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(12) **United States Patent**  
**Cooper et al.**

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(54) **SURGICAL TOOL HAVING POSITIVELY POSITIONABLE TENDON-ACTUATED MULTI-DISK WRIST JOINT**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 161 days.

(57) **ABSTRACT**

(21) Appl. No.: **10/187,248**

The present invention is directed to a tool having a wrist mechanism that provides pitch and yaw rotation in such a way that the tool has no singularity in roll, pitch, and yaw. A positively positionable multi-disk wrist mechanism includes a plurality of disks or vertebrae stacked in series. Each vertebra is configured to rotate in pitch or in yaw with respect to each neighboring vertebra. Actuation cables are used to manipulate and control movement of the vertebrae. In specific embodiments, some of the cables are distal cables that extend from a proximal vertebra through one or more intermediate vertebrae to a distal vertebra, while the remaining cables are medial cables that extend from the proximal vertebra to one or more of the intermediate vertebrae. The cables are actuated by a pivoted plate cable actuator mechanism. In specific embodiments, the actuator mechanism includes a plurality of small radius holes or grooves for receiving the medial cables and a plurality of large radius holes or grooves for receiving the distal cables. The holes or grooves restrain the medial cables to a small radius of motion and the distal cables to a large radius of motion, so that the medial cables to the medial vertebra move only a fraction of the amount as the distal cables to the distal vertebra, so as to achieve precise control and manipulation of the vertebrae.

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(65) **Prior Publication Data**

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**Related U.S. Application Data**

(60) Provisional application No. 60/301,967, filed on Jun. 29, 2001, and provisional application No. 60/327,702, filed on Oct. 5, 2001.

(51) **Int. Cl.**<sup>7</sup> ..... **A61B 1/00**

(52) **U.S. Cl.** ..... **600/142; 606/205**

(58) **Field of Search** ..... 600/139-142, 600/146; 606/205-208, 210, 211

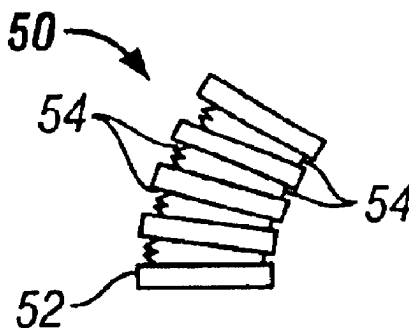
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**45 Claims, 55 Drawing Sheets**



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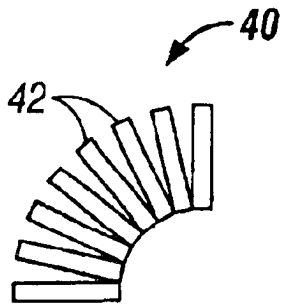


FIG. 1

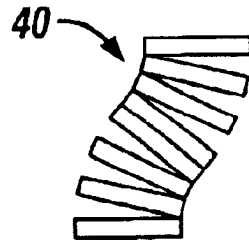


FIG. 2

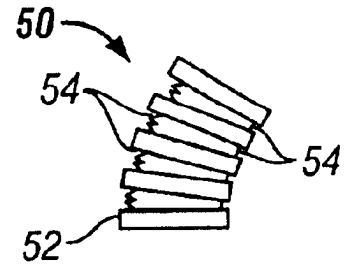


FIG. 3

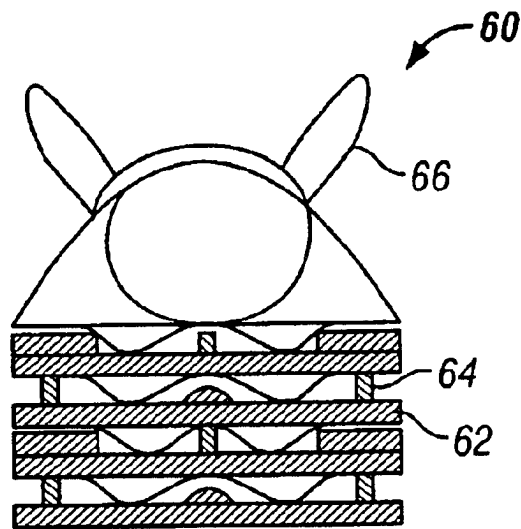


FIG. 4

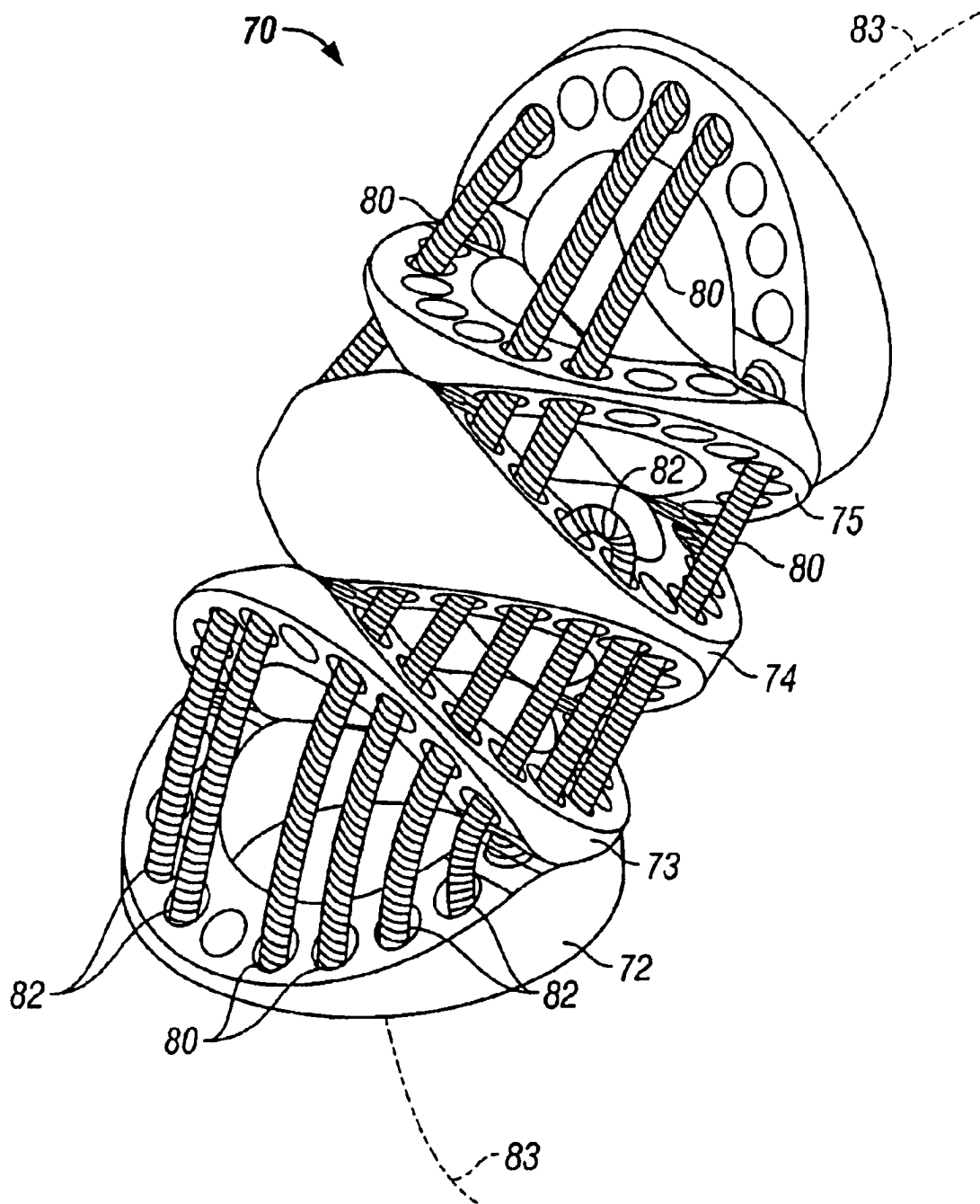


FIG. 5

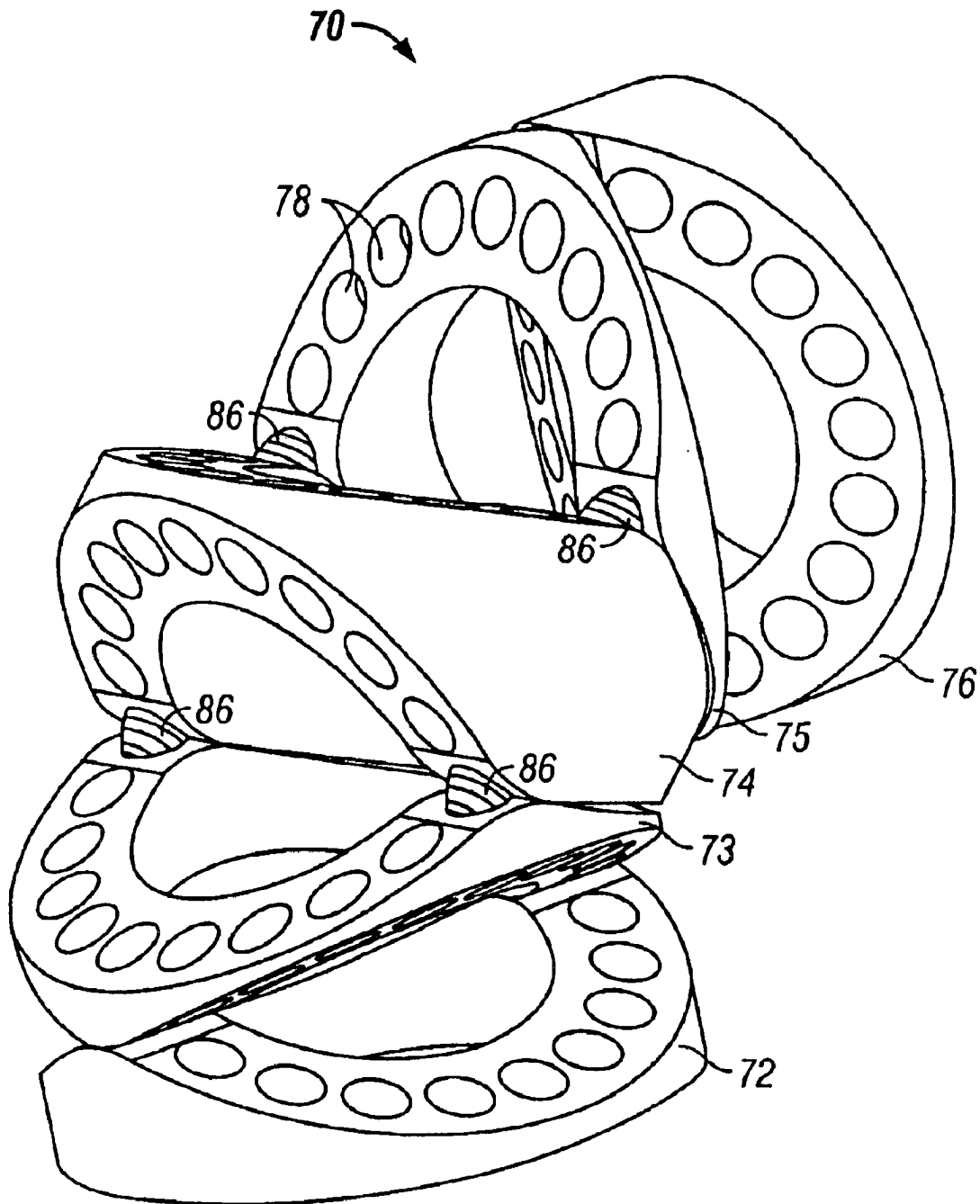


FIG. 6

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