

CLAIMS

1. A relay for a near-field communication system comprising:
a flexible substrate; and
an electric circuit on the flexible substrate,
5 wherein the electric circuit comprises
a hub inductor pattern configured to receive and transmit via electro-magnetic induction;
one or more terminal inductor patterns laterally spaced apart from the hub inductor pattern relative to a surface of the flexible substrate and configured to receive and transmit via electro-magnetic induction; and
10 a connecting trace between the hub inductor and the one or more terminal inductors.
2. The relay of claim 1, wherein the flexible substrate comprises textile.
3. The relay of claim 2, wherein the textile comprises clothing.
- 15 4. The relay of any one of claim 1 to 3, wherein the connecting trace is configured to connect two or more of the terminal inductor patterns in series to the hub inductor.
5. The relay of any one of claim 1 to 4, wherein the connecting trace is configured to connect two or more of the terminal inductor patterns in parallel to the hub inductor.
6. The relay of any one of claims 1 to 5, wherein the hub inductor pattern, the one or more terminal inductor patterns and the connecting trace are formed from a conductive thread.
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7. The relay of claim 6, wherein the conductive thread is embroidered on the flexible substrate.
8. The relay of claim 7, comprising a textile thread securing the conductive thread on the flexible substrate.
- 25 9. The relay of any one of claims 6 to 8, wherein the conductive thread comprises one or more of a group consisting of a bare wire, an encapsulated wire, and a tubing filled with a conductive material.
10. The relay of claim 9, wherein the tubing comprises Perfluoroalkoxy and the conductive material comprises Galinstan.
- 30 11. A near-field communication system comprising one or more relays of any one of the preceding claims.

12. The system of claim 11, further comprising one or more sensors/devices configured to receive and transmit via electro-magnetic induction and disposable within a near-filed communication range of respective ones of the one or more terminal induction patterns.
13. The system of claim 12, wherein the one or more sensors/devices are configured for
5 near-filed communication including data communication and power extraction.
14. The system of claims 12 or 13, wherein the sensors/devices are disposed at clothing and/or skin, or implanted.
15. The system of any one of claim 11 to 14, further comprising at least one reader device configured to receive and transmit via electro-magnetic induction and disposable within a near-
10 filed communication range of one of the hub induction patterns.
16. The system of claim 15, wherein the one or more reader devices are configured for near-filed communication including data communication and power transmission.
17. A conductive tubing comprising:
a tubing element capable of being embroidered on a textile; and
15 Galinstan filled into the tubing element.
18. A wearable wireless powering system comprising:
a flexible substrate having an inductor pattern formed thereon; and
a powering source comprising a battery and a circuit on a flexible print circuit board, the powering source configured to be attachable to the flexible substrate;
20 wherein the powering source is further configured for near-field power transmission via the inductor pattern when attached to the flexible substrate.
19. The system of claim 18, wherein the powering source is attached to the flexible substrate.
20. The system of claims 18 or 19, wherein the flexible substrate comprises textile.
- 25 21. The system of claim 20, wherein the textile comprises clothing.
22. A method of fabricating a relay for a near-field communication system, comprising the steps of:
providing a flexible substrate; and
providing an electric circuit on the flexible substrate,
30 wherein the electric circuit comprises

a hub inductor pattern configured to receive and transmit via electro-magnetic induction;

one or more terminal inductor patterns laterally spaced apart from the hub inductor pattern relative to a surface of the flexible substrate and configured to receive and transmit via electro-magnetic induction; and

a connecting trace between the hub inductor and the one or more terminal inductors.

23. The method of claim 22, wherein the flexible substrate comprises textile.

24. The method of claim 23, wherein the textile comprises clothing.

25. The method of any one of claim 22 to 24, comprising connecting two or more of the terminal inductor patterns in series to the hub inductor.

26. The method of any one of claim 22 to 25, comprising connecting two or more of the terminal inductor patterns in parallel to the hub inductor.

27. The method of any one of claims 22 to 26, wherein the hub inductor pattern, the one or more terminal inductor patterns and the connecting trace are formed from a conductive thread.

28. The method of claim 27, comprising embroidering the conductive thread on the flexible substrate.

29. The method of claim 28, comprising using a textile thread for securing the conductive thread on the flexible substrate.

30. The method of any one of claims 27 to 29, wherein the conductive thread comprises one or more of a group consisting of a bare wire, an encapsulated wire, and a tubing filled with a conductive material.

31. The method of claim 30, wherein the tubing comprises Perfluoroalkoxy and the conductive material comprises Galinstan.

32. The method of any one of claims 22 to 31, further comprising providing one or more sensors/devices configured to receive and transmit via electro-magnetic induction and disposable within a near-field communication range of respective ones of the one or more terminal induction patterns.

33. The method of claim 32, wherein the one or more sensors/devices are configured for near-field communication including data communication and power extraction.

34. The method of claims 32 or 33, comprising disposing the sensors/devices at clothing and/or skin, or implanting the sensors/devices.

35. The method of any one of claims 22 to 34, further comprising providing at least one reader device configured to receive and transmit via electro-magnetic induction and disposable within a near-filed communication range of one of the hub induction patterns.
36. The method of claim 35, wherein the one or more reader devices are configured for
5 near-filed communication including data communication and power transmission.
37. A method of fabricating a conductive tubing, comprising the steps of:
providing a tubing element capable of being embroidered on a textile; and
filling Galinstan into the tubing element.
38. A method of fabricating a wearable wireless powering system, comprising the steps of:
10 providing a flexible substrate having an inductor pattern formed thereon; and
providing a powering source comprising a battery and a circuit on a flexible print circuit board, the powering source configured to be attachable to the flexible substrate;
wherein the powering source is further configured for near-field power transmission via the inductor pattern when attached to the flexible substrate.
- 15 39. The method of claim 38, comprising attaching the powering source to the flexible substrate.
40. The method of claims 38 or 39, wherein the flexible substrate comprises textile.
41. The method of claim 40, wherein the textile comprises clothing.