws on the same side; and

said rod is held in said lined up implant screws on the same side of the vertebrae.