improvements are desired. It is therefore an object of the present invention to provide a novel wireless electric field power transmission system and method.

Summary of the Invention

[0008] Accordingly, in one aspect there is provided a wireless electric field power transmission system comprising: a transmitter; a transmitter antenna connected to the transmitter, the transmitter antenna comprising at least two conductors defining a volume therebetween; and at least one receiver, wherein the transmitter antenna transfers power wirelessly via electric field coupling when the at least one receiver is within the volume.

[0009] According to another aspect there is provided a method for wirelessly transmitting power, the method comprising: oscillating a transmitter antenna comprising at least two conductors defining a volume at a transmitter resonant frequency; generating an electric field in the volume; positioning a receiver antenna comprising two plates in the volume; and oscillating the receiver antenna at the transmitter resonant frequency.

[0010] According to yet another aspect there is provided a method for wirelessly transferring power, the method comprising: resonating a transmitter antenna comprising at least two conductors and a transmitter coil at a start-up frequency; tuning the transmitter antenna and the transmitter coil to their resonant frequency; generating an electric field within a volume defined by the at least two conductors; placing a receiver with a receiver antenna comprising two plates in the volume; accumulating a potential difference on the two plates; resonating the receiver antenna at the resonant frequency; and gathering power from the receiver antenna.

[0011] According to yet another aspect there is provided a transmitter for wirelessly transmitting power, the transmitter comprising: an antenna for creating an electric field, the antenna comprising at least two conductors defining a volume therebetween; a coil connected to the antenna; and a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency, the resonator comprising an auto frequency tuning circuit for automatically tuning the resonator to the resonant frequency.

[0012] The antenna may comprise at least two generally parallel plates that are

components are configured to automatically detect and tune to the frequency of power transmitted by the transmitter antenna 16 to enhance or optimize wireless electric field power transfer to receivers 14 positioned within the volume 20 as will be described. The circuitry comprises a delay line 41, a current gain stage 43 and a voltage gain stage 45 connected in series. The voltage gain stage 45 is connected to the power amplifier 36. A decoupling circuit in the form of a balun 48 is connected between the power amplifier 36 and the transmitter coil 30 to decouple the power amplifier output from ground. A current sensor in the form of a current sensing toroid 49 senses the current output by the balun 48. The current sensing toroid 49 and the current gain stage 43 provide output to a feedback and control circuit 47.

[0084] As shown in Figure 5b, the delay line 41 is implemented using an active inverter delay chain 502 that receives input from a start-up oscillator 504 via a normally closed semiconductor switch 506. The inverter delay chain 502 comprises a plurality of complementary metal-oxide-semiconductor (CMOS) inverters 508 connected in series. The inverter delay chain 502 is connected to the current gain stage 43 which comprises a plurality of current boosting inverting stages 510 arranged in parallel. In this embodiment, the current gain stage 43 comprises three (3) inverting stages 510. The last inverting stage 510 comprises forty (40) CMOS inverters 510a, the middle inverting stage 510 comprises twelve (12) CMOS inverters 510a and the first inverting stage 510 comprises four (4) CMOS inverters 510a. The outputs of the inverters 510a of the last inverting stage 510 are coupled and connected to the voltage gain stage 45 which in this embodiment is a wideband transformer 512. The wideband transformer 512 has a turn ratio of 1:4. The last inverting stage 510 of the current gain stage 43 is connected to one coil of the wideband transformer 512. The other coil of the wideband transformer 512 is connected to the power amplifier 36. The output of the power amplifier 36 is coupled to one coil of the balun 48. The balun 48 in this embodiment has a ferrite core and a turn ratio of slightly higher than 1:1 for impedance matching purposes. The ferrite core balun has been found to provide twice as much current as an air balun and greater efficiency. The other coil of the balun 48 provides balanced differential output ports. One output port of the balun 48 is connected to the transmitter coil 30 via a tuning capacitor 514. The other output port of the balun 48 passes through the current sensing toroid 49 and is connected to the transmitter antenna 16.

[0085] The current sensing toroid 49 provides a feedback signal to the active

the bridge rectifier 64, it will have a four hundred (400) V potential and one (1) mA of current. Down-converting this rectified output voltage to a more useable form such as for example, a five (5) V and eighty (80) mA output is beneficial in particular applications. In this embodiment, the maximum input voltage of the DC-DC voltage converter 66 is greater than one thousand (1000) V while the output voltage is between five (5) V and fourteen (14) V with a power rating of one (1) W to four (4) W. The output of the bridge rectifier 64 is connected to the DC-DC voltage converter 66 (not shown) which then outputs the converted power to the device requiring power through jacks and connectors.

[0094] The receiver safety circuit 62 automatically shuts off the receiver 14 if an electric field is detected that is higher than the standard safety limits. The receiver safety circuit 62 also disables DC power to any device connected to the receiver 14 if a short circuit load is detected.

[0095] The receiver antenna 54 in this embodiment comprises two generally rectangular, approximately parallel conductors which in this embodiment are conductive plates 58. The distance between the two plates 58 is approximately equal to the average dimension of each plate 58. The plates 58 may either be rigid or flexible. The receiver antenna 54 has a low reactance (approximately seven (7) pf to nine (9) pf) relative to its dimension and the received signal wavelength. When resonant, the receiver antenna 54, the power harvester 50 harvests electrical power through the electric field created within the volume 20 between the conductors 18 of the transmitter antenna 16. As will be appreciated, the receiver 14 is small relative to the amount of power it can harvest within the volume 20.

[0096] The receiver coil 52 in this embodiment is a cylindrical spiral coil as illustrated in Figure 11. The receiver coil 52 is constructed of insulated, solid copper wire and has a diameter of approximately four (4) inches (twelve (12) cm). The receiver coil 52 is positioned adjacent to the two plates 58.

[0097] In general, during operation the transmitter 12 is operated so that it drives the transmitter antenna 16 causing an electric field to be generated within the volume 20 between the conductors 18 by running opposite phase, equal magnitude currents through the conductors 18. When a receiver 14 is positioned within the volume 20, the receiver antenna 54 begins to oscillate at the resonant frequency resulting in wireless power being transmitted from the transmitter 12 to the receiver

14 via electric field coupling.

[0098] The closed-loop architecture of the transmitter 12 ensures the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair at all times. In particular, initially the start-up oscillator 504 is used to inject a start-up signal that is applied to the inverter delay chain 502 of the delay signal line 41. The current level of the signal is then boosted by the current gain stage 43 and applied to the power amplifier 36 via the wideband transformer 512 of the voltage gain stage 45. The output of the power amplifier 36 is then applied to the balun 48 which decouples the signal from ground and provides output to the transmitting coil 30 via the tuning capacitor 514. The transmitting coil 30 in turn drives the transmitter antenna 16 resulting in the electric field being generated within the volume 20. The feedback signal output by the current sensing toroid 49, which senses the current in the transmitter antenna 16, is used by the envelope detector 520 to condition the semiconductor switch 520 to isolate the start-up oscillator 504 from the inverter delay chain 502. As a result, the feedback signal that is applied to the inverter delay chain 502 is used to sustain the transmitter output. As will be appreciated, by generating the feedback signal using the current sensing toroid 49 that senses the current running through the transmitter antenna 16 and feeding the signal back into the transmitter 12, the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair.

[0099] As will be appreciated, the transmitter 12 has a fast self-tuning and compact design. Because the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair, the transmitter antenna 16 stays tuned and does not require hand tuning or automatic tuning circuitry. Also, the transmitter 12 does not require a pre-amplifier or a digital control system to perform automatic frequency tuning.

[00100] As mentioned above, when the transmitter coil 30 drives the transmitter antenna 16, the electric field (a reactive near field) is created within the volume 20 which can be used by each receiver 14 positioned within the volume to harvest power. An exemplary electric field generated within the volume 20 is shown in Figure 12. As can be seen, the intensity of the electric field increases towards the conductors 18 and weakens towards the middle of the volume 20. Greater efficiency wireless power transfer to a receiver 14 is therefore achieved when the receiver is closer to the conductors 18 and lower efficiency wireless power transfer to the

What is claimed is:

1. A wireless electric field power transmission system comprising:

a transmitter comprising a transmitter antenna, the transmitter antenna comprising at least two conductors defining a volume therebetween; and

at least one receiver, wherein the transmitter antenna transfers power wirelessly via electric field coupling when the at least one receiver is within the volume.

2. A method for wirelessly transmitting power, the method comprising:

oscillating a transmitter antenna comprising at least two conductors defining a volume at a transmitter resonant frequency;

generating an electric field in the volume;

positioning a receiver antenna comprising two plates in the volume; and

oscillating the receiver antenna at the transmitter resonant frequency.

3. A method for wirelessly transferring power, the method comprising:

resonating a transmitter antenna comprising at least two conductors and a transmitter coil at a start-up frequency;

tuning the transmitter antenna and the transmitter coil to their resonant frequency;

generating an electric field within a volume defined by the at least two conductors;

placing a receiver with a receiver antenna comprising two plates in the volume;

accumulating a potential difference on the two plates;

resonating the receiver antenna at the resonant frequency; and

gathering power from the receiver antenna.

4. A transmitter for wirelessly transmitting power, the transmitter comprising:

an antenna for creating an electric field, the antenna comprising at least two conductors defining a volume therebetween;

a coil connected to the antenna; and

a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency, the resonator comprising an auto frequency tuning circuit configured to automatically tune the transmitter.

5. The transmitter of claim 4, wherein the antenna comprises at least two generally parallel plates that are laterally spaced to define the volume.

6. The transmitter of claim 4, wherein the antenna comprises six conductors defining the volume.

7. The transmitter of any one of claims 4 to 6, wherein the antenna is a near-field antenna.

8. The transmitter of any one of claims 4 to 7, wherein each conductor is formed of conductive tape.

9. The transmitter of any one of claims 4 to 8, wherein the coil is constructed using strand wire.

10. The transmitter of any one of claims 4 to 8, wherein the coil is a toroid spiral, cylindrical spiral, flat spiral or pancake coil.

11. The transmitter of claim any one of claims 4 to 10, wherein the auto frequency tuning circuit further comprises circuitry configured to boost a signal to the antenna.

12. The transmitter of claim 11, wherein the circuitry comprises at least one of a voltage gain, a current gain and a power amplifier.

13. The transmitter of claim 12, wherein the power amplifier is a push-pull power amplifier.

14. The transmitter of any one of claims 4 to 13, wherein the auto frequency tuning circuit further comprises a delay line configured to delay the signal within the auto frequency tuning circuit.

15. The transmitter of claim 14, wherein the delay line is an active inverter delay chain comprising complementary metal-oxide-semiconductor (CMOS) inverters connected in series.

16. The transmitter of any one of claims 4 to 15, wherein the auto frequency tuning circuit further comprises a decoupling circuit configured to decouple an output signal of the transmitter.

17. The transmitter of claim 16, wherein the decoupling circuit comprises a balun.

18. The transmitter of claim any one of claims 4 to 17, wherein the auto frequency tuning circuit further comprises a current sensing circuit configured to provide a feedback signal.

19. The transmitter of claim any one of claims 4 to 18, wherein the auto frequency tuning circuit further comprises an oscillator configured to inject a start-up signal into the auto frequency tuning circuit.

20. The transmitter of any one of claims 4 to 19, wherein the resonator further comprises modification circuitry configured to modify the output signal of the transmitter when a condition occurs.

21. The transmitter of claim 20, wherein the modification circuitry adjusts the power level of the output signal when the condition occurs.

22. The transmitter of claim 20 or 21, wherein the modification circuitry shuts off output of the transmitter when the condition occurs.

23. A vehicle comprising the transmitter of any one of claims 4 to 22.

24. A table comprising the transmitter of any one of claims 4 to 22.

25. A container comprising the transmitter of any one of claims 4 to 22.

26. The container of claim 25, wherein the container is shielded to prevent electromagnetic field (EMF) leakage.

27. The container of claim 26, wherein electric field strength is increased when the container is closed.

28. A receiver for receiving wirelessly transmitted power, the receiver comprising:

an antenna comprising two conductors;

a coil connected to the antenna;

a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency, the resonator comprising an auto frequency tuning circuit configured to automatically tune the resonator.

29. The receiver of claim 28, wherein the conductors are external to a housing accommodating the coil and the resonator.

30. The receiver of claim 28 or 29, wherein the conductors are plates or rails.

31. The receiver of claim 30, wherein the rails are rectangular and parallel.

32. The receiver of claim 30 or 31, wherein the rails are metallic.

33. The receiver of any one of claims 28 to 32, wherein the coil is constructed of strand wire or inductors.

34. The receiver of any one of claims 28 to 32, wherein the coil is a toroid, cylindrical spiral, flat spiral or pancake coil.

35. The receiver of any one of claims 28 to 34, wherein the resonator further comprises modification circuitry configured to modify a signal received by the receiver when a condition occurs.

36. The receiver of claim 35, wherein the modification circuitry adjusts the signal received by the receiver when the condition occurs.

37. The receiver of claim 35 or 36, wherein the modification circuitry is a voltage converter and/or a rectifier.

38. The receiver of any one of claims 28 to 37, further comprising an impedance matching circuit.

39. The receiver of claim 38, wherein the impedance matching circuit comprises a balun.

40. A backpack for receiving wirelessly transmitted power, the backpack comprising the receiver of any one of claims 28 to 39.

41. The backpack of claim 40, further comprising a battery charger connected to the receiver.

42. The backpack of claim 41, further comprising at least one rechargeable battery connected to the receiver configured to charge when no batteries are present in the battery charger.

43. A radio communication device for receiving wirelessly transmitted power, the device comprising the receiver of any one of claims 28 to 39.

44. A computing device for receiving wirelessly transmitted power, the device comprising the receiver of any one of claims 28 to 39.

45. A device comprising:
the transmitter of any one of claims 4 to 22; and
the receiver of any one of claims 28 to 39.

46. A wireless electric field power transmission system comprising:

a transmitter comprising a transmitter antenna, the transmitter antenna comprising at least one conductor; and

at least one receiver, wherein the transmitter antenna transfers power wirelessly via electric field coupling when the at least one receiver is coupled to the transmitter.

improvements are desired. It is therefore an object of the present invention to provide a novel wireless electric field power transmission system and method.

Summary of the Invention

[0008] Accordingly, in one aspect there is provided a wireless electric field power transmission system comprising: a transmitter; a transmitter antenna connected to the transmitter, the transmitter antenna comprising at least two conductors defining a volume therebetween; and at least one receiver, wherein the transmitter antenna transfers power wirelessly via electric field coupling when the at least one receiver is within the volume.

[0009] According to another aspect there is provided a method for wirelessly transmitting power, the method comprising: oscillating a transmitter antenna comprising at least two conductors defining a volume at a transmitter resonant frequency; generating an electric field in the volume; positioning a receiver antenna comprising two plates in the volume; and oscillating the receiver antenna at the transmitter resonant frequency.

[0010] According to yet another aspect there is provided a method for wirelessly transferring power, the method comprising: resonating a transmitter antenna comprising at least two conductors and a transmitter coil at a start-up frequency; tuning the transmitter antenna and the transmitter coil to their resonant frequency; generating an electric field within a volume defined by at least two conductors; placing a receiver with a receiver antenna comprising two plates in the volume; accumulating a potential difference on the two plates; resonating the receiver antenna at the resonant frequency; and gathering power from the receiver antenna.

[0011] According to yet another aspect there is provided a transmitter for wirelessly transmitting power, the transmitter comprising: an antenna for creating an electric field, the antenna comprising at least two conductors defining a volume therebetween; a coil connected to the antenna; and a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency, the resonator comprising an auto frequency tuning circuit for automatically tuning the resonator to the resonant frequency.

[0012] The antenna may comprise at least two generally parallel plates that are

components are configured to automatically detect and tune to the frequency of power transmitted by the transmitter antenna 16 to enhance or optimize wireless electric field power transfer to receivers 14 positioned within the volume 20 as will be described. The circuitry comprises a delay line 41, a current gain stage 43 and a voltage gain stage 45 connected in series. The voltage gain stage 45 is connected to the power amplifier 36. A decoupling circuit in the form of a balun 48 is connected between the power amplifier 36 and the transmitter coil 30 to decouple the power amplifier output from ground. A current sensor in the form of a current sensing toroid 49 senses the current output by the balun 48. The current sensing toroid 49 and the current gain stage 43 provide output to a feedback and control circuit 47.

[0084] As shown in Figure 5b, the delay line 41 is implemented using an active inverter delay chain 502 that receives input from a start-up oscillator 504 via a normally closed semiconductor switch 506. The inverter delay chain 502 comprises a plurality of complementary metal-oxide-semiconductor (CMOS) inverters 508 connected in series. The inverter delay chain 502 is connected to the current gain stage 43 which comprises a plurality of current boosting inverting stages 510 arranged in parallel. In this embodiment, the current gain stage 43 comprises three (3) inverting stages 510. The last inverting stage 510 comprises forty (40) CMOS inverters 510a, the middle inverting stage 510 comprises twelve (12) CMOS inverters 510a and the first inverting stage 510 comprises four (4) CMOS inverters 510a. The outputs of the inverters 510a of the last inverting stage 510 are coupled and connected to the voltage gain stage 45 which in this embodiment is a wideband transformer 512. The wideband transformer 512 has a turn ratio of 1:4. The last inverting stage 510 of the current gain stage 43 is connected to one coil of the wideband transformer 512. The other coil of the wideband transformer 512 is connected to the power amplifier 36. The output of the power amplifier 36 is coupled to one coil of the balun 48. The balun 48 in this embodiment has a ferrite core and a turn ratio of slightly higher than 1:1 for impedance matching purposes. The ferrite core balun has been found to provide twice as much current as an air balun and greater efficiency. The other coil of the balun 48 provides balanced differential output ports. One output port of the balun 48 is connected to the transmitter coil 30 via a tuning capacitor 518. The other output port of the balun 48 passes through the current sensing toroid 49 and is connected to the transmitter antenna 16.

[0085] The current sensing toroid 49 provides a feedback signal to the active

the bridge rectifier 64, it will have a four hundred (400) V potential and one (1) mA of current. Down-converting this rectified output voltage to a more useable form such as for example, a five (5) V and eighty (80) mA output is beneficial in particular applications. In this embodiment, the maximum input voltage of the DC-DC voltage converter 66 is greater than one thousand (1000) V while the output voltage is between five (5) V and fourteen (14) V with a power rating of one (1) W to four (4) W. The output of the bridge rectifier 64 is connected to the DC-DC voltage converter 66 (not shown) which then outputs the converted power to the device requiring power through jacks and connectors.

[0094] The receiver safety circuit 62 automatically shuts off the receiver 14 if an electric field is detected that is higher than the standard safety limits. The receiver safety circuit 62 also disables DC power to any device connected to the receiver 14 if a short circuit load is detected.

[0095] The receiver antenna 54 in this embodiment comprises two generally rectangular, approximately parallel conductors which in this embodiment are conductive plates 58. The distance between the two plates 58 is approximately equal to the average dimension of each plate 58. The plates 58 may either be rigid or flexible. The receiver antenna 54 has a low reactance (approximately seven (7) pF to nine (9) pF) relative to its dimension and the received signal wavelength. When resonant, the power harvester 50 harvests electrical power through the electric field created within the volume 20 between the conductors 18 of the transmitter antenna 16. As will be appreciated, the receiver 14 is small relative to the amount of power it can harvest within the volume 20.

[0096] The receiver coil 52 in this embodiment is a cylindrical spiral coil as illustrated in Figure 11a. The receiver coil 52 is constructed of insulated, solid copper wire and has a diameter of approximately four (4) inches (twelve (12) cm). The receiver coil 52 is positioned adjacent to the two plates 58.

[0097] In general, during operation the transmitter 12 is operated so that it drives the transmitter antenna 16 causing an electric field to be generated within the volume 20 between the conductors 18 by running opposite phase, equal magnitude currents through the conductors 18. When a receiver 14 is positioned within the volume 20, the receiver antenna 54 begins to oscillate at the resonant frequency resulting in wireless power being transmitted from the transmitter 12 to the receiver

14 via electric field coupling.

[0098] The closed-loop architecture of the transmitter 12 ensures the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair at all times. In particular, initially the start-up oscillator 504 is used to inject a start-up signal that is applied to the inverter delay chain 502 of the delay signal line 41. The current level of the signal is then boosted by the current gain stage 43 and applied to the power amplifier 36 via the wideband transformer 512 of the voltage gain stage 45. The output of the power amplifier 36 is then applied to the balun 48 which decouples the signal from ground and provides output to the transmitting coil 30 via the tuning capacitor 518. The transmitting coil 30 in turn drives the transmitter antenna 16 resulting in the electric field being generated within the volume 20. The feedback signal output by the current sensing toroid 49, which senses the current in the transmitter antenna 16, is used by the envelope detector 520 to condition the semiconductor switch 520 to isolate the start-up oscillator 504 from the inverter delay chain 502. As a result, the feedback signal that is applied to the inverter delay chain 502 is used to sustain the transmitter output. As will be appreciated, by generating the feedback signal using the current sensing toroid 49 that senses the current running through the transmitter antenna 16 and feeding the signal back into the transmitter 12, the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair.

[0099] As will be appreciated, the transmitter 12 has a fast self-tuning and compact design. Because the transmitter 12 automatically oscillates at the resonant frequency of the transmitter antenna-transmitter coil pair, the transmitter antenna 16 stays tuned and does not require hand tuning or automatic tuning circuitry. Also, the transmitter 12 does not require a pre-amplifier or a digital control system to perform automatic frequency tuning.

[00100] As mentioned above, when the transmitter coil 30 drives the transmitter antenna 16, the electric field (a reactive near field) is created within the volume 20 which can be used by each receiver 14 positioned within the volume to harvest power. An exemplary electric field generated within the volume 20 is shown in Figure 12. As can be seen, the intensity of the electric field increases towards the conductors 18 and weakens towards the middle of the volume 20. Greater efficiency wireless power transfer to a receiver 14 is therefore achieved when the receiver is closer to the conductors 18 and lower efficiency wireless power transfer to the

What is claimed is:

1. A wireless electric field power transmission system comprising:

a transmitter comprising a transmitter antenna and a high quality factor (Q-factor) coil, the transmitter antenna comprising at least two conductors defining a volume, the at least two conductors configured to resonate with the high Q-factor coil to generate a resonant electric field in the volume; and

at least one receiver, wherein the transmitter antenna transfers power wirelessly via resonant electric field coupling when the at least one receiver is within the volume.

2. A method for wirelessly transmitting power, the method comprising:

resonating a transmitter antenna and a high quality factor (Q-factor) coil, the transmitter antenna comprising at least two conductors defining a volume at a transmitter resonant frequency;

generating a resonant electric field in the volume;

positioning a receiver antenna comprising two plates in the volume; and

resonating the receiver antenna at the transmitter resonant frequency.

3. A method for wirelessly transferring power, the method comprising:

resonating a transmitter antenna comprising at least two conductors and a high quality factor (Q-factor) transmitter coil at a start-up frequency;

tuning the transmitter antenna and the transmitter coil to their resonant frequency;

generating a resonant electric field within a volume defined by the at least two conductors;

placing a receiver with a receiver antenna comprising two plates in the volume;

accumulating a potential difference on the two plates;

resonating the receiver antenna at the resonant frequency; and

gathering power from the receiver antenna.

4. A transmitter for wirelessly transmitting power, the transmitter comprising:

an antenna for creating a resonant electric field, the antenna comprising at

least two conductors defining a volume;

a high quality factor (Q-factor) coil connected to the antenna; and

a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency to transfer power via resonant electric field coupling, the resonator comprising an auto tuning circuit configured to automatically tune the transmitter.

5. The transmitter of claim 4, wherein the antenna comprises at least two generally parallel plates that are laterally spaced to define the volume.

6. The transmitter of claim 4, wherein the antenna comprises six conductors defining the volume.

7. The transmitter of claim 4, wherein the antenna is a near-field antenna.

8. The transmitter of claim 7, wherein each conductor is formed of conductive tape.

9. The transmitter of claim 4, wherein the coil is constructed using strand wire.

10. The transmitter of claim 4, wherein the coil is a toroid spiral, cylindrical spiral, flat spiral or pancake coil.

11. The transmitter of claim 4, wherein the auto tuning circuit further comprises circuitry configured to boost a signal to the antenna.

12. The transmitter of claim 11, wherein the circuitry comprises at least one of a voltage gain, a current gain and a power amplifier.

13. The transmitter of claim 12, wherein the power amplifier is a push-pull power amplifier.

14. The transmitter of claim 4, wherein the auto tuning circuit further comprises a delay line configured to delay the signal within the auto tuning circuit.

15. The transmitter of claim 14, wherein the delay line is an active inverter delay chain comprising complementary metal-oxide-semiconductor (CMOS) inverters connected in series.

16. The transmitter of claim 4, wherein the auto tuning circuit further comprises a decoupling circuit configured to decouple an output signal of the transmitter.

17. The transmitter of claim 16, wherein the decoupling circuit comprises a balun.

18. The transmitter of claim 4, wherein the auto tuning circuit further comprises a current sensing circuit configured to provide a feedback signal.

19. The transmitter of claim 4, wherein the auto tuning circuit further comprises an oscillator configured to inject a start-up signal into the auto tuning circuit.

20. The transmitter of claim 4, wherein the resonator further comprises modification circuitry configured to modify the output signal of the transmitter when a condition occurs.

21. The transmitter of claim 20, wherein the modification circuitry adjusts the power level of the output signal when the condition occurs.

22. The transmitter of claim 20, wherein the modification circuitry shuts off output of the transmitter when the condition occurs.

23. A vehicle comprising the transmitter of claim 4.

24. A table comprising the transmitter of claim 4.

25. A container comprising the transmitter of claim 4.

26. The container of claim 25, wherein the container is shielded to prevent electromagnetic field (EMF) leakage.

27. The container of claim 26, wherein electric field strength is increased when the container is closed.

28. A receiver for receiving wirelessly transmitted power, the receiver comprising:

an antenna comprising at least two conductors;

a high quality factor (Q-factor) coil connected to the antenna; and

a resonator connected to the coil for resonating the coil and the antenna at a resonant frequency to extract power from a transmitter via resonant electric field coupling.

29. The receiver of claim 28, wherein the conductors are external to a housing accommodating the coil and the resonator.

30. The receiver of claim 28, wherein the conductors are plates or rails.

31. The receiver of claim 30, wherein the rails are rectangular and parallel.

32. The receiver of claim 30, wherein the rails are metallic.

33. The receiver of claim 28, wherein the coil is constructed of strand wire or inductors.

34. The receiver of claim 28, wherein the coil is a toroid, cylindrical spiral, flat spiral or pancake coil.

35. The receiver of claim 28, wherein the resonator further comprises modification circuitry configured to modify a signal received by the receiver when a condition occurs.

36. The receiver of claim 35, wherein the modification circuitry adjusts the signal received by the receiver when the condition occurs.

37. The receiver of claim 35, wherein the modification circuitry is a voltage

converter and/or a rectifier.

38. The receiver of claim 28, further comprising an impedance matching circuit.

39. The receiver of claim 38, wherein the impedance matching circuit comprises a balun.

40. A backpack for receiving wirelessly transmitted power, the backpack comprising the receiver of claim 28.

41. The backpack of claim 40, further comprising a battery charger connected to the receiver.

42. The backpack of claim 41, further comprising at least one rechargeable battery connected to the receiver configured to charge when no batteries are present in the battery charger.

43. A radio communication device for receiving wirelessly transmitted power, the device comprising the receiver of claim 28.

44. A computing device for receiving wirelessly transmitted power, the device comprising the receiver of claim 28.

45. A wireless electric field power transmission system comprising:

a transmitter comprising a transmitter antenna and a high quality factor (Q-factor) coil, the transmitter antenna comprising at least one conductor configured to resonate with the high Q-factor coil to generate a resonant electric field in a volume around the at least one conductor; and

at least one receiver, wherein the transmitter antenna transfers power wirelessly via resonant electric field coupling when the at least one receiver is coupled to the transmitter.

46. The system of claim 46, wherein the at least one receiver comprises a receiver antenna and a high Q-factor receiver coil connected to the receiver antenna,

and wherein the receiver antenna and the receiver coil resonate at a resonant frequency to extract power from the transmitter via resonant electric field coupling when the at least one receiver is in the volume.

47. The system of claim 1, wherein the at least one receiver comprises a receiver antenna and a high Q-factor receiver coil connected to the receiver antenna, and wherein the receiver antenna and the receiver coil resonate at a resonant frequency to extract power from the transmitter via resonant electric field coupling when the at least one receiver is in the volume.

48. The method of claim 2, wherein resonating the receiver antenna further comprises resonating a high Q-factor receiver coil connected to the receiver antenna at the transmitter resonant frequency.

49. The method of claim 3, wherein the receiver further comprises a high Q-factor receiver coil connected to the receiver antenna, and wherein resonating the receiver antenna further comprises resonating the receiver coil at the resonant frequency.

50. The receiver of claim 28, wherein the resonator further comprises an auto tuning circuit configured to automatically tune the resonator.

51. The receiver of claim 37, wherein the modification circuitry is a rectifier and the receiver further comprises a load electrically connected to the rectifier.