CLAIMS:

1. A wireless power transfer device comprising:

a first set of electrical coils disposed along a first central axis of a cubic-shaped housing, the first set of electrical coils comprising:

a first primary coil and a first electrical sub-coil, the first electrical sub-coil being an intermediate winding portion of a first continuous wire forming the first primary coil, the intermediate winding portion forming a nested inner loop within the first primary coil and in a same plane as the first primary coil,

a second primary coil and a second electrical sub-coil, the second electrical sub-coil being another intermediate winding portion of the first continuous wire forming the second primary coil, the another intermediate winding portion forming a nested inner loop within the second primary coil and in a same plane as the second primary coil,

wherein the first and second primary coils are disposed on different planes that are parallel to each other;

whereby the first set of electrical coils is configured to generate a first uniform magnetic field between the first primary coil and the second primary coil when the first set of electrical coils are electrically driven, the first uniform magnetic field being produced by magnetic flux interaction between each primary coil of the first set of electrical coils and its corresponding nested electrical sub-coil;

a second set of electrical coils disposed along a second central axis of the cubic-shaped housing, the second central axis being perpendicular to the first central axis, the second set of electrical coils comprising:

a third primary coil and a third electrical sub-coil, wherein the third electrical sub-coil being an intermediate winding portion of a second continuous wire forming the third primary coil, the intermediate winding portion forming a nested inner loop within the third primary coil in a same plane as the third primary coil,

a fourth primary coil and a fourth electrical sub-coil, wherein the fourth electrical sub-coil being another intermediate winding portion of the second continuous wire forming the fourth primary coil, the intermediate winding portion forming a nested inner loop within the fourth primary coil and in a same plane as the fourth primary coil,

wherein the third and fourth primary coils are disposed on different planes that are parallel to each other;

whereby the second set of electrical coils is configured to generate a second uniform magnetic field between the third primary coil and the fourth primary coil when the second set of electrical coils are electrically driven, the second uniform magnetic field being produced by magnetic flux interaction between each primary coil of the second set of electrical coils and its corresponding nested electrical sub-coil.

2. The wireless power transfer device according to claim 1,

wherein the first set of electrical coils further comprises a first relay coil that is disposed on a different plane from the first and second primary coils, and wherein the first relay coil is positioned equidistant between the first and the second primary coils; and

wherein the second set of electrical coils further comprises a second relay coil that is disposed on a different plane from the third and fourth primary coils, and wherein the second relay coil is positioned equidistant between the third and the fourth primary coils.

3. The wireless power transfer device according to claim 1,

wherein the first set of electrical coils further comprises a first plurality of relay coils, each of the first plurality of relay coils being disposed on a plane different from each other and from the planes of the first and second primary coils, and wherein the first plurality of relay coils are positioned between the first and second primary coils such that all the coils in the first set of electrical coils are equidistant apart; and

wherein the second set of electrical coils further comprises a second plurality of relay coils, each of the second plurality of relay coils being disposed on a plane different from each other and from the planes of the third and fourth primary coils, and wherein the second plurality of relay coils are positioned between the third and fourth primary coils such that all the coils in the second set of electrical coils are equidistant apart.

4. The wireless power transfer device according to claim 3,

wherein the first and second plurality of relay coils each comprise two relay coils.

5. The wireless power transfer device according to claim 3,

wherein the first and second plurality of relay coils each comprise three relay coils.

6. The wireless power transfer device according to claim 1,

wherein the first primary coil is wound around edges of a first surface of the cubic-shaped housing, the second primary coil is wound around edges of a second surface of the cubic-shaped housing, the third primary coil is wound around edges of a third surface of the cubic-shaped housing, and the fourth primary coil is wound around edges of a fourth surface of the cubic-shaped housing.

7. The wireless power transfer device according to any one of claims 1 to 6 further comprising:

a first driving circuit electrically connected to the first set of electrical coils, the first driving circuit configured to provide a sinusoidal current to drive the first set of electrical coils; and

a second driving circuit electrically connected to the second set of electrical coils, the second driving circuit configured to provide a cosinusoidal current to drive the second set of electrical coils,

wherein the sinusoidal and cosinusoidal currents are phase-shifted by 90 degrees such that a rotating magnetic field is generated within the cubic-shaped housing by the driven first and second sets of electrical coils.

8. The wireless power transfer device according to claim 6,

wherein the first set of electrical coils further comprises:

a first U-shaped relay coil comprising a first segment arranged in a U-shape around edges of a fifth surface of the cubic-shaped housing, and a second segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the first and second segments are connected by first and second connecting segments and parts of the first and second segments overlap with parts of the first primary coil;

a second U-shaped relay coil comprising a third segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a fourth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the third and fourth segments are connected by third and fourth connecting segments and parts of the third and fourth segments overlap with parts of the second primary coil;

wherein the second set of electrical coils further comprises:

a third U-shaped relay coil comprising a fifth segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a sixth segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the fifth and

sixth segments are connected by fifth and sixth connecting segments and parts of the fifth and sixth segments overlap with parts of the third primary coil;

a fourth U-shaped relay coil comprising a seventh segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and an eighth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the seventh and eighth segments are connected by seventh and eighth connecting segments and parts of the seventh and eighth segments overlap with parts of the fourth primary coil.

9. The wireless power transfer device according to claim 6,
wherein the first set of electrical coils further comprises:

a first plurality of sets of U-shaped relay coils, each set comprising a first segment arranged in a U-shape around edges of a fifth surface of the cubic-shaped housing, and a second segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the first and second segments are connected by first and second connecting segments and parts of the first and second segments overlap with parts of the first primary coil,

wherein the first and second segments of each of the first plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

a second plurality of sets of U-shaped relay coils, each set comprising a third segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a fourth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the third and fourth segments are connected by third and fourth connecting segments and parts of the third and fourth segments overlap with parts of the second primary coil;

wherein the third and fourth segments of each of the second plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

wherein the second set of electrical coils further comprises:

a third plurality of sets of U-shaped relay coils, each set comprising a fifth segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a sixth segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the fifth and sixth segments are connected by fifth and sixth connecting

segments and parts of the fifth and sixth segments overlap with parts of the third primary coil;

wherein the fifth and sixth segments of each of the third plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

a fourth plurality of sets of U-shaped relay coils, each set comprising a seventh segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and an eighth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the seventh and eighth segments are connected by seventh and eighth connecting segments and parts of the seventh and eighth segments overlap with parts of the fourth primary coil; and

wherein the seventh and eighth segments of each of the fourth plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil.

10. A method for wirelessly transferring power using a device having a cubic-shaped housing, the method comprising:

providing a first set of electrical coils along a first central axis of the cubic-shaped housing, the first set of electrical coils comprising:

a first primary coil and a first electrical sub-coil, the first electrical sub-coil being an intermediate winding portion of a first continuous wire forming the first primary coil, the intermediate winding portion forming a nested inner loop within the first primary coil and in a same plane as the first primary coil,

a second primary coil and a second electrical sub-coil, the second electrical sub-coil being another intermediate winding portion of the first continuous wire forming the second primary coil, the another intermediate winding portion forming a nested inner loop within the second primary coil and in a same plane as the second primary coil,

wherein the first and second primary coils are disposed on different planes that are parallel to each other;

electrically driving the first set of electrical coils to generate a first uniform magnetic field between the first primary coil and the second primary coil, the first uniform magnetic field being produced by magnetic flux interaction between each primary coil of the first set of electrical coils and its corresponding nested electrical sub-coil;

providing a second set of electrical coils along a second central axis of the cubic-shaped housing, the second central axis being perpendicular to the first central axis, the second set of electrical coils comprising:

a third primary coil and a third electrical sub-coil, the third electrical sub-coil being an intermediate winding portion of a second continuous wire forming the third primary coil, the intermediate winding portion forming a nested inner loop within the third primary coil and in a same plane as the third primary coil,

a fourth primary coil and a fourth electrical sub-coil, the fourth electrical sub-coil being another intermediate winding portion of the second continuous wire forming the fourth primary coil, the another intermediate winding portion forming a nested inner loop within the fourth primary coil and in a same plane as the fourth primary coil,

wherein the third and fourth primary coils are disposed on different planes that are parallel to each other; and

electrically driving the second set of electrical coils to generate a second uniform magnetic field between the third primary coil and the fourth primary coil, the second uniform magnetic field being produced by magnetic flux interaction between each primary coil of the second set of electrical coils and its corresponding nested electrical sub-coil.

11. The method according to claim 10,

wherein the first set of electrical coils further comprises a first relay coil that is provided on a different plane from the first and second primary coils, and wherein the first relay coil is positioned equidistant between the first and the second primary coils; and

wherein the second set of electrical coils further comprises a second relay coil that is provided on a different plane from the third and fourth primary coils, and wherein the second relay coil is positioned equidistant between the third and the fourth primary coils.

12. The method according to claim 10,

wherein the first set of electrical coils further comprises a first plurality of relay coils, each of the first plurality of relay coils being provided on a plane different from each other and from the planes of the first and second primary coils, and wherein the first plurality of relay coils are positioned between the first and second primary coils such that all the coils in the first set of electrical coils are equidistant apart; and

wherein the second set of electrical coils further comprises a second plurality of relay coils, each of the second plurality of relay coils being provided on a plane different from each other

and from the planes of the third and fourth primary coils, and wherein the second plurality of relay coils are positioned between the third and fourth primary coils such that all the coils in the second set of electrical coils are equidistant apart.

13. The method according to claim 10,

wherein the first primary coil is wound around edges of a first surface of the cubic-shaped housing, the second primary coil is wound around edges of a second surface of the cubic-shaped housing, the third primary coil is wound around edges of a third surface of the cubic-shaped housing, and the fourth primary coil is wound around edges of a fourth surface of the cubic-shaped housing.

14. The method according to claim 13,

wherein the first set of electrical coils further comprises:

a first U-shaped relay coil comprising a first segment arranged in a U-shape around edges of a fifth surface of the cubic-shaped housing, and a second segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the first and second segments are connected by first and second connecting segments and parts of the first and second segments overlap with parts of the first primary coil;

a second U-shaped relay coil comprising a third segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a fourth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the third and fourth segments are connected by third and fourth connecting segments and parts of the third and fourth segments overlap with parts of the second primary coil;

wherein the second set of electrical coils further comprises:

a third U-shaped relay coil comprising a fifth segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a sixth segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the fifth and sixth segments are connected by fifth and sixth connecting segments and parts of the fifth and sixth segments overlap with parts of the third primary coil;

a fourth U-shaped relay coil comprising a seventh segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and an eighth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the seventh and eighth segments are connected by seventh and eighth connecting

segments and parts of the seventh and eighth segments overlap with parts of the fourth primary coil.

15. The method according to claim 13,

wherein the first set of electrical coils further comprises:

a first plurality of sets of U-shaped relay coils, each set comprising a first segment arranged in a U-shape around edges of a fifth surface of the cubic-shaped housing, and a second segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the first and second segments are connected by first and second connecting segments and parts of the first and second segments overlap with parts of the first primary coil,

wherein the first and second segments of each of the first plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

a second plurality of sets of U-shaped relay coils, each set comprising a third segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a fourth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the third and fourth segments are connected by third and fourth connecting segments and parts of the third and fourth segments overlap with parts of the second primary coil;

wherein the third and fourth segments of each of the second plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

wherein the second set of electrical coils further comprises:

a third plurality of sets of U-shaped relay coils, each set comprising a fifth segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and a sixth segment arranged in a U-shape around edges of a sixth surface of the cubic-shaped housing, wherein the fifth and sixth segments are connected by fifth and sixth connecting segments and parts of the fifth and sixth segments overlap with parts of the third primary coil;

wherein the fifth and sixth segments of each of the third plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil;

a fourth plurality of sets of U-shaped relay coils, each set comprising a seventh segment arranged in a U-shape around edges of the fifth surface of the cubic-shaped housing, and an eighth segment arranged in a U-shape around edges of the sixth surface of the cubic-shaped housing, wherein the seventh and eighth segments are connected by seventh and eighth connecting segments and parts of the seventh and eighth segments overlap with parts of the fourth primary coil; and

wherein the seventh and eighth segments of each of the fourth plurality of sets of U-shaped relay coils are configured to have lengths specific to the respective U-shaped relay coil.