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(54) **WIRELESS POWERING AND CHARGING STATION**

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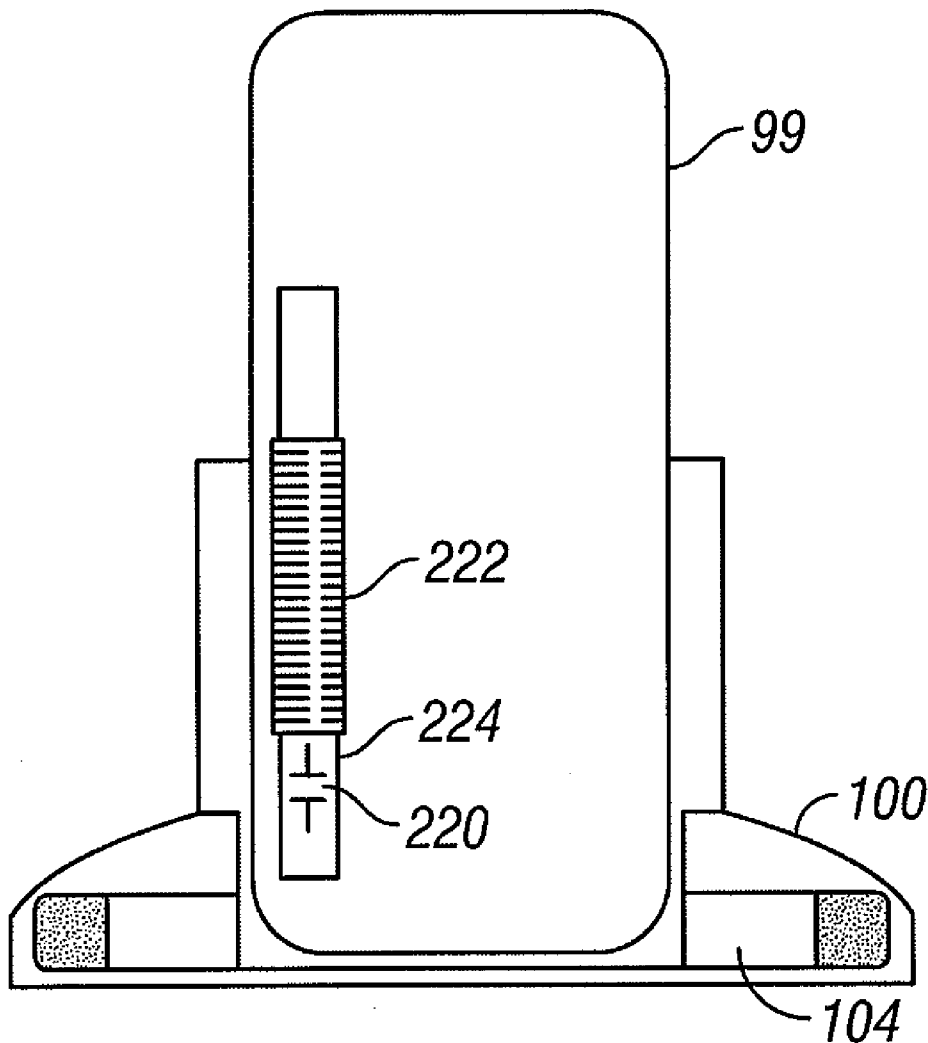
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(57) **ABSTRACT**

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A base including a magnetically resonant antenna therein for relaying energy to a portable device.



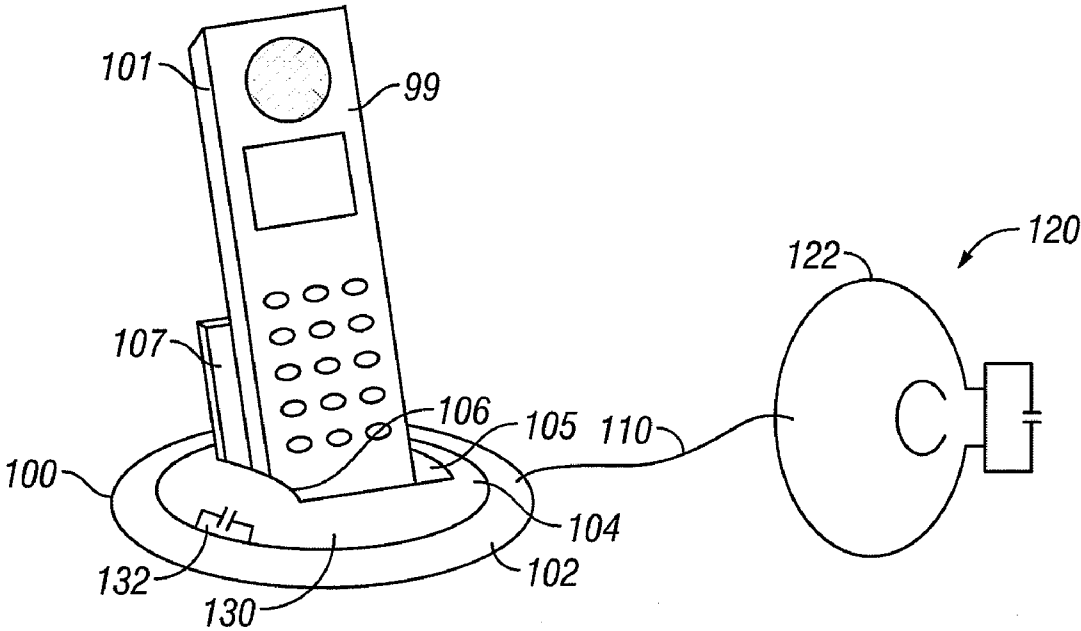


FIG. 1

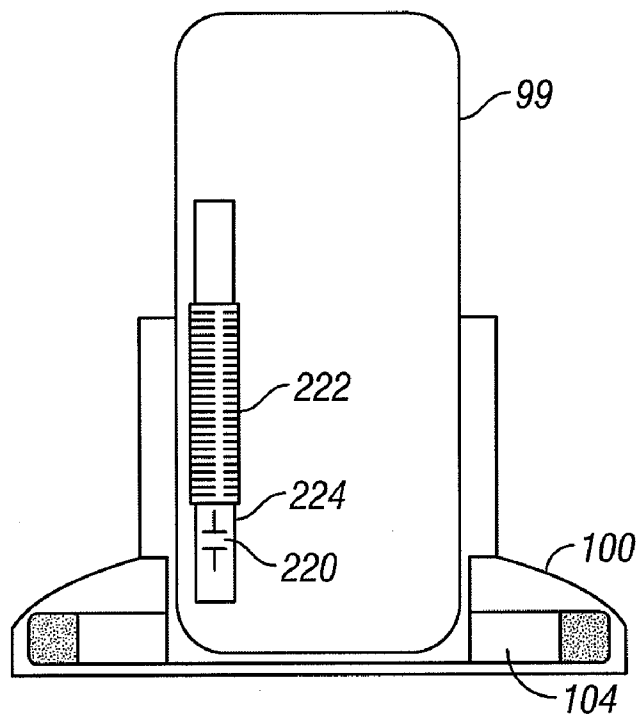


FIG. 2

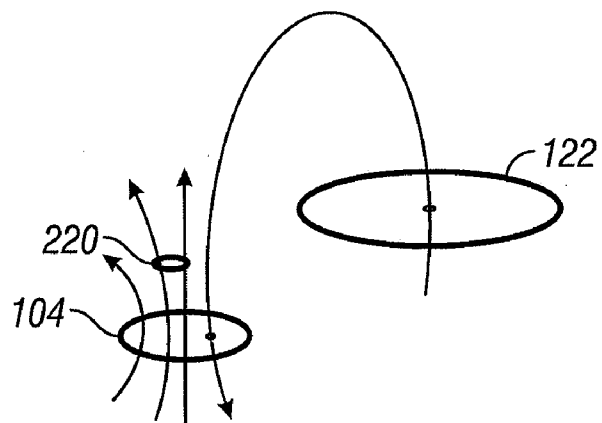


FIG. 3

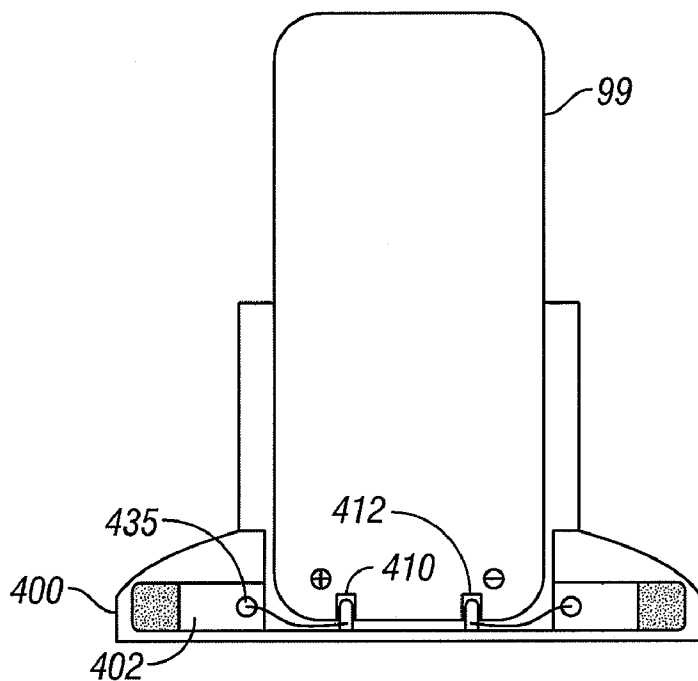


FIG. 4

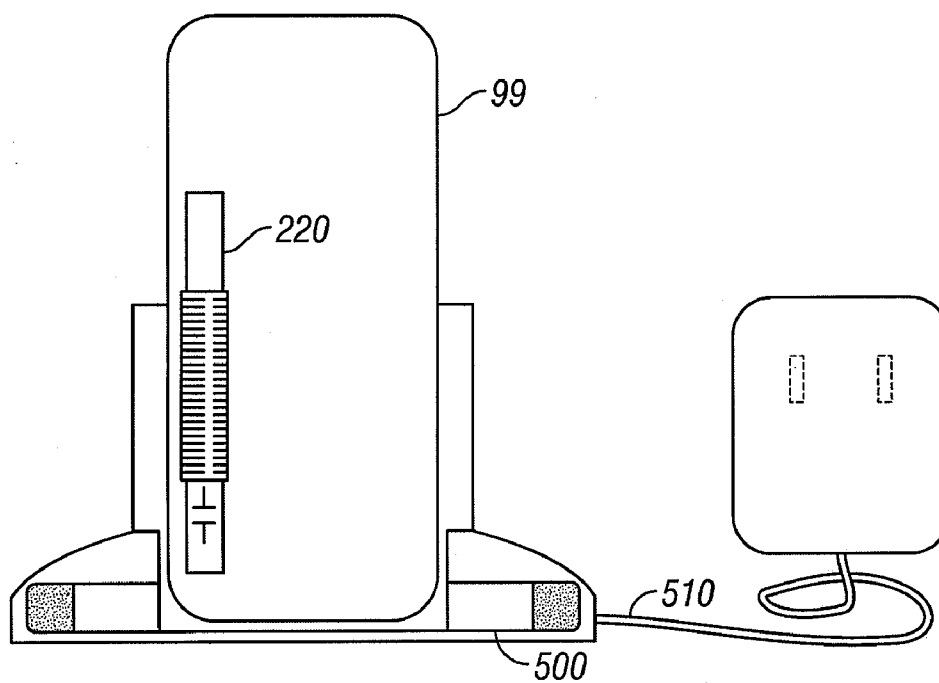


FIG. 5

WIRELESS POWERING AND CHARGING STATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of U.S. patent application Ser. No. 12/353,851 entitled "Wireless Powering and Charging Station" filed on Jan. 14, 2009, which claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 61/021,001 entitled "Wireless Powering and Charging Station" filed on Jan. 14, 2008, both of which are incorporated by reference herein in their entireties.

BACKGROUND

Field of the Invention

[0002] Previous applications by Nigel Power LLC have described a wireless powering and/or charging system using a transmitter that sends a magnetic signal with a substantially unmodulated carrier. A receiver extracts energy from the radiated field of the transmitter. The energy that is extracted can be rectified and used to power a load or charge a battery.

[0003] It is desirable to transfer electrical energy from a source to a destination without the use of wires to guide the electromagnetic fields. Previous attempts has often received low efficiency together with an inadequate amount of delivered power.

[0004] Our previous applications and provisional applications, including, but not limited to, U.S. patent application Ser. No. 12/018,069, filed Jan. 22, 2008, entitled "Wireless Apparatus and Methods", the entire contents of the disclosure of which is herewith incorporated by reference, describe wireless transfer of power.

[0005] The system can use transmit and receiving antennas that are preferably resonant antennas, which are substantially resonant, e.g., within 10% of resonance, 15% of resonance, or 20% of resonance. The antenna(s) are preferably of a small size to allow it to fit into a mobile, handheld device where the available space for the antenna may be limited. An efficient power transfer may be carried out between two antennas by storing energy in the near field of the transmitting antenna, rather than sending the energy into free space in the form of a travelling electromagnetic wave. Antennas with high quality factors can be used. Two high-Q antennas are placed such that they react similarly to a loosely coupled transformer, with one antenna inducing power into the other. The antennas preferably have Qs that are greater than 200, although the receive antenna may have a lower Q caused by integration and damping.

SUMMARY OF THE INVENTION

[0006] The present application describes a wireless desktop for wireless power transfer.

[0007] An embodiment discloses a base that receives wireless power, and repeats it for use with a portable electronic device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the Drawings:

[0009] FIG. 1 shows a block diagram of a device transmitting to a remote receiver;

[0010] FIG. 2 shows a cross section of the FIG. 1 embodiment;

[0011] FIG. 3 shows how the base of the FIG. 1 embodiment can repeat the signal;

[0012] FIG. 4 shows a second embodiment; and

[0013] FIG. 5 shows a third embodiment.

DETAILED DESCRIPTION OF CERTAIN IMPLEMENTATIONS

[0014] Several embodiments of wireless powering and charging station for low power portable electronic devices are disclosed herein.

[0015] A first embodiment discloses a wireless power station for a portable electronic device, e.g. a cordless phone, with reference to FIG. 1. According to the embodiments, the term "wireless power station" is used to refer to a device that wirelessly transmits power that can either provide power to a device, or can charge a rechargeable battery within that device. According to the embodiment, the device 100 can include a base 102 which has an antenna 104 incorporated therein. The antenna 104 can receive power via magnetically coupled resonance, shown generically as 110, from a transmitter of magnetic power 120 that is remote from the antenna 104.

[0016] The transmitter 120 can produce magnetic fields as disclosed in our co-pending applications, and may include loosely coupled resonant loop/coil antennas that are preferably of high-quality factor e.g. quality factor Q larger than 500. These devices may operate in either a low-frequency range or a high frequency range.

[0017] FIG. 2 illustrates a cross-section of the embodiment shown in FIG. 1. The phone 99 is mounted on the base 100. 104 shows a cross-section of the loop/coil antenna that is integrated into the wireless charging station. This antenna receives wirelessly power from the remote transmitter 120. In the embodiment of FIG. 2, the integrated coil in the charging base acts as a parasitic antenna that relays and in essence focuses the magnetically-generated power to a coil form antenna 220 integrated into the phone 99. One advantage of this embodiment is that the phone 99 can then operate as a wireless receiver of power with or without the charging base. The charging base becomes a system that allows operation more effectively via repeating of the magnetic energy.

[0018] The antenna 220 may be an integrated ferrite Rod antenna formed of a spool wound coil 222 and a capacitive device 224 in series with the spool wound coil. The inductance and capacitance together form a circuit that has an LC constant which is substantially resonant with the frequency used by the transmitter 120, and as repeated by the antenna 104.

[0019] An advantage of FIG. 2 embodiment is that the form factor of the structures fit well within the space provided. The loop coil antenna 104 is round in cross-section, and fits into the round cross section base 100. The coil antenna 220 is straight and cylindrical, and fits well into the straight body of the phone. Other shaped devices can of course be used.

[0020] FIG. 3 illustrates how the primary antenna 122 of the transmitter produces magnetic power that have electrical energy therein. This is transmitted via magnetic field coupling to a secondary antenna 104 that is integrated into the base of the power station 100. This relays the power again via magnetic field coupling to the tertiary antenna 220 which is within the portable device. This forms a locally increased

field due to the mutual coupling. In addition, as described above, the portable device may also receive power directly from the base station.

[0021] However, the inventors recognized that the antenna **220** integrated in the portable device may be constrained by the size and/or geometry of the portable device. As such, it may be less efficient than the antenna integrated in the charging station. The less efficient antenna may make it more difficult to receive sufficient power directly from the power base station at the desired distance. The effect of the secondary antenna may be considered as that of a parasitic antenna locally magnifying the magnetic field in the vicinity of the charging station, increasing the overall efficiency of the receive antenna in the portable device. Therefore the embodiment of FIG. **2** may increase the distance and/or efficiency and/or power density of a wireless power station.

[0022] When the portable device **99** is placed closely enough to the primary antenna, the same portable device **99** may also receive electrical energy directly from the power base station **120**.

[0023] Thus, the repeating station of the first embodiment may be most useful when used to obtain power at longer distances or otherwise fringe areas.

[0024] Moreover, the magnetic coupling between charging station and portable device may have certain advantages compared to the conductive coupling using electrical contacts (the classical solution). For example, contacts in electrical charging may become soiled or oxidized. Also, an electronic charging device typically is only usable with one device, into which the connector mates. A magnetic coupled charging station may be configured to charge e.g. different types of wireless power-enabled cordless phones.

[0025] In all of the embodiments, the portable device such as **99** is formed in a case such as **101**. The case has outer dimensions. The base **100** has a holding portion **105** for the portable device. The holding portion **105** includes surfaces such as **106** that are sized in a way that hold the case in place. For example, this may only hold the case on the bottom as near the surfaces **106** in FIG. **1**. There may also be a rear holding place such as **107** which holds the portable device upright, and prevents it from falling or moving. Many different portable devices can fit within the opening **105**. However, by holding the device **99** in a specified location, the efficiency of coupling magnetically between the antenna **104** and an antenna in the portable device may be improved.

[0026] In the embodiments, the portable device is described as being portable phone such as a cellular phone. However, in other embodiments, the portable device may be a personal digital assistant such as PDA, a portable computer such as a laptop or other portable computer, a media player, such as an iPod or others, or other portable electronic device that operates from stored power.

[0027] In an embodiment, the antenna **104** includes an inductive loop coil **130**, in series with a capacitor **132**. The coil and capacitor are selected to have high Q values, for example to provide a Q greater than 500 and even more preferably greater than 1000. In addition, the LC value of the coil is tuned to be substantially resonant with the transmission value from the transmitter **120**.

[0028] One important feature is that was noted by the inventor is that the efficiency of magnetic transmission of this type may be proportional to the size of the antennas. That is, a bigger loop antenna may produce more efficient transfer of

energy. Accordingly, in an embodiment, a loop antenna is used which is integrated as close to the outer perimeter of the base **100** as possible.

[0029] In an embodiment shown in FIG. **1**, the base has a substantially disk shaped an outer perimeter. This allows the use of a round antenna. However, the disc outer perimeter may be any shape, and in fact a rectangular outer shape base may be used with a rectangular shaped antenna.

[0030] Embodiment 2, depicted in FIG. **4**, is similar to embodiment 1 with a base **400**, antenna **402**. Electrical energy received by the wireless charging station is forwarded to the portable device **99** using conductive coupling over contacts **410**, **412**.

[0031] In embodiments where a conductive charging is used, there may be a separate coupling antenna loop **435** which is directly connected to the magnetic contacts. While the coupling loop is connected to the electrical contacts, the Main antenna **400** is electrically unconnected. This maintains the integrity of its impedance and matching.

[0032] Embodiment 3, depicted in FIG. **5**, a charging station **500** which receives power through a wired connection **510**, e.g. directly from the 110/220 V mains or from a wall plug power supply as in classical solutions. This may use the same kind of portable device **99** as in the first embodiment. The power is magnetically modulated and coupled to the antenna **220** based on magnetic coupled resonance.

[0033] Although only a few embodiments have been disclosed in detail above, other embodiments are possible and the inventors intend these to be encompassed within this specification. The specification describes specific examples to accomplish—more general goal that may be accomplished in another way. This disclosure is intended to be exemplary, and the claims are intended to cover any modification or alternative which might be predictable to a person having ordinary skill in the art. For example, other sizes, materials and connections can be used. Other structures can be used to receive the magnetic field. In general, an electric field can be used in place of the magnetic field, as the primary coupling mechanism. Other kinds of antennas can be used. The above has described how the base can be round, but the base can also be rectangular, in which case the antenna can be either round or rectangular. Other shapes of the antennas can also be used.

[0034] Also, the inventors intend that only those claims which use the-words “means for” are intended to be interpreted under 35 USC 112, sixth paragraph. Moreover, no limitations from the specification are intended to be read into any claims, unless those limitations are expressly included in the claims.

[0035] Where a specific numerical value is mentioned herein, it should be considered that the value may be increased or decreased by 20%, while still staying within the teachings of the present application, unless some different range is specifically mentioned. Where a specified logical sense is used, the opposite logical sense is also intended to be encompassed.

What is claimed is:

1. An apparatus for wireless charging an electronic device, the apparatus comprising:

a holder having at least one surface that is shaped to contact at least one outer surface of the electronic device, the portable electronic device including a wireless power receive element coupled to a load; and

an antenna located within the holder, the antenna having an inductive-capacitive value that is tuned to a frequency

and configured to receive power from a transmitter via a wireless field, and further configured to focus wirelessly received power to a power level sufficient to charge or power the load.

2. The apparatus of claim 1, wherein the wireless field comprises a magnetically coupled resonance field.

3. The apparatus of claim 2, wherein focusing the wirelessly received power improves an efficiency of the magnetically coupled resonance field.

4. The apparatus of claim 2, wherein focusing the wirelessly received power increases a field density of the magnetically coupled resonance field.

5. The apparatus of claim 1, wherein the antenna further comprises an inductive loop coil and a capacitor, the inductive loop in series with the capacitor.

6. The apparatus of claim 5, wherein a Q value of the coil and the capacitor is substantially between 500 and 1000.

7. The apparatus of claim 5, wherein the coil and the capacitor are tuned to be substantially resonant with the wireless field.

8. The apparatus of claim 1, wherein the antenna is integrated into a base of the holder.

9. The apparatus of claim 8, wherein the perimeter of the holder is substantially circular.

10. The apparatus of claim 8, wherein inner surfaces of the holder are sized to mount a phone in the holder's base.

11. A method of wirelessly charging an electronic device, the method comprising:

receiving power from a transmitter via a wireless field by an antenna located within a holder, the holder having at least one surface that is shaped to contact at least one outer surface of the electronic device, the portable electronic device including a wireless power receive element coupled to a load; and

focusing wirelessly received power to a power level sufficient to charge or power the load.

12. The method of claim 11, wherein receiving the power comprises receiving power from the transmitter via a magnetically coupled resonance field.

13. The method of claim 12, wherein focusing the wirelessly received power comprises focusing the wirelessly received power to improve an efficiency of the magnetically coupled resonance field.

14. The method of claim 12, wherein focusing the wirelessly received power comprises focusing the wirelessly received power to increase a field density of the magnetically coupled resonance field.

15. The method of claim 11, wherein receiving the power comprises receiving the power by the antenna further comprising an inductive loop coil and a capacitor, the inductive loop in series with the capacitor, and the coil and the capacitor tuned to be substantially resonant with the wireless field.

16. An apparatus for wirelessly charging an electronic device, the apparatus comprising:

means for receiving power from a transmitter via a wireless field by an antenna located within a holder, the holder having at least one surface that is shaped to contact at least one outer surface of the electronic device, the portable electronic device including a wireless power receive element coupled to a load; and

means for focusing wirelessly received power to a power level sufficient to charge or power the load.

17. The apparatus of claim 16, wherein the wireless field comprises a magnetically coupled resonance field.

18. The apparatus of claim 16, wherein the antenna further comprises an inductive loop coil and a capacitor, the inductive loop in series with the capacitor.

19. The apparatus of claim 18, wherein the coil and the capacitor are tuned to be substantially resonant with the wireless field.

20. The apparatus of claim 16, wherein the antenna is integrated into a base of the holder.

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