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Baarman

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(54) **PORTABLE INDUCTIVE POWER STATION**

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(51) **Int. Cl.**
B60L 1/00 (2006.01)

(52) **U.S. Cl.** **307/9.1**; 307/150

(58) **Field of Classification Search** 307/150, 307/9.1

See application file for complete search history.

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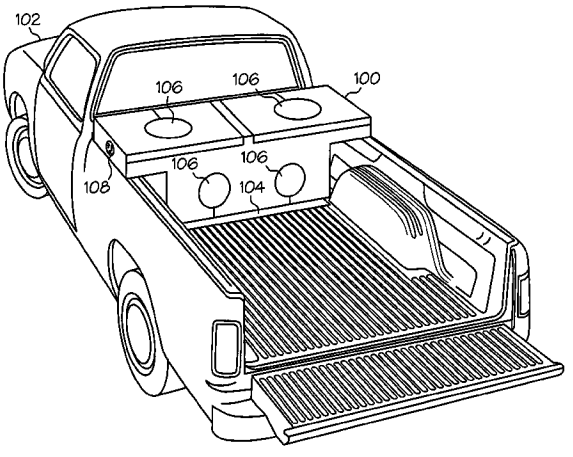
(57) **ABSTRACT**

An inductive recharging station has an inductive power supply and a portable power station. The portable power station is movable with respect to the inductive power supply. In order to recharge portable devices, the devices are placed within the portable power station. When the portable power station is placed in proximity to the inductive recharging station, the devices are powered. If a device has a rechargeable battery, the battery is recharged.

4 Claims, 8 Drawing Sheets



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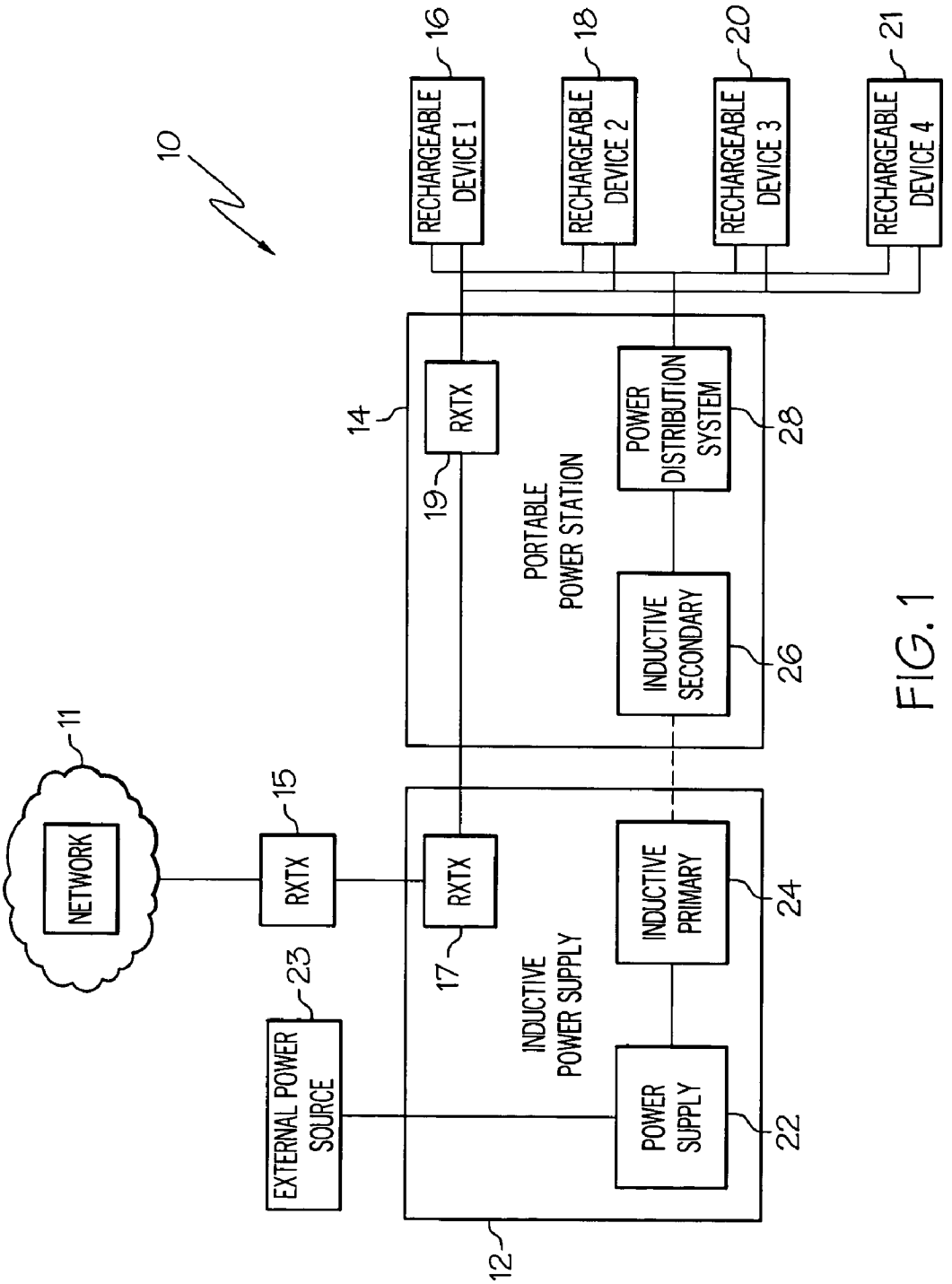

10
RECHARGEABLE DEVICE 1
16
RECHARGEABLE DEVICE 2
18
RECHARGEABLE DEVICE 3
20
RECHARGEABLE DEVICE 4
21
14
RXTX
19
PORTABLE POWER STATION
POWER DISTRIBUTION SYSTEM
28
INDUCTIVE SECONDARY
26
11
NETWORK
15
RXTX
17
INDUCTIVE POWER SUPPLY
INDUCTIVE PRIMARY
24
23
EXTERNAL POWER SOURCE
POWER SUPPLY
22
12

FIG. 1

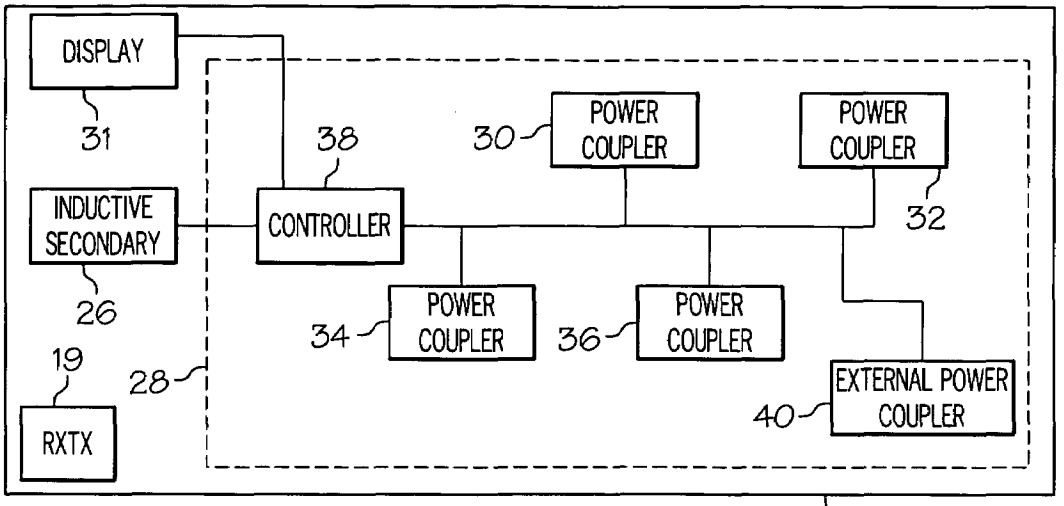


FIG. 2

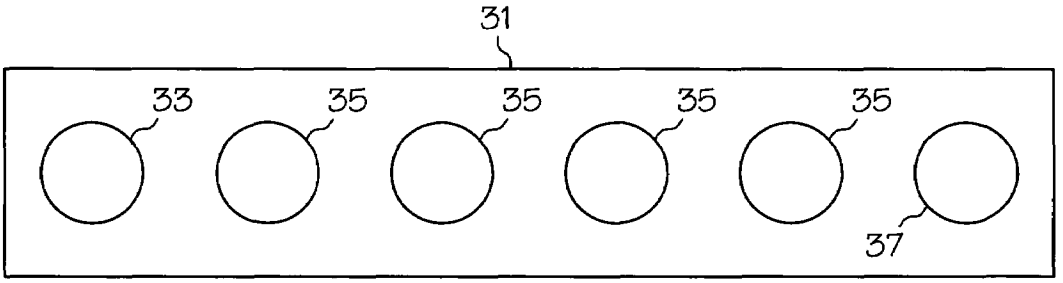


FIG. 2A

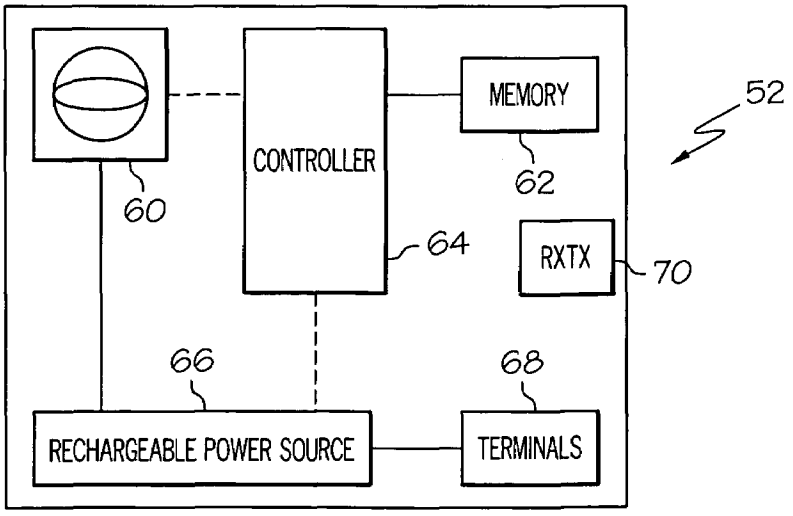


FIG. 4

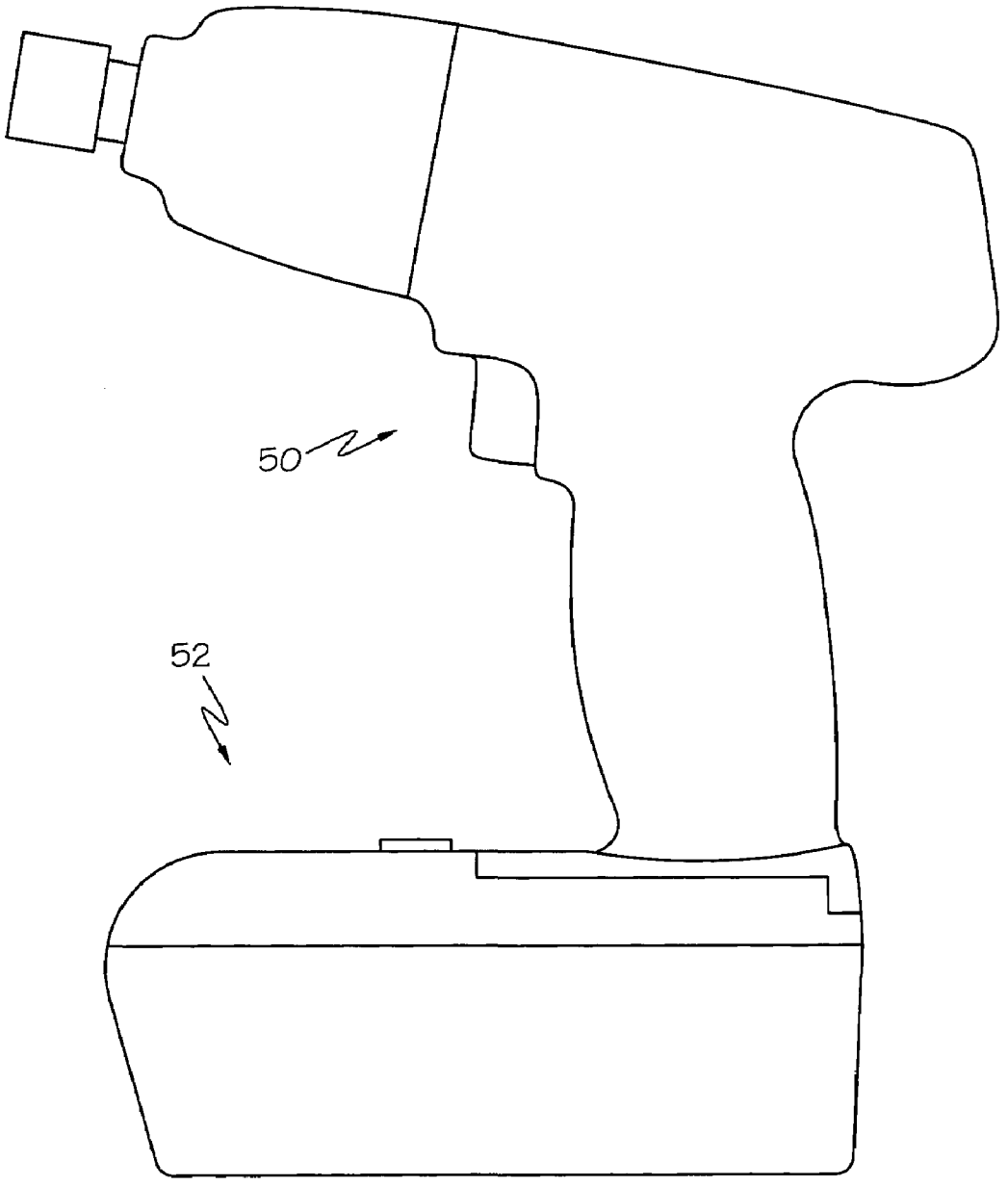


FIG. 3

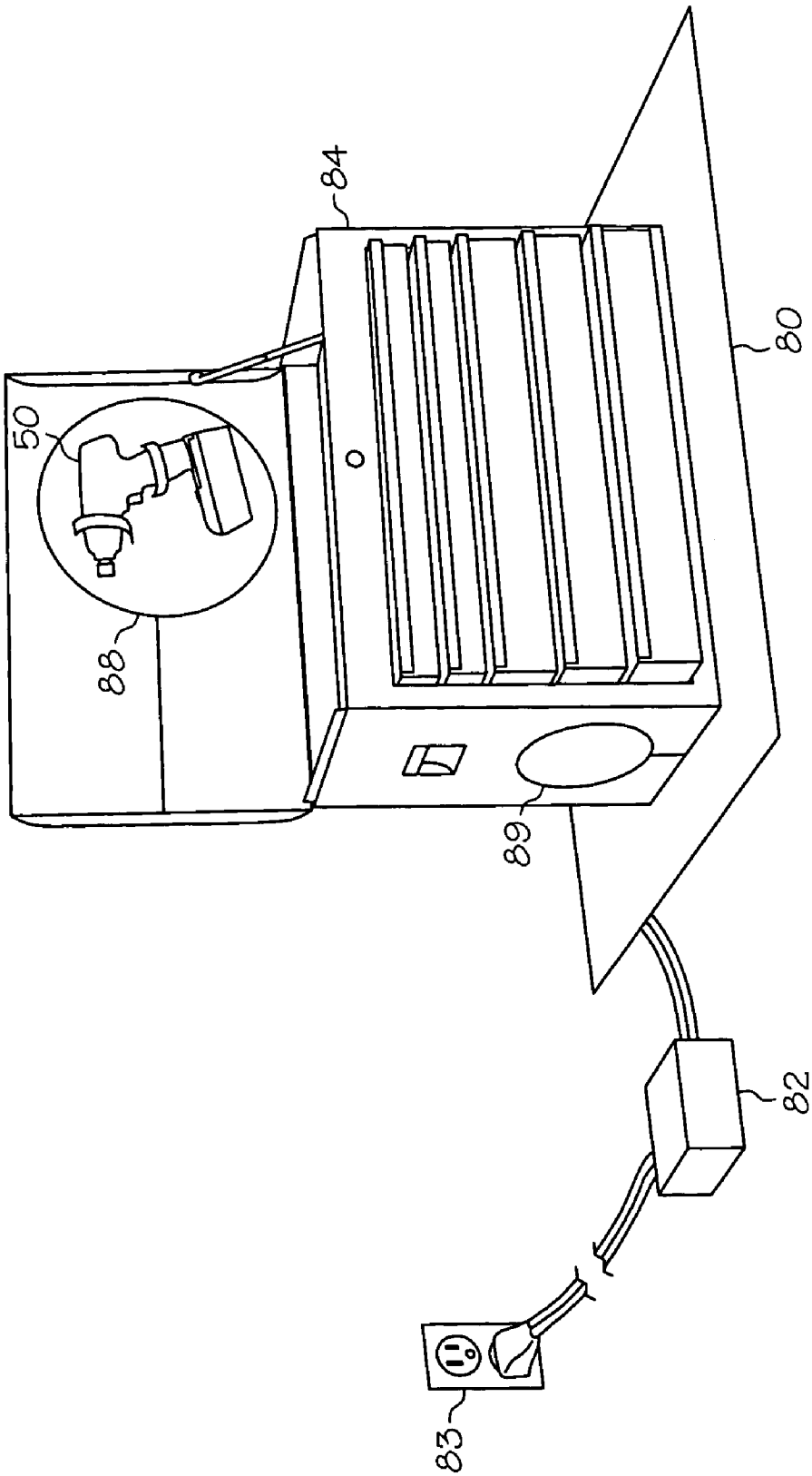
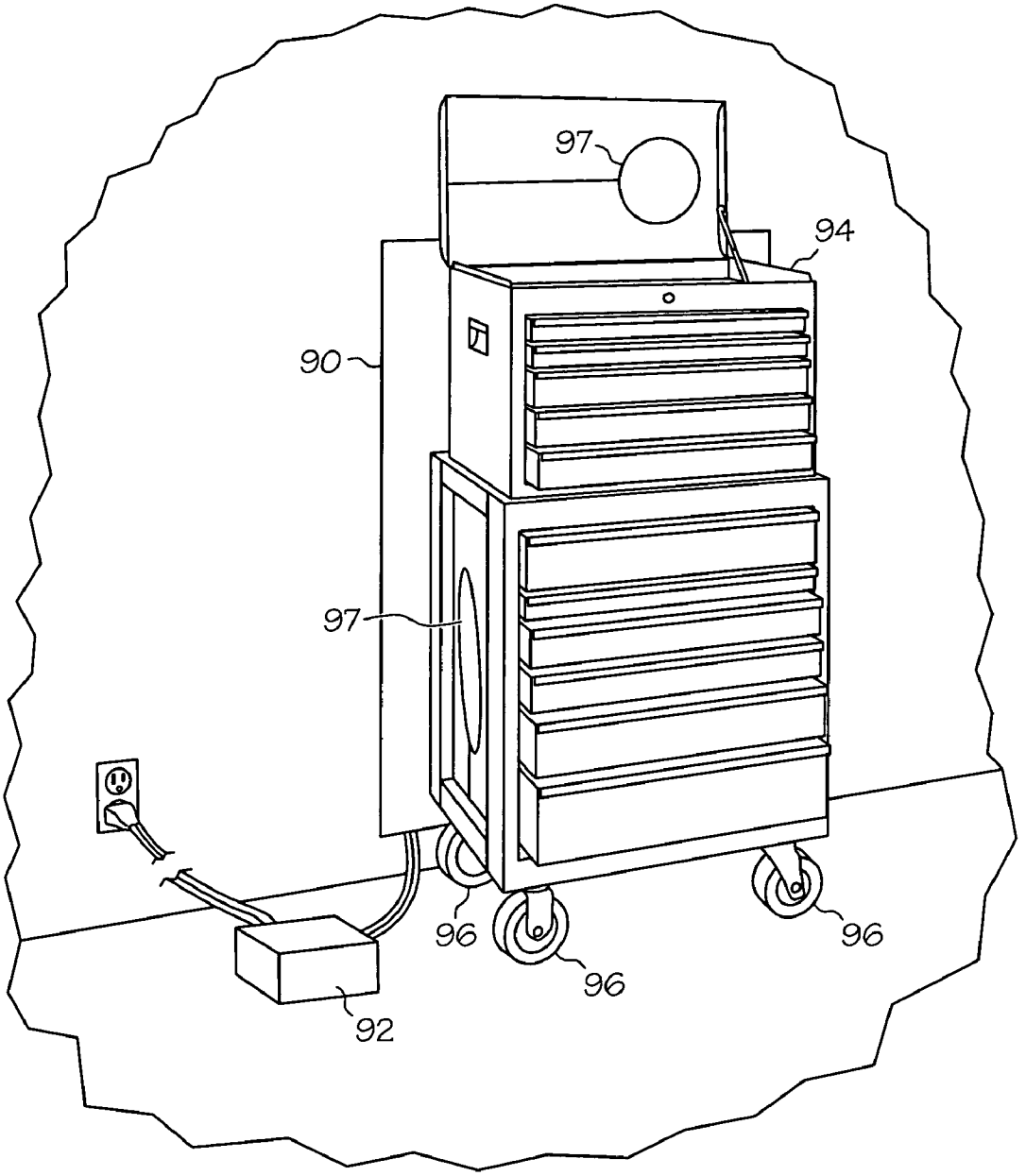


FIG. 5



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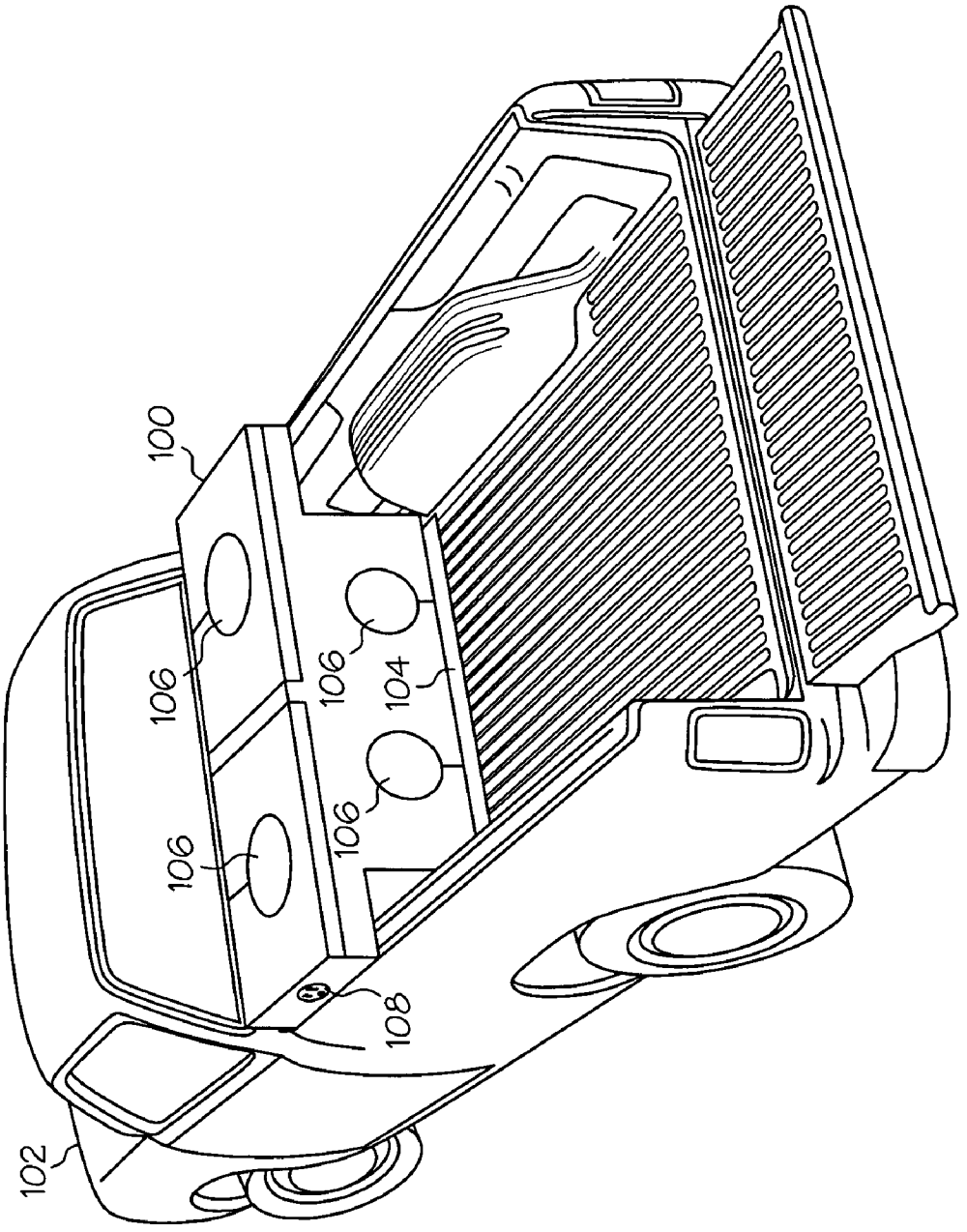

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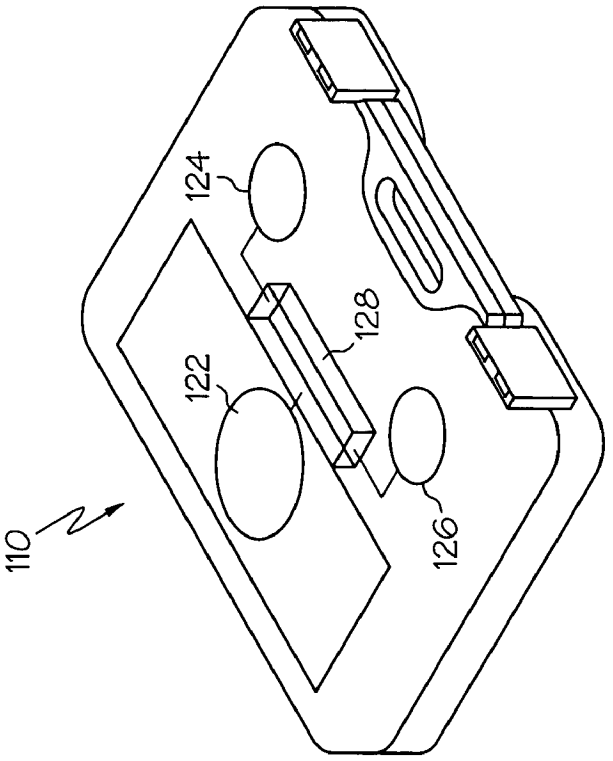

FIG. 9

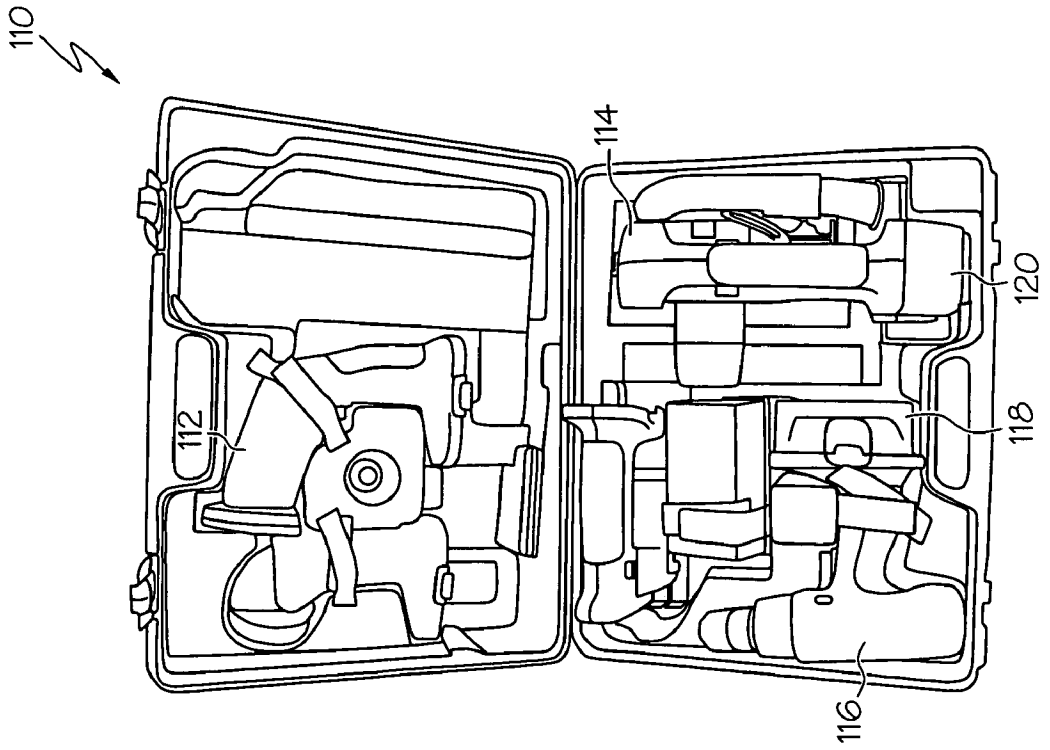

FIG. 8

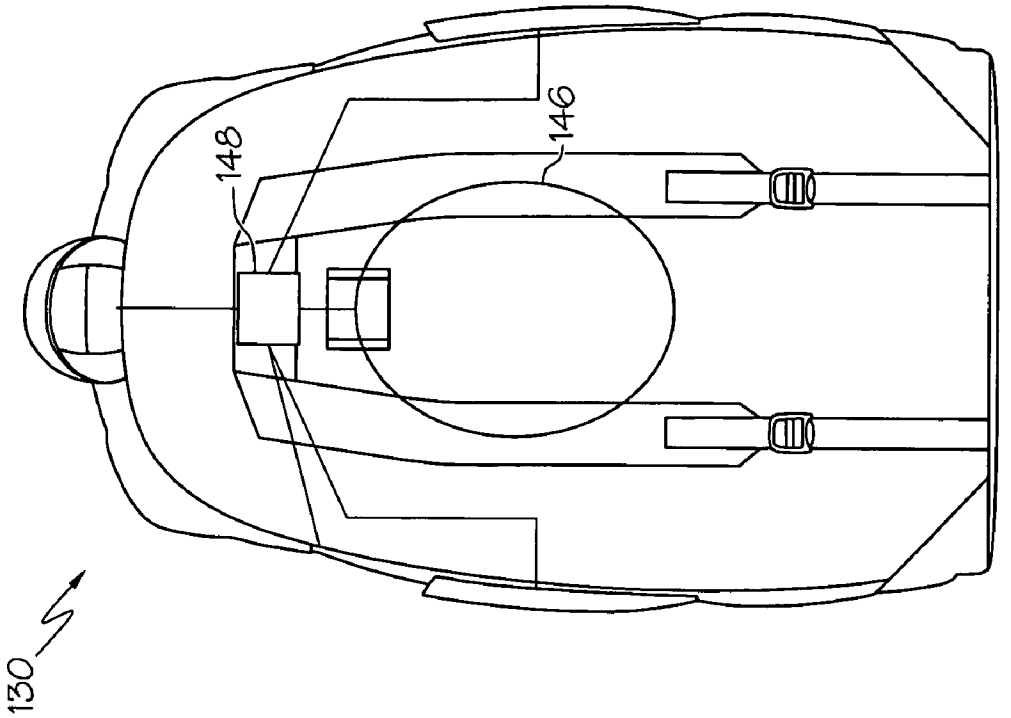

FIG. 11

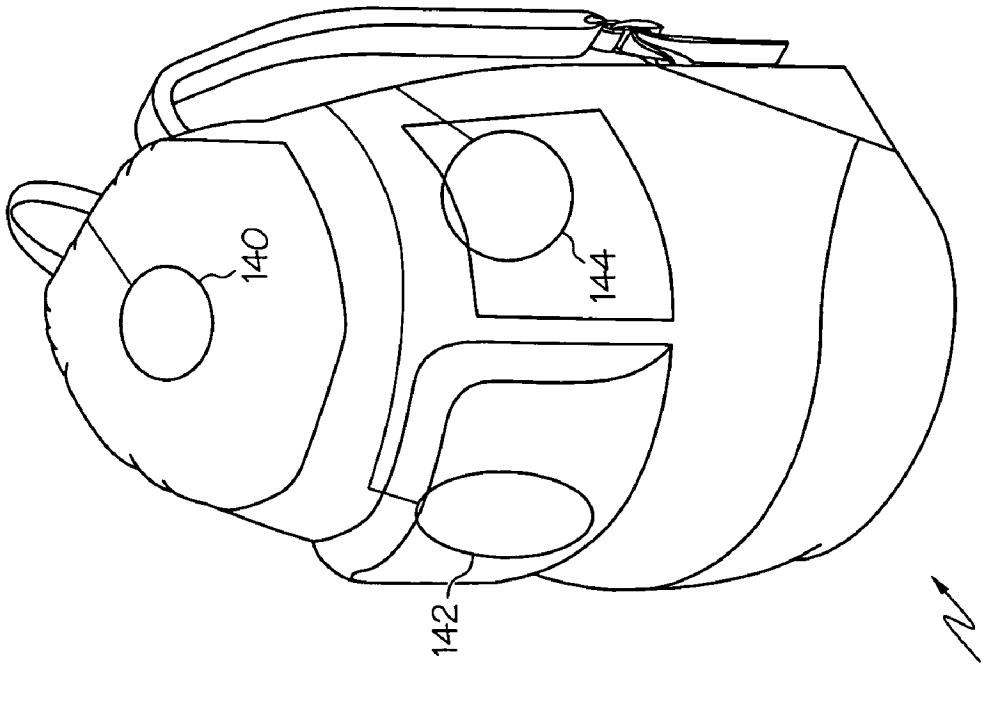

FIG. 10

PORTABLE INDUCTIVE POWER STATION

BACKGROUND OF THE INVENTION

Battery powered handheld tools such as drills, saws, and vacuum cleaners, have proven very popular. Such a handheld tool usually has a rechargeable battery, referred to generally as a "power pack", attached at some location on the tool. The power pack has to be periodically recharged. In order to recharge the power pack, the power pack is removed from the tool and placed in a recharging cradle. The recharging cradle is connected to a source of AC power. After the power pack is charged, the power pack is placed once again on the tool.

While battery powered handheld tools have proven very useful, they do have drawbacks. The power pack must be regularly recharged. If not, the tool will cease to function. Further, the power pack is usually plugged into an AC outlet separate from the handheld tool, which is inconvenient to a user and may lead to the loss of the power pack.

Finally, battery powered handheld tools are so popular that a person or entity may have, use, sell or rent several such tools. Often, each battery is unique for each handheld tool, requiring the person or entity to have a myriad number of recharging cradles, wires, and outlets.

A system for recharging battery powered handheld tools without the attendant problems is thus highly desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of inductive recharging station.

FIG. **2** shows the portable power station block diagram in more detail.

FIG. **2***a* shows one embodiment of a display.

FIG. **3** shows a portable tool.

FIG. **4** is a block diagram of the power pack for the portable tool shown in FIG. **3**.

FIG. **5** show a tool box having a portable power station.

FIG. **6** shows a wheeled tool box having a portable power station.

FIG. **7** shows a tool box for a truck having a portable power station.

FIG. **8** shows an embodiment of a multi-tool case.

FIG. **9** shows the exterior of the multi-tool case.

FIG. **10** shows one embodiment of a backpack.

FIG. **11** shows the rear of the backpack.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a block diagram of inductive recharging station **10**. Inductive power supply **12** inductively energizes portable power station **14**. Portable power station **14** then provides power to recharge a plurality of rechargeable devices **16**, **18**, **20**, **21**. Inductive power supply **12** is connected to an external power source **23**. External power source **23** could be a source of AC power, such as 110 V AC, or DC power, such as a conventional 12 V DC vehicle battery, or any other type of electric power.

Inductive power supply **12** includes power supply **22** and inductive primary **24**. Power supply **22** converts the power from external power source **23** into electrical power for powering the inductive recharging station **10**. When portable power station **14** is placed within proximity of inductive primary **24**, inductive secondary **26** is energized and supplies power to power distribution system **28**. Power distribution system **28** then supplies power to rechargeable devices **16**, **18**, **20**, **22**.

Inductive power supply **12** could be an adaptive inductive power supply, such as those described in detail in U.S. Pat. No. 6,731,071 issued May 4, 2004 and entitled "Inductively Powered Lamp Assembly"; patent application Ser. No. 10/357,932, filed Feb. 4, 2003 and entitled "Inductively Powered Apparatus"; patent application Ser. No. 10/689,224, filed Oct. 20, 2003 and entitled "Inductive Coil Assembly"; patent application Ser. No. 10/246,155, filed Sep. 18, 2002 and entitled "Inductively Coupled Ballast Circuit"; patent application Ser. No. 10/689,499, filed Oct. 20, 2003 and entitled "Adaptive Inductive Power Supply"; and patent application Ser. No. 10/689,148, filed Oct. 20, 2003 and entitled "Adaptive Inductive Power Supply With Communication", which are hereby incorporate by reference.

Inductive power station **10** could include external RXTX **15** (transceiver). External RXTX **15** is coupled to network **11** and allows communication with inductive power supply RXTX **17**. Inductive power supply RXTX **17** then relays any communication to portable power station RXTX **19**, which then forwards the communication to rechargeable devices **16**, **18**, **20**, **21**. The communication protocol between the various devices could include 802.11b, 802.11g, power line communication, Bluetooth, cellular, or any of the other myriad types of communication schemas. As shown, communication could be managed by inductive power supply **12**. However, communication could flow directly from external RXTX **15** to portable power station RXTX **19**.

FIG. **2** shows portable power station **14** in more detail. Power distribution system **28** comprises several power couplers **30**, **32**, **34**, **36**. Power couplers **30**, **32**, **34**, **36** could be physical connectors, whereby a portable device would be physically connected to the power coupler. Alternatively, power couplers **30**, **32**, **34**, **36** could be an adaptive inductive primary for power transfer for an adaptive inductive power supply such as those described in detail in U.S. Pat. No. 6,731,071 issued May 4, 2004 and entitled "Inductively Powered Lamp Assembly"; patent application Ser. No. 10/357,932, filed Feb. 4, 2003 and entitled "Inductively Powered Apparatus"; patent application Ser. No. 10/689,224, filed Oct. 20, 2003 and entitled "Inductive Coil Assembly"; patent application Ser. No. 10/246,155, filed Sep. 18, 2002 and entitled "Inductively Coupled Ballast Circuit"; patent application Ser. No. 10/689,499, filed Oct. 20, 2003 and entitled "Adaptive Inductive Power Supply"; and patent application Ser. No. 10/689,148, filed Oct. 20, 2003 and entitled "Adaptive Inductive Power Supply With Communication", which are hereby incorporate by reference.

Portable power station **14** could also include controller **38**. Controller **38** would monitor the various devices receiving power from inductive power supply **26** and control the power provided to the devices. For example, controller **38** could maximize the efficiency of the system so that power is optimally transferred from inductive power supply **26** to the rechargeable devices. Alternatively, controller **38** could prioritize the supply of power to the rechargeable devices in accordance with an established hierarchy so that some rechargeable devices are charged before other devices.

Power couplers **30**, **32**, **34**, **36** could be specially adapted for a particular device. For example, one power coupler could be a pair of contacts for interfacing with contacts on a rechargeable device, another power coupler could be a conventional inductive coupler, a third could be an adaptive inductive power coupler, and a fourth could provide both power and communication. Alternatively, all four power couplers could be the same type of coupler.

In order to provide information regarding the status of portable power station **14**, optional display **31** is coupled to

controller **38**. Display **31** is shown in FIG. **2**A. In accordance with one embodiment, indicator **33** is energized whenever portable power station **14** is receiving power from inductive power supply **12**. Lights **35** are energized when power is being supplied by one of the power coupler **30**, **32**, **34**, **36**. Light **37** is energized when power is being supplied by external power coupler **40**. Display **31** could be an LCD (liquid crystal diode) display or a series of LED (light emitting diode).

Portable power station **14** could also include external power coupler **40**. External power coupler **40** converts power from inductive power supply **26** into conventional power, such as 60 Hz 110V AC power. External power coupler **40** could be as simple as a transformer, or it could be a conventional inverter. External power coupler **40** could supply AC power or DC power, or both, through several external outlets. A user would therefore plug an AC or DC device directly into portable power station **14**.

FIG. **3** shows portable tool **50**. Portable tool **50** is shown as a portable drill, but it could also be, for example, a reciprocating or circular saw, a screwdriver, a vacuum cleaner, a rechargeable flashlight, a radio, a computer, a media player or any other portable tool. Portable tool **50** also includes rechargeable power supply **52**. Rechargeable power supply **52** could be removable from portable tool **50** or it could be permanently affixed to portable tool **50**.

FIG. **4** is a block diagram of power pack **52** for portable tool **50**. Power pack **52** also includes secondary **60**. Secondary **60** could be a triaxial multi-coil primary described in U.S. patent application Ser. No. 10/689,224, filed Oct. 20, 2003 and entitled "Inductive Coil Assembly", which is hereby incorporated by reference. Power pack **52** includes memory **62**, controller **64**, rechargeable power source **66**, and terminals **68**. Controller **64** could be a microcontroller or a microprocessor, depending upon the specific requirements for operation of portable tool **50**.

Briefly, secondary **60** receives power from an inductive primary. Controller **64** regulates the recharging of rechargeable power source **66**. Memory **62** contains information regarding power pack **52** and rechargeable tool **50**. This information can be communicated to the inductive power supply in order to better control the recharging of power pack **52** as well as any other rechargeable devices receiving power from the inductive power supply. The inter-operation of controller **64**, rechargeable power source **66**, and secondary **60** are described in more detail in U.S. patent application Ser. No. 10/689,148, filed Oct. 20, 2003 and entitled "Adaptive Inductive Power Supply With Communication" which is hereby incorporated by reference.

Power pack **52** could also include power tool RXTX **70**. Power tool RXTX **70** is a communication interface for power tool **50** and power pack **52**. If power tool **50** contained a memory, power tool RXTX **70** could provide a communication link with network **11**. Power tool RXTX **70** is shown here as part of power pack **52**. Power tool RXTX **70** could also be located within power tool **50** rather than in power pack **52**.

Because the power tool RXTX **70** is designed to work specifically with power station RXTX **19**, power tool RXTX **70** need not be able to communicate in a plethora of different protocols. Rather, power tool RXTX **70** need only be able to communicate in the same protocol as that of power station RXTX **19**. The task of translating between the various protocols of network **11** would fall to one of the other RXTXs **17**, **19**, **15**. Thus, the computing power and hardware required within power tool RXTX **70** would be minimized.

Inductive recharging station **10** could have a variety of physical configurations. FIG. **5** shows one configuration. Inductive power supply **12** could be in the form of a mat with the inductive primary incorporated into mat **80**. Power supply **22** is located within enclosure **82**, and is connected to power outlet **83**. Obviously, depending upon the sizes of the components and the power requirements, power supply **22** could be incorporated within mat **80**. In the embodiment shown, portable power station **14** has been incorporated within tool box **84**.

In this configuration, power couplers **32**, **34**, **36**, **38** could be incorporated within the walls of tool box **84**. Inductive secondary **26** could also be incorporated within the base of tool box **84**. Power would be transferred from to from the inductive primary in mat **80** to the inductive secondary located within the base of tool box **84**. Power would then be transferred to the various power couplers located within tool box **84**.

As shown in FIG. **5**, tool box **84** is provided with retainers to attach power tool **50** in a fixed position with relative to power coupler **88**. According to one embodiment, power coupler **88** is designed to work exclusively with power tool **50**, and therefore power coupler **88** could have operating characteristics designed specifically for power tool **50**. Other power couplers contained within tool box **84** could also be specifically designed for each of several power tools contained within the tool box. Attachment means for attaching a power tool near its respective power couple could also be provided.

An additional or alternative power coupler placement is illustrated by power coupler **89**. According to this embodiment, power tool **50** is not attached to power coupler **50**, but is instead placed within a proximity that provide inductive power transfer between power coupler **89** and power tool **50**. According to this embodiment, coupler **89** could be a general purpose coupler or one tailored for a specific power tool.

FIG. **6** shows an additional configuration for the portable power station. Mat **90** contains the inductive primary. As before, the power supply and other electronics for the inductive power supply could be within enclosure **92**, although those items could be incorporated within mat **90**. According to one embodiment, the inductive secondary is contained within the back wall of tool box **94**. Tool box **94** has one or more power couplers **97** and is provided with wheels **96**. Power couplers **97** could also be positioned within one or more drawers of tool box **94**. If rechargeable devices were placed within tool box **94**, tool box **94** could then be positioned near mat **90**, and power would then be transferred to the rechargeable devices located within tool box **94**.

FIG. **7** shows a further configuration for the portable power station. Tool box **100** is located on or within vehicle **102**. Inductive power supply **104** is incorporated within the body of vehicle **102**. Power couplers **106** could be incorporated within the walls of tool box **100** or could be external to tool box **100**. External power outlet **108** is a standard power outlet, which could be AC or DC. Obviously, multiple external power outlets could be provided. Inductive power supply **104** is connected to the electrical power system of vehicle **102**.

Vehicles incorporating an inductive power supply system are described in more detail in U.S. patent application Ser. No. 10/871,420, filed Jun. 18, 2004 and entitled "Vehicle Interface" which is hereby incorporated by reference.

FIG. **8** shows a further embodiment. Multi-tool case **110** includes specific locations for various power tools such as sander **112**, saw **114** and drill **116**. Power pack **118** is used to power drill **116** while power pack **120** is used to power saw **114**.

FIG. **9** shows the exterior of multi-tool case **110**. Multi-tool case **110** has inductive secondary **122**. Power couplers **124**, **126** supply power to power packs **118**, **120**. Controller **128**

manages the power distribution from inductive secondary **122** to power couplers **124**, **126**. In this embodiment, power coupler **124**, **126** are shown as inductive primaries to be coupled to inductive secondaries within power packs **118**, **120**. Alternatively, power couplers **124**, **126** could be physical connections with power packs **118**, **120**. Multi-tool case **110** would be placed in proximity to a pad similar to pad **80** shown in FIG. **5**. Power packs **118**, **120** would thereby be charged without the need to remove them from multi-tool case **110**.

FIG. **10** shows backpack **130**. Backpack **130** has multiple power couplers **140**, **142**, **144** located at different positions on backpack **130**. Power couplers **140**, **142**, **144** could be contained within the fabric of backpack **130**, located on the exterior of backpack **130**, or located on the interior of backpack **130**. FIG. **11** shows the rear of backpack **130**. Power couplers **140**, **142**, **144** are coupled to inductive secondary **146** by way of controller **148**. Controller **148** could manage the power supplied to power couplers **140**, **142**, **144**. In operation, various portable devices equipped with a suitable power coupler, such as an inductive coupler, could be placed within backpack **130**. When backpack **130** is placed within proximity of a mat similar to that shown in FIG. **5**, then power received by inductive secondary **146** would be used to charge or power the devices.

The above description is of the preferred embodiment. Various alterations and changes can be made without departing from the spirit and broader aspects of the invention as defined in the appended claims, which are to be interpreted in accordance with the principles of patent law including the doctrine of equivalents. Any references to claim elements in the singular, for example, using the articles "a," "an," "the," or "said," is not to be construed as limiting the element to the singular.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A portable recharging toolbox comprising:

a first inductor for receiving AC electrical power inductively from an inductive power supply;

a power distribution system electrically coupled to the first inductor, where the power distribution system receives the AC electrical power from the first inductor and distributes the electrical power to a device; and

where the toolbox has a base, and the first inductor is located in the base.

2. A portable recharging toolbox comprising:

a first inductor for receiving AC electrical power inductively from an inductive power supply;

a power distribution system electrically coupled to the first inductor, where the power distribution system receives the AC electrical power from the first inductor and distributes the electrical power to a device; and

where the toolbox has at least one sidewall, and the inductor is located in the sidewall.

3. A portable recharging toolbox comprising:

a first inductor for receiving AC electrical power inductively from an inductive power supply;

a power distribution system electrically coupled to the first inductor, where the power distribution system receives the AC electrical power from the first inductor and distributes the electrical power to a device; and

where the toolbox has at least one sidewall, and the inductor is located on the sidewall.

4. A vehicle comprising:

a vehicle power supply;

an inductive power supply incorporated within the vehicle and electrically coupled to the vehicle power supply, where the inductive power supply is partially located within a floor of the vehicle;

a portable power station, inductively powered by the inductive power supply, movable with respect to the inductive power supply, the portable power station having a power distribution system capable of energizing a plurality of devices.

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