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current through the flexible connection would effect a simultaneous migration of ions in each of the composites. In these embodiments, it is preferred that the composites **10** be connected in parallel such that each composite **10** contracts simultaneously. However, in circumstances where a more gradual contraction is desired, a combination of parallel and series circuits may be utilized. In either event, the use of multiple composites allows many very thin composites **10** to be used, speeding the rate of contraction while providing adequate strength due to the distribution of force load across the composites **10**.

Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, it is understood that other versions would be readily apparent to those of ordinary skill in the art. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained herein.

What is claimed is:

1. A contractile apparatus comprising:

an electrical conductor;

a polymer composite in electrical communication with said conductor, said polymer composite comprising;

a nonionic polymer hydrogel containing a soluble ionic salt; and

an ionic polymer hydrogel in intimate contact with said nonionic polymer hydrogel;

means for passing a first electric current of predetermined polarity through said electrical conductor to said polymer composite to cause said soluble salt in said nonionic polymer hydrogel to pass ions to said ionic polymer hydrogel resulting in a contraction of said ionic polymer hydrogel; and means for passing a second electrical current of predetermined and opposite polarity to the polarity of said first electrical current through said electrical conductor to said polymer composite to cause said ions from said ionic polymer hydrogel to pass to said soluble salt in said nonionic polymer hydrogel resulting in a relaxation of said ionic polymer hydrogel; wherein both of said means result in two-way migration of said ions in said polymer composite.

2. The contractile apparatus as claimed in claim **1** further comprising a second ionic polymer hydrogel in intimate contact with said nonionic polymer hydrogel.

3. The contractile apparatus as claimed in claim **2** wherein said ionic polymer hydrogel is a cationic polymer hydrogel and wherein said second polymer hydrogel is an anionic polymer hydrogel.

4. The contractile apparatus as claimed in claim **3** wherein said soluble salt comprises a cation producing salt and an anion producing salt.

5. The contractile apparatus as claimed in claim **1** wherein said polymer composite is formed into a substantially cylindrical rod comprising a conductive core, a layer of said nonionic polymer hydrogel disposed about said core, a layer of said ionic polymer hydrogel disposed about said layer of nonionic polymer hydrogel, and a conductive coating disposed about said layer of ionic polymer hydrogel.

6. The contractile apparatus as claimed in claim **5** further comprising a second layer of ionic polymer hydrogel disposed between said conductive core and said nonionic polymer hydrogel and wherein one ionic polymer hydrogel is a cationic polymer hydrogel and another ionic polymer hydrogel is an anionic polymer hydrogel.

7. The contractile apparatus as claimed in claim **1** further comprising a colorimetric device to monitor a concentration of said soluble ionic salt.

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8. The contractile apparatus as claimed in claim **7** further comprising a controller for controlling the means for passing the first and second electrical current to said polymer composite based upon said concentration of said soluble ionic salt.

9. The contractile apparatus as claimed in claim **1** further comprising a strain gauge to monitor a length of said polymer composite.

10. The contractile apparatus as claimed in claim **9** further comprising a controller for controlling the means for passing the first and second electrical current to said polymer composite based upon said length of said polymer composite.

11. The contractile apparatus as claimed in claim **1** further comprising a plurality of polymer composites and wherein said electrical conductor is in electrical communication with each of said plurality of polymer composites such that each of said polymer composites may be controlled substantially simultaneously.

12. A contractile apparatus comprising:

an electrical conductor;

a polymer composite in electrical communication with said conductor, said polymer composite comprising;

a nonionic polymer hydrogel containing a soluble ionic salt; and

an ionic polymer hydrogel in intimate contact with said nonionic polymer hydrogel;

a measuring device to measure the state of said polymer composite;

means for passing a first electric current of predetermined polarity passed through said electrical conductor to said polymer composite to cause said soluble salt in said nonionic polymer hydrogel to pass ions to said ionic polymer hydrogel resulting in a contraction of said ionic polymer hydrogel; and means for passing a second electric current of predetermined and opposite polarity to the polarity of said first electric current through said electrical conductor to said polymer composite to cause said ions from said ionic polymer hydrogel to pass to said soluble salt in said nonionic polymer hydrogel resulting in a relaxation of said ionic polymer hydrogel; wherein both of said means result in two-way migration of said ions in said polymer composite.

13. The contractile apparatus as claimed in claim **12** further comprising a controller for controlling the means for passing the first and second electrical current to said polymer composite based upon said state of said polymer composite.

14. The contractile apparatus as claimed in claim **13** further comprising a second ionic polymer hydrogel in intimate contact with said nonionic polymer hydrogel.

15. The contractile apparatus as claimed in claim **14** wherein said ionic polymer hydrogel is a cationic polymer hydrogel and wherein said second polymer hydrogel is an anionic polymer hydrogel.

16. The contractile apparatus as claimed in claim **15** wherein said soluble salt comprises a cation producing salt and an anion producing salt.

17. The contractile apparatus as claimed in claim **13** wherein said polymer composite is formed into a substantially cylindrical rod comprising a conductive core, a layer of said nonionic polymer hydrogel disposed about said core, a layer of said ionic polymer hydrogel disposed about said layer of nonionic polymer hydrogel, and a conductive coating disposed about said layer of ionic polymer hydrogel.