according to the Bluetooth address, can also be applied to various pairs of units, in addition to the pair of the personal computer 51 and the portable telephone 52, described above.

For example, a communication system such as that described above can be formed between a portable terminal, such as the portable telephone 52 or the PDA 53, and an apparatus, such as a TV receiver, a car navigation apparatus, a vending machine, or an ATM (automatic teller machine). In this case, the portable terminal, such as the portable telephone 52 or the PDA 53, needs to have at least a Bluetooth module and a non-contact IC card, and the apparatus, such as a TV receiver, a car navigation apparatus, a vending machine, or an ATM, needs to have at least a Bluetooth module, and a reader/writer for a non-contact IC card.

The present invention can also be applied to processing for establishing synchronization in a Piconet formed of a pair of portable telephones, a pair of PDAs, a PDA and digital camera pair, or a PDA and a digital video camera pair if one of the pair has a reader/writer.

The present invention is not limited to a connection between units. It is also possible for electromagnetic-induction communication blocks (a reader/writer and a non-contact IC card) and Bluetooth modules to be provided, for example, to moving objects, such as automobiles, trains, ships, airplanes, inside buildings or all over a city, and to connect them to networks, such as the Internet, LANs (local area networks), or WANs (wide area networks) through the Bluetooth modules to form a so-called ubiquitous society (ubiquitous network society or ubiquitous computing society).

FIG. 30 is a view showing the concept of a ubiquitous society formed by a communication system to which the present invention is applied.

In the figure, the Internet 354 is connected to access points 351 and 352, servers 355 and 356, and a client PC 357, and various pieces of information can be transmitted and received among them.

The access point 351 is provided with a non-contact IC card 371, a Bluetooth module 372, and a reader/writer 373. When the user of the portable telephone 52 merely brings the portable telephone

PGR2023-00016 - Home Depot
Ex. 1003 - Page 650

52 close to the access point 351, the above-described processing for identifying a partner of communication is performed, and then, the user can access the Internet 354 through Bluetooth.

The access point 352 is provided with a reader/writer 381 and a wireless LAN access point 382. Therefore, when the user of a PDA 353 having a built-in non-contact IC card 391 and a wireless LAN client 392 merely brings the PDA 353 close to the access point 352, the above-described processing for identifying a partner of communication is performed, and then the user can access the Internet 354 through a wireless LAN.

For example, the user of the portable telephone 52 can easily and at any time obtain desired contents from the server 355, participate in a community developed on the server 356, or operate the client PC 357 located at a remote place just by bringing the portable telephone 52 close to any of the access points 351 installed all over the city.

When a unique address similar to a Bluetooth address is assigned to each device, the present invention can be applied to communication made by a wireless LAN (IEEE (Institute of Electrical and Electronics Engineers) 802.11b) performed between the access point 352 and the PDA 353 shown in FIG. 33, in addition to communication done by Bluetooth.

Specifically, when an IPv6 (Internet protocol version 6) of 128 bits, for example, set by a PDA 353 is reported to the reader/writer 381 of the access point 352, the user of the PDA 353 can access the Internet 354 through the wireless LAN merely by bringing the PDA 353 close to the access point 352.

The present invention can also be applied to communication performed, for example, by IrDA, HomeRF (SWAP), or Wireless1394, in addition to communication performed by Bluetooth.

Instead of the above-described communication method in which electric-power transmission and data transfer are performed by using a loop antenna such as that of a non-contact IC card, any

communication methods may be used in which an output is suppressed and a communication distance is made, in advance, shorter than that of the Bluetooth communication method.

As described above, in Bluetooth communication, when synchronization is established, and the partner of communication with which synchronization has been established is a terminal performing communication for the first time, it is usually required to input the same PIN code to both units. However, in a case in which the present invention is applied, and the partner of communication is identified, for example, according to identification information provided by communication which uses electromagnetic induction or the like to make Bluetooth communication ready, PIN-code input may be made unnecessary in advance. In this case, a predetermined PIN code is shared by both terminals, for example, by communication which uses electromagnetic induction.

In a case in which the partner of communication is identified, for example, according to identification information provided by communication which uses electromagnetic induction or the like to make Bluetooth communication ready, settings may be made in advance such that communication is performed according to a predetermined profile. In this case, both terminals share profiles which they themselves can provide by communication which uses electromagnetic induction, and predetermined profiles are selected from the profiles.

Instead of the memory stick 223, described above, any devices having a shape which can be inserted into the predetermined slot may be used. For example, devices conforming to an SD-card (registered trademark) standard and devices conforming to a CF-card (registered trademark) standard may be used instead of the memory stick 223.

In the above-described cases, the reader/writer 105 and the non-contact IC card 246 are individually configured. A device having the functions of both of these devices may be respectively provided to the personal computer 51 and the portable telephone 52. In addition, a device having the functions of both may be stored, for example, in the memory stick 223, described above, to extend the functions of the personal computer 51 and the portable telephone 52.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 652

A unit having a reader/writer (such as the personal computer 51, described above) may store information related to units which have performed Bluetooth communication in the past, as history information. With this, when the Bluetooth address of a nearby unit is reported by communication which uses electromagnetic induction, the nearby unit can be identified by referring to the history information.

For example, the Bluetooth address or Bluetooth device name of a unit, or the category of the unit, described by referring to FIG. 2, or profiles which can be provided by the unit, are stored as history information.

The above-described series of processes can be implemented not only by hardware but also by software.

When a series of processes is executed by software, a program constituting the software is installed from a network or recording media onto a computer incorporating special hardware, or onto a unit which can execute various functions by installing various programs, such as a general-purpose personal computer.

The recording media include not only packaged media storing the program and distributed separately from the apparatus to provide the program to users, such as a magnetic disk 101 (including a floppy disk), an optical disk 102 (including a CD-ROM (compact disk read-only memory) or DVD (digital versatile disk)), a magneto-optical disk 103 (including an MD (registered trademark (Mini-disk)), or semiconductor memory 104, as shown in FIG. 11, but also units incorporated in advance into the apparatus and provided to users, such as an HDD 114 or ROM 118 which have the program recorded.

In the present specification, steps describing the program recorded in a recording medium include not only processing executed in a time-sequential manner in the described order, but also processing which is not necessarily executed in a time-sequential manner but is processed in parallel or separately.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 653

In the present specification, system refers to the entire apparatus formed of a plurality of apparatuses.

INDUSTRIAL APPLICABILITY

As described above, according to a communication system and a communication method of the present invention, the identification information of a nearby communication terminal is acquired by using a first wireless communication block for transmitting electric power and for transmitting and receiving data vis-à-vis a communication terminal by a loop antenna, the attribute information of each of a plurality of communication terminals, which include the communication terminal, is acquired from the plurality of communication terminals by using a second wireless communication block for transmitting and receiving data, and a partner of communication is identified by using the identification information and the attribute information. Then, synchronization is established for wireless communication performed by using the identified communication terminal and the second wireless communication block. The identification information of the communication terminal is provided to an information processing apparatus by using a third wireless communication block for transmitting and receiving data and using at least part of induced electric power obtained through a loop antenna, the attribute information of the communication terminal is provided by using a fourth wireless communication block for transmitting and receiving data, in response to a request sent from the information processing apparatus through the second wireless communication block, and synchronization is established by transmitting and receiving a predetermined signal through the fourth communication block, in response to a request sent from the information processing apparatus when synchronization is established for wireless communication performed by the second wireless communication block. Therefore, a terminal serving as a partner of communication can be identified, and communication can be started more easily and quickly.

According to a first information processing apparatus, an information processing method, and a program of the present invention, identification information is acquired from a communication terminal by using a first wireless communication block for transmitting and receiving predetermined data, the attribute information of each of a plurality of communication terminals, which include the communication terminal, is acquired from the plurality of communication terminals by using a second wireless communication block for transmitting and receiving desired data, and a partner of communication is identified by using the acquired identification information and the attribute information. Synchronization is also established for wireless communication performed by using the identified communication terminal and the second wireless communication block. Therefore, a terminal can be identified as a partner of communication, and communication can be started more easily and quickly.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 654

According to a communication terminal, a communication method, and a program of the present invention, a communication terminal provides its own identification information by using a first wireless communication block for transmitting and receiving predetermined data, in response to a predetermined request sent from an information processing apparatus, and provides its own attribute information by using a second wireless communication block for transmitting and receiving data, in response to a predetermined request sent from the information processing apparatus. Synchronization is also established by transmitting and receiving a predetermined signal through the second wireless communication block, in response to a request sent from the information processing apparatus when synchronization is established for wireless communication performed by using the second wireless communication block. Therefore, communication can be started more easily and quickly.

According to a first extension apparatus of the present invention, identification information is acquired from a communication terminal by using a first wireless communication block electrically connected to an information processing apparatus, and for transmitting and receiving predetermined data, and attribute information for each of a plurality of communication terminals is acquired from the plurality of communication terminals by using a second wireless communication block for transmitting and receiving desired data. A partner of communication is identified by using the acquired identification information and the attribute information acquired from the plurality of communication terminals, and synchronization is established for wireless communication performed by using the identified communication terminal and the second wireless communication block. Therefore, even when first and second wireless communication blocks are not provided to the information processing apparatus, the functions thereof can be added by the first extension apparatus, and communication can be started more easily and quickly.

According to a second extension apparatus of the present invention, a communication terminal provides its own identification information by using a connection terminal electrically connected to a communication terminal for transmitting and receiving data, and a first wireless communication block for transmitting and receiving predetermined data, in response to a request sent from an information processing apparatus, and provides its own attribute information by using a second wireless communication block for transmitting and receiving data, in response to a request sent from the information processing apparatus. Then, synchronization is established by transmitting and receiving a predetermined signal through the second wireless communication block, in response to a request sent from the information processing apparatus when synchronization is established for wireless communication performed by the second wireless communication block. Therefore, even when first

PGR2023-00016 - Home Depot
Ex. 1003 - Page 655

and second wireless communication blocks are not provided to the information processing apparatus, the functions thereof can be added by the second extension apparatus, and communication can be started more easily and quickly.

According to a second information processing apparatus of the present invention, identification information is acquired from a communication terminal by using a first wireless communication block for transmitting and receiving predetermined data, information related to a plurality of communication terminals with which communication has been performed, by using a second wireless communication block for transmitting and receiving desired data, is stored as history information, and a partner of communication is identified by using the acquired identification information and history information. Synchronization is also established for wireless communication performed by using the identified communication terminal and the second wireless communication block. Therefore, communication performed by using the second wireless communication block can be easily started without obtaining information related to communication units with which communication has been performed in the past.

Claims

1. A communication system in a ubiquitous network, comprising an information processing apparatus and a plurality of communication terminals, characterized in that

the information processing apparatus is provided with:

a first acquisition means for acquiring distinguishing information for a communication terminal, by use of a first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna;

a second acquisition means for acquiring attribute information for each of a plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for transmitting and receiving data;

an identification means for identifying a communication partner by using the distinguishing information obtained from the first acquisition means and the attribute information obtained from the second acquisition means; and,

a first synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit;

and the communication terminals are provided with:

a first providing means for providing one's own distinguishing information to the information processing apparatus, by use of at least some of the induced electric power obtained via a loop antenna and a third wireless communication unit for transmitting and receiving data;

a second providing means for providing one's own attribute information, by use of a fourth wireless communication unit for transmitting and receiving data, in response to a request from the information processing apparatus sent via the second wireless communication unit; and,

a second synchronization-establishment means for transmitting and receiving predetermined signals and establishing synchronization via the fourth wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

2. A communication method for a communication system in a ubiquitous network, comprising an information processing apparatus and a plurality of communication terminals, characterized in that

the information processing method for the information processing apparatus is provided with:

a first acquisition step of acquiring distinguishing information for a communication terminal, by use of a first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna;

a second acquisition step of acquiring attribute information for each of the plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of the second wireless communication unit for transmitting and receiving data;

an identification step for identifying a communication partner by using the distinguishing information obtained from the first acquisition step and the attribute information obtained from the second acquisition step; and,

a first synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit;

and the information processing method for the communication terminals is provided with:

a first providing step of providing one's own distinguishing information to the information processing apparatus, by use of at least some of the induced electric power obtained via a loop antenna and a third wireless communication unit for transmitting and receiving data;

a second providing step of providing one's own attribute information by use of a fourth wireless communication unit for transmitting and receiving data, in response to a request from the information processing apparatus sent via the second wireless communication unit; and,

a second synchronization-establishment step for transmitting and receiving predetermined signals and establishing synchronization via the fourth communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

3. An information processing apparatus characterized in being provided with:

a first acquisition means for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition means for acquiring attribute information from each of a plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification means for identifying a communication partner by using the distinguishing information obtained by the first acquisition means and the attribute information obtained by the second acquisition means; and,

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and second wireless communication unit.

4. The information processing apparatus of claim 3, characterized in that the distance over which the first wireless communication unit is capable of communicating wirelessly is shorter than the distance over which the second wireless communication unit is capable of communicating wirelessly.

5. The information processing apparatus of claim 3, characterized in that the first acquisition means acquires the distinguishing information for the communication terminal by use of the first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna.

6. The information processing apparatus of claim 3, characterized in that the attribute information includes address information that makes it possible to distinguish each of the plurality of communication terminals, and information about the clock that the communication terminal manages.

7. The information processing apparatus of claim 3, characterized in being further provided with an initiation means for initiating the second wireless communication unit in response to the first acquisition means having obtained the distinguishing information.

8. The information processing apparatus of claim 3, characterized in that

the distinguishing information includes at least a Bluetooth address for the communication terminal;

by way of the second acquisition means, the plurality of communication terminals each acquire a plurality of responding FHS packets in response to IQ packets sent by use of the second wireless communication unit; and,

by way of the synchronization-establishment means, [the information process apparatus] sends ID packets. by use of the second wireless communication unit, to the communication terminal identified

by the identification means, and when there is a response from the communication terminal to an ID packet that was sent, [the information process apparatus] further sends its own FHS packet.

9. An information processing method characterized by being provided with

a first acquisition step of acquiring distinguishing information from a communication terminal by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition step of acquiring attribute information for each of the plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification step for identifying a communication partner using the distinguishing information obtained by the first acquisition step and the attribute information obtained by the second acquisition step; and

a synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit.

10. The information processing method of claim 9 characterized in that the distance over which the first wireless communication unit is capable of communicating wirelessly is shorter than the distance over which the second wireless communication unit is capable of communicating wirelessly.

11. The information processing method of claim 9 characterized in that the first acquisition step acquires the distinguishing information for the communication terminal by use of the first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, a nearby communication terminal by means of a loop antenna.

12. The information processing method of claim 9 characterized in that the attribute information includes address information that makes it possible to distinguish each of the plurality of communication terminals, and information about the clock that the communication terminal manages.

13. The information processing method of claim 9 characterized in that

in the second acquisition step, the plurality of communication terminals each acquire a plurality of responding FHS packets in response to IQ packets sent by use of the second wireless communication unit; and

PGR2023-00016 - Home Depot
Ex. 1003 - Page 660

in the synchronization-establishment step, ID packets are sent, by use of the second wireless communication unit, to the communication terminal identified in the identification step, and when there is a response from the communication terminal to the ID packet that was sent, [the information process apparatus] further sends its own FHS packet.

14. A communication terminal characterized by being provided with

a first providing means for providing one's own distinguishing information in response to a predetermined request from an information processing apparatus, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second providing means for providing one's own attribute information in response to a predetermined request from the information processing apparatus, by use of a second wireless communication unit for transmitting and receiving data; and

a synchronization-establishment means for transmitting and receiving predetermined signals and establishing synchronization via the second wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

15. The communication terminal of claim 14 characterized in that the distance over which the first wireless communication unit is capable of communicating wirelessly is shorter than the distance over which the second wireless communication unit is capable of communicating wirelessly.

16. The communication terminal of claim 14 characterized in that the first providing means provides one's own distinguishing information in response to a predetermined request from the information processing apparatus, by use of a first wireless communication unit that uses at least some of the induced electric power obtained via a loop antenna.

17. The communication terminal of claim 14 characterized in that the attribute information includes at least address information that can distinguish one's own terminal.

18. The communication terminal of claim 17 characterized in that the distinguishing information includes at least the address information and information for the clock managed by the communication terminal.

19. The communication terminal of claim 14 characterized in being further provided with an initiation means for initiating the second wireless communication unit in response to the first providing means providing the

distinguishing information.

20. The communication terminal of claim 14 characterized in that

the distinguishing information includes at least Bluetooth address information;

by way of the second providing means an FHS packet is returned in response to an IQ packet received using the second wireless communication unit; and,

by way of the synchronization-establishment means, in response to an ID packet received using the second wireless communication unit the ID packet is returned, and when an FHS packet is then received the ID packet is sent again.

21. A communication method characterized by being provided with

a first providing step for providing one's own distinguishing information in response to a predetermined request from an information processing apparatus by use of a first wireless communication unit for transmitting and receiving predetermined data ;

a second providing step for providing one's own attribute information in response to a predetermined request from the information processing apparatus by use of a second wireless communication unit for transmitting and receiving data;

a synchronization-establishment step for transmitting and receiving predetermined signals and establishing synchronization via a second wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using a second wireless communication unit.

22. The communication method of claim 21 characterized in that in the first providing step [the communication terminal] provides its own distinguishing information in response to a predetermined request from an information processing apparatus by use of a first wireless communication unit for transmitting and receiving data that uses at least some of the induced electric power obtained via a loop antenna.

23. The communication method of claim 21 characterized in that the distinguishing information includes at least address information distinguishing one's own terminal.

24. The communication method of claim 23 characterized in that the attribute information includes the address information and information about the clock that the communication terminal manages.

25. The communication method of claim 21 characterized in being further provided with an initiation step for initiating the second wireless communication unit in response to the first providing step providing the

distinguishing information.

26. The communication method of claim 21 characterized in that

the distinguishing information includes at least Bluetooth address information;

by way of the second providing step an FHS packet is returned in response to an IQ packet received using the second wireless communication unit; and,

by way of the synchronization-establishment step, in response to an ID packet received by use of the second wireless communication unit the ID packet is returned, and when an FHS packet is then received, the ID packet is sent again.

27. An extension device characterized by being provided with

a connecting terminal for the purpose of receiving data, electrically connected to the information processing apparatus;

a first acquisition means for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition means for acquiring attribute information from each of a plurality of a communication terminals, by use of a second wireless communication unit for transmitting and receiving desired data; and

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit.

28. An extension device capable of being installed in a communication terminal, characterized by being provided with

a connecting terminal for the purpose of receiving data, electrically connected to the communication terminal;

a first providing means for providing one's own distinguishing information, in response to a request from an information processing apparatus, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second providing means for providing one's own attribute information in response to a requestion from the information processing apparatus, by use of a second wireless communication unit for transmitting and receiving data; and

a synchronization-establishment means for transmitting and receiving predetermined signals and establishing synchronization via the second wireless communication unit in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

29. A program that causes the information processing apparatus to execute

a first acquisition step for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition step for acquiring attribute information for each of the plurality of wireless terminals from the plurality of wireless terminals, including the wireless terminal, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification step for identifying a communication partner by using the distinguishing information obtained from the first acquisition step and the attribute information obtained from the second acquisition step; and,

a synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit.

30. A program that causes a communication terminal to execute

a first providing step for providing one's own distinguishing information in response to a predetermined request from an information processing apparatus, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second providing step for providing one's own attribute information in response to a predetermined request from the information processing apparatus, by use of a second wireless communication unit for transmitting and receiving data; and,

a synchronization-establishment step for transmitting and receiving predetermined signals and establishing synchronization via the second wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

31. An information processing apparatus characterized by being provided with

a first acquisition means for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a recording means for recording, as history information, information pertaining to a plurality of communication terminals with which communication has been performed by use of the second wireless communication unit for transmitting and receiving desired data;

an identification means for identifying a communication partner by using the distinguishing information obtained by the first acquisitions means and the history information; and,

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit.

32. The information processing apparatus of claim 31 characterized in that

the history information includes at least Bluetooth address information; and

by way of the synchronization-establishment means, the information processing apparatus sends ID packets generated on the basis of the Bluetooth address information to the communication terminal identified by the identification means, by use of the second wireless communication unit, and when there is a response from the communication terminal to an ID packet that was sent, [the information process apparatus] further sends its own FHS packet.

Amended Claims

[November 7, 2002 (11/07/02), International Bureau, Receiving Office: Claims 1, 2, 3, 9, 27, 29, 30, and 31 of the application have been amended; new claims 33 and 34 have been added; the remaining claims are unaltered (7 pages)]

1. (Amended) A communication system in a ubiquitous network, comprising an information processing apparatus and a plurality of communication terminals, characterized in that

the information processing apparatus is provided with:

a first acquisition means for acquiring distinguishing information for a communication partner, by use of a first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna;

a second acquisition means for acquiring attribute information for each of a plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for transmitting and receiving data;

an identification means for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a first synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit;

and the communication terminals are provided with:

a first providing means for providing one's own distinguishing information to the information processing apparatus, by use of at least some of the induced electric power obtained via a loop antenna and a third wireless communication unit for transmitting and receiving data;

a second providing means for providing one's own attribute information, by use of a fourth wireless communication unit for transmitting and receiving data, in response to a request from the information processing apparatus sent via the second wireless communication unit; and,

a second synchronization-establishment means for transmitting and receiving predetermined signals and establishing synchronization via the fourth wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

2. (Amended) A communication method for a communication system in a ubiquitous network, comprising

an information processing apparatus and a plurality of communication terminals, characterized in that

the information processing method for the information processing apparatus is provided with:

a first acquisition step of acquiring distinguishing information for a communication terminal, by use of a first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna;

a second acquisition step of acquiring attribute information for each of the plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of the second wireless communication unit for transmitting and receiving data;

an identification step for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition step; and,

a first synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit;

and the information processing method for the communication terminals is provided with:

a first providing step of providing one's own distinguishing information to the information processing apparatus, using a third wireless communication unit for transmitting and receiving data that uses at least some induced electric power obtained via a loop antenna;

a second providing step of providing one's own attribute information, by use of a fourth wireless communication unit for transmitting and receiving data, in response to a request from the information processing apparatus sent via the second wireless communication unit; and,

a second synchronization-establishment step for transmitting and receiving predetermined signals and establishing synchronization via the fourth communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

3. (Amended) An information processing apparatus characterized by being provided with:

a first acquisition means for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition means for acquiring attribute information from each of a plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for

transmitting and receiving desired data;

an identification means for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and second wireless communication unit.

4. The information processing apparatus of claim 3, characterized in that the distance over which the first wireless communication unit is capable of communicating wirelessly is shorter than the distance over which the second wireless communication unit is capable of communicating wirelessly.

5. The information processing apparatus of claim 3, characterized in that the first acquisition means acquires the distinguishing information for the communication terminal by use of the first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, the nearby communication terminal by means of a loop antenna.

6. The information processing apparatus of claim 3, characterized in that the attribute information includes address information that makes it possible to distinguish each of the plurality of communication terminals, and information about the clock that the communication terminal manages.

7. The information processing apparatus of claim 3, characterized in being further provided with an initiation means for initiating the second wireless communication unit in response to the first acquisition means having obtained the distinguishing information.

8. The information processing apparatus of claim 3, characterized in that

the distinguishing information includes at least a Bluetooth address for the communication terminal;

by way of the second acquisition means, the plurality of communication terminals each acquire a plurality of responding FHS packets in response to IQ packets sent by use of the second wireless communication unit; and,

by way of the synchronization-establishment means, [the information process apparatus] sends ID packets. by use of the second wireless communication unit, to the communication terminal identified

by the identification means, and when there is a response from the communication terminal to an ID packet that was sent, [the information process apparatus] further sends its own FHS packet.

9. (Amended) An information processing method characterized by being provided with

a first acquisition step of acquiring distinguishing information from a communication terminal by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition step of acquiring attribute information for each of the plurality of communication terminals from the plurality of communication terminals, including the communication terminal, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification step for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit.

10. The information processing method of claim 9 characterized in that the distance over which the first wireless communication unit is capable of communicating wirelessly is shorter than the distance over which the second wireless communication unit is capable of communicating wirelessly.

11. The information processing method of claim 9 characterized in that the first acquisition step acquires the distinguishing information for the communication terminal by use of the first wireless communication unit for transmitting power to, and transmitting and receiving data to and from, a nearby communication terminal by means of a loop antenna.

12. The information processing method of claim 9 characterized in that the attribute information includes address information that makes it possible to distinguish each of the plurality of communication terminals, and information about the clock that the communication terminal manages.

13. The information processing method of claim 9 characterized in that

in the second acquisition step, the plurality of communication terminals each acquire a plurality of responding FHS packets in response to IQ packets sent by use of the second wireless communication unit; and

in the synchronization-establishment step, ID packets are sent, by use of the second wireless communication unit, to the communication terminal identified in the identification step, and when there

is a response from the communication terminal to an ID packet that was sent, [the information process apparatus] further sends its own FHS packet.

26. The communication method of claim 21 characterized in that

the distinguishing information includes at least Bluetooth address information;

by way of the second providing step, an FHS packet is returned in response to an IQ packet received by use of the second wireless communication unit; and,

by way of the synchronization-establishment step, in response to an ID packet received by use of the second wireless communication unit the ID packet is returned, and when an FHS packet is then received the ID packet is sent again.

27. (Amended) An extension device characterized by being provided with

a connecting terminal for the purpose of receiving data, electrically connected to the information processing apparatus;

a first acquisition means for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition means for acquiring attribute information for each of a plurality of a communication terminals from the plurality of communication terminals, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification means for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit.

28. An extension device capable of being installed in a communication terminal, characterized by being provided with

a connecting terminal for the purpose of receiving data, electrically connected to the communication terminal;

a first providing means for providing one's own distinguishing information, in response to a request from an information processing apparatus, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second providing means for providing one's own attribute information in response to a requestion from an information processing apparatus, by use of a second wireless communication unit for transmitting and receiving data; and

a synchronization-establishment means for transmitting and receiving predetermined signals and establishing synchronization in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

29. (Amended) A program that causes the information processing apparatus to execute

a first acquisition step for acquiring distinguishing information from a communication terminal, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second acquisition step for acquiring attribute information for each of the plurality of wireless terminals from the plurality of wireless terminals, including the wireless terminal, by use of a second wireless communication unit for transmitting and receiving desired data;

an identification step for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a synchronization-establishment step for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification step and the second wireless communication unit.

30. (Amended) A program that causes a communication terminal to execute

a first providing step for providing one's own distinguishing information in response to a predetermined request from an information processing apparatus, by use of a first wireless communication unit for transmitting and receiving predetermined data;

a second providing step for providing one's own attribute information in response to a predetermined request from the information processing apparatus, by use of a second wireless communication unit for transmitting and receiving data; and,

a synchronization-establishment step for transmitting and receiving predetermined signals and establishing synchronization via the second wireless communication unit, in response to a request from the information processing apparatus when synchronization has been established for wireless communication using the second wireless communication unit.

31. (Amended) An information processing apparatus characterized by being provided with

a first acquisition means for acquiring distinguishing information from a communication terminal, by use

of a first wireless communication unit for transmitting and receiving predetermined data;

a recording means for recording, as history information, information pertaining to a plurality of communication terminals with which communication has been performed by use of the second wireless communication unit for transmitting and receiving desired data;

an identification means for retrieving the attribute information acquired by the second acquisition means and identifying, as a communication partner, a communication terminal having the distinguishing information obtained from the first acquisition means; and,

a synchronization-establishment means for establishing synchronization for the purpose of performing wireless communication using the communication terminal identified by the identification means and the second wireless communication unit.

32. The information processing apparatus of claim 31 characterized in that

the history information includes at least Bluetooth address information; and

by way of the synchronization-establishment means, the information processing apparatus sends ID packets generated on the basis of the Bluetooth address information, by use of the second wireless communication unit, to the communication terminal identified by the identification means, and when there is a response from the communication terminal to an ID packet that was sent, [the information processing apparatus] further sends its own FHS packet.

33. (Added) The information processing apparatus of claim 3 characterized in that

the first acquisition means operates when a communication terminal is detected nearby, based on a change in load for the first wireless communication unit.

34. (Added) The information processing apparatus of claim 9 characterized in that

a process based on the first acquisition step executes when a communication terminal is detected, based on a change in load for the first wireless communication unit.

Written Explanation Based on the Provisions of PCT Article 19

Claims 1-3, 9, 27, and 29 are based on Fig. 21 and wording in lines 16-22 on page 41 of the specification which describe step S105 of Fig. 21. The amendments clarify that attribute information obtained from communication using a second wireless communication unit is detected, and from among those communication terminals that have provided attribute information, a communication terminal having distinguishing information obtained using a first wireless communication unit is identified as a communication partner.

This particular configuration is not disclosed in any of the cited documents. For example, Patent Application No. 2001-156704 discloses listing terminals able to communicate and starting wireless communication with a communication terminal selected for connection, but the user is required to select a predetermined terminal from among the terminals listed (statements in paragraphs [0025], [0039], [0049], [0060], and [0070]).

The present invention has the effect of being able to start communication with a terminal merely by bring it into proximity, without the user selecting the terminal as a communication partner.

Note, the addition of claims 33 and 34 is based on statements on page 27 of the specification, lines 16-19.

FIG. 1

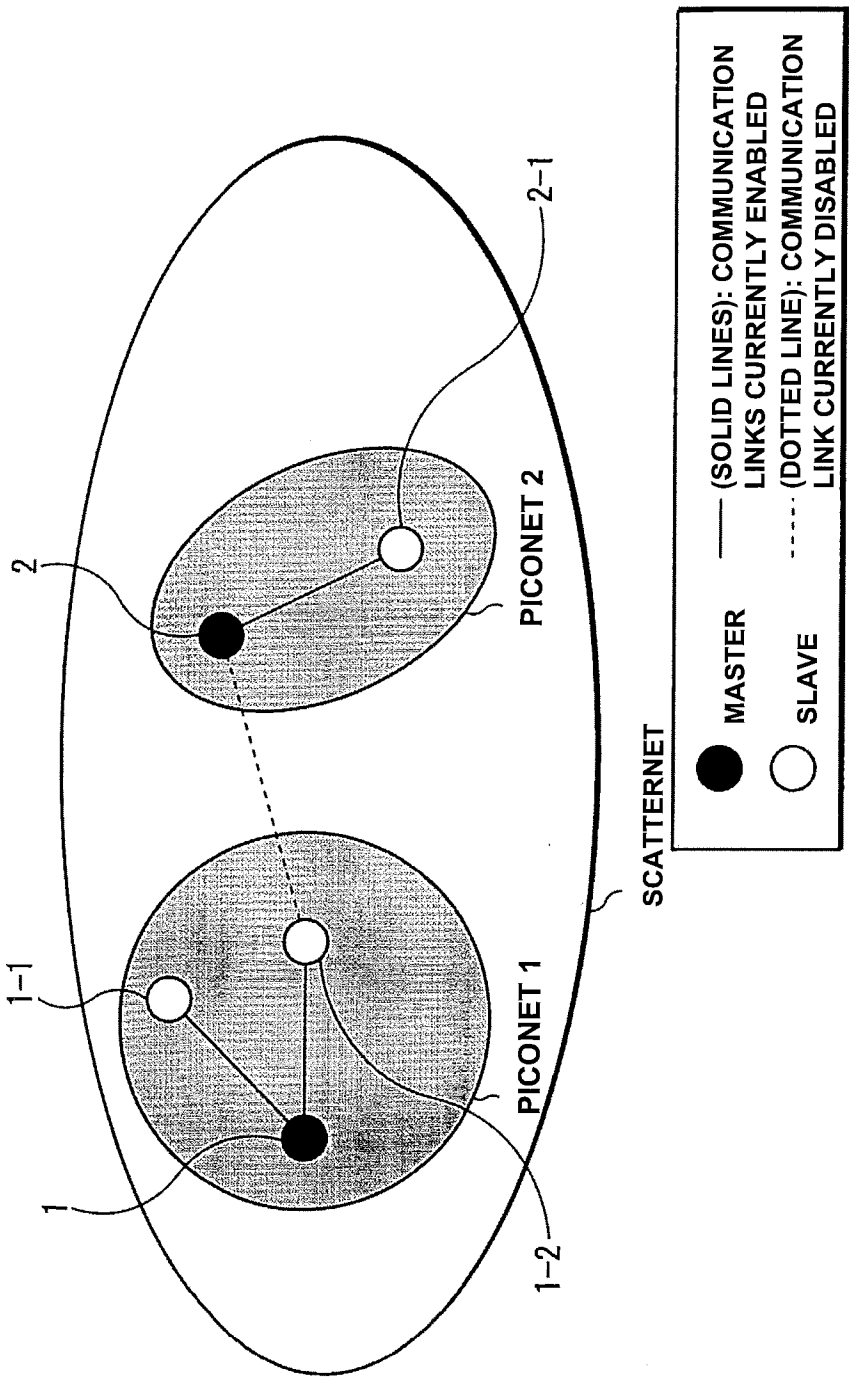

SCATTERNET
PICONET 1
PICONET 2
1
1–1
1–2
2
2–1
MASTER
SLAVE
(SOLID LINES): COMMUNICATION LINKS CURRENTLY ENABLED
(DOTTED LINE): COMMUNICATION LINK CURRENTLY DISABLED

FIG. 2

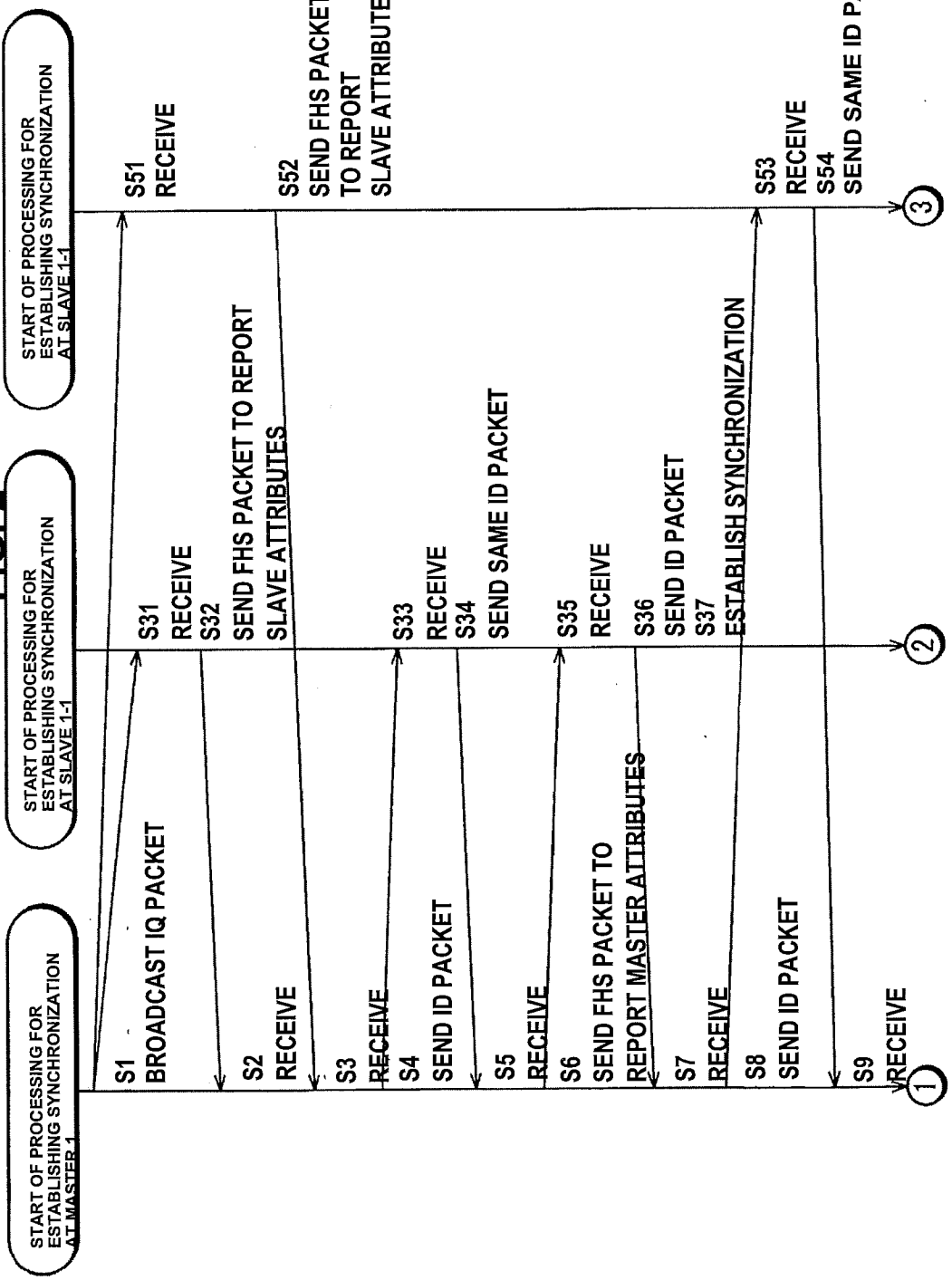

START OF PROCESSING FOR ESTABLISHING SYNCHRONIZATION AT MASTER 1
START OF PROCESSING FOR ESTABLISHING SYNCHRONIZATION AT SLAVE 1-1
START OF PROCESSING FOR ESTABLISHING SYNCHRONIZATION AT SLAVE 1-1
S1 BROADCAST IQ PACKET
S31 RECEIVE
S51 RECEIVE
S2 RECEIVE
S32 SEND FHS PACKET TO REPORT SLAVE ATTRIBUTES
S52 SEND FHS PACKET TO REPORT SLAVE ATTRIBUTES
S3 RECEIVE
S33 RECEIVE
S4 SEND ID PACKET
S34 SEND SAME ID PACKET
S5 RECEIVE
S35 RECEIVE
S6 SEND FHS PACKET TO REPORT MASTER ATTRIBUTES
S36 SEND ID PACKET
S7 RECEIVE
S37 ESTABLISH SYNCHRONIZATION
S53 RECEIVE
S8 SEND ID PACKET
S54 SEND SAME ID PACKET
S9 RECEIVE
1
2
3

FIG. 3

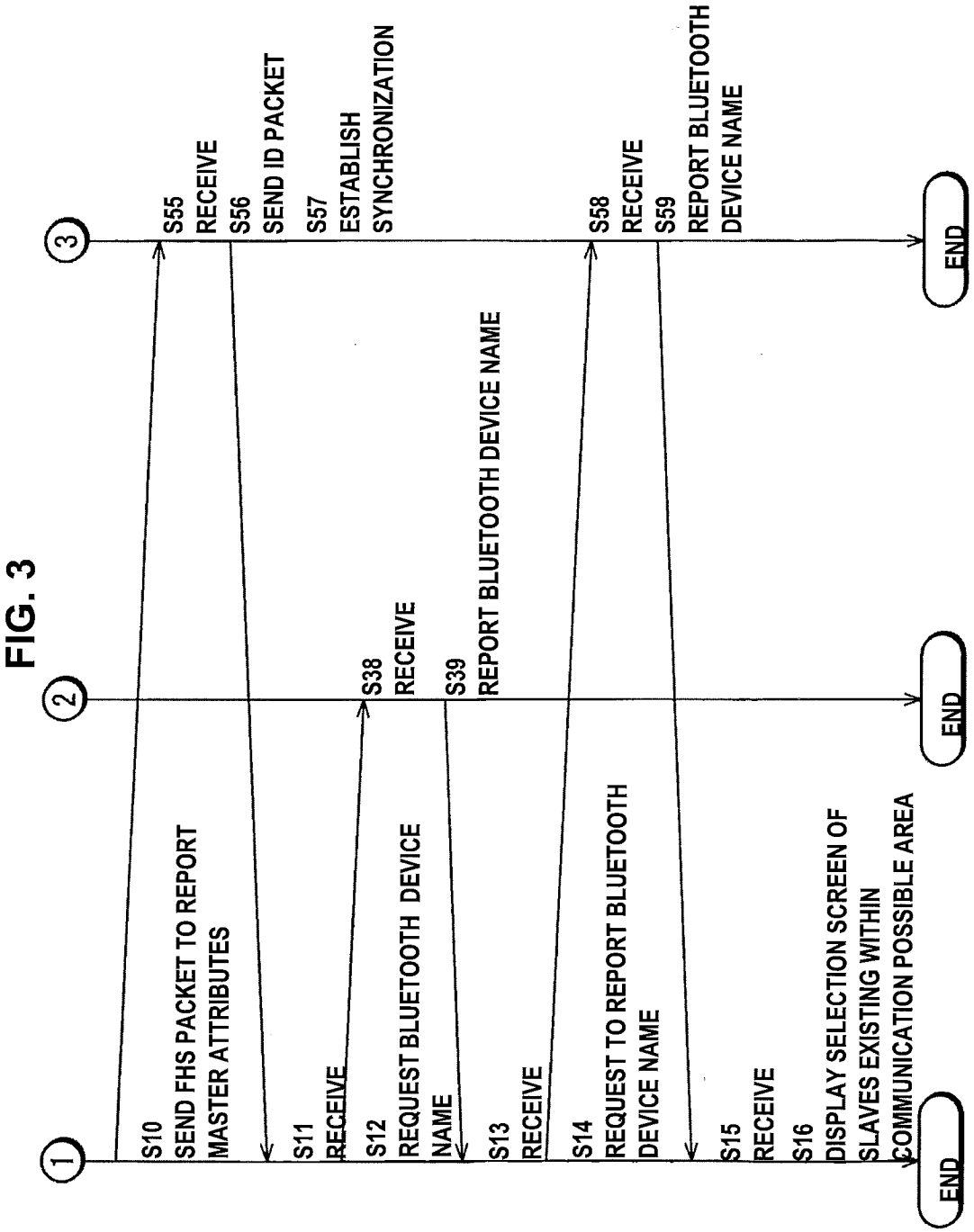

1
2
3
S10
SEND FHS PACKET TO REPORT MASTER ATTRIBUTES
S11
RECEIVE
S12
REQUEST BLUETOOTH DEVICE NAME
S13
RECEIVE
S14
REQUEST TO REPORT BLUETOOTH DEVICE NAME
S15
RECEIVE
S16
DISPLAY SELECTION SCREEN OF SLAVES EXISTING WITHIN COMMUNICATION POSSIBLE AREA
END
S38
RECEIVE
S39
REPORT BLUETOOTH DEVICE NAME
END
S55
RECEIVE
S56
SEND ID PACKET
S57
ESTABLISH SYNCHRONIZATION
S58
RECEIVE
S59
REPORT BLUETOOTH DEVICE NAME
END

FIG. 4

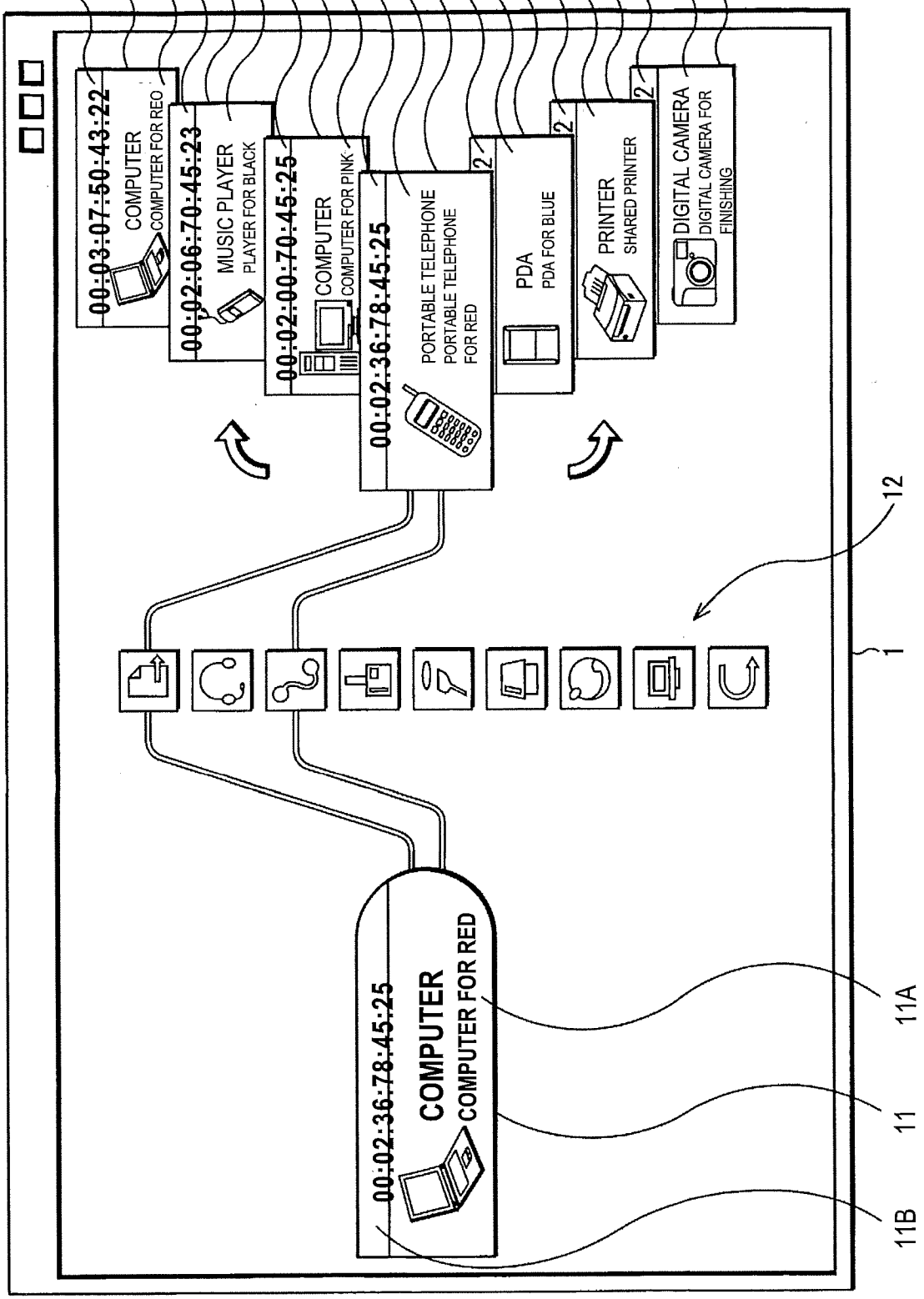

13A
13
13B
14A
14
14B
15A
15
15B
16A
16B
16
17A
17B
17
18A
18B
18
19A
19B
19
00:03:07:50:43:22
COMPUTER
COMPUTER FOR REO
00:02:06:70:45:23
MUSIC PLAYER
PLAYER FOR BLACK
00:02:00:70:45:25
COMPUTER
COMPUTER FOR PINK
00:02:36:78:45:25
PORTABLE TELEPHONE
PORTABLE TELEPHONE FOR RED
PDA
PDA FOR BLUE
PRINTER
SHARED PRINTER
DIGITAL CAMERA
DIGITAL CAMERA FOR FINISHING
12
1
00:02:36:78:45:25
COMPUTER
COMPUTER FOR RED
11A
11
11B

FIG. 5

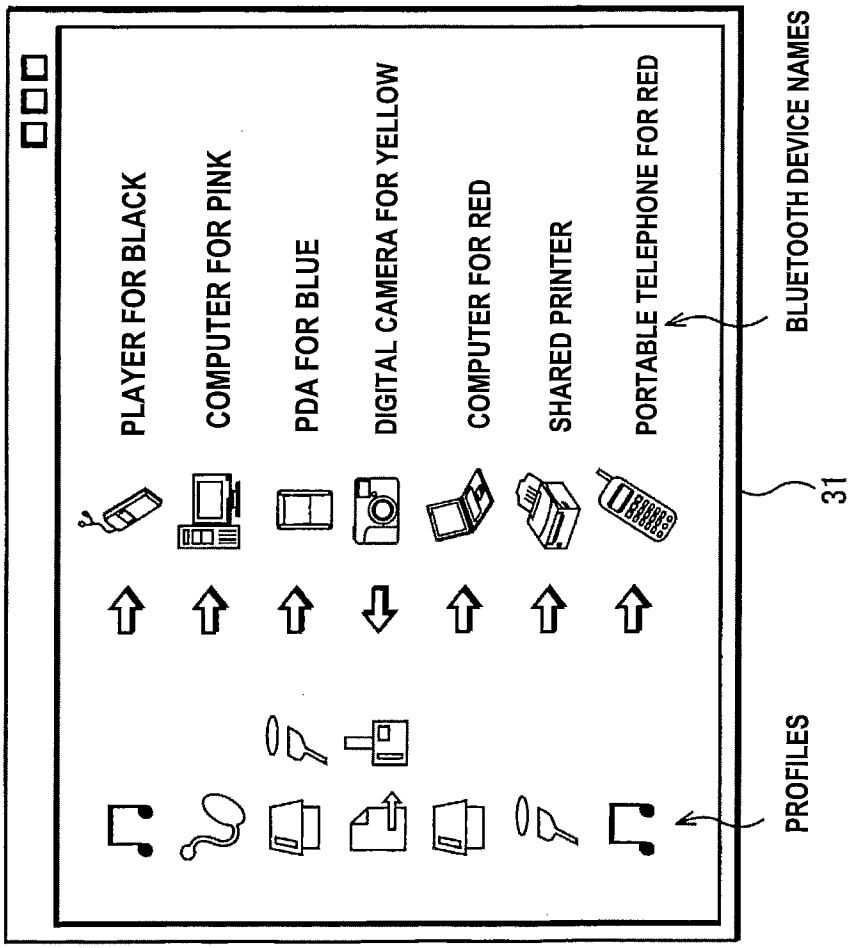

PLAYER FOR BLACK
COMPUTER FOR PINK
PDA FOR BLUE
DIGITAL CAMERA FOR YELLOW
COMPUTER FOR RED
SHARED PRINTER
PORTABLE TELEPHONE FOR RED
BLUETOOTH DEVICE NAMES
PROFILES
31

FIG. 6

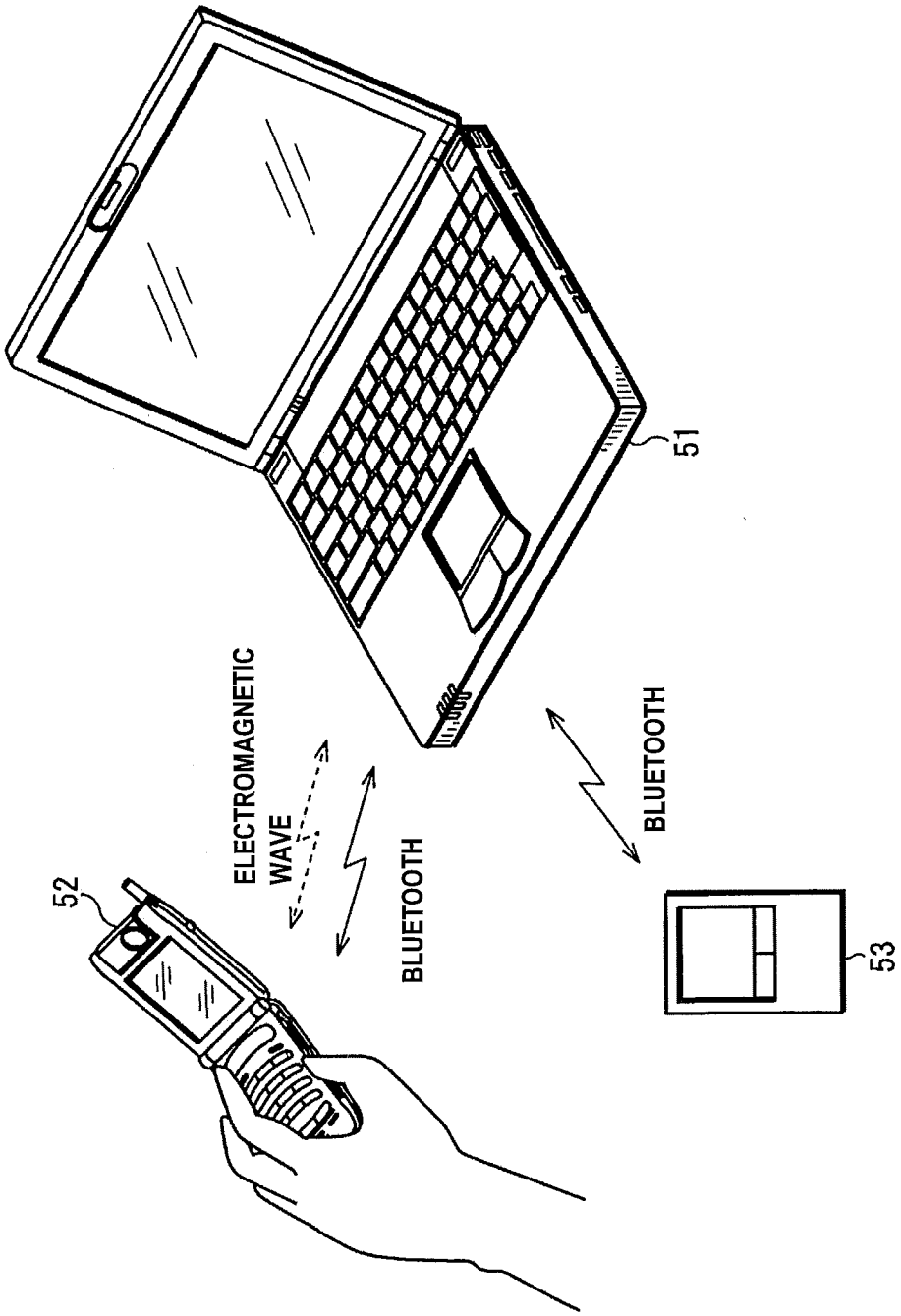
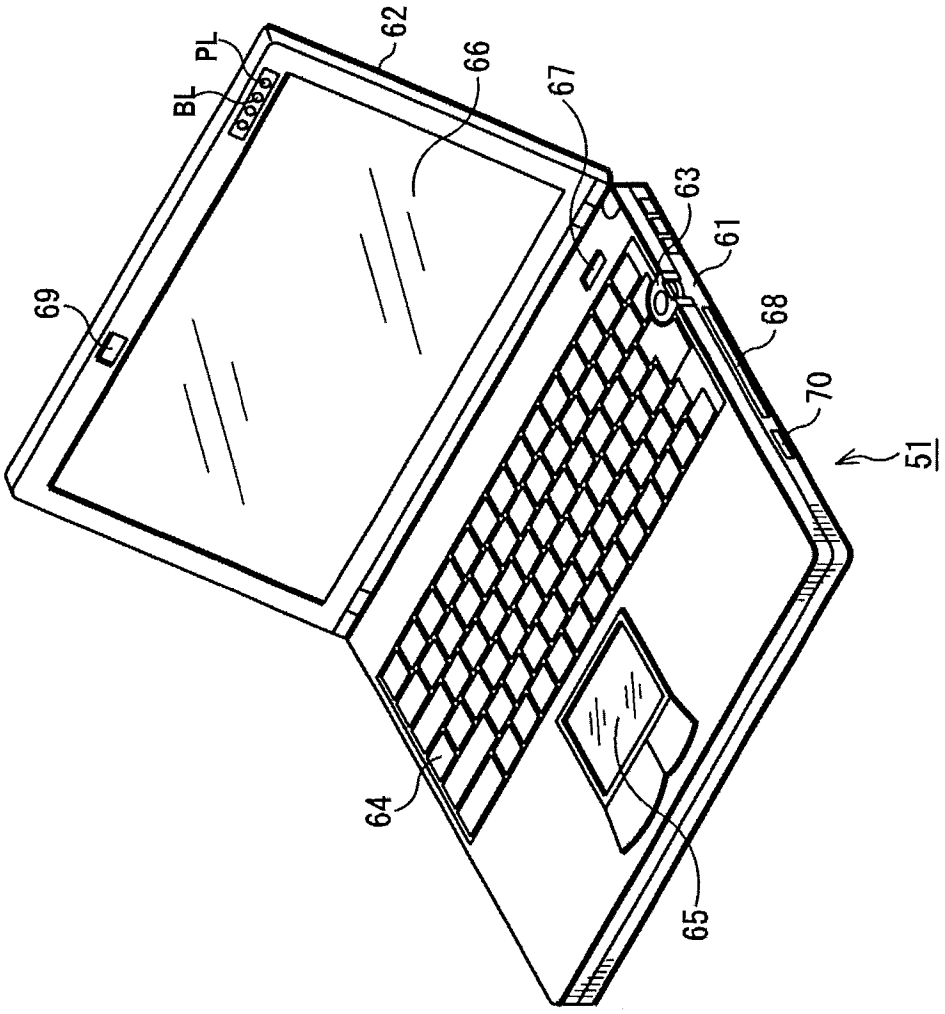


FIG. 7



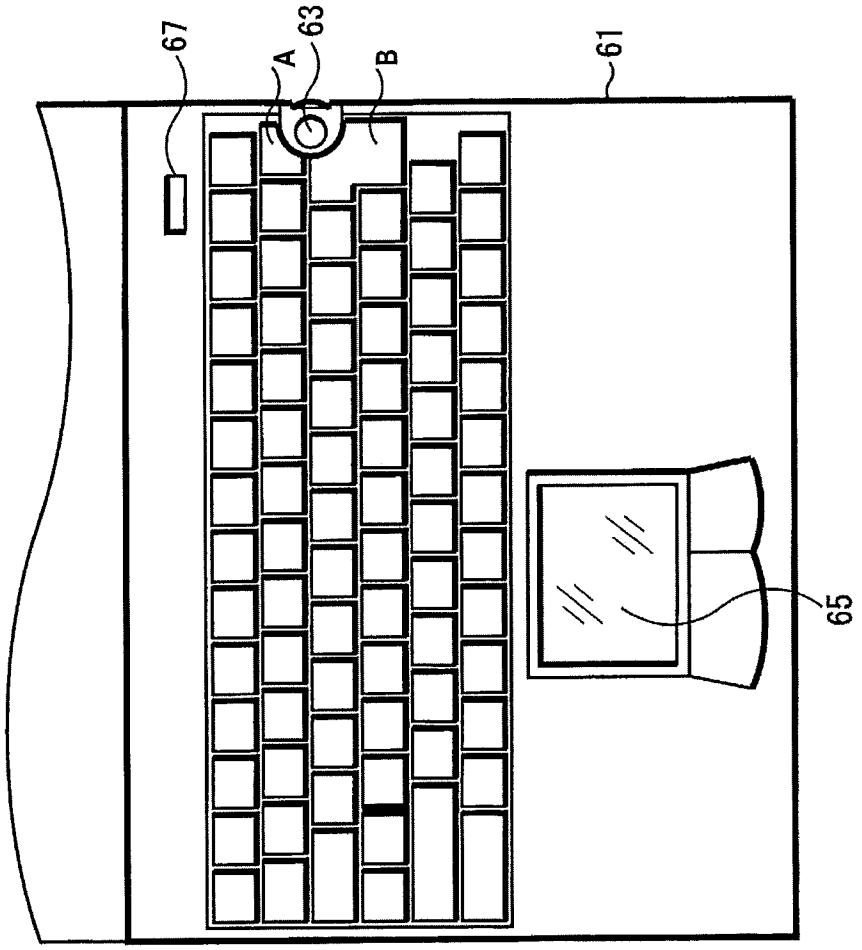
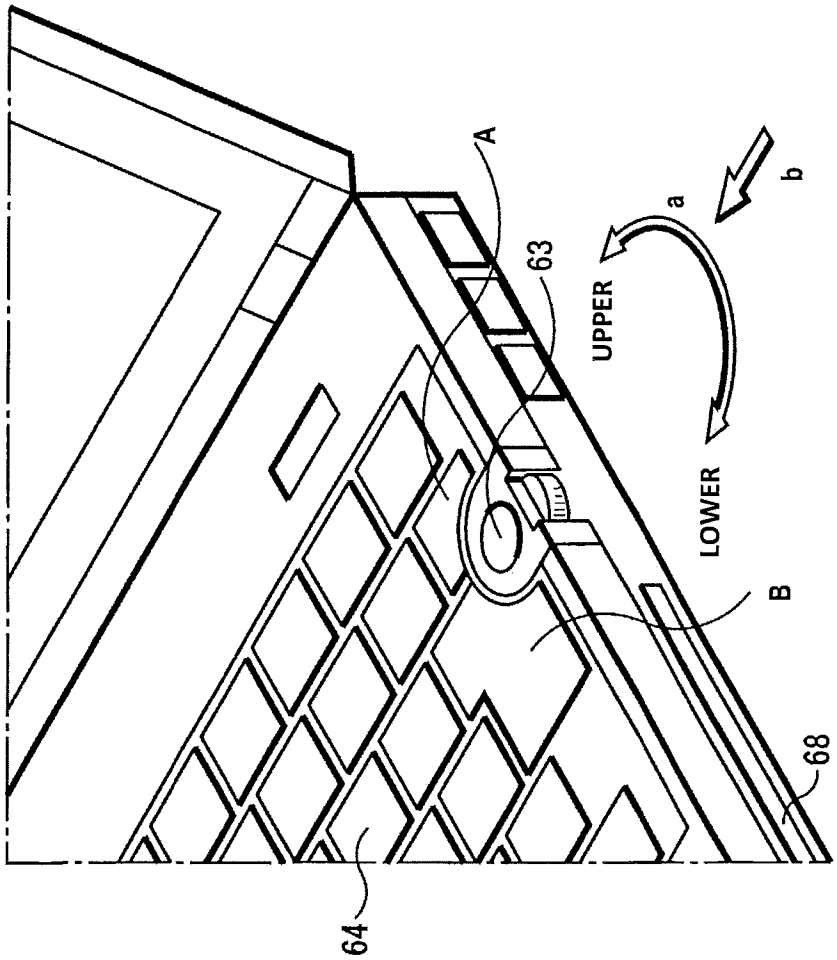


FIG. 8

FIG. 9



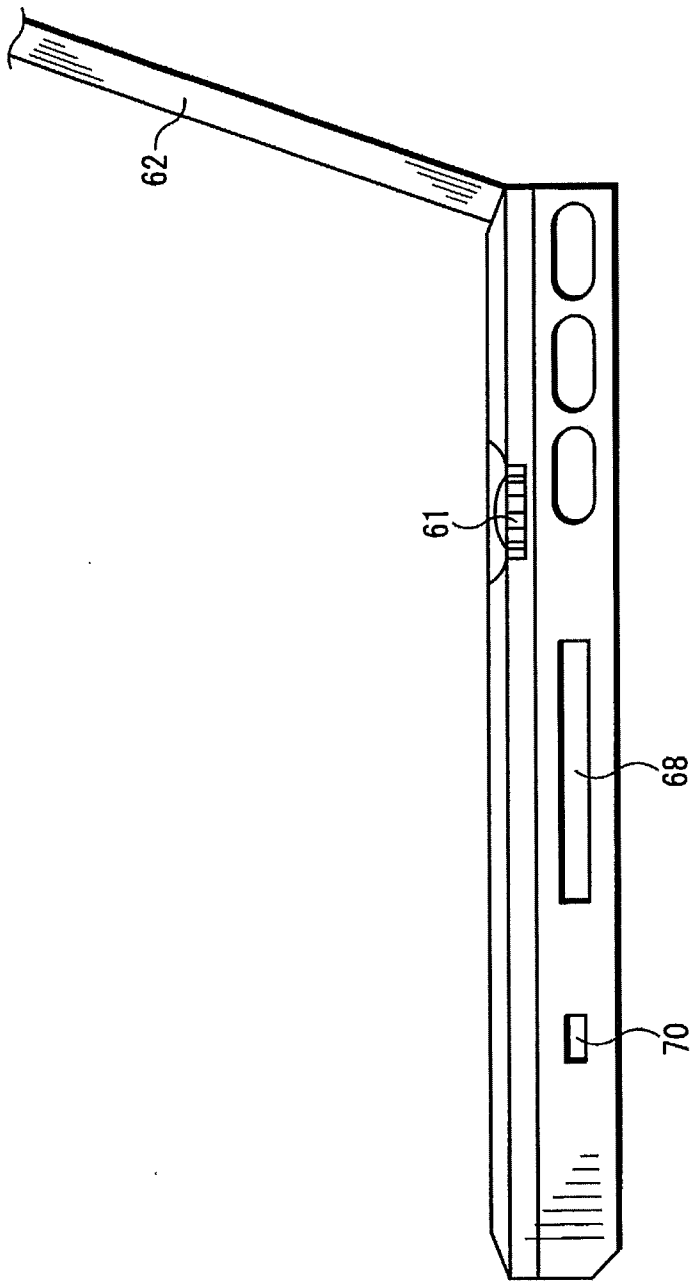
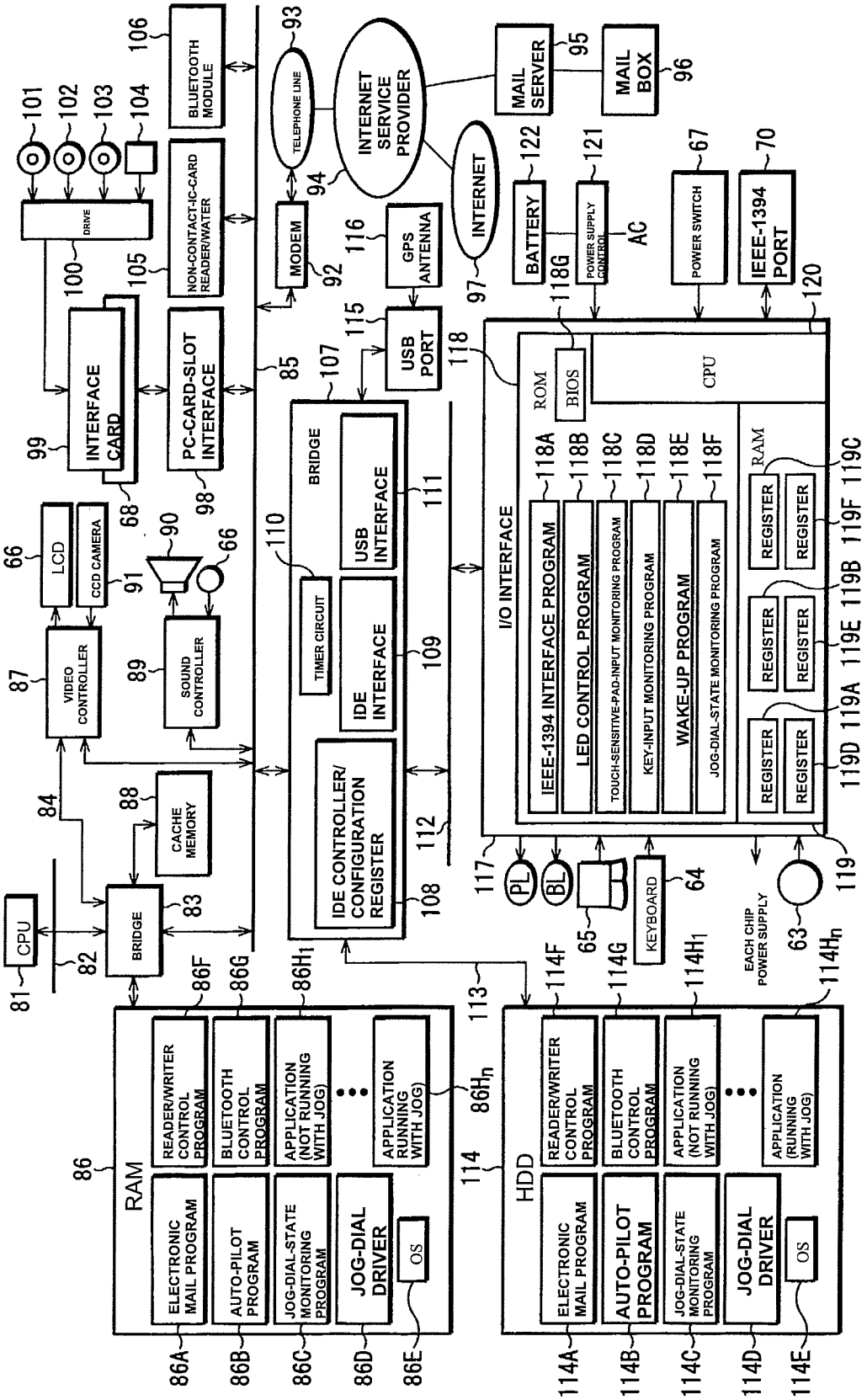


FIG. 10

FIG. 11



PGR2023-00016 - Home Depot
Ex. 1003 - Page 684

FIG. 12

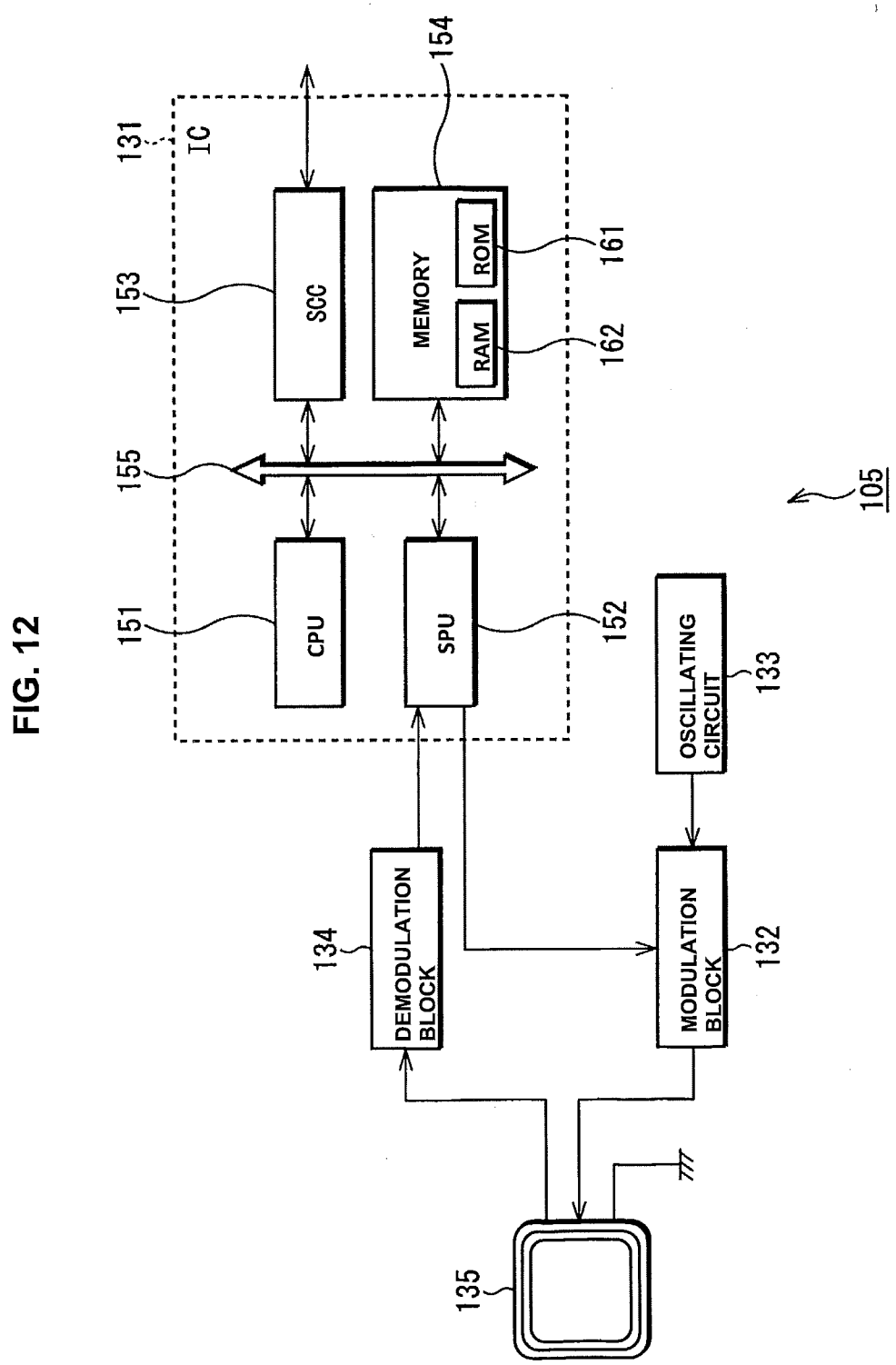
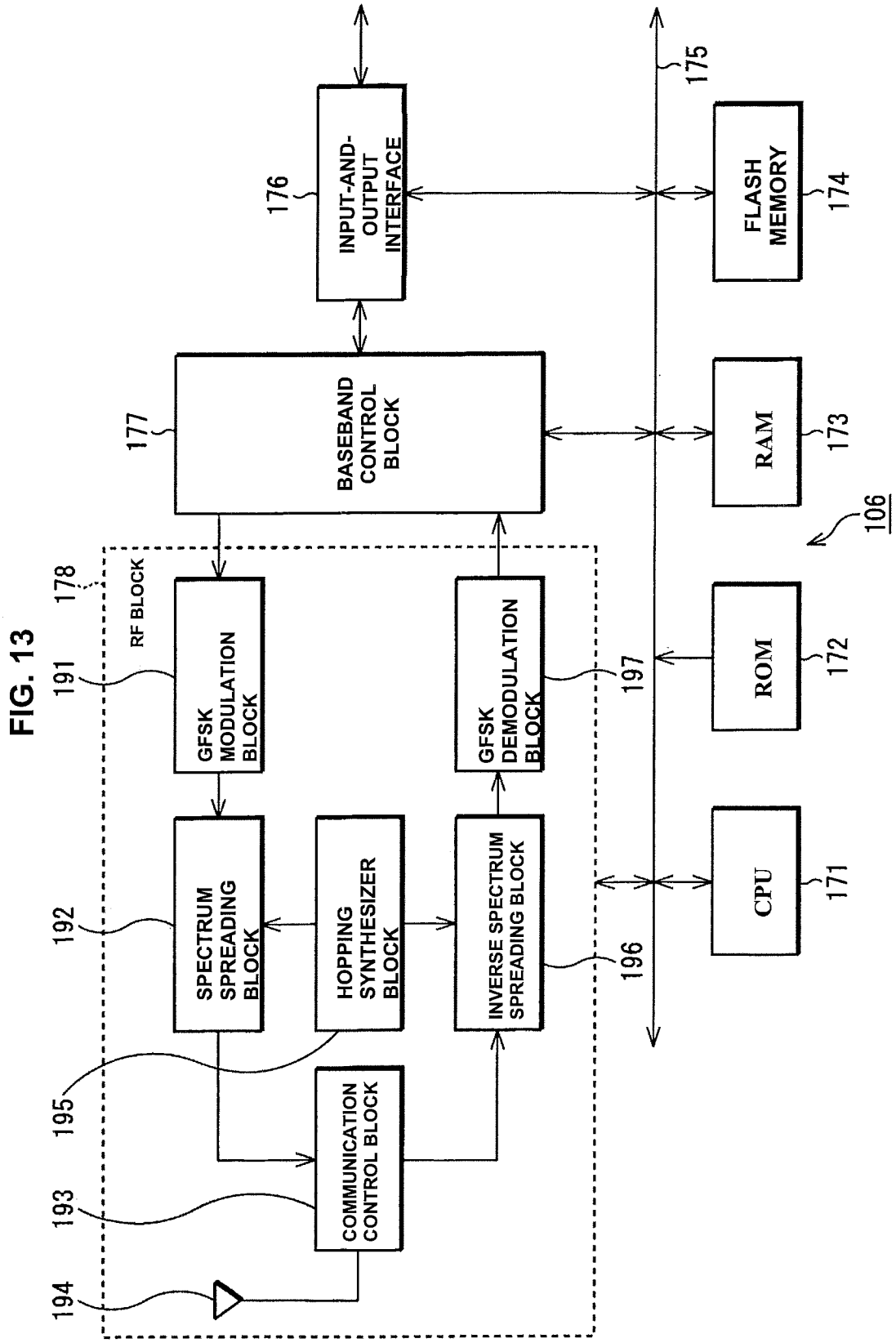

105
131
IC
154
153
SCC
MEMORY
ROM
161
RAM
162
155
151
CPU
SPU
152
OSCILLATING CIRCUIT
133
134
DEMODULATION BLOCK
MODULATION BLOCK
132
135

FIG. 13



PGR2023-00016 - Home Depot
Ex. 1003 - Page 686

FIG. 14

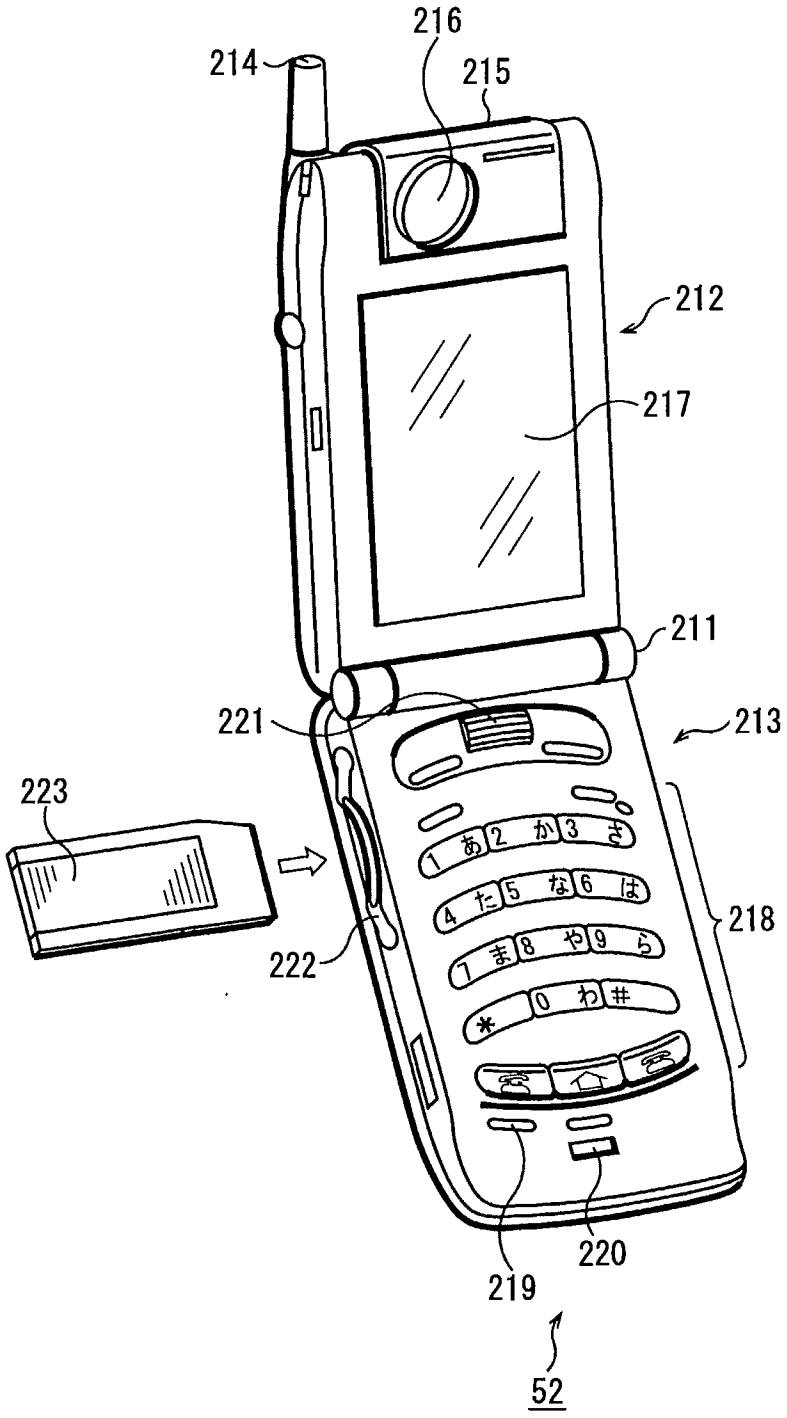


FIG. 15

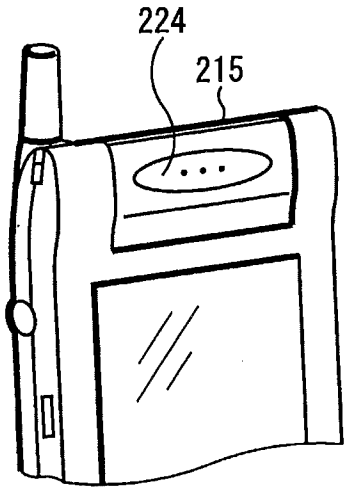


FIG. 16

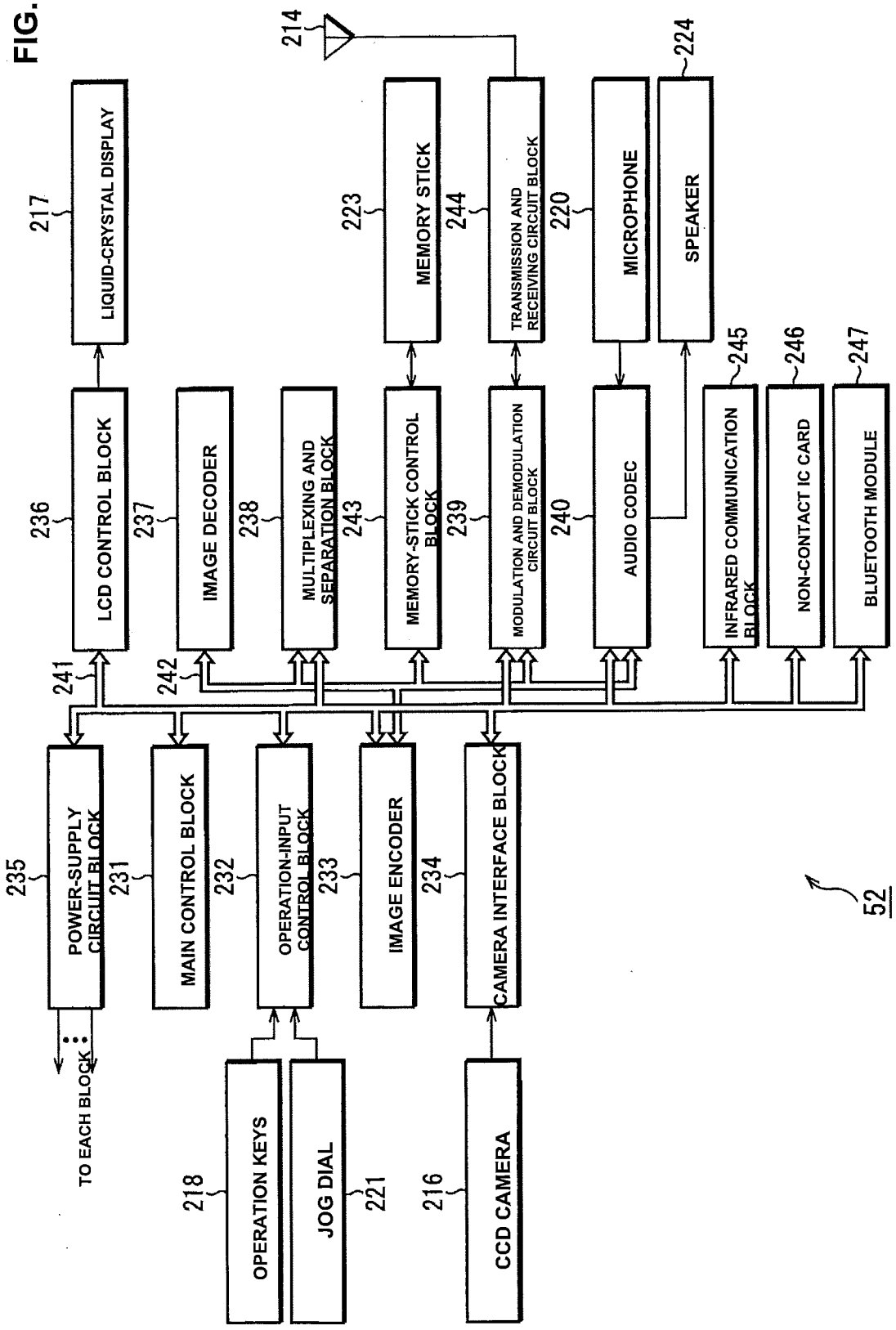
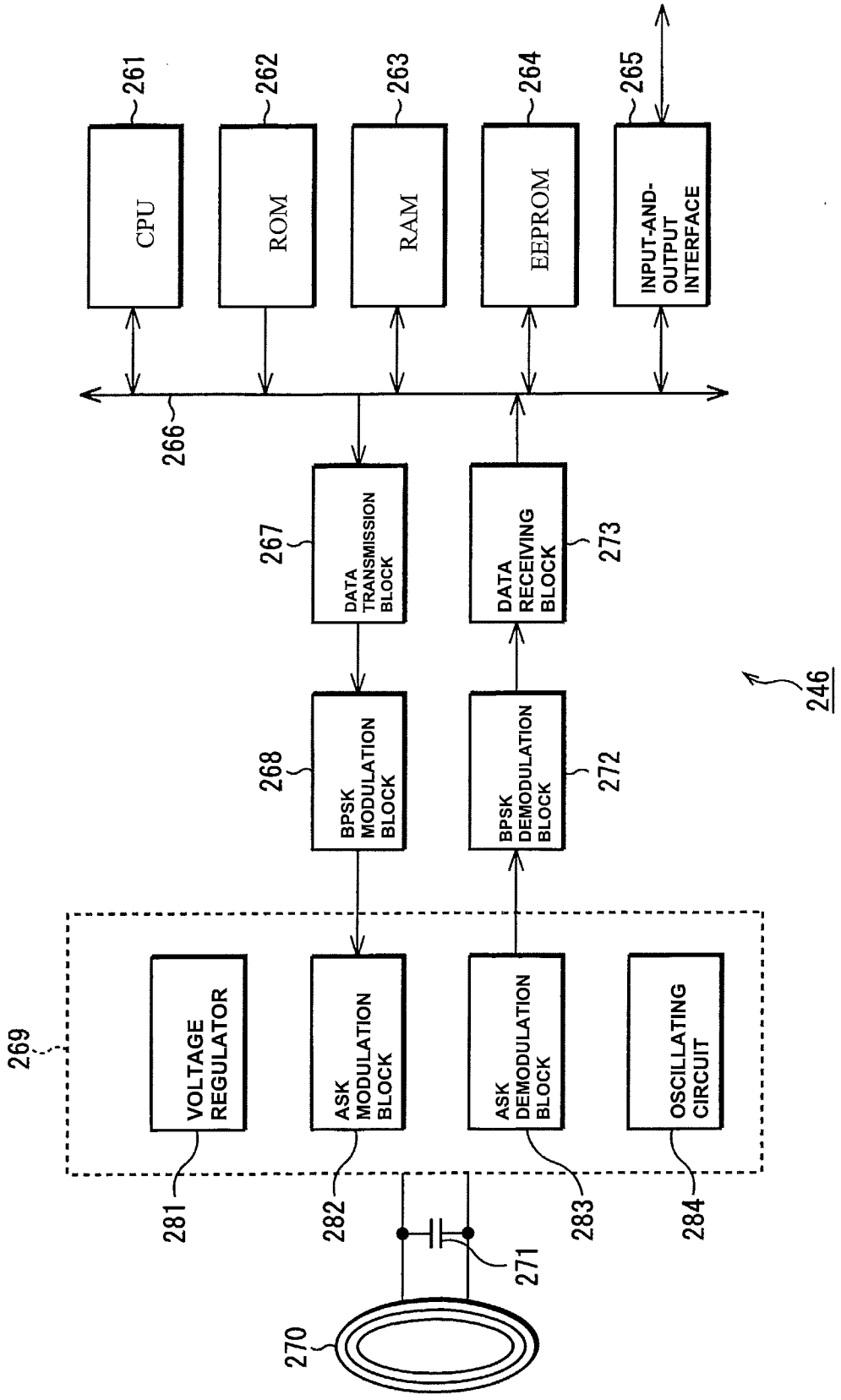

214
224
217
LIQUID-CRYSTAL DISPLAY
223
MEMORY STICK
244
TRANSMISSION AND RECEIVING CIRCUIT BLOCK
220
MICROPHONE
SPEAKER
236
LCD CONTROL BLOCK
237
IMAGE DECODER
238
MULTIPLEXING AND SEPARATION BLOCK
243
MEMORY-STICK CONTROL BLOCK
239
MODULATION AND DEMODULATION CIRCUIT BLOCK
240
AUDIO CODEC
245
INFRARED COMMUNICATION BLOCK
246
NON-CONTACT IC CARD
247
BLUETOOTH MODULE
241
242
235
POWER-SUPPLY CIRCUIT BLOCK
231
MAIN CONTROL BLOCK
232
OPERATION-INPUT CONTROL BLOCK
233
IMAGE ENCODER
234
CAMERA INTERFACE BLOCK
52
TO EACH BLOCK
218
OPERATION KEYS
JOG DIAL
221
216
CCD CAMERA

FIG. 17



PGR2023-00016 - Home Depot
Ex. 1003 - Page 690

FIG. 18

ITEMS IN SPECIFICATIONS			
COMMUNICATION RATE			211.875 kbps
ELECTRIC POWER TRANSMISSION		CENTER FREQUENCY	13.56 MHz
		OUTPUT	350 mW
DATA TRANSFER	R/W → CARD	CENTER FREQUENCY	13.56 MHz
		MODULATION METHOD	ASK
	CARD → R/W	CENTER FREQUENCY	13.56 MHz
		MODULATION METHOD	LOAD SWITCHING

FIG. 19

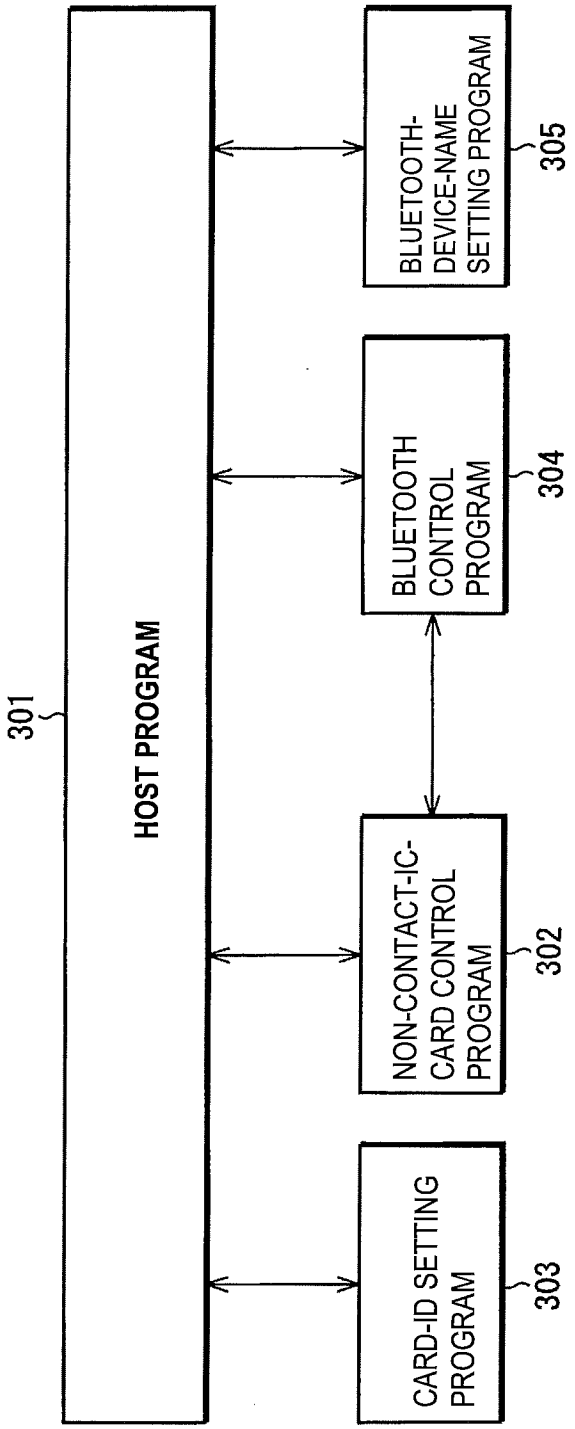

301
HOST PROGRAM
BLUETOOTH-DEVICE-NAME SETTING PROGRAM
305
BLUETOOTH CONTROL PROGRAM
304
NON-CONTACT-IC-CARD CONTROL PROGRAM
302
CARD-ID SETTING PROGRAM
303

FIG. 20

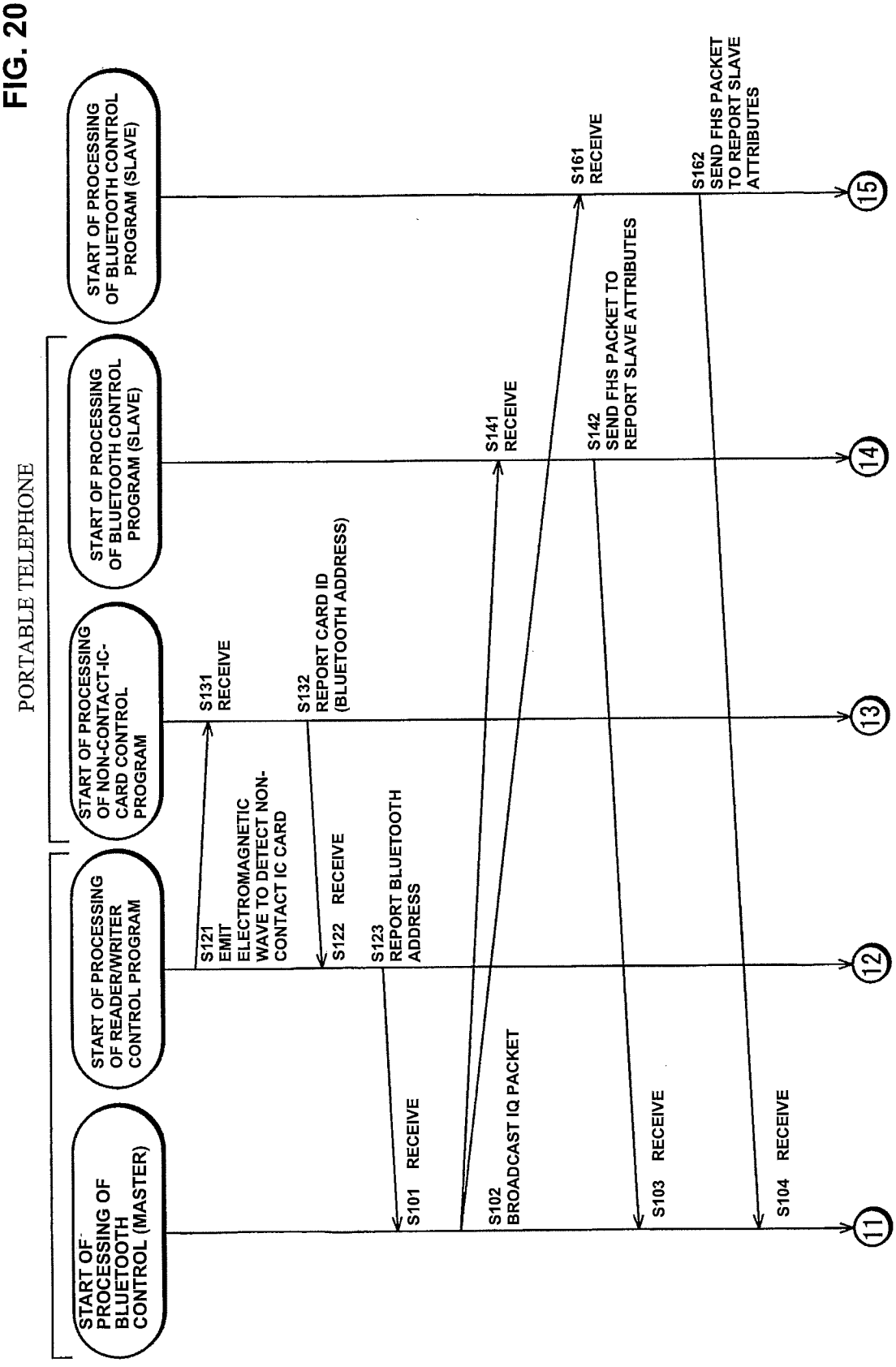

PORTABLE TELEPHONE
START OF PROCESSING OF BLUETOOTH CONTROL (MASTER)
START OF PROCESSING OF READER/WRITER CONTROL PROGRAM
START OF PROCESSING OF NON-CONTACT-IC-CARD CONTROL PROGRAM
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM (SLAVE)
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM (SLAVE)
S121 EMIT ELECTROMAGNETIC WAVE TO DETECT NON-CONTACT IC CARD
S122 RECEIVE
S123 REPORT BLUETOOTH ADDRESS
S131 RECEIVE
S132 REPORT CARD ID (BLUETOOTH ADDRESS)
S141 RECEIVE
S142 SEND FHS PACKET TO REPORT SLAVE ATTRIBUTES
S161 RECEIVE
S162 SEND FHS PACKET TO REPORT SLAVE ATTRIBUTES
S101 RECEIVE
S102 BROADCAST IQ PACKET
S103 RECEIVE
S104 RECEIVE
11
12
13
14
15

FIG. 21

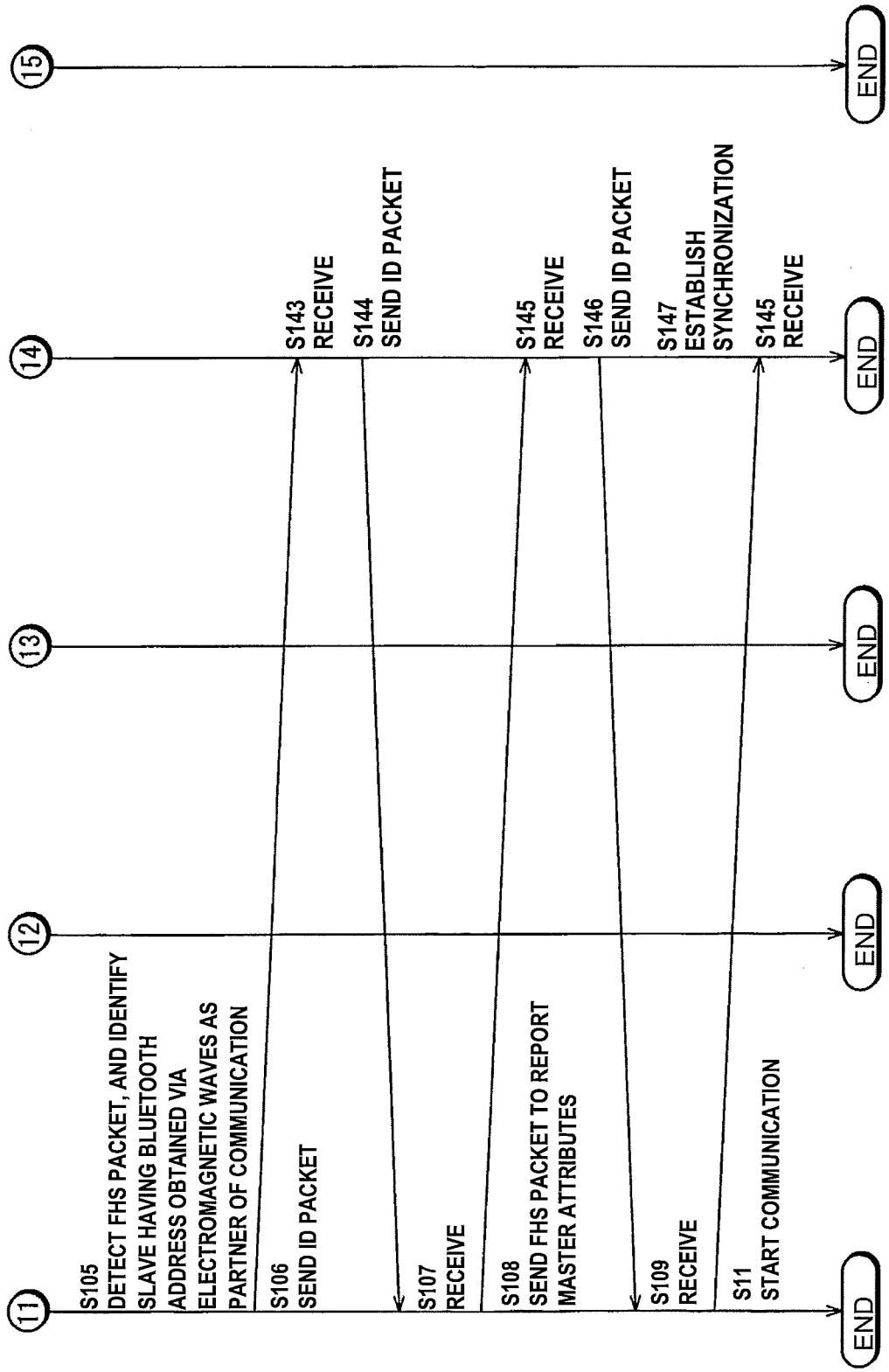

11
12
13
14
15
S105
DETECT FHS PACKET, AND IDENTIFY SLAVE HAVING BLUETOOTH ADDRESS OBTAINED VIA ELECTROMAGNETIC WAVES AS PARTNER OF COMMUNICATION
S106
SEND ID PACKET
S107
RECEIVE
S108
SEND FHS PACKET TO REPORT MASTER ATTRIBUTES
S109
RECEIVE
S11
START COMMUNICATION
S143
RECEIVE
S144
SEND ID PACKET
S145
RECEIVE
S146
SEND ID PACKET
S147
ESTABLISH SYNCHRONIZATION
S145
RECEIVE
END
END
END
END
END

FIG. 22

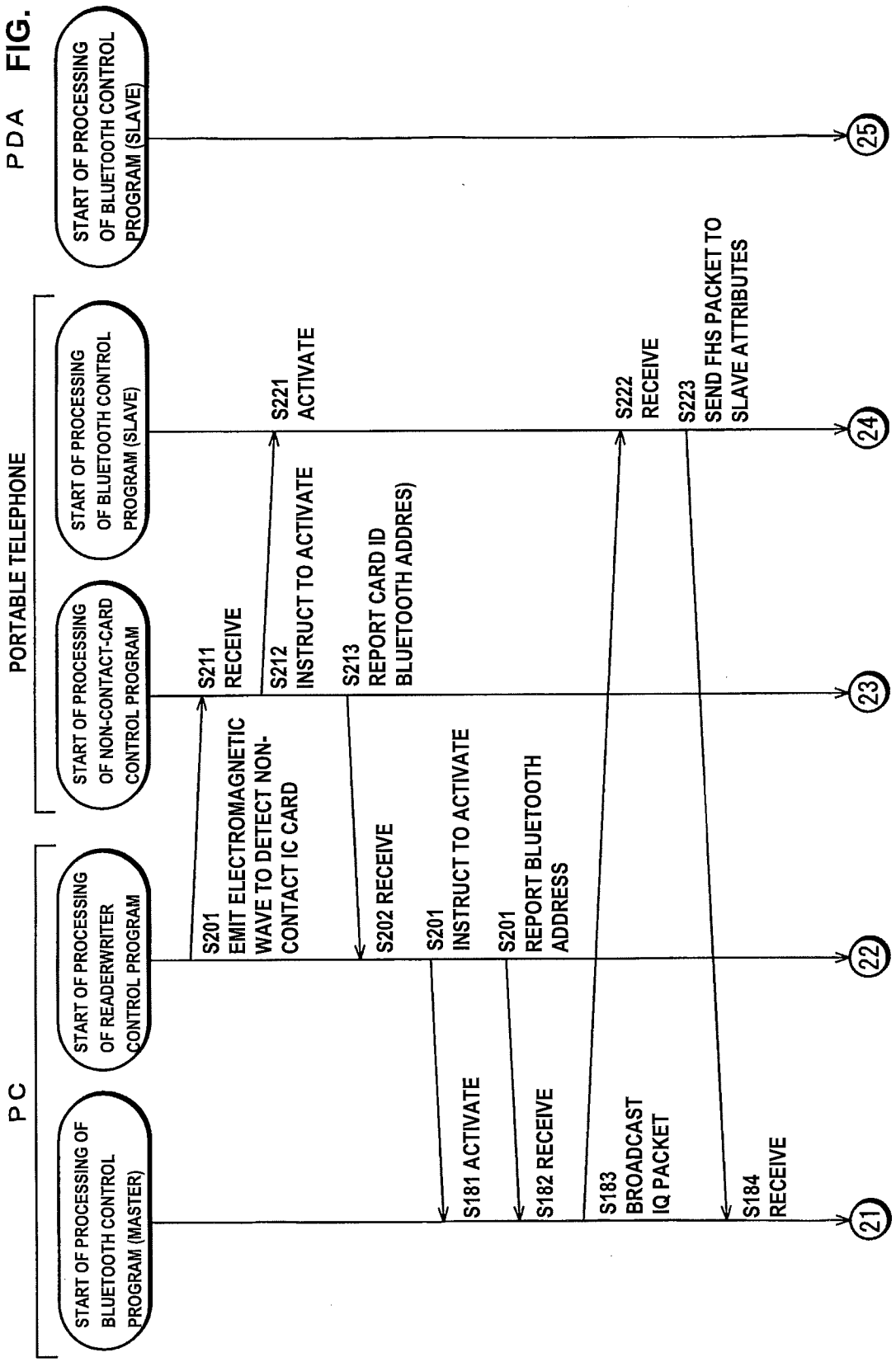

PC
PDA
PORTABLE TELEPHONE
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM (MASTER)
START OF PROCESSING OF READERWRITER CONTROL PROGRAM
START OF PROCESSING OF NON-CONTACT-CARD CONTROL PROGRAM
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM (SLAVE)
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM (SLAVE)
S201 EMIT ELECTROMAGNETIC WAVE TO DETECT NON-CONTACT IC CARD
S211 RECEIVE
S212 INSTRUCT TO ACTIVATE
S221 ACTIVATE
S213 REPORT CARD ID BLUETOOTH ADDRES)
S202 RECEIVE
S201 INSTRUCT TO ACTIVATE
S201 REPORT BLUETOOTH ADDRESS
S222 RECEIVE
S223 SEND FHS PACKET TO SLAVE ATTRIBUTES
S181 ACTIVATE
S182 RECEIVE
S183 BROADCAST IQ PACKET
S184 RECEIVE
21
22
23
24
25

FIG. 23

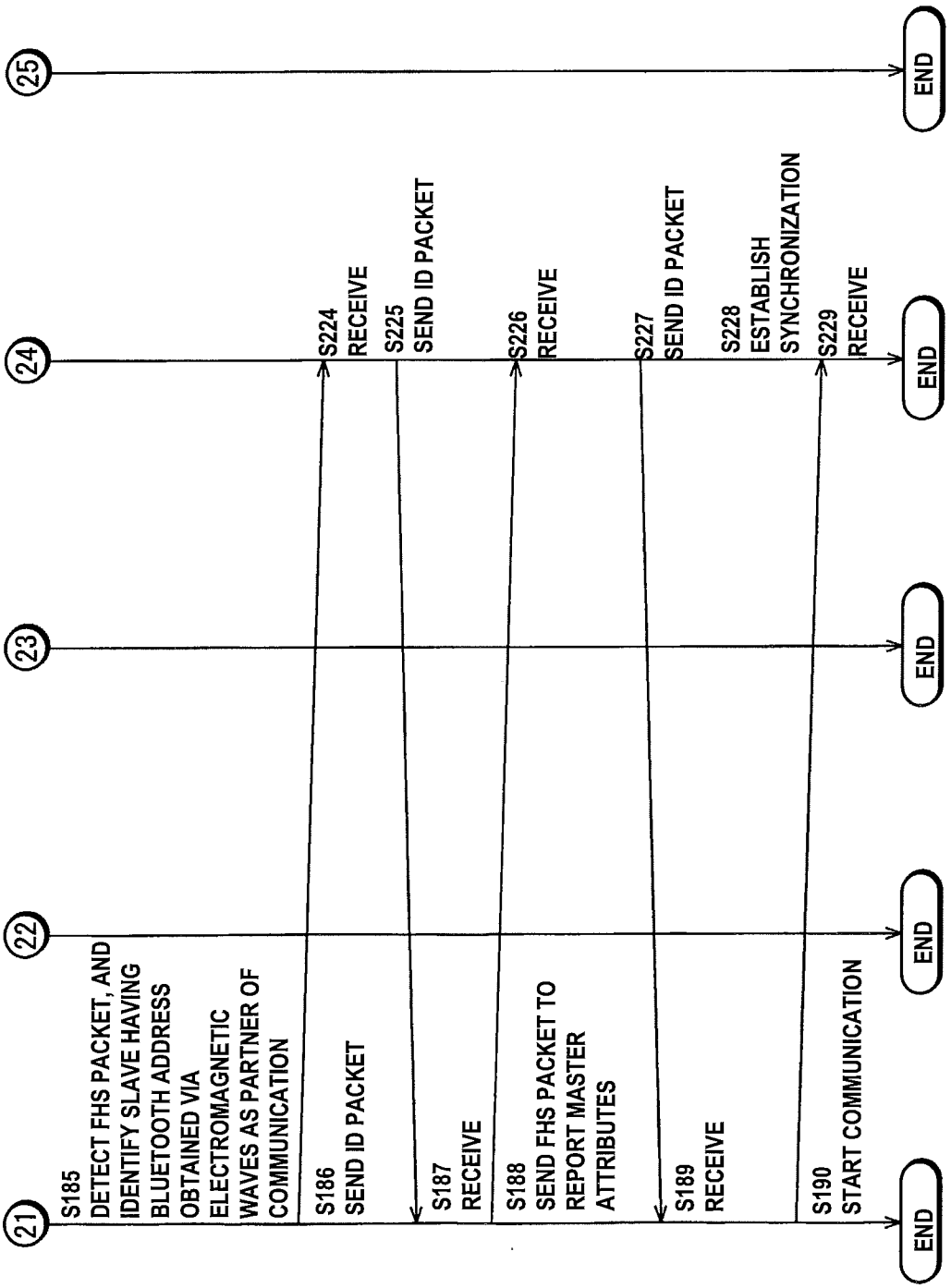

21
22
23
24
25
S185
DETECT FHS PACKET, AND IDENTIFY SLAVE HAVING BLUETOOTH ADDRESS OBTAINED VIA ELECTROMAGNETIC WAVES AS PARTNER OF COMMUNICATION
S186
SEND ID PACKET
S187
RECEIVE
S188
SEND FHS PACKET TO REPORT MASTER ATTRIBUTES
S189
RECEIVE
S190
START COMMUNICATION
S224
RECEIVE
S225
SEND ID PACKET
S226
RECEIVE
S227
SEND ID PACKET
S228
ESTABLISH SYNCHRONIZATION
S229
RECEIVE
END
END
END
END
END
END

FIG. 24A

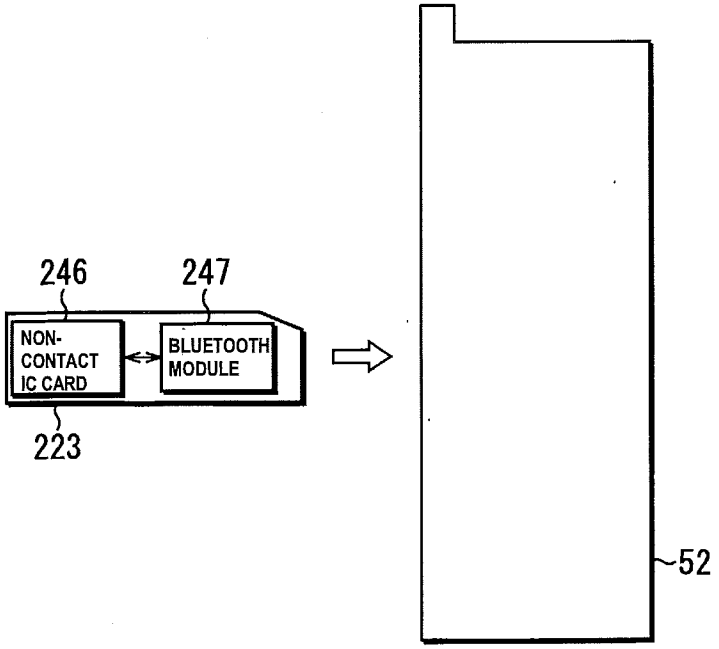


FIG. 24B

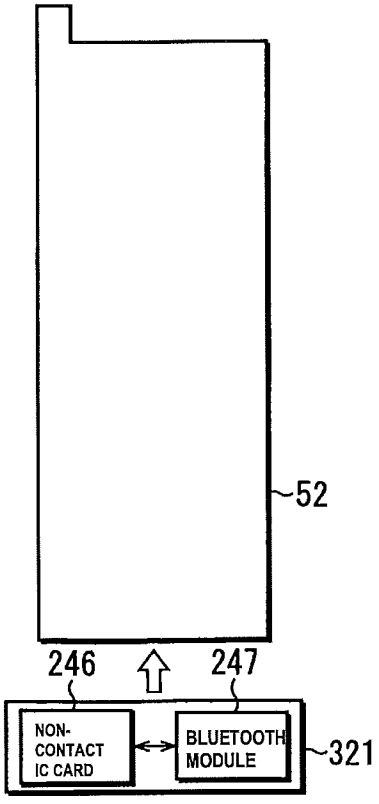


FIG. 25A

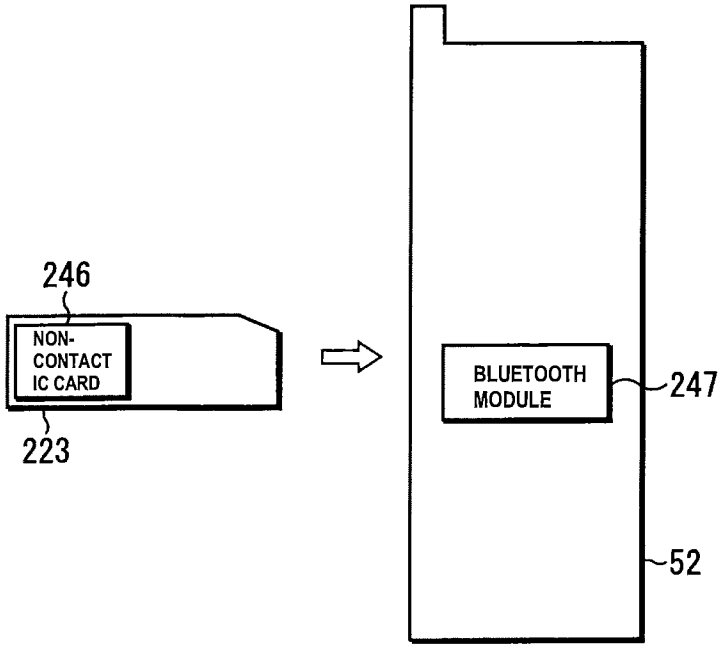


FIG. 25B

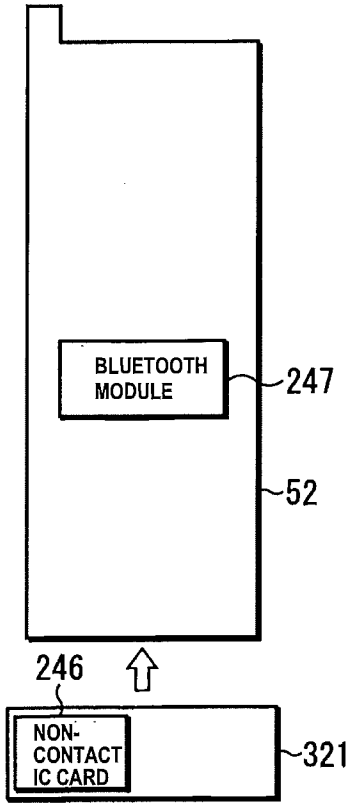


FIG. 26A

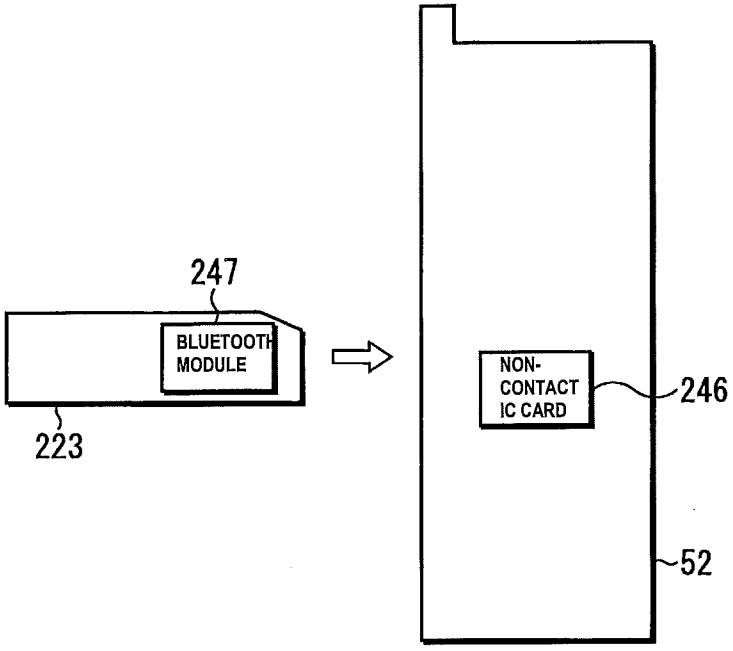


FIG. 26B

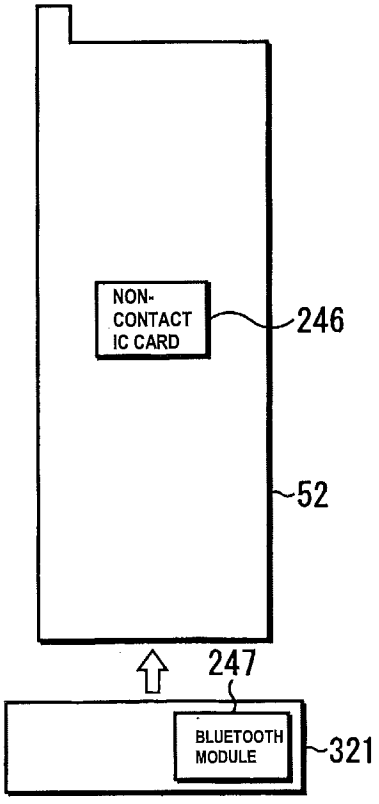
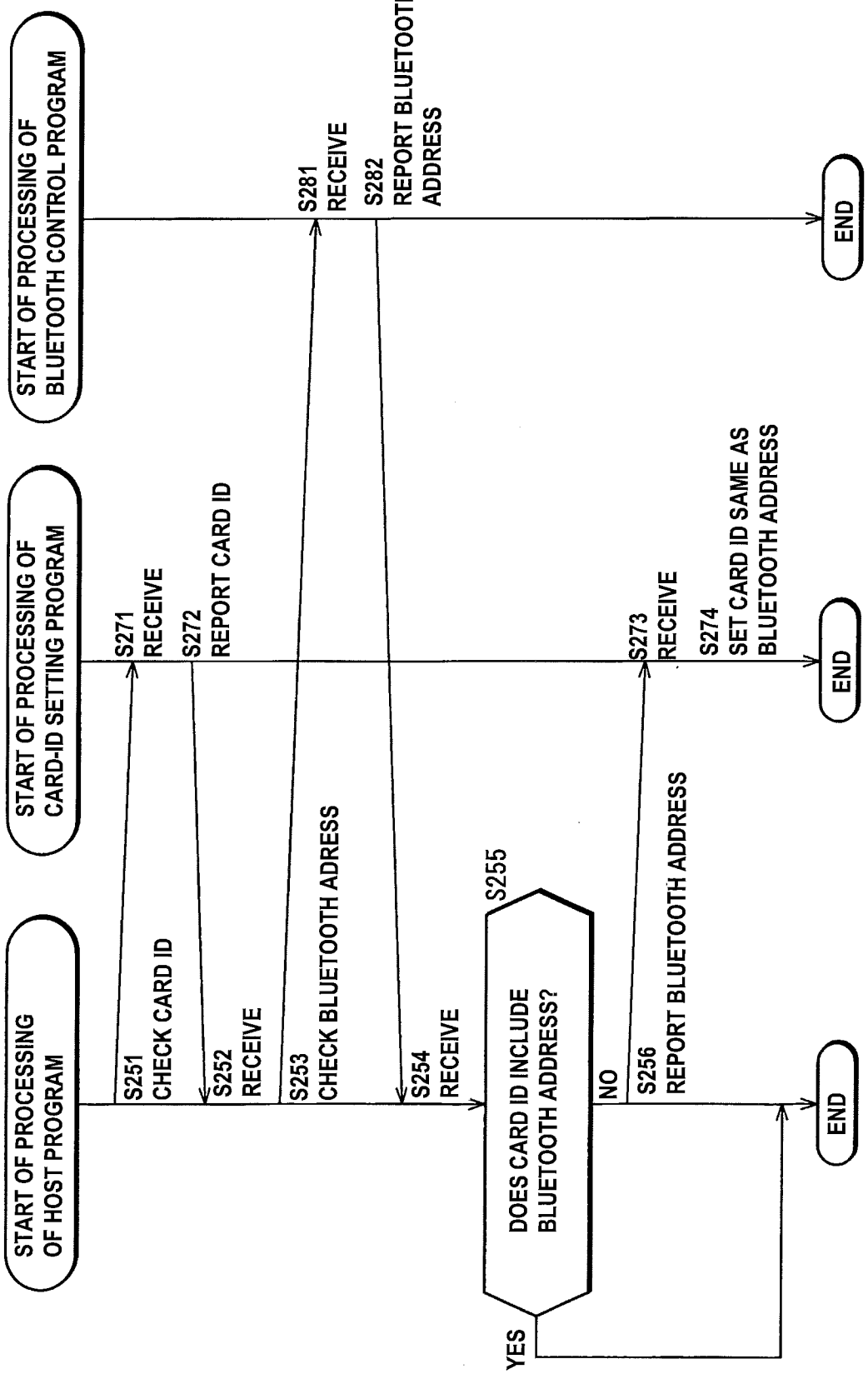


FIG. 27


START OF PROCESSING OF HOST PROGRAM
START OF PROCESSING OF CARD-ID SETTING PROGRAM
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM
S251 CHECK CARD ID
S252 RECEIVE
S253 CHECK BLUETOOTH ADRESS
S254 RECEIVE
S255 DOES CARD ID INCLUDE BLUETOOTH ADDRESS?
YES
NO
S256 REPORT BLUETOOTH ADDRESS
S271 RECEIVE
S272 REPORT CARD ID
S273 RECEIVE
S274 SET CARD ID SAME AS BLUETOOTH ADDRESS
S281 RECEIVE
S282 REPORT BLUETOOTH ADDRESS
END
END
END

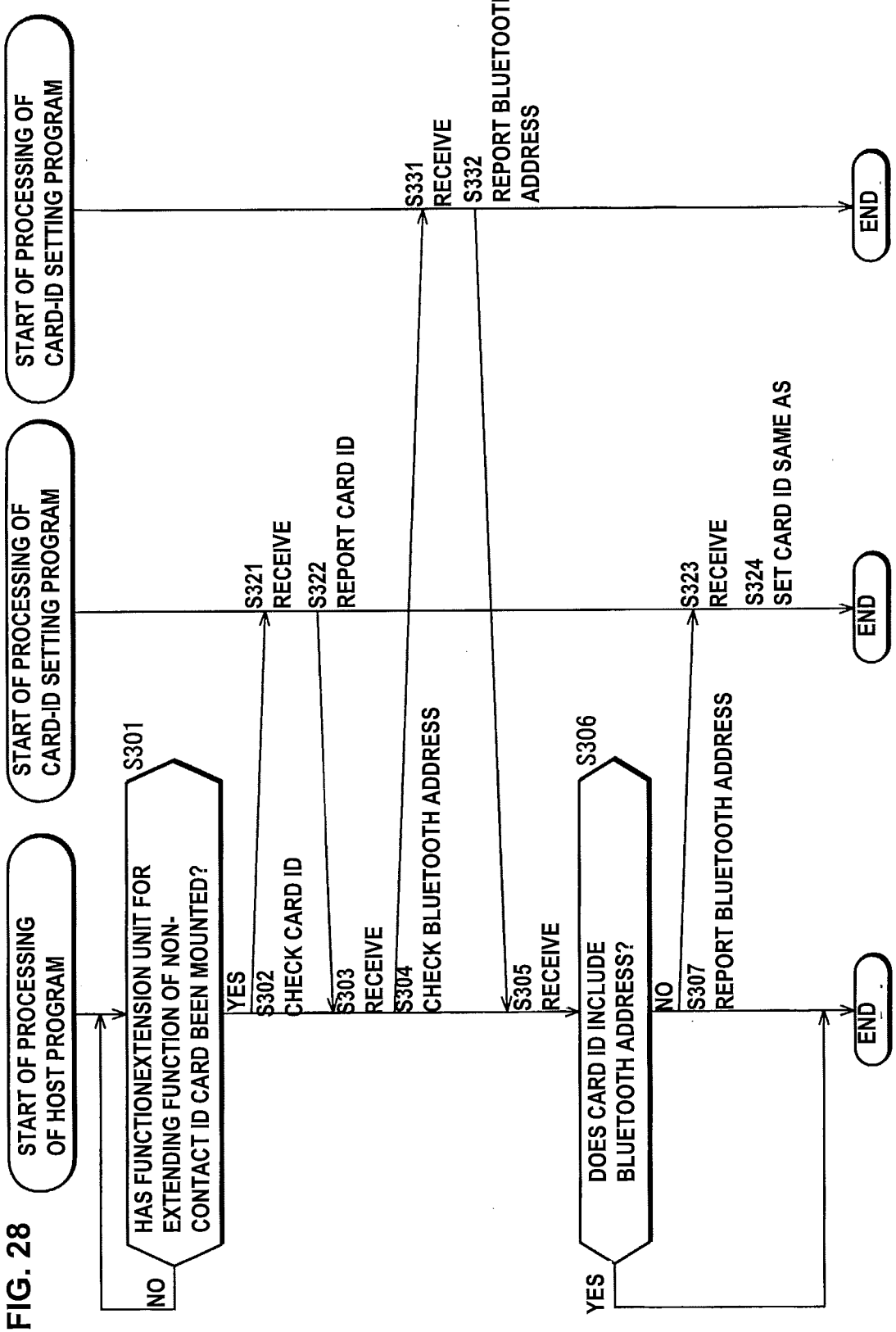

START OF PROCESSING OF HOST PROGRAM
START OF PROCESSING OF CARD-ID SETTING PROGRAM
START OF PROCESSING OF CARD-ID SETTING PROGRAM
S301
HAS FUNCTIONEXTENSION UNIT FOR EXTENDING FUNCTION OF NON-CONTACT ID CARD BEEN MOUNTED?
NO
YES
S302
CHECK CARD ID
S303
RECEIVE
S304
CHECK BLUETOOTH ADDRESS
S305
RECEIVE
S306
DOES CARD ID INCLUDE BLUETOOTH ADDRESS?
YES
NO
S307
REPORT BLUETOOTH ADDRESS
S321
RECEIVE
S322
REPORT CARD ID
S323
RECEIVE
S324
SET CARD ID SAME AS
S331
RECEIVE
S332
REPORT BLUETOOTH ADDRESS
END
END
END

FIG. 28

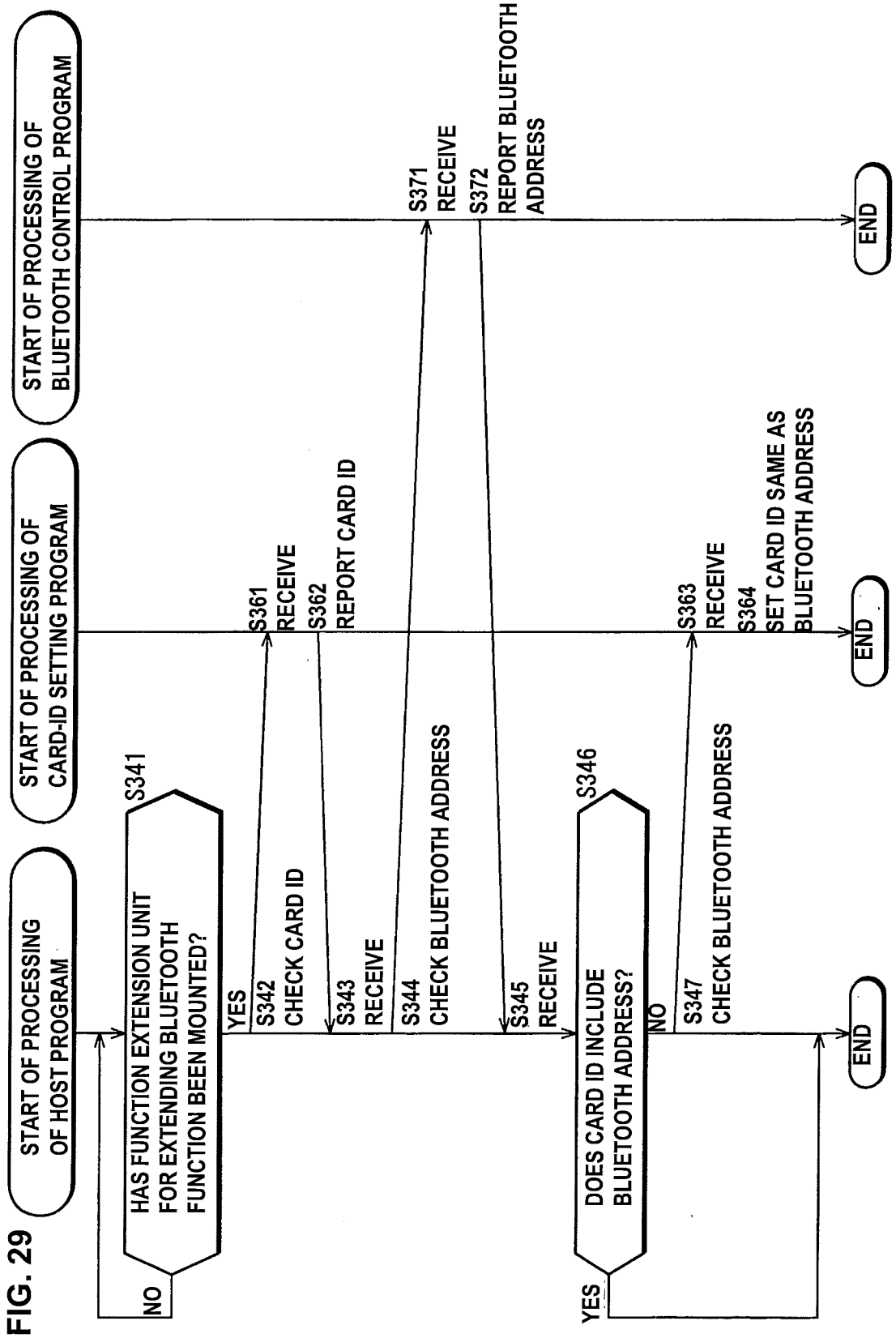
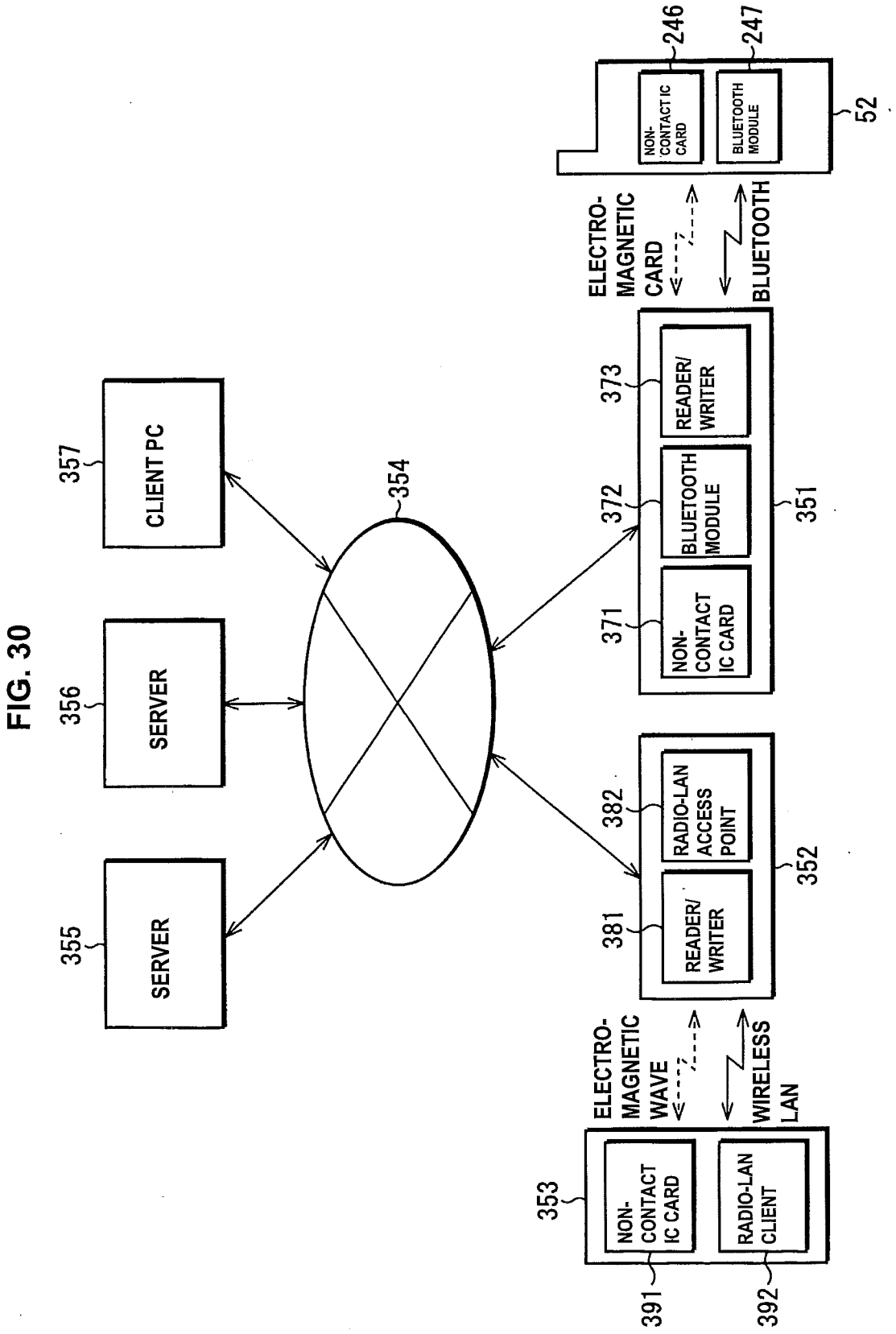

START OF PROCESSING OF HOST PROGRAM
START OF PROCESSING OF CARD-ID SETTING PROGRAM
START OF PROCESSING OF BLUETOOTH CONTROL PROGRAM
S341
HAS FUNCTION EXTENSION UNIT FOR EXTENDING BLUETOOTH FUNCTION BEEN MOUNTED?
NO
YES
S342
CHECK CARD ID
S343
RECEIVE
S344
CHECK BLUETOOTH ADDRESS
S345
RECEIVE
S346
DOES CARD ID INCLUDE BLUETOOTH ADDRESS?
YES
NO
S347
CHECK BLUETOOTH ADDRESS
S361
RECEIVE
S362
REPORT CARD ID
S363
RECEIVE
S364
SET CARD ID SAME AS BLUETOOTH ADDRESS
S371
RECEIVE
S372
REPORT BLUETOOTH ADDRESS
END
END
END

FIG. 29

FIG. 30


CLIENT PC
357
SERVER
356
SERVER
355
354
ELECTRO-MAGNETIC WAVE
WIRELESS LAN
353
NON-CONTACT IC CARD
391
RADIO-LAN CLIENT
392
352
READER/WRITER
381
RADIO-LAN ACCESS POINT
382
351
NON-CONTACT IC CARD
371
BLUETOOTH MODULE
372
READER/WRITER
373
ELECTRO-MAGNETIC CARD
BLUETOOTH
52
NON-CONTACT IC CARD
246
BLUETOOTH MODULE
247

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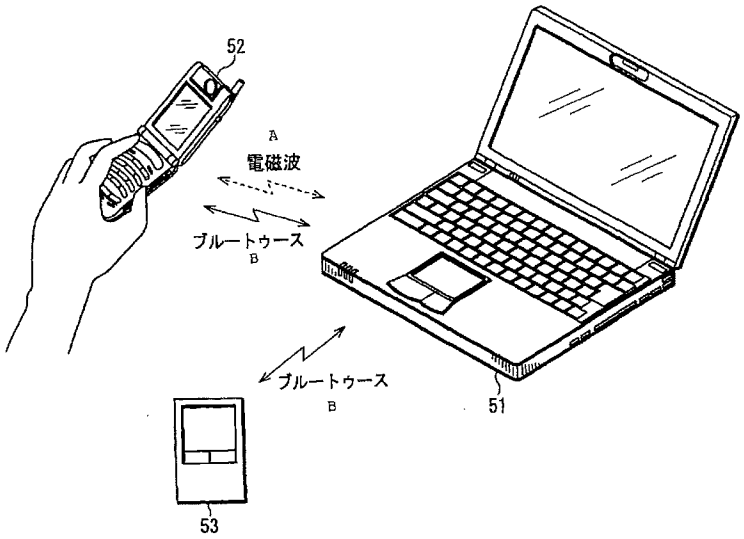
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[続葉有]

(54) Title: COMMUNICATION SYSTEM AND METHOD

(54) 発明の名称: 通信システムおよび方法



A...ELECTROMAGNETIC WAVE
B...BLUETOOTH

(57) Abstract: A communication system and method capable of easily identifying a communication mate. A cellular telephone (52) has a non-contact IC card communicating with a reader/writer of a personal computer (51) by an electromagnetic wave. When an electromagnetic wave radiated from the reader-writer is received by the non-contact IC card, the cellular telephone (52) reports the card ID set in the

[続葉有]

WO 03/009535 A1

PGR2023-00016 - Home Depot
Ex. 1003 - Page 704

(74) 代理人: 稲本 義雄 (INAMOTO,Yoshio); 〒160-0023 東京都 新宿区 西新宿７丁目１１番１８号 ７１１ビルディング４階 Tokyo (JP).

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— 補正書・説明書

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non-contact IC card to the personal computer (51). This card ID includes a Bluetooth address of the cellular telephone (52). When the personal computer (51) fetches the Bluetooth address of the cellular telephone (52) and a PDA (53) upon query, the personal computer (51) identifies the cellular telephone (52) as a Bluetooth device to establish synchronization according to the Bluetooth address reported in advance. The present invention can be applied to an information processing apparatus such as a personal computer and a cellular telephone.

(57) 要約:

本発明は、通信相手を容易に特定できるようにする通信システムおよび方法に関する。携帯電話機５２には、パーソナルコンピュータ５１のリーダライタと電磁波により通信する非接触 IC カードが設けられている。リーダライタから輻射される電磁波が、その非接触 IC カードにおいて受信されたとき、携帯電話機５２は、非接触 IC カードに設定されているカード ID をパーソナルコンピュータ５１に通知する。このカード ID には、携帯電話機５２のブルートゥースアドレスが含まれている。パーソナルコンピュータ５１は、問い合わせ時において、携帯電話機５２と PDA５３のブルートゥースアドレスを取得したとき、予め通知されているブルートゥースアドレスに基づいて、携帯電話機５２を、同期を確立するブルートゥースデバイスとして特定する。本発明は、パーソナルコンピュータや携帯電話機などの情報処理装置に適用できる。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 705

明細書

通信システムおよび方法

技術分野

本発明は、特に、ブルートゥースにより通信を行う場合において、通信相手の端末を特定できるようにし、より簡単に、かつ迅速に通信を開始することができるようにする通信システムおよび方法に関する。

背景技術

近年、近距離間の無線通信手段として、ブルートゥース（Bluetooth（登録商標））が注目されており、様々な対応機器が開発、販売されている。

ブルートゥースは、BluetoothSIG(Special Interest Group)により標準化されている無線通信規格であり、２．４GHz 帯（IMS(Industrial Science Medical)帯）を使用して、ブルートゥースモジュールが設けられている他のデバイスと通信する。

そして、ブルートゥースによって形成されるネットワークは、その形態に応じて、ピコネット(piconet)、または複数のピコネットが相互接続されたスカッタネット(scatternet)と呼ばれ、そこには、マスタとスレーブと呼ばれる役割を有するブルートゥースデバイスが存在する。以下、適宜、マスタの役割を有するブルートゥースデバイスを単にマスタと、スレーブの役割を有するブルートゥースデバイスを単にスレーブとそれぞれ称する。

図１は、ピコネット、およびスカッタネットの概念を示す図である。

図１に示すように、それぞれのピコネットには、１つのマスタが存在し、その制御に基づいて、複数、または単数のスレーブが通信を行う。この例においては、マスタ１とスレーブ１－１、およびスレーブ１－２によりピコネット１が形成され、マスタ２とスレーブ２－１によりピコネット２が形成されている。

そして、ピコネット１とピコネット２が相互接続されることにより、スカッタ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 706

ネットが形成される。なお、図１においては、ピコネット１とピコネット２の間の通信リンクは無効とされている。

このようなピコネットが形成され、各種の情報を送受信するためには、ピコネット内の全てのブルートゥースデバイスにより、周波数軸と時間軸の同期が確立されている必要がある。

ここで、周波数軸の同期と時間軸の同期について説明する。

ブルートゥースでは、７９MHz の周波数幅を使って、例えば、マスタからスレーブに対して信号が送信されるが、このとき、マスタは、７９MHz の周波数幅を同時に占有して情報を送信するのではなく、情報の送信周波数を、１MHz の周波数幅でランダムに変化（ホッピング）させて送信する。

また、受信側のスレーブは、ランダムに変化されるマスタの送信周波数と同期をとり、適宜、受信周波数を変化させて、マスタから送信されてきた情報を受信する。

このマスタとスレーブにより変化される周波数のパターンが周波数ホッピングパターンと呼ばれ、周波数ホッピングパターンをマスタとスレーブとの間で共有している状態が、周波数軸の同期が確立した状態とされる。

また、ブルートゥースでは、マスタと複数のスレーブが通信するために、マスタと各スレーブ間の通信路（チャンネル）が６２５μ 秒単位で時分割多重されている。そして、この６２５μ 秒単位の時間間隔が時間スロットと呼ばれ、時間スロットを共有している状態が、時間軸の同期が確立した状態とされる。

なお、後に詳述するように、全てのスレーブは、マスタのブルートゥースアドレスに基づいて、周波数軸の同期を確立するための周波数ホッピングパターンを算出し、マスタのブルートゥースクロックに基づいて、自分自身が管理するブルートゥースクロックにオフセットを加え、時間軸の同期を確立するための時間スロットのタイミングをとる。

なお、このブルートゥースアドレスは、それぞれのブルートゥースデバイスに対して固有な４８ビットで表され、それに基づいて、周波数ホッピングパターン

が一義的に算出される。また、ブルートゥースクロックは、全てのブルートゥースデバイスがそれぞれ管理するものである。

従って、ピコネットを形成する前には、周波数軸の同期、および時間軸の同期を確立させるためのブルートゥースアドレス、およびブルートゥースクロックを含む各種の情報が、マスタとスレーブ間で送受信される。

次に、周波数軸の同期、および時間軸の同期を確立し、ピコネットを形成する従来のブルートゥースデバイスの処理について、図２、および図３のフローチャートを参照して説明する。

なお、図１に示したマスタ１、スレーブ１－１、およびスレーブ１－２により同期が確立され、ピコネット１が形成される処理について説明する。また、送受信されるパケット等に関しては、後に詳述するものとし、ここでは、全体の流れについて説明する。

ステップＳ１において、マスタ１は、周囲に存在するスレーブを検出するためのIQ（Inquiry）パケットをブロードキャストする。

例えば、図１に示すように、マスタ１の近傍にスレーブ１－１とスレーブ１－２が存在する場合、スレーブ１－１は、ステップＳ３１において、マスタ１から送信されてきたIQパケットを受信し、ステップＳ３２に進み、自らの属性情報を示すパケット（FHSパケット）によりマスタに応答する。

また、スレーブ１－２も同様にして、ステップＳ５１でIQパケットを受信したとき、ステップＳ５２に進み、FHSパケットによりマスタに応答する。

スレーブがマスタに対して送信するFHSパケットには、スレーブの属性情報として、それぞれのスレーブのブルートゥースアドレスと、ブルートゥースクロックが含まれている。

そして、マスタ１は、スレーブ１－１から送信されてきたFHSパケットをステップＳ２において受信し、スレーブ１－２から送信されてきたFHSパケットをステップＳ３において受信する。

なお、IQパケットをブロードキャストし、それに応じて送信されてくるFHS

PGR2023-00016 - Home Depot
Ex. 1003 - Page 708

パケットを受信するマスタの一連の処理、および、送信されてくる IQ パケットを受信し、それに応じて FHS パケットを送信するスレーブの一連の処理は、「問い合わせ（Inquiry）」と呼ばれている。

ステップＳ４において、マスタ１は、ステップＳ２で受信した FHS パケットに基づいて生成した ID パケットをスレーブ１－１に対して送信する。

スレーブ１－１は、ステップＳ３３で、この ID パケットを受信したとき、ステップＳ３４に進み、受信したものと同一の ID パケットをマスタ１に送信し、パケットの送受信が可能であることを通知する。

マスタ１は、ステップＳ５でスレーブ１－１から送信されてきた ID パケットを受信したとき、ステップＳ６に進み、FHS パケットをスレーブ１－１に送信し、自らの属性情報としてのブルートゥースアドレス、およびブルートゥースクロックをスレーブ１－１に通知する。

ステップＳ３５において、マスタ１からの FHS パケットがスレーブ１－１により受信され、これにより、ピコネット内同期を確立するために必要なブルートゥースアドレスとブルートゥースクロックが、マスタ１とスレーブ１－１との間で相互に交換された状態となる。

ステップＳ３６において、スレーブ１－１は、ID パケットをマスタ１に対して送信し、FHS パケットを受信できたことを通知する。

そして、ステップＳ３７において、スレーブ１－１は、マスタ１から通知されてきたブルートゥースアドレスとブルートゥースクロックに基づいて、マスタ１との同期を確立する。マスタから通知された情報に基づいて同期を確立するスレーブの処理については、後に詳述する。

ステップＳ７において、スレーブ１－１からの通知を受けたマスタ１は、ステップＳ８に進み、スレーブ１－１との間で FHS パケット、および ID パケットを送受信することに続けて、スレーブ１－２との間で、それらの情報の送受信を行う。すなわち、マスタ１によるステップＳ８乃至ステップＳ１１の処理、およびスレーブ１－２によるステップＳ５３乃至ステップＳ５７の処理は、上述した

ステップＳ４乃至ステップＳ７の処理、およびステップＳ３３乃至ステップＳ３７の処理とそれぞれ同様の処理である。

具体的には、ステップＳ８において、マスタ１が ID パケットをスレーブ１－２に対して送信することに応じて、スレーブ１－２からは、その受信ができたことを通知する ID パケットが送信されてくる。そして、マスタ１は、ステップＳ１０において、スレーブ１－２に対して FHS パケットを送信し、自らの属性情報を通知する。

ステップＳ５５において、マスタ１からの FHS パケットを受信したとき、スレーブ１－２は、ステップＳ５６に進み、ID パケットをマスタ１に送信する。そして、ステップＳ５７において、スレーブ１－２は、マスタ１から通知されてきたブルートゥースアドレスとブルートゥースクロックに基づいて、マスタ１との同期を確立する。

なお、上述した「問い合わせ」から、同期が確立されるまでの一連の処理は、「呼び出し(page)」と呼ばれている。

ステップＳ１２において、マスタ１は、ブルートゥースデバイス名を通知することをスレーブ１－１に要求する。すなわち、ブルートゥースデバイスには、それぞれ、ブルートゥースデバイス名が設定されており、その設定は、ユーザにより変更可能とされている。

ブルートゥースデバイス名は、例えば、マスタを操作するユーザが通信相手（スレーブ）を選択するときなどに使用される。すなわち、ブルートゥースアドレスに基づいて通信相手を選択しなければならないとすると、ユーザは、ピコネット内に存在する全てのブルートゥースデバイスのアドレスを４８ビットで表される数字で覚えておく必要がある。

スレーブ１－１は、ステップＳ３８において、マスタ１からの要求を受けたとき、ステップＳ３９に進み、設定されているブルートゥースデバイス名をマスタ１に通知する。

そして、ステップＳ１３において、マスタ１は、スレーブ１－１から通知され

PGR2023-00016 - Home Depot
Ex. 1003 - Page 710

てきたブルートゥースデバイス名を受信する。

また、マスタ１は、ステップＳ１４において、スレーブ１－２に対しても、ブルートゥースデバイス名の通知を要求する。

ステップＳ５８において、この要求を受けたスレーブ１－２は、ステップＳ５９に進み、設定されているブルートゥースデバイス名をマスタ１に通知する。

ステップＳ１５において、スレーブ１－２からの通知を受けたマスタ１は、ステップＳ１６に進み、通信するスレーブを選択する画面を表示部に表示する。この選択画面には、ステップＳ１３、およびステップＳ１５において取得された、ブルートゥースデバイス名などが表示され、ユーザは、選択画面を確認し、その後の通信を行うスレーブを選択することができる。

図４は、同期確立後に、ブルートゥースデバイス（マスタ）に表示される選択画面の例を示す図である。

図に示すように、選択ウインドウ１が表示され、その左方にはユーザが操作するマスタの情報が表示されるマスタ表示部１１が設けられている。

マスタ表示部１１は、デバイス名表示部１１Ａとアドレス表示部１１Ｂとからなり、デバイス名表示部１１Ａには、マスタのブルートゥースデバイス名が表示され、アドレス表示部１１Ｂには、マスタのブルートゥースアドレスが表示されている。

より詳細には、デバイス名表示部１１Ａの上段には、マスタのブルートゥースデバイスのカテゴリが表示され、その下段には、ユーザが好みに応じて変更可能なブルートゥースデバイス名が表示されている。なお、この例において、マスタのカテゴリは、「コンピュータ（パーソナルコンピュータ）」とされ、デバイス名は、「レッド用コンピュータ」とされている。

選択ウインドウ１のほぼ中央には、プロファイル選択ボタン１２が縦列して表示されており、ユーザは、スレーブに対するプロファイルを選択する。プロファイルは、スレーブとの通信方法を規定するものであり、図４においては、８つのプロファイル選択ボタン１２が表示されている。

選択ウインドウ１の右方には、スレーブ表示部１３乃至１９が表示されており、それぞれのスレーブ表示部には、マスタ表示部１１と同様に、デバイス名表示部とアドレス表示部が設けられている。

そして、図４の例においては、現在、スレーブ表示部１６に表示されているスレーブとマスタの間で通信が行われている状態とされている。なお、スレーブ表示部１６に表示されているブルートゥースデバイスのカテゴリは「携帯電話機」であり、そのブルートゥースデバイス名は、「レッド用携帯」とされている。

図５は、同期確立後に、ブルートゥースデバイスに表示される選択画面の他の例を示す図である

この選択ウインドウ３１には、その左方にプロファイルが表示され、白抜き矢印を挟んで、スレーブのブルートゥースデバイス名がそれぞれ表示されている。そして、マスタから、例えば、選択ウインドウ３１の１段目に表示されているスレーブ（ブラック用プレーヤ）に対しては、音楽ファイルを転送するためのプロファイルでブルートゥースによる通信が可能とされている。

しかしながら、以上のような処理によりピコネットを確立し、通信を開始する場合、通信可能なブルートゥースデバイスが図４、および図５に示すように一覧表示されるものの、ユーザは、その相手をわざわざ選択する必要がある。

また、ユーザは、通信相手を選択した後、さらに、通信相手の機器に応じてプロファイルを選択する必要がある。

ブルートゥースを利用したシステムとして、例えば、ブルートゥースモジュールが内蔵された携帯電話機を利用して、自動販売機で購入した商品の代金を支払うことが提案されているが、程度の違いこそあれ、上述したような通信相手の選択などが必要とされることが予想される。

従って、実際に紙幣等を使用する場合に較べて、自動販売機における購入手続きが、より煩雑なものとなるおそれがある。

発明の開示

PGR2023-00016 - Home Depot
Ex. 1003 - Page 712

本発明はこのような状況に鑑みてなされたものであり、ブルートゥースにより通信を行う場合において、通信相手の端末を特定できるようにし、より簡単に、かつ迅速に通信を開始することができるようにしたものである。

本発明の通信システムの情報処理装置は、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報を取得する第１の取得処理手段と、データの送受信を行う第２の無線通信部を用いて通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、第１の取得処理手段により取得された識別情報と、第２の取得処理手段により取得された属性情報とを用いて通信相手を特定する特定処理手段と、特定処理手段により特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する第１の同期確立処理手段とを備えることを特徴とする。また、通信端末は、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、情報処理装置に自身の識別情報を提供する第１の提供処理手段と、第２の無線通信部を介して送信された情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の属性情報を提供する第２の提供処理手段と、第２の無線通信部を用いた無線通信の同期の確立に伴い情報処理装置からの要求に応じて、第４の無線通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理手段とを備えることを特徴する。

本発明の通信方法を構成する情報処理装置の情報処理方法は、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報を取得する第１の取得処理ステップと、データの送受信を行う第２の無線通信部を用いて通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、第１の取得処理ステップにより取得された識別情報と、第２の取得処理ステップにより取得された属性情報とを用いて通信相手を特定する特定処理ステップと、特定処理ステップにより特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確

立する第１の同期確立処理ステップとを備えることを特徴とする。また、通信端末の情報処理方法は、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、情報処理装置に自身の識別情報を提供する第１の提供処理ステップと、第２の無線通信部を介して送信された情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の前記属性情報を提供する第２の提供処理ステップと、第２の無線通信部を用いた無線通信の同期の確立に伴い情報処理装置からの要求に応じて、第４の通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理ステップとを備えることを特徴する。

本発明の第１の情報処理装置は、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、所望のデータの送受信を行う第２の無線通信部を用いて、通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、第１の取得処理手段により取得された識別情報と、第２の取得処理手段により取得された属性情報とを用いて通信相手を特定する特定処理手段と、特定処理手段により特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段とを備えることを特徴とする。

第１の無線通信部による無線通信可能な距離が、第２の無線通信部による無線通信可能な距離より短いようにすることができる。

第１の取得処理手段は、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報を取得するようにすることができる。

属性情報には、複数の通信端末を各々識別可能にするアドレス情報と通信端末が管理するクロック情報が含まれているようにすることができる。

第１の取得処理手段により識別情報が取得されたことに応じて、第２の無線通信部を起動させる起動処理手段を更に備えるようにすることができる。

識別情報には、通信端末のブルートゥースアドレスが少なくとも含まれており、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 714

第２の取得処理手段では、第２の無線通信部を用いて送信した IQ パケットに応答して複数の通信端末が各々返信した複数の FHS パケットを取得し、同期確立処理手段では、特定処理手段により特定された通信端末に対し、第２の無線通信部を用いて ID パケットの送信を行い、該 ID パケットの送信に対する通信端末からの応答があったときは自身の FHS パケットを更に送信するようにすることができる。

本発明の第１の情報処理装置の情報処理方法は、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、所望のデータの送受信を行う第２の無線通信部を用いて、通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、第１の取得処理ステップにより取得された識別情報と、第２の取得処理ステップにより取得された属性情報とを用いて通信相手を特定する特定処理ステップと、特定処理ステップにより特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップとを備えることを特徴とする。

第１の無線通信部による無線通信可能な距離が、第２の無線通信部による無線通信可能な距離より短いようにすることができる。

第１の取得処理ステップは、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報を取得するようにすることができる。

属性情報には、複数の通信端末を各々識別可能にするアドレス情報と通信端末が管理するクロック情報が含まれているようにすることができる。

第２の取得処理ステップでは、第２の無線通信部を用いて送信した IQ パケットに応答して複数の通信端末が各々返信した複数の FHS パケットを取得し、同期確立処理ステップでは、特定処理ステップにより特定された通信端末に対し、第２の無線通信部を用いて ID パケットの送信を行い、該 ID パケットの送信に対する通信端末からの応答があったときは自身の FHS パケットを更に送信するようにすることができる。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 715

本発明の通信端末は、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処理手段と、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理手段と、第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理手段とを備えることを特徴とする。

第１の無線通信部による無線通信可能な距離が、第２の無線通信部による無線通信可能な距離より短いようにすることができる。

第１の提供処理手段は、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータ送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供するようにすることができる。

識別情報は、自身の端末を識別可能にするアドレス情報を少なくとも含んでいるようにすることができる。

属性情報には、アドレス情報と自身の端末が管理するクロック情報とが含まれているようにすることができる。

第１の提供処理手段により識別情報を提供したことに応じて、第２の無線通信部を起動させる起動処理手段を更に備えるようにすることができる。

識別情報は、ブルートゥースアドレス情報を少なくとも含んでおり、第２の提供処理手段では、第２の無線通信部を用いて受信した IQ パケットに応答して FHS パケットを返信し、同期確立処理手段では、第２の無線通信部を用いて受信した ID パケットに応答して ID パケットを返信し、更に FHS パケットを受信したときは再度 ID パケットを返信するようにすることができる。

本発明の通信端末の通信方法は、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処理ステップと、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処

理ステップと、第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理ステップとを備えることを特徴とする。

第１の提供処理ステップは、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータ送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供するようにすることができる。

識別情報は、自身の端末を識別するアドレス情報を少なくとも含んでいるようにすることができる。

属性情報には、アドレス情報と自身の端末が管理するクロック情報とが含まれているようにすることができる。

第１の提供処理ステップにより識別情報を提供したことに応じて、第２の無線通信部を起動させる起動処理ステップを更に備えるようにすることができる。

識別情報は、ブルートゥースアドレス情報を少なくとも含んでおり、第２の提供処理ステップでは、第２の無線通信部を用いて受信した IQ パケットに応答して FHS パケットを返信し、同期確立処理ステップでは、第２の無線通信部を用いて受信した ID パケットに応答して ID パケットを返信し、更に FHS パケットを受信したときは再度 ID パケットを返信するようにすることができる。

本発明の第１の拡張装置は、情報処理装置に電気的に接続しデータの授受を行うための接続端子と、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、所望のデータの送受信を行う第２の無線通信部を用いて、複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、第１の取得処理手段により取得された識別情報と、前記複数の通信端末から取得した属性情報とを用いて通信相手を特定する特定処理手段と、特定処理手段により特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段とを備えることを特徴とする。

本発明の第２の拡張装置は、通信端末に電気的に接続しデータの授受を行うための接続端子と、所定のデータの送受信を行う第１の無線通信部を用いて、情報

PGR2023-00016 - Home Depot
Ex. 1003 - Page 717

処理装置からの要求に応じて自身の識別情報を提供する第１の提供処理手段と、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの要求に応じて自身の属性情報を提供する第２の提供処理手段と、第２の無線通信部を用いた無線通信の同期確立に伴い情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理手段とを備えることを特徴とする。

本発明の第１のプログラムは、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、所望のデータの送受信を行う第２の無線通信部を用いて、通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、第１の取得処理ステップにより取得された識別情報と、第２の取得処理ステップにより取得された属性情報とを用いて通信相手を特定する特定処理ステップと、特定処理ステップにより特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップとを情報処理装置に実行させることを特徴とする。

本発明の第２のプログラムは、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処ステップと、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理ステップと、第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理ステップとを通信端末に実行させることを特徴とする。

本発明の第２の情報処理装置は、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、所望のデータの送受信を行う第２の無線通信部を用いて通信を行ったことのある複数の通信端末に関する情報を履歴情報として記憶する記憶処理手段と、第１の取得処理手段により取得された識別情報と履歴情報とを用いて通信相手を特定する特定処理

手段と、特定処理手段により特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段とを備えることを特徴とする。

履歴情報は、少なくともブルートゥースアドレス情報を含み、同期確立処理手段では、ブルートゥースアドレス情報に基づいて生成された ID パケットを特定処理手段により特定された通信端末に対して送信し、該 ID パケットに対する通信端末からの応答があったときは自身の FHS パケットを更に送信するようにすることができる。

本発明の通信システムおよび方法においては、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報が取得され、データの送受信を行う第２の無線通信部を用いて通信端末を含む複数の通信端末から各々の属性情報が取得され、識別情報と、属性情報とを用いて通信相手が特定される。そして、特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期が確立される。また、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、情報処理装置に自身の識別情報が提供され、第２の無線通信部を介して送信された情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の属性情報が提供され、第２の無線通信部を用いた無線通信の同期の確立に伴い情報処理装置からの要求に応じて、第４の無線通信部を介して所定の信号の送受信を行い同期が確立される。

本発明の第１の情報処理装置および方法、並びにプログラムにおいては、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報が取得され、所望のデータの送受信を行う第２の無線通信部を用いて、通信端末を含む複数の通信端末から各々の属性情報が取得され、取得された識別情報と、取得された属性情報とを用いて通信相手が特定される。また、特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期が確立される。

本発明の通信端末および方法、並びにプログラムにおいては、所定のデータの

PGR2023-00016 - Home Depot
Ex. 1003 - Page 719

送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報が提供され、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の属性情報が提供される。また、第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期が確立される。

本発明の第１の拡張装置においては、情報処理装置に電気的に接続され、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報が取得され、所望のデータの送受信を行う第２の無線通信部を用いて、複数の通信端末から各々の属性情報が取得される。また、取得された識別情報と、前記複数の通信端末から取得された属性情報とを用いて通信相手が特定され、特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期が確立される。

本発明の第２の拡張装置においては、通信端末に電気的に接続され、データの授受を行うための接続端子と、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの要求に応じて自身の識別情報が提供され、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの要求に応じて自身の属性情報が提供される。そして、第２の無線通信部を用いた無線通信の同期確立に伴い情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期が確立される。

本発明の第２の情報処理装置においては、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報が取得され、所望のデータの送受信を行う第２の無線通信部を用いて通信を行ったことのある複数の通信端末に関する情報を履歴情報として記憶され、取得された識別情報と履歴情報とを用いて通信相手が特定される。また、特定された通信端末と第２の無線通信部を用いた無線通信を行うための同期が確立される。

図面の簡単な説明

図１は、ピコネットとスカッタネットの概念を示す図である。

図２は、ピコネット内同期を確立する従来の処理を説明するフローチャートである。

図３は、ピコネット内同期を確立する従来の処理を説明する、図２に続くフローチャートである。

図４は、通信端末を選択する画面の表示例を示す図である。

図５は、通信端末を選択する画面の他の表示例を示す図である。

図６は、本発明を適用した通信システムの構成例を示す図である。

図７は、図６のパーソナルコンピュータの外観の例を示す図である。

図８は、図６のパーソナルコンピュータの外観の他の例を示す図である。

図９は、図６のパーソナルコンピュータの外観のさらに他の例を示す図である。

図１０は、図６のパーソナルコンピュータの側面の例を示す図である。

図１１は、図６のパーソナルコンピュータの構成例を示すブロック図である。

図１２は、図１１の非接触 IC カードリーダライタの構成例を示すブロック図である。

図１３は、図１１のブルートゥースモジュールの構成例を示すブロック図である。

図１４は、図６の携帯電話機の外観の例を示す図である。

図１５は、図６の携帯電話機の外観の他の例を示す図である。

図１６は、図６の携帯電話機の構成例を示すブロック図である。

図１７は、図１６の非接触 IC カードの構成例を示すブロック図である。

図１８は、図１７の非接触 IC カードの仕様の例を示す図である。

図１９は、図６の携帯電話機の機能構成の例を示すブロック図である。

図２０は、図６の通信システムの処理を説明するフローチャートである。

図２１は、図６の通信システムの処理を説明する図１９に続くフローチャートである。

図２２は、図６の通信システムの他の処理を説明するフローチャートである。

図２３は、図６の通信システムの他の処理を説明する図２１に続くフローチャートである。

図２４Ａは、図６の携帯電話機の他の構成例を示す模式図である。

図２４Ｂは、図６の携帯電話機の他の構成例を示す模式図である。

図２５Ａは、図６の携帯電話機のさらに他の構成例を示す模式図である。

図２５Ｂは、図６の携帯電話機のさらに他の構成例を示す模式図である。

図２６Ａは、図６の携帯電話機の構成例を示す模式図である。

図２６Ｂは、図６の携帯電話機の構成例を示す模式図である。

図２７は、図６の携帯電話機の処理を説明するフローチャートである。

図２８は、図６の携帯電話機の他の処理を説明するフローチャートである。

図２９は、図６の携帯電話機のさらに他の処理を説明するフローチャートである。

図３０は、本発明を適用したユビキタス社会の概念を示す図である。

発明を実施するための最良の形態

図６は、本発明を適用した通信システムの構成例を示す図である。

図６に示す通信システムにおいて、パーソナルコンピュータ５１、携帯電話機５２、および PDA(Personal Digital Assistants)５３には、それぞれブルートゥースモジュールが内蔵されており、ブルートゥースに準拠した近距離無線通信により、各種の情報を送受信できるようになされている。

また、携帯電話機５２には、非接触 IC カード（IC タグ）２４６（図１６参照）が内蔵されており、パーソナルコンピュータ５１には、その非接触 IC カード２４６に対して、各種の情報の書き込み、または読み出しが可能な非接触 IC カードリーダライタ１０５（図１１参照）が設けられている。従って、パーソナルコンピュータ５１と携帯電話機５２の間では、ブルートゥースによる通信だけでなく、非接触 IC カードリーダライタ１０５から輻射される電磁波を介しても通信を行うことができる。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 722

そして、本発明を適用した通信システムにおいては、例えば、パーソナルコンピュータ５１がピコネットのマスタである場合、パーソナルコンピュータ５１は、電磁波を介して携帯電話機５２から取得した情報に基づいて、携帯電話機５２をブルートゥースにより通信するスレーブとして特定し、その後のピコネット内同期の確立処理（上述した呼び出しの処理）を行う。

詳細な処理に関しては、フローチャートを参照して後述するが、ユーザが携帯電話機５２をパーソナルコンピュータ５１に近付け、パーソナルコンピュータ５１の非接触 IC カードリーダライタ１０５から輻射される電磁波を受信したとき、携帯電話機５２に内蔵されている非接触 IC カード２４６は、設定されている識別情報（以下、カード ID と称する）をパーソナルコンピュータ５１に提供する。

このカード ID は、例えば、携帯電話機５２に対して設定されているブルートゥースアドレス（に関する情報）と同一の情報である。そして、パーソナルコンピュータ５１は、上述した問い合わせにより、携帯電話機５２と PDA５３のブルートゥースアドレスが取得されたとき、既に通知されているブルートゥースアドレスを参照し、それに対応する携帯電話機５２を識別し、通信相手として特定する。

従って、図６において、パーソナルコンピュータ５１の問い合わせに対して、携帯電話機５２と PDA５３が、ともに応じることになるが、その後の呼び出しは、パーソナルコンピュータ５１と携帯電話機５２との間でのみ行われる。

このような処理により、携帯電話機５２のユーザは、上述したような選択画面から通信相手を選択することなく、図のように携帯電話機５２をパーソナルコンピュータ５１に近付けるだけで、ブルートゥースによる通信を開始することができる。

例えば、ユーザが PDA５３からパーソナルコンピュータ５１にブルートゥースで所定のデータを送信する場合には、上述したような画面から通信相手のデバイスとしてパーソナルコンピュータ５１を選択する必要があるが、携帯電話機５２から送信する場合には、そのような煩雑な処理をすることなく、パーソナルコ

ンピュータ５１に所定のデータを送信することができる。

次に、図６の通信システムの各構成について説明する。

図７乃至図１０は、図６のパーソナルコンピュータ５１の外観を示している。このノート型のパーソナルコンピュータ５１は、基本的に、本体６１と、この本体６１に対して開閉自在とされる表示部６２により構成されている。図７は表示部６２を本体６１に対して開いた状態を示す外観斜視図である。図８は本体６１の平面図、図９は本体６１に設けられている、後述するジョグダイヤル６３付近の拡大図である。また、図１０は本体６１のジョグダイヤル６３側の側面図である。

本体６１には、その上面に、各種の文字や記号などを入力するとき操作されるキーボード６４、ポインタ（マウスカーソル）を移動させるときなどに操作されるポインティングデバイスとしてのタッチパッド６５、および電源スイッチ６７が設けられており、また、側面側に、ジョグダイヤル６３、スロット６８、および IEEE1394 ポート７０等が設けられている。なお、タッチパッド６５に代えて、例えば、スティック式のポインティングデバイスを設けることも可能である。

また、表示部６２の正面には、画像を表示する LCD（Liquid Crystal Display）６６が設けられている。表示部６２の右上部には、電源ランプ PL、電池ランプ BL、必要に応じてメッセージランプ ML、その他の LED よりなるランプが設けられている。なお、電源ランプ PL や電池ランプ BL、メッセージランプ ML 等は表示部６２の下部に設けることも可能である。

次に、ジョグダイヤル６３は、本体６１上のキーボード６４のキーの間に組み込まれ、また、キーとほぼ同じ高さになるように取り付けられている。ジョグダイヤル６３は、図９の矢印 a に示す回転操作に対応して所定の処理を実行し、かつ、矢印 b に示す移動操作に対応した処理を実行する。なお、ジョグダイヤル６３は、本体６１の左側面に配置してもよく、LCD６６が設けられた表示部６２の左側面又は右側面、あるいは、キーボード６４のＧキーとＨキーの間に縦方向に配置してもよい。また、ジョグダイヤル６３は、タッチパッド６５を人差し指

PGR2023-00016 - Home Depot
Ex. 1003 - Page 724

で操作しながら親指で操作可能なように、前面の中央部に配置してもよく、あるいは、タッチパッド６５の上端縁又は下端縁に沿って横方向に配置しても、また、タッチパッド６５の右ボタンと左ボタンの間に縦方向に配置してもよい。更に、ジョグダイヤル６３は、縦方向や横方向に限定せず、各指で操作し易い斜め方向へ、所定角度を付けて配置してもよい。その他、ジョグダイヤル６３は、ポインティングデバイスであるマウスの側面の親指で操作可能な位置に配置することも可能である。

次に、図１１は、パーソナルコンピュータ５１の電気的構成を示すブロック図である。

CPU（Central Processing Unit（中央処理装置））８１は、例えば、インテル（Intel）社製のペンティアム（登録商標）（Pentium（Ｒ））プロセッサ等で構成され、ホストバス８２に接続されている。ホストバス８２には、更に、ブリッジ８３が接続されており、ブリッジ８３は、AGP（Accelerated Graphics Port）８４及び PCI バス８５にも接続されている。ブリッジ８３は、例えば、インテル社製の４００BX などで構成されており、CPU８１や RAM（Random Access Memory）８６周辺の制御を行うようになされている。更に、ブリッジ８３は、AGP８４を介してビデオコントローラ８７に接続されている。なお、このブリッジ８３とブリッジ１０７とで、いわゆるチップセットが構成されている。

ブリッジ８３は、更に、RAM８６及びキャッシュメモリ８８とも接続されている。キャッシュメモリ８８は、CPU８１が使用するデータをキャッシュするようになされている。なお、図示していないが、CPU８１にも１次的なキャッシュメモリが内蔵されている。

RAM８６は、例えば、DRAM（Dynamic Random Access Memory）で構成され、CPU８１が実行するプログラムや、CPU８１の行動上必要なデータを記憶するようになされている。具体的には、RAM８６には、起動が完了した時点において、例えば、電子メールプログラム８６Ａ、オートパイロットプログラム

PGR2023-00016 - Home Depot
Ex. 1003 - Page 725

８６Ｂ、ジョグダイヤル状態監視プログラム８６Ｃ、ジョグダイヤルドライバ８６Ｄ、オペレーティングプログラム（OS）８６Ｅ、リーダライタ制御プログラム８６Ｆ、およびブルートゥース制御プログラム８６Ｇ、その他のアプリケーションプログラム８６Ｈ1 乃至８６Ｈn が HDD１１４から転送され、記憶される。

電子メールプログラム８４Ａは、モデム９２を介して、電話回線９３のような通信回線からネットワーク経由で通信文を授受するプログラムである。電子メールプログラム８４Ａは、特定機能としての着信メール取得機能を有している。この着信メール取得機能は、インターネットサービスプロバイダ９４が備えるメールサーバ９５に対して、そのメールボックス９６内に自分（利用者）宛のメールが着信しているかどうかを確認して、自分宛のメールがあれば取得する処理を実行する。

オートパイロットプログラム８６Ｂは、予め設定された複数の処理（またはプログラム）などを、予め設定された順序で順次起動して、処理するプログラムである。

ジョグダイヤル状態監視プログラム８６Ｃは、アプリケーションプログラム８６Ｈ１乃至８６Ｈn からジョグダイヤル対応であるか否かの通知を受け取り、そのアプリケーションプログラムがジョグダイヤル対応であれば、ジョグダイヤル６３を操作することで実行できる操作を、アプリケーションが有するユーザインターフェース機能を用いて、ユーザに対して表示するために行動する。ジョグダイヤル状態監視プログラム８６Ｃは、通常、ジョグダイヤル６３のイベント待ちになっており、アプリケーションプログラムからの通知を受け取るリストを有している。ジョグダイヤルドライバ８６Ｄは、ジョグダイヤル６３の操作に対応して各種機能を実行する。

OS（Operation System（基本プログラムソフトウェア））８６Ｅは、例えば、マイクロソフト社のウィンドウズ（登録商標）９５（Windows（Ｒ）95）、ウィンドウズ（登録商標）９８（Windows（Ｒ）98）、あるいは、アップルコンピュータ社のマック OS（商標）等に代表される、コンピュータの基本的な行動

を制御するものである。

リーダライタ制御プログラム８６Ｆは、非接触 IC カードリーダライタ１０５（以下、適宜、リーダライタ１０５と称する）を制御し、パーソナルコンピュータ５１に対して近接されている、非接触 IC カードを内蔵する端末の存在を検出したり、その端末と電磁波を介して各種の情報を送受信するなどの処理を行う。

ブルートゥース制御プログラム８６Ｇは、ブルートゥースモジュール１０６を制御し、例えば、近傍に存在するブルートゥースデバイスの検出や、そのブルートゥースデバイスと通信するための同期を確立するなどの処理を行う。

ビデオコントローラ８７は、PCI バス８５に接続されており、更に、AGP８４を介してブリッジ８３に接続されており、PCI バス８５、もしくは AGP８４を介して供給されるデータに基づいて、LCD６６の表示を制御する。

PCI バス８５には、サウンドコントローラ８９が接続され、スピーカ９０とマイクロフォン６６が接続されている。サウンドコントローラ８９は、マイクロフォン６６からの音声入力を取り込み、あるいはスピーカ９０に対して音声信号を供給する。

また、PCI バス８５には、モデム９２および PC カードスロットインターフェース９８も接続されている。

モデム９２は、電話回線９３、インターネットサービスプロバイダ９４を介して、インターネット９７やメールサーバ９５等に接続することができる。

また、オプション機能を追加する場合、PC カードスロットインターフェース９８に接続されているスロット６８に、インターフェースカード９９が適宜装着されることにより、外部装置とのデータの授受ができるようになされている。例えば、インターフェースカード９９には、ドライブ１００を接続することができ、ドライブ１００に挿入される磁気ディスク１０１、光ディスク１０２、光磁気ディスク１０３、および半導体メモリ１０４などとデータの授受を行うことができる。

なお、磁気ディスク１０１、光ディスク１０２、光磁気ディスク１０３、およ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 727

び半導体メモリ１０５とデータの授受を行うドライブ１００は、USB ポート１１５を介して接続することもできる。

更に、PCI バス８５にはブリッジ１０７も接続されている。ブリッジ１０７は、例えば、インテル社製の PIIX４Ｅなどで構成されており、各種の入出力を制御するようになされている。すなわち、ブリッジ１０７は、IDE (Integrated Drive Electronics) コントローラ／コンフィギュレーションレジスタ１０８、IDE インターフェース１０９、タイマ回路１１０、および USB (Universal Serial Bus) インターフェース１１１で構成され、IDE バス１１３に接続されるデバイス、USB ポート１１５に接続されるデバイス、もしくは、ISA/EIO (Industry Standard Architecture / Extended Input Output) バス１１２および I/O インターフェース１１７を介して接続されるデバイスの制御等を行うようになされている。

例えば、USB ポート１１５に、GPS (Global Positioning System) アンテナ１１６が装着された場合、USB インターフェース１１１は、GPS アンテナ１１６から供給される位置データ、および時刻データを PCI バス８５、ブリッジ８３、およびホストバス８２を介して CPU８１へ送出する。

IDE コントローラ／コンフィギュレーションレジスタ１０８は、いわゆるプライマリ IDE コントローラとセカンダリ IDE コントローラとの２つの IDE コントローラ、およびコンフィギュレーションレジスタ (configuration register) 等から構成されている。

プライマリ IDE コントローラは、IDE バス１１３を介して、コネクタ（図示せず）に接続しており、コネクタには、HDD１１４が接続されている。また、セカンダリ IDE コントローラは、他の IDE バス（図示せず）を介して、外部装置と接続可能なようになされている。

なお、HDD１１４には、電子メールプログラム１１４Ａ、オートパイロットプログラム１１４Ｂ、ジョグダイヤル状態監視プログラム１１４Ｃ、ジョグダイヤルドライバ１１４Ｄ、OS（基本プログラムソフトウェア）１１４Ｅ、リーダ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 728

ライタ制御プログラム１１４F、およびブルートゥース制御プログラム１１４G、その他の複数のアプリケーションプログラム１１４H１乃至１１４Hn、さらに、それらのプログラムで用いられるデータ等が記憶されている。HDD１１４に記憶されているプログラム１１４Ａ乃至１１４Ｈｎは、起動（ブートアップ）処理の過程で、RAM８６内に順次転送され、格納される。

ISA/EIO バス１１２には、更に、I/O インターフェース１１７が接続されている。この I/O インターフェース１１７と、ROM１１８、RAM１１９、および CPU１２０とは、相互に接続されて構成されている。

ROM１１８には、例えば、IEEE1394I/F プログラム１１８Ａ、LED 制御プログラム１１８Ｂ、タッチパッド入力監視プログラム１１８C、キー入力監視プログラム１１８D、ウェイクアッププログラム１１８Ｅ、ジョグダイヤル状態監視プログラム１１８Ｆが予め格納されている。

IEEE1394I/F プログラム１１８Ａは IEEE1394 入出力ポート７０を介して送受信される IEEE1394 準拠のデータの入出力を行うプログラムである。LED 制御プログラム１１８Ｂは、電源ランプ PL、電池ランプ BL、必要に応じてメッセージランプ ML、その他の LED よりなるランプの点灯の制御を行うプログラムである。タッチパッド入力監視プログラム１１８Cは、タッチパッド６５を用いたユーザによる入力を監視するプログラムである。キー入力監視プログラム１１８Dは、キーボード６４やその他のキースイッチを用いたユーザによる入力を監視するプログラムである。ウェイクアッププログラム１１８Ｅは、ブリッジ１０８内のタイマ回路１１０から供給される現在時刻データに基づいて、予め設定された時刻になったかどうかをチェックして、設定された時刻になると、所定の処理（またはプログラム）を起動するために各チップ電源の管理を行うプログラムである。ジョグダイヤル状態監視プログラム１１８Ｆは、ジョグダイヤル６３の回転型エンコーダ部の回転、あるいは押下を常に監視するためのプログラムである。

更に、ROM１１８には、BIOS（Basic Input/Output System）１１８Gが

PGR2023-00016 - Home Depot
Ex. 1003 - Page 729

書き込まれている。BIOS とは、基本入出力システムのことをいい、OS やアプリケーションプログラムと周辺機器（ディスプレイ、キーボード、HDD 等）の間でのデータの入出力を制御するソフトウェアプログラムである。

RAM１１９は、LED 制御、タッチパッド入力ステイタス、キー入力ステイタス、設定時刻用の各レジスタや、ジョグダイヤル状態監視用の I/O レジスタ、IEEE1394I/F レジスタ等を、レジスタ１１９Ａ乃至１１９Ｆとして有している。例えば、LED 制御レジスタは、ジョグダイヤル６３が押下された場合、電子メールの瞬時の立ち上げ状態を表示するメッセージランプ ML の点灯を制御する。キー入力ステイタスレジスタは、ジョグダイヤル６３が押下されると、操作キーフラグが格納されるようになっている。設定時刻レジスタは、ある時刻を任意に設定することができる。

また、この I/O インターフェース１１７には、図示を省略したコネクタを介して、ジョグダイヤル６３、キーボード６４、タッチパッド６５、IEEE1394 入出力ポート７０がそれぞれ接続されており、ジョグダイヤル６３、キーボード６４、タッチパッド６５を用いて、ユーザが操作を行った場合、ジョグダイヤル６３、キーボード６４、タッチパッド６５から、それぞれが受けた操作に対応する信号を入力され、ISA/EIO バス１１２に出力するようになされている。更に、I/O インターフェース１１７は、IEEE1394 入出力ポート７０を介して外部との間でデータの送受信を行う。更に、I/O インターフェース１１７には、電源ランプ PL、電池ランプ BL、メッセージランプ ML、電源制御回路１２１、その他の LED よりなるランプが接続されている。

電源制御回路１２１は、内蔵バッテリ１２２又は AC 電源に接続されており、各ブロックに、必要な電源を供給するとともに、内蔵バッテリ１２２や、周辺装置のセカンドバッテリの充電のための制御を行うようになされている。また、CPU１２０は、I/O インターフェース１１７を介して、電源をオン又はオフするとき操作される電源スイッチ６７を監視している。

CPU１２０は、電源がオフ状態の場合においても、常に内部電源により、IE

PGR2023-00016 - Home Depot
Ex. 1003 - Page 730

EE1394I/F プログラム１１８Ａ乃至 BIOS１１８Ｇを実行することができる。すなわち、IEEE1394I/F プログラム１１８Ａ乃至 BIOS１１８Ｇは、表示部６２の LCD６６上にいずれかのウインドウが開いていない場合においても、常時行動している。従って、CPU１２０は、電源スイッチ６７がオフ状態で、OS８６Ｅが CPU８１で起動されていなくても、常時、ジョグダイヤル状態監視プログラム１１８Ｅを実行しており、パーソナルコンピュータ５１に専用のキーを設けなくとも、プログラマブルパワーキー（PPK）機能を有するようになされており、ユーザは、例えば、省電力状態、あるいは電源オフ状態であっても、ジョグダイヤル６３を押下するだけで、好みのソフトウエアやスクリプトファイルを起動することができる。

図１２は、図１１の非接触 IC カードリーダライタ１０５の詳細な構成例を示すブロック図である。

IC１３１は、CPU１５１、SPU（Signal Processing Unit）１５２、SCC（Serial Communication Controller）１５３、並びにメモリ１５４により構成され、さらに、メモリ１５４は、ROM１６１、および RAM１６１から構成されている。これらの CPU１５１乃至メモリ１５４は、バス１５５を介して相互に接続されている。

CPU１５１は、ROM１６１に格納されている制御プログラムを RAM１６２に展開し、非接触 IC カード２４６から送信されてきた応答データや、図１１の CPU８１から供給されてきた制御信号に基づいて、各種の処理を実行する。例えば、CPU１５１は、非接触 IC カード２４６に送信するコマンドを生成し、それを、バス１５５を介して SPU１５２に出力したり、非接触 IC カード２４６から送信されてきたデータの認証処理などを行う。

また、CPU１５１は、携帯電話機５２が近接され、後述する各部の処理によりカード ID が通知されてきたとき、CPU８１の指示に基づいて、それをブルートゥースモジュール１０６に通知するなどの処理を行う。

SPU１５２は、非接触 IC カード２４６からの応答データが復調部１３４から

PGR2023-00016 - Home Depot
Ex. 1003 - Page 731

供給されてきたとき、そのデータに対して、例えば、BPSK（Binary Phase Shift Keying）復調（マンチェスターコードのデコード）などを施し、取得したデータを CPU１５１に供給する。また、SPU１５２は、非接触 IC カード２４６に送信するコマンドがバス１５５を介して供給されてきたとき、そのコマンドに BPSK 変調（マンチェスターコードへのコーディング）を施し、取得したデータを変調部１３２に出力する。

SCC１５３は、CPU８１から供給されてきたデータを、バス１５５を介して CPU１５１に供給したり、CPU１５１から、バス１５５を介して供給されてきたデータを CPU８１に出力する。

変調部１３２は、発振回路（OSC）１３３から供給される所定の周波数（例えば、１３．５６MHz）の搬送波を、SPU１５２より供給されるデータに基づいて、ASK（Amplitude Shift Keying）変調し、生成された変調波を、電磁波として、アンテナ１３５から出力する。一方、復調部１３４は、アンテナ１３５を介して取得した変調波（ASK 変調波）を復調し、復調されたデータを SPU１５２に出力する。

アンテナ１３５は、所定の電磁波を輻射し、それに対する負荷の変化に基づいて、非接触 IC カード２４６（携帯電話機５２）が近接されたか否かを検出する。そして、非接触 IC カード２４６が近接されたとき、アンテナ１３５は、非接触 IC カード２４６と各種のデータを送受信する。

図１３は、図１１のブルートゥースモジュール１０６の詳細な構成例を示すブロック図である。

CPU１７１は、ROM１７２に格納されている制御プログラムを RAM１７３に展開し、ブルートゥースモジュール１０６の全体の動作を制御する。これらの CPU１７１乃至 RAM１７３は、バス１７５を介して相互に接続されており、このバス１７５には、また、フラッシュメモリ１７４が接続されている。

フラッシュメモリ１７４には、例えば、それぞれのブルートゥースデバイスに対して設定され、ユーザが好みに応じて変更することが可能なブルートゥースデ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 732

バイス名、および、それぞれのブルートゥースデバイスに対して固有なブルートゥースアドレスなどが記憶されている。

ブルートゥースアドレスは、４８ビットの識別子であり、それぞれのブルートゥースデバイスに対して固有（一義的）であることから、ブルートゥースデバイスの管理に関する様々な処理に利用される。

例えば、上述したように、ピコネット内同期を確立するためには、全てのスレーブがマスタの周波数ホッピングパターンに関する情報を取得している必要があり、この周波数ホッピングパターンは、マスタのブルートゥースアドレスに基づいてスレーブにより算出されるようになされている。

より詳細には、ブルートゥースアドレスは、その下位２４ビットが LAP(Low Address Part)と、次の８ビットが UAP(Upper Address Part)と、そして残りの１６ビットが NAP(Non-significant Address Part)とそれぞれ区分されており、周波数ホッピングパターンの算出には、LAP 全体の２４ビットと UAP の下位４ビットからなる２８ビットが用いられる。

それぞれのスレーブは、ピコネット内同期を確立するための呼び出し時において取得した、マスタのブルートゥースアドレスの上述した２８ビットの部分と、同様にマスタから通知された、ブルートゥースクロックに基づいて、周波数ホッピングパターンを算出することができる。

なお、この周波数ホッピングパターンには、問い合わせ時において使用される問い合わせ周波数ホッピングパターンと、呼び出し時において使用される呼び出し周波数ホッピングパターンと、ピコネット内同期が確立された後に、スレーブとマスタの間で通信するときに使用されるチャネル周波数ホッピングパターンが規定されている。以下において、この３つの周波数ホッピングパターンを個々に区別する必要がない場合、単に、周波数ホッピングパターンと称する。

図１３の説明に戻り、フラッシュメモリ１７４には、また、ピコネット内同期確立後に、通信相手のブルートゥースデバイスを認証したり、送信するデータを暗号化したりするためのリンクキーなどが記憶され、必要に応じて CPU１７１

PGR2023-00016 - Home Depot
Ex. 1003 - Page 733

に提供される。

入出力インタフェース１７６は、CPU１７１からの指示に基づいて、図１１の CPU８１から供給されてきたデータ、およびベースバンド制御部１７７から供給されてきたデータの入出力を管理する。

ベースバンド制御部１７７は、入出力インタフェース１７６から供給されてきたデータを携帯電話機５２に送信すべく、GFSK(Gaussian Frequency Shift Keying)変調部１９１に供給し、GFSK 復調部１９７からデータが供給されてきたとき、それをバス１７５、または入出力インタフェース１７６に出力する。

GFSK 変調部１９１は、ベースバンド制御部１７７から供給されてきたデータの高域成分をフィルタにより制限し、１次変調として周波数変調を行い、取得したデータをスペクトラム拡散部１９２に出力する。

スペクトラム拡散部１９２は、上述したようにして算出され、ホッピングシンセサイザ部１９５から通知される周波数ホッピングパターンに基づいて搬送周波数を切り替え、供給されてきたデータに対してスペクトラム拡散を施した後に得られた信号を通信制御部１９３に出力する。ブルートゥースにおいては、スペクトラム拡散部１９２は、６２５μ 秒毎に周波数をホッピングさせて、データを送信するようになされている。

通信制御部１９３は、２．４GHz 帯を使用して、スペクトラム拡散が施された信号をアンテナ１９４から送信する。また、通信制御部１９３は、アンテナ１９４からの受信信号を逆スペクトラム拡散部１９６に出力する。

逆スペクトラム拡散部１９６は、ホッピングシンセサイザ部１９５から通知される周波数ホッピングパターンに基づいて受信周波数をホッピングさせ、例えば、携帯電話機５２からの信号を取得する。また、逆スペクトラム拡散部１９６は、取得した信号を逆スペクトラム拡散し、携帯電話機５２からの信号を再生した後に得られた信号を GFSK 復調部１９７に出力する。GFSK 復調部１９７は、逆スペクトラム拡散部１９６から供給されてきた信号を GFSK 復調し、得られたデータをベースバンド制御部１７７に出力する。

次に、携帯電話機５２の構成例について説明する。

図１４は、図６の携帯電話機５２の外観の構成例を示している。

図１４に示されるように、携帯電話機５２は、表示部２１２および本体２１３で構成され、中央のヒンジ部２１１により折り畳み可能に形成されている。

表示部２１２は、上端左部に、引出しまたは収納可能な送受信用のアンテナ２１４を有する。携帯電話機５２は、アンテナ２１４を介して、固定無線端末である基地局との間で電波を送受信する。

また、表示部２１２は、上端中央部にほぼ１８０度の角度範囲で回動自在なカメラ部２１５を有する。携帯電話機５２は、カメラ部２１５の CCD(Charge Coupled Device)カメラ２１６によって所望の撮像対象を撮像する。

カメラ部２１５がユーザによってほぼ１８０度回動されて位置決めされた場合、図１５に示されるように、表示部２１２は、カメラ部２１５の背面側中央に設けられたスピーカ２２４が正面側に位置する状態となる。これにより、携帯電話機５２は、通常の音声通話状態に切り換わる。

さらに、表示部２１２の中央に液晶ディスプレイ２１７が設けられている。液晶ディスプレイ２１７は、電波の受信状態、電池残量、電話帳として登録されている相手先名や電話番号、および発信履歴等の他、電子メールの内容、簡易ホームページ、カメラ部２１５の CCD カメラ２１６で撮像した画像などを表示する。

一方、本体２１３には、その表面に「０」乃至「９」の数字キー、発呼キー、リダイヤルキー、終話及び電源キー、クリアキー及び電子メールキー等の操作キー２１８が設けられている。操作キー２１８の操作に対応した各種指示が、携帯電話機５２に入力される。

また、本体２１３の操作キー２１８の下部にメモボタン２１９およびマイクロフォン２２０が設けられている。携帯電話機５２は、メモボタン２１９が操作されたとき、通話中の相手の音声を録音する。携帯電話機５２は、マイクロフォン２２０によって通話時のユーザの音声を集音する。

さらに、本体２１３の操作キー２１８の上部に回動自在なジョグダイヤル２２

PGR2023-00016 - Home Depot
Ex. 1003 - Page 735

１が、本体２１３の表面から僅かに突出した状態で設けられている。携帯電話機５２は、ジョグダイヤル２２１に対する回動操作に応じて、液晶ディスプレイ２１７に表示されている電話帳リストもしくは電子メールのスクロール動作、簡易ホームページのページ捲り動作、または画像の送り動作等の種々の動作を実行する。

例えば、本体２１３は、ユーザによるジョグダイヤル２２１の回動操作に応じて液晶ディスプレイ２１７に表示された電話帳リストの複数の電話番号の中から所望の電話番号を選択し、ジョグダイヤル２２１が本体２１３の内部方向に押圧されたとき、選択されている電話番号を確定して、その電話番号に対して発呼処理を行う。

なお、本体２１３は、背面側に図示せぬバッテリパックが装着されており、終話／電源キーがオン状態になると、バッテリパックから各回路部に対して電力が供給されて動作可能な状態に起動する。

ところで、本体２１３の左側面上部に抜差自在なメモリースティック（登録商標）２２３を装着するためのメモリースティックスロット２２２が設けられている。携帯電話機５２は、メモボタン２１９が押下されると、通話中の相手の音声を装着されているメモリースティック２２３に記録する。携帯電話機５２は、ユーザの操作に応じて、電子メール、簡易ホームページ、CCD カメラ２１６で撮像した画像を、装着されているメモリースティック２２３に記録する。

メモリースティック２２３は、本願出願人であるソニー株式会社によって開発されたフラッシュメモリカードの一種である。このメモリースティック２２３は、縦２１．５×横５０×厚さ２．８[mm] の小型薄型形状のプラスチックケース内に電気的に書換えや消去が可能な不揮発性メモリである EEPROM（Electrically Erasable and Programmable Read Only Memory ）の一種であるフラッシュメモリ素子を格納したものであり、１０ピン端子を介して画像や音声、音楽等の各種データの書き込み及び読み出しが可能となっている。

従って、携帯電話機５２は、このようなメモリースティック２２３を装着可能

PGR2023-00016 - Home Depot
Ex. 1003 - Page 736

に構成されているために、メモリースティック２２３を介して、他の電子機器との間でデータの共有化を図ることができる。

また、所定の機能を拡張するためのモジュール（チップ）をメモリースティック２２３に組み込み、メモリースティックスロット２２２にそれを装着させることにより、携帯電話機５２の機能をさらに拡張させることができる。

例えば、後述するように、ブルートゥースモジュールや非接触 IC カードが組み込まれたメモリースティック２２３を携帯電話機５２に装着することにより、例えば、それらのモジュールが携帯電話機５２に内蔵されていない場合であっても、パーソナルコンピュータ５１とブルートゥースによる通信、および非接触 IC カードによる通信ができるように機能を拡張させることもできる。

図１６は、携帯電話機５２の内部の構成例を示している。

表示部２１２および本体２１３の各部を統括的に制御する主制御部２３１に対して、電源回路部２３５、操作入力制御部２３２、画像エンコーダ２３３、カメラインターフェース（I/F）部２３４、LCD 制御部２３６、多重分離部２３８、変復調回路部２３９、音声コーデック２４０、赤外線通信部２４５、非接触 IC カード２４６、およびブルートゥースモジュール２４７がメインバス２４１を介して互いに接続されるとともに、画像エンコーダ２３３、画像デコーダ２３７、多重分離部２３８、メモリースティック制御部２４３、変復調回路部２３９、および音声コーデック２４０が同期バス２４２を介して互いに接続されている。

電源回路部２３５は、ユーザの操作により終話／電源キーがオン状態にされると、バッテリパックから各部に対して電力を供給することにより携帯電話機５２を動作可能な状態に起動する。また、電源回路部２３５は、後述するように、非接触 IC カード２４６から、ブルートゥースモジュール２４７を起動させることが指示された場合、ブルートゥースモジュール２４７に電源を供給し、起動させる。

なお、ブルートゥースモジュール２４７の電源がオフにされている状態において、非接触 IC カード２４６からの指示に基づいて、その電源を起動させるタイ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 737

ミングは、例えば、携帯電話機５２がパーソナルコンピュータ５１に近接され、非接触 IC カードリーダライタ１０５から輻射されている電磁波を非接触 IC カード２４６が受信したタイミングとされる。

携帯電話機５２は、CPU、ROM、および RAM 等でなる主制御部２３１の制御に基づいて、音声通話モード時において、マイクロフォン２２０で集音した音声信号を音声コーデック２４０によってデジタル音声データに変換する。携帯電話機５２は、デジタル音声データを変復調回路部２３９でスペクトラム拡散処理し、送受信回路部２４４でデジタルアナログ変換処理および周波数変換処理を施した後、アンテナ２１４を介して送信する。

また、携帯電話機５２は、音声通話モード時において、アンテナ２１４で受信した受信信号を増幅して周波数変換処理およびアナログデジタル変換処理を施し、変復調回路部２３９でスペクトラム逆拡散処理し、音声コーデック２４０によってアナログ音声信号に変換する。携帯電話機５２は、アナログ音声信号に対応する音声をスピーカ２２４に出力させる。

さらに、携帯電話機５２は、データ通信モード時において、電子メールを送信する場合、操作キー２１８およびジョグダイヤル２２１の操作によって入力されたテキストデータを、操作入力制御部２３２を介して主制御部２３１に送出する。

主制御部２３１は、テキストデータを変復調回路部２３９でスペクトラム拡散処理し、送受信回路部２４４でデジタルアナログ変換処理及び周波数変換処理を施した後、アンテナ２１４を介して基地局へ送信する。

これに対して、携帯電話機５２は、データ通信モード時において、電子メールを受信する場合、アンテナ２１４を介して基地局から受信した受信信号を変復調回路部２３９で逆スペクトラム拡散処理して、元のテキストデータを復元した後、LCD 制御部２３６を介して液晶ディスプレイ２１７に電子メールとして表示する。

この後、携帯電話機５２は、ユーザの操作に応じて受信した電子メールを、メモリースティック制御部２４３を介してメモリースティック２２３に記録するこ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 738

とも可能である。

携帯電話機５２は、データ通信モード時において画像データを送信する場合、CCD カメラ２１６で撮像された画像データを、カメラインターフェース部２３４を介して画像エンコーダ２３３に供給する。

因みに、携帯電話機５２は、画像データを送信しない場合には、CCD カメラ２１６で撮像した画像データを、カメラインターフェース部２３４および LCD 制御部２３６を介して、液晶ディスプレイ２１７に直接表示することも可能である。

画像エンコーダ２３３は、CCD カメラ２１６から供給された画像データを、例えば、MPEG(Moving Picture Experts Group)２または MPEG４等の所定の符号化方式によって圧縮符号化することにより符号化画像データに変換し、これを多重分離部２３８に送出する。

このとき同時に、携帯電話機５２は、CCD カメラ２１６で撮像中にマイクロフォン２２０で集音した音声を、音声コーデック２４０を介してデジタルの音声データとして多重分離部２３８に送出する。

多重分離部２３８は、画像エンコーダ２３３から供給された符号化画像データと音声コーデック２４０から供給された音声データとを所定の方式で多重化し、その結果得られる多重化データを変復調回路部２３９でスペクトラム拡散処理し、送受信回路部２４４でデジタルアナログ変換処理及び周波数変換処理を施した後、アンテナ２１４を介して送信する。

これに対して、携帯電話機５２は、データ通信モード時において、例えば、簡易ホームページ等にリンクされた動画像ファイルのデータを受信する場合、アンテナ２１４を介して基地局から受信した受信信号を変復調回路部２３９で逆スペクトラム拡散処理し、その結果得られる多重化データを多重分離部２３８に送出する。

多重分離部２３８は、多重化データを符号化画像データと音声データとに分離し、同期バス２４２を介して、符号化画像データを画像デコーダ２３７に供給す

PGR2023-00016 - Home Depot
Ex. 1003 - Page 739

るとともに、音声データを音声コーデック２４０に供給する。

画像デコーダ２３７は、符号化画像データを MPEG２または MPEG４等の所定の符号化方式に対応した復号方式でデコードすることにより再生動画像データを生成し、これを、LCD 制御部２３６を介して液晶ディスプレイ２１７に供給する。これにより、携帯電話機５２は、例えば、簡易ホームページにリンクされた動画像ファイルに含まれる動画データを表示する。

このとき同時に、音声コーデック２４０は、音声データをアナログ音声信号に変換した後、これをスピーカ２２４に供給する。これにより、携帯電話機５２は、例えば、簡易ホームページにリンクされた動画像ファイルに含まれる音声データを再生する。

この場合も電子メールの場合と同様に、携帯電話機５２は、受信した簡易ホームページ等にリンクされたデータを、ユーザの操作により、メモリースティック制御部２４３を介してメモリースティック２２３に記録することが可能である。

非接触 IC カード２４６は、パーソナルコンピュータ５１に近接され、リーダライタ１０５から輻射される電磁波を受信したとき、それに応じて、各種の情報をリーダライタ１０５に提供する。

図１７は、非接触 IC カード２４６の詳細な構成例を示すブロック図である。

非接触 IC カード２４６は、例えば、図に示すアンテナ（ループアンテナ）２７０およびコンデンサ２７１と、それ以外の構成が１チップに格納された IC から構成され、電磁誘導を利用してリーダライタ１０５と各種のデータを半二重通信するものであって、必ずしもカード状のものとして構成されるわけではない。また、IC カードとは、説明の便宜上用いた名称であり、上述したような、または後述するような機能を意図するものである。この非接触 IC カード２４６と基本的に同様の機能を提供するものとして、例えば、Felica（登録商標）などがある。

CPU２６１は、ROM２６２に格納されている制御プログラムを RAM２６３に展開し、非接触 IC カード２４６の全体の動作を制御する。例えば、CPU２６

１は、リーダライタ１０５から輻射されている電磁波がアンテナ２７０において受信されたとき、それに応じて、非接触 IC カード２４６に設定されている識別情報としてのカード ID をリーダライタ１０５に通知する。

このカード ID は、自由に設定を変更できるものであり、例えば、ブルートゥースモジュール２４７（携帯電話機５２）に設定されているブルートゥースデバイス名と同一、またはブルートゥースデバイス名を含むものとされる。

インターフェース部２６９は、ASK 復調部２８３において、アンテナ２７０を介して受信した変調波（ASK 変調波）を包絡線検波して復調し、復調後のデータを BPSK 復調部２７２に出力する。アンテナ２７０とコンデンサ２７１により構成される LC 回路においては、リーダライタ１０５から輻射される所定の周波数の電磁波により共振が生じている。

また、インターフェース部２６９は、アンテナ２７０において励起された交流磁界を ASK 復調部２８３により整流し、それを電圧レギュレータ２８１において安定化し、各部に直流電源として供給する。リーダライタ１０５から輻射される電磁波の電力は、後述するように、非接触 IC カード２４６に必要な電力を賄う磁界を発生させるように調整されている。

また、インターフェース部２６９は、発振回路２８４においてデータのクロック周波数と同一の信号を発振し、それを図示せぬ PLL 部に出力する。

さらに、インターフェース部２６９は、例えば、カード ID などのデータをリーダライタ１０５に送信する場合、BPSK 変調部２６８から供給されるデータに対応して、例えば、所定のスイッチング素子をオン／オフさせ、スイッチング素子がオン状態であるときだけ、所定の負荷をアンテナ２７０に並列に接続させることにより、アンテナ２７０の負荷を変動させる。

ASK 変調部２８２は、アンテナ２７０の負荷の変動により、アンテナ２７０において受信されているリーダライタ１０５からの変調波を ASK 変調し、その変調成分をアンテナ２７０を介してリーダライタ１０５に送信する（リーダライタ１０５のアンテナ１３５の端子電圧を変動させる）（ロードスイッチング方

式）。

BPSK 復調部２７２は、ASK 復調部２８３で復調されたデータが BPSK 変調されている場合、図示せぬ PLL 部から供給されるクロック信号に基づいて、そのデータの復調（マンチェスターコードのデコード）を行い、復調したデータをデータ受信部２７３に出力する。データ受信部２７３は、供給されてきたデータを CPU２６１等に適宜出力する。

BPSK 変調部２６８は、データ送信部２６７から供給されてきたデータに BPSK 変調（マンチェスターコードへのコーディング）を行い、それを ASK 変調部２８２に出力する。

また、非接触 IC カード２４６においては、カード ID をパーソナルコンピュータ５１に通知するだけでなく、例えば、リーダライタ１０５との間での認証処理や、送信するデータの暗号化処理など、様々な処理が行われる。

図１８は、非接触 IC カード２４６の仕様の例を示す図である。

上述したように、リーダライタ１０５と非接触 IC カード２４６間の通信は、半二重により行われ、その通信速度は、例えば、２１１．８７５kbps である。

また、図に示すように、リーダライタ１０５から非接触 IC カード２４６に対する電力電送、およびデータ転送、並びに、非接触 IC カード２４６からリーダライタ１０５に対するデータ転送により使用される周波数帯域の中心周波数は、例えば、１３．５６MHz である。

そして、電力電送のためにリーダライタ１０５から出力される電波の出力は、例えば、３５０mW であり、アンテナの特性などの通信環境にもよるが、その通信距離は、例えば、１０cm 前後とされる。

リーダライタ１０５から非接触 IC カード２４６に対するデータ転送は、上述したように、マンチェスターコードにコード化されたデータを ASK 変調することにより行われ、その変調度（データ信号の最大振幅／搬送波の最大振幅）は、例えば、約０．１とされる。また、非接触 IC カード２４６からリーダライタ１０５に対するデータ転送は、上述したように、ロードスイッチング方式により出

力データを送信信号に変換する（出力データに応じてスイッチング素子をオン／オフさせることによりアンテナ１３５の負荷を変動させる）ことにより行われる。

図１６の説明に戻り、ブルートゥースモジュール２４７は、例えば、パーソナルコンピュータ５１のブルートゥースモジュール１０６とピコネットを形成し、主制御部２３１からの指示に基づいて、各種のデータを送受信する。

なお、ブルートゥースモジュール２４７の構成は、図１３に示したものと同様の構成であるため、その詳細な説明は省略する。以下において、例えば、ブルートゥースモジュール１０６の CPU は CPU１７１Ａとし、ブルートゥースモジュール２４７の CPU は CPU１７１Ｂとして適宜説明する。他の構成についても同様にして説明する。

以上においては、非接触 IC カード２４６、およびブルートゥースモジュール２４７は、携帯電話機５２に内蔵されるとしたが、例えば、メモリースティック２２３に組み込まれた状態で携帯電話機５２に装着され、メモリースティック制御部２４３により制御されるようにしてもよい。

図１９は、携帯電話機５２の機能ブロックの例を示す図である。

ホストプログラム３０１は、携帯電話機５２の基本的な機能を提供し、例えば、通話機能や、電子メールの送受信機能を提供する。非接触 IC カード制御プログラム３０２は、非接触 IC カード２４６の動作を制御するとともに、カード ID 設定プログラム３０３、およびブルートゥース制御プログラム３０４等と連動し、各種の処理を行う。

例えば、非接触 IC カード制御プログラム３０２は、携帯電話機５２がパーソナルコンピュータ５１に近接されたとき、ブルートゥースアドレスと対応するカード ID をリーダライタ１０５に提供したり、リーダライタ１０５からの電磁波を受信することに応じて、ブルートゥースモジュール２４７（ブルートゥース制御プログラム３０４）を起動させたりする。

カード ID 設定プログラム３０３は、EEPROM２６４に格納されているカード ID を管理し、ユーザから指示されたとき、適宜、それを書き換える。また、

カード ID 設定プログラム３０３は、ブルートゥースモジュール２４７に設定されているブルートゥースアドレスが含まれるように、カード ID を書き換えて設定する。

ブルートゥース制御プログラム３０４は、ブルートゥースモジュール２４７の動作を制御し、他のブルートゥースデバイスとの通信を実現させる。ブルートゥースデバイス名設定プログラム３０５は、フラッシュメモリ１７４Ｂ（ブルートゥースモジュール２４７のフラッシュメモリ）に設定されているブルートゥースデバイス名を管理する。

次に、図６の通信システムの動作について説明する。

始めに、図２０、および図２１のフローチャートを参照して、パーソナルコンピュータ５１が通信相手を特定し、そのブルートゥースデバイスに対してのみ、ピコネット内同期の確立処理を行う一連の処理について説明する。

なお、以下の処理においては、パーソナルコンピュータ５１をマスタとし、その他のブルートゥースデバイス（携帯電話機５２、PDA５３）をスレーブとする。また、以下のフローチャートの説明において、適宜、通信とはピコネット内同期を確立し、相手を特定した後に行われる、ブルートゥースによる通信を意味する。

ステップＳ１２１において、リーダライタ制御プログラム８６Ｆは、非接触 IC カードが内蔵されている端末（携帯電話機５２）を検出するための電磁波を輻射する。リーダライタ制御プログラム８６Ｆは、所定の制御コマンドによりリーダライタ１０５を制御し、アンテナ１３５から所定の周期で電磁波を輻射させる。

非接触 IC カード制御プログラム３０２は、携帯電話機５２がパーソナルコンピュータ５１に近接され、ステップＳ１３１で、その電磁波を受信したとき、ステップＳ１３２に進み、ブルートゥースモジュール２４７に設定されているブルートゥースアドレスに対応するカード ID を EEPROM２６４から読み出させ、それをリーダライタ１０５に通知させる。

ステップＳ１２２において、リーダライタ制御プログラム８６Ｆは、非接触 I

Cカード２４６から通知されてきたブルートゥースアドレスを受信し、ステップＳ１２３に進み、それをブルートゥース制御プログラム８６Ｇに通知する。

そして、ステップＳ１０１において、ブルートゥース制御プログラム８６Ｇは、携帯電話機５２（ブルートゥースモジュール２４７）に設定されているブルートゥースアドレスを取得する。

ステップＳ１０２乃至ステップＳ１０９において、ブルートゥース制御プログラム８６Ｇにより実行される処理、ステップＳ１４１以降においてブルートゥース制御プログラム３０４により実行される処理、およびステップＳ１６１以降において PDA５３のブルートゥース制御プログラムにより実行される処理は、図２、および図３を参照して説明した問い合わせ、および呼び出しと同様の処理である。

すなわち、ステップＳ１０２において、ブルートゥース制御プログラム８６Ｇは、ブルートゥースモジュール１０６を制御し、IQ パケットをブロードキャストする。

具体的には、ブルートゥース制御プログラム８６Ｇは、予め設定されている LAP の２４ビット（９Ｅ８Ｂ３３）と UAP の４ビット（全て０）、およびブルートゥースクロックの全体の２８ビットを用いて、問い合わせ周波数ホッピングパターンを生成する。

また、ブルートゥース制御プログラム８６Ｇは、予め設定されている９Ｅ８Ｂ００乃至９Ｅ８Ｂ３Ｆの LAP から１つのアドレスブロックを用いて IAC(Inquiry Access Code)を生成し、そのアクセスコードからなる IQ パケットを、算出した問い合わせホッピングパターンでブロードキャストする。

なお、ブルートゥースにおいて送受信されるパケットは、送信パケットの宛先を示す基本となる６８ビット、または７２ビットのアクセスコードと、通信リンクを管理するためのパラメータを含む５４ビットのパケットヘッダと、ユーザデータである０乃至２７４５ビット（可変長）のペイロードから構成されている。

ブルートゥースモジュール１０６の各部の処理により、アンテナ１９４からブ

ロードキャストされた IQ パケットは、ステップＳ１４１において、携帯電話機５２のブルートゥース制御プログラム３０４により受信され、ステップＳ１６１において、PDA５３のブルートゥース制御プログラムにより受信される。

そして、ステップＳ１４２において、ブルートゥース制御プログラム３０４は、スレーブの属性を通知するための FHS パケットをパーソナルコンピュータ５１に送信し、問い合わせに応答する。この FHS パケットには、ブルートゥースモジュール２４７のブルートゥースアドレスとブルートゥースクロックに関する情報が、そのペイロードに含まれている。

この FHS パケットは、ブルートゥース制御プログラム８６Ｇにより、ステップＳ１０３において受信され、携帯電話機５２の属性情報が取得される。

また、ステップＳ１６２において、同様に PDA５３の属性を示す FHS パケットが送信されており、それがブルートゥース制御プログラム８６Ｇにより、ステップＳ１０４で受信される。

以上のような問い合わせの処理により、ブルートゥース制御プログラム８６Ｇは、近傍に存在する全てのスレーブの属性情報を取得した状態となる。

ブルートゥース制御プログラム８６Ｇは、ステップＳ１０５において、取得した FHS パケットの属性情報を検索し、電磁波を介して取得されたブルートゥースアドレスを有するスレーブを識別し、通信相手として特定する。すなわち、携帯電話機５２のブルートゥースアドレスがリーダライタ制御プログラム８６Ｆから予め通知されているため、ブルートゥース制御プログラム８６Ｇは、そのブルートゥースアドレスを含む FHS パケットを送信してきた携帯電話機５２を通信相手の端末として特定する。

そして、ブルートゥース制御プログラム８６Ｇは、その後、通信相手として特定した携帯電話機５２に対してのみ、呼び出し（ピコネット内同期の確立処理）を行う。すなわち、ブルートゥース制御プログラム８６Ｇと PDA５３のブルートゥース制御プログラムとの間では、以降の処理が行われないことになる。

ステップＳ１０６において、ブルートゥース制御プログラム８６Ｇは、携帯電

PGR2023-00016 - Home Depot
Ex. 1003 - Page 746

話機５２から取得した FHS パケットに記述されている情報に基づいて ID パケットを生成し、それを携帯電話機５２に対して送信する。

具体的には、ブルートゥース制御プログラム８６Ｇは、FHS パケットに含まれている、ブルートゥースモジュール２４７に設定されているブルートゥースアドレスの LAP の２４ビットと UAP の下位４ビット、およびブルートゥースクロックの２８ビットを用いて呼び出し周波数ホッピングパターンを算出する。

また、ブルートゥース制御プログラム８６G は、ブルートゥースモジュール２４７の LAP を用いて DAC(Device Access Code)を生成し、その DAC からなる ID パケットを、算出した呼び出し周波数ホッピングパターンを利用して携帯電話機５２に送信する。

ブルートゥース制御プログラム３０４は、その ID パケットをステップＳ１４３において受信したとき、ステップＳ１４４に進み、同一の ID パケットをパーソナルコンピュータ５１に送信し、ID パケットを正常に受信できたことを通知する。

ブルートゥース制御プログラム８６Ｇは、ステップＳ１０７において、携帯電話機５２から送信されてきた ID パケットを受信したとき、ステップＳ１０８に進み、自分自身の属性を通知するための FHS パケットを携帯電話機５２に送信する。

ステップＳ１４５において、ブルートゥース制御プログラム３０４は、パーソナルコンピュータ５１から送信されてきた FHS パケットを受信し、マスタの属性情報を取得する。ブルートゥース制御プログラム３０４は、ステップＳ１４６に進み、ID パケットをパーソナルコンピュータ５１に送信し、FHS パケットを受信できたことを通知する。

そして、ブルートゥース制御プログラム３０４は、ステップＳ１４７に進み、パーソナルコンピュータ５１とピコネット内同期を確立する。

具体的には、ブルートゥース制御プログラム３０４は、パーソナルコンピュータ５１（ブルートゥースモジュール１０６）に設定されているブルートゥースア

ドレスの LAP の２４ビットと UAP の下位４ビット、およびブルートゥースクロックの２７ビットを用いてチャンネル周波数ホッピングパターンを生成し、周波数軸の同期を確立する。

また、ブルートゥース制御プログラム３０４は、パーソナルコンピュータ５１から通知されたブルートゥースクロックに基づいて、自らが管理するブルートゥースクロックにオフセット（差分）を加え、時間軸の同期を確立する。

ブルートゥース制御プログラム８６Ｇは、ステップＳ１０９において、携帯電話機５２から送信されてきた ID パケットを受信する。

そして、携帯電話機５２との間でピコネット内同期が確立された後、ブルートゥース制御プログラム８６Ｇは、ステップＳ１１０に進み、ブルートゥースによる通信を開始する。

例えば、ブルートゥース制御プログラム８６Ｇは、携帯電話機５２に対し、携帯電話機５２が提供可能なプロファイル（サービス）の通知を要求する。ブルートゥースにおいては、搭載が想定される機器毎に、全てのプロトコルの仕様、およびユーザインタフェースが規定されており、使用するプロトコルによってプロファイルが規定されている。このプロファイルは、ブルートゥースの各レイヤの機能と、そのレイヤとの連携についてアプリケーション毎に規定されている。

ブルートゥース制御プログラム８６Ｇは、携帯電話機５２から通知されたプロファイルから所定のプロファイルを選択し、それに基づいて通信を行う。

なお、提供可能なプロファイルを取得する前に、またはプロファイルを選択し、通信を行う前に、互いの認証が必要とされることがある。パーソナルコンピュータ５１と携帯電話機５２は、それぞれのデータベースにリンクキーを設定しており、そのリンクキーを用いて認証を行う。

例えば、パーソナルコンピュータ５１と携帯電話機５２が初めて通信を行う場合には、リンクキーの設定に際し、ユーザに対して、PIN(Personal Identification Number)コードの入力が要求され、入力された PIN コードと、発生した乱数に基づいて、そのリンクキーが設定される。設定されたリンクキーは、通信す

PGR2023-00016 - Home Depot
Ex. 1003 - Page 748

る相手のブルートゥースアドレスと対応付けて、それぞれのデータベースに登録される。

リンクキーは、その用途に応じて、「初期化キー」、「単体キー」、「複合キー」、および「マスタキー」が規定されており、上述したように、初めて通信を行う際に PIN コードと乱数に基づいて設定されるリンクキーは、初期化キーである。そして、初期化キーを用いて行われる認証においては、初期化キーと、認証を要求してきた端末のブルートゥースアドレスと、認証判断する端末が発生した１２８ビットの乱数が用いられる。

以上のように、リーダライタ１０５における通信により、パーソナルコンピュータ５１は、ピコネット内同期を確立すべきスレーブのブルートゥースアドレスを非接触 IC カード２４６から取得することができる。従って、図６に示すように、パーソナルコンピュータ５１の近傍に PDA５３が存在する場合であっても、パーソナルコンピュータ５１と携帯電話機５２との間でのみ、端末の選択等を行うことなく、ブルートゥースによる通信が開始される。

これにより、例えば、携帯電話機５２のユーザは、パーソナルコンピュータ５１とブルートゥースによる通信を行う場合、携帯電話機５２をパーソナルコンピュータ５１に近付けることで、その通信を開始させることができる。また、パーソナルコンピュータ５１から携帯電話機５２にデータを転送する場合も、ユーザは、同様にして携帯電話機５２をパーソナルコンピュータ５１に近付けるだけで通信を開始させることができる。

以上においては、パーソナルコンピュータ５１と携帯電話機５２、および PDA５３のブルートゥースモジュールが予め起動している状態であるとしたが、それらのブルートゥースモジュールが起動していない場合、例えば、電磁波を受信するタイミングで起動し、その後にピコネット内同期を確立するようにしてもよい。

次に、図２２、および図２３のフローチャートを参照して、それぞれのブルートゥースモジュールが起動していない状態において、ピコネット内同期を確立す

PGR2023-00016 - Home Depot
Ex. 1003 - Page 749

る通信システムの一連の処理について説明する。

図２２、および図２３に示す処理は、図２０、および図２１を参照して説明した同期確立処理と基本的に同様の処理である。そして、リーダライタ１０５から輻射された電磁波が受信されることに応じて携帯電話機５２のブルートゥースモジュール２４７が起動され、非接触 IC カード２４６から送信されたカード ID がリーダライタ１０５において受信されることに応じてパーソナルコンピュータ５１のブルートゥースモジュール１０６が起動されるようになされている点が相違している。

リーダライタ制御プログラム８６Ｆは、ステップＳ２０１において、非接触 IC カードが内蔵されている端末を検出するための電磁波を輻射する。

そして、非接触 IC カード制御プログラム３０２は、ステップＳ２１１で、その電磁波を受信したとき、ステップＳ２１２に進み、ブルートゥース制御プログラム３０４（ブルートゥースモジュール２４６）に対して起動を指示する。

例えば、非接触 IC カード制御プログラム３０２は、ホストプログラム３０１に対して電磁波を受信したことを通知する。そして、ホストプログラム３０１は、この通知に応じて、ブルートゥース制御プログラム３０４を起動させるとともに、電源回路部２３５を制御し、ブルートゥースモジュール２４７に電源を供給させる。

ブルートゥース制御プログラム３０４は、ステップＳ２２１において起動し、例えば、マスタ（パーソナルコンピュータ５１）からの問い合わせ待ちの状態（Inquiry Scan）となる。

一方、非接触 IC カード制御プログラム３０２は、ブルートゥース制御プログラム３０４を起動させた後、ステップＳ２１３に進み、ブルートゥースアドレスに対応するカード ID をリーダライタ１０５に通知する。

リーダライタ制御プログラム８６Ｆは、ステップＳ２０２において、カード ID を受信したとき、ステップＳ２０３に進み、ブルートゥース制御プログラム８６Ｇを起動させるとともに、ブルートゥースモジュール１０６に電源を供給さ

せる。

ブルートゥース制御プログラム８６Ｇは、ステップＳ１８１において起動し、ステップＳ１８２に進み、リーダライタ制御プログラム８６Ｆが携帯電話機５２から取得したブルートゥースアドレス（カードID）を受信する。

すなわち、ステップＳ２０３において、ブルートゥース制御プログラム８６Ｇを起動させた後、リーダライタ制御プログラム８６Ｆは、ステップＳ２０４に進み、携帯電話機５２から取得したカードIDをブルートゥース制御プログラム８６Ｇに対して通知している。

そして、以降の処理（ステップＳ１８３乃至ステップＳ１８９の処理、およびステップＳ２２２乃至ステップＳ２２７の処理）において、ブルートゥース制御プログラム８６Ｇは、図２０、および図２１を参照して説明したような問い合わせ、および呼び出しをブルートゥースモジュール２４６との間で行う。

すなわち、ブルートゥース制御プログラム８６Ｇは、リーダライタ１０５から通知されたブルートゥースアドレスに基づいて、携帯電話機５２を、ピコネット内同期を確立すべきスレーブとして特定し、その携帯電話機５２との間でのみ、ピコネット内同期を確立する。

なお、PDA５３は、リーダライタ１０５からの電磁波を受信していないため、起動されない状態のまま保持される。従って、より容易に通信相手を特定することができる。

このように、電磁波の受信をトリガとしてブルートゥースモジュール２４６を起動させるようにしたので、携帯電話機５２のユーザは、例えば、ブルートゥース制御プログラム３０４を起動させるような操作をすることなく、パーソナルコンピュータ５１に近付けるだけで、ブルートゥース制御プログラム３０４を起動させることができる。また、上述したものと同様に、非接触ICカード２４６から通知されたカードIDに基づいて通信相手が特定されるため、いずれの操作もすることなく、パーソナルコンピュータ５１とブルートゥースによる通信を行うことができる。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 751

以上においては、リーダライタ１０５から輻射される電磁波が受信されることに応じて、携帯電話機５２のブルートゥースモジュール２４７が起動され、携帯電話機５２から送信されるカード ID が受信されることに応じて、パーソナルコンピュータ５１のブルートゥースモジュール１０６が起動されることとしたが、様々なタイミングで起動するようにしてもよい。

例えば、カード ID がパーソナルコンピュータ５１に対して通知されたタイミング（ステップＳ２１３の直後のタイミング）で、携帯電話機５２のブルートゥース制御プログラム３０４が起動されるようにしてもよい。

また、携帯電話機５２の全体の電源がオフとされている状態において、電磁波が受信されたこと応じて発生された起電力に基づいて、携帯電話機５２の全体の電源をオンとし、続けて、ブルートゥース制御プログラム３０４を起動させるようにすることもできる。

以上においては、非接触 IC カード２４６とブルートゥースモジュール２４７が、ともに携帯電話機５２に内蔵されているとしたが、例えば、それらのモジュールが組み込まれているメモリースティック２２３をメモリースティックスロット２２２に装着させ、上述したような処理を実行させるようにしてもよい。

図２４Ａは、非接触 IC カード２４６とブルートゥースモジュール２４７が組み込まれているメモリースティック２２３を装着することにより、その機能が拡張される携帯電話機５２を示す模式図である。

このメモリースティック２２３を携帯電話機５２に装着させることにより、例えば、携帯電話機５２に非接触 IC カード２４６とブルートゥースモジュール２４７が内蔵されていない場合であっても、その機能を拡張させることができ、上述したようなピコネット内同期の確立処理を実行させることができる。

なお、拡張する新たな機能を制御するための制御プログラムも、メモリースティック２２３から読み出され、携帯電話機５２にインストールされている。また、その制御プログラムが、例えば、図１１に示すような磁気ディスク１０１乃至半導体メモリ１０４などの記録媒体から、USB ケーブルを介してインストールさ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 752

れるようにしてもよい。

また、メモリースティック２２３だけでなく、図２４Ｂに示すような、非接触 IC カード２４６とブルートゥースモジュール２４７が組み込まれた外付けユニット３２１により、携帯電話機５２の機能を拡張させるようにしてもよい。外付けユニット３２１は、例えば、携帯電話機５２の所定の位置に設けられている USB のコネクタや、充電ケーブルのコネクタなどに接続される。

図２５Ａは、ブルートゥースモジュール２４７が内蔵されており、メモリースティック２２３により、非接触 IC カード２４６の機能だけを拡張させる携帯電話機５２を示す模式図である。

このメモリースティック２２３を携帯電話機５２に装着させ、非接触 IC カード２４６に設定されているカード ID を、ブルートゥースモジュール２４７に設定されているブルートゥースアドレスを含むものに設定することにより、上述したようなピコネット内同期の確立処理を実行させることができる。カード ID の書き換え処理については、フローチャートを参照して後述する。

また、図２５Ｂに示すように、携帯電話機５２に外付けユニット３２１を装着させることにより、非接触 IC カード２４６の機能のみを拡張させることもできる。

図２６Ａは、図２５Ａに示したものと反対に、非接触 IC カード２４６が内蔵されており、メモリースティック２２３によりブルートゥースモジュール２４７の機能を拡張させる携帯電話機５２を示す模式図である。また、図２６Ｂは、ブルートゥースモジュール２４７の機能を外付けユニット３２１により拡張させる携帯電話機５２を示す模式図である。

以下において、非接触 IC カード２４６の機能、またはブルートゥースモジュール２４７の機能、或いはその両方の機能を拡張させる、メモリースティック２２３と外付けユニット３２１を区別する必要がない場合、まとめて機能拡張ユニットと称する。

次に、カード ID を必要に応じて書き換える携帯電話機５２の処理について、

フローチャートを参照して説明する。

始めに、図２７のフローチャートを参照して、ブルートゥースアドレスに基づいてカードIDを書き換える携帯電話機５２の処理について説明する。

ステップＳ２５１において、ホストプログラム３０１は、カードID設定プログラム３０３に問い合わせ、カードIDを確認する。カードID設定プログラム３０３は、ステップＳ２７１において、その問い合わせを受信したとき、ステップＳ２７２に進み、EEPROM２６４に設定されているカードIDを読み出し、ホストプログラム３０１に通知する。

ホストプログラム３０１は、ステップＳ２５２においてカードIDを受信したとき、ステップＳ２５３に進み、ブルートゥース制御プログラム３０４に問い合わせ、ブルートゥースアドレスを確認する。

ブルートゥース制御プログラム３０４は、ステップＳ２８１において、その問い合わせを受信したとき、ステップＳ２８２に進み、フラッシュメモリ１７４Ｂに保存されているブルートゥースアドレスを読み出し、ホストプログラム３０１に通知する。

ステップＳ２５４において、ホストプログラム３０１は、ブルートゥース制御プログラム３０４から通知されてきたブルートゥースアドレスを取得し、既に通知されているカードIDと比較する。そして、ホストプログラム３０１は、ステップＳ２５５において、取得したカードIDに、少なくともブルートゥースアドレス（ブルートゥースアドレスに関する情報）が含まれているか否かを判定する。

ホストプログラム３０１は、ステップＳ２５５において、カードIDとブルートゥースアドレスが同一である、またはカードIDにブルートゥースアドレスが含まれていると判定した場合、処理を終了させる。一方、ステップＳ２５５において、カードIDにブルートゥースアドレスが含まれていないと判定した場合、ホストプログラム３０１は、ステップＳ２５６に進み、カードID設定プログラム３０３に対して、取得したブルートゥースアドレスを通知する。

カードID設定プログラム３０３は、ステップＳ２７３において、そのブルー

PGR2023-00016 - Home Depot
Ex. 1003 - Page 754

トゥースアドレスを受信したとき、ステップＳ２７４に進み、ブルートゥースアドレスと同一のカードIDを設定する。すなわち、カードID設定プログラム３０３は、EEPROM２６４に設定されているカードIDをブルートゥースアドレスと同一のものに書き換える。

これにより、カードIDにブルートゥースアドレスが含まれることとなり、上述したように、携帯電話機５２を近付けるだけで、マスタであるパーソナルコンピュータ５１に、ピコネット内同期を確立すべきスレーブを識別させることができる。

以下に説明する処理も含めて、このようなカードIDを書き換える処理は、所定の周期で行われるようにしてもよい。非接触ICカード２４６は、ブルートゥースによる通信以外に、例えば、改札口の通行や、購入した商品の代金の支払いなどの、様々な用途に利用されるため、ユーザにより、必要に応じてその都度変更されることがある。従って、所定の周期毎にそのような書き換えが実行されることにより、ユーザは、ブルートゥースにより通信を開始しようとする毎に、カードIDを設定し直すといった手間を省くことができる。

また、リーダライタ１０５からの電磁波が受信されたタイミングで、このような書き換えが行われるようにしてもよい。これにより、リーダライタを有しているマスタは、より確実に通信相手を特定することができる。

次に、図２８のフローチャートを参照して、非接触ICカード２４６の機能を拡張する機能拡張ユニットを装着した場合の携帯電話機５２の処理について説明する。

ステップＳ３０１において、ホストプログラム３０１は、非接触ICカード２４６の機能を拡張する機能拡張ユニットが装着されたか否かを判定し、装着されたと判定するまで待機する。ホストプログラム３０１は、ステップＳ３０１において、例えば、図２５Ａに示したようなメモリースティック２２３、または図２５Ｂに示したような外付けユニット３２１が所定の位置に装着されたと判定した場合、ステップＳ３０２に進む。

以降の処理は、図２７を参照して説明した処理と同様の処理である。すなわち、ホストプログラム３０１は、カード ID とブルートゥースアドレスを取得し、ステップＳ３０６において、少なくとも、カード ID にブルートゥースアドレスが含まれているか否かを判定する。

ホストプログラム３０１は、ステップＳ３０６において、カード ID にブルートゥースアドレスが含まれていると判定した場合、処理を終了させ、含まれていないと判定した場合、ステップＳ３０７に進み、カード ID 設定プログラム３０３にブルートゥースアドレスを通知する。

そして、カード ID 設定プログラム３０３は、例えば、設定されているカード ID を、受信したブルートゥースアドレスと同一のものに書き換える。

これにより、例えば、非接触 IC カード２４６の機能を拡張させるメモリースティック２２３を購入したユーザは、そのメモリースティック２２３を携帯電話機５２に装着させるだけで、必要に応じて、非接触 IC カード２４６のカード ID を書き換えることができる。

従って、ユーザは、機能が拡張された携帯電話機５２により、上述したようなピコネット内同期の確立処理を実行させることができ、通信相手を選択することなく、ブルートゥースによる通信を開始させることができる。

次に、図２９のフローチャートを参照して、ブルートゥースモジュール２４７の機能を拡張する機能拡張ユニットを装着した場合の携帯電話機５２の処理について説明する。

ステップＳ３４１において、ホストプログラム３０１は、ブルートゥースモジュール２４７の機能を拡張する機能拡張ユニットが装着されたか否かを判定し、装着されたと判定するまで待機する。ホストプログラム３０１は、ステップＳ３４１において、例えば、図２６Ａに示したようなメモリースティック２２３、または図２６Ｂに示したような外付けユニット３２１が所定の位置に装着されたと判定した場合、ステップＳ３４２に進む。

以降の処理は、図２７を参照して説明した処理と同様の処理である。すなわち、

ホストプログラム３０１は、カード ID とブルートゥースアドレスを取得し、ステップＳ３４６において、少なくとも、カード ID にブルートゥースアドレスが含まれているか否かを判定する。

ホストプログラム３０１は、ステップＳ３４６において、カード ID にブルートゥースアドレスが含まれていると判定した場合、処理を終了させ、含まれていないと判定した場合、ステップＳ３４７に進み、カード ID 設定プログラム３０３にブルートゥースアドレスを通知する。

そして、カード ID 設定プログラム３０３は、例えば、設定されているカード ID を、受信したブルートゥースアドレスと同一のものに書き換える。

以上の処理により、ユーザは、例えば、ブルートゥースモジュール２４７の機能を拡張させるメモリースティック２２３を購入し、それを携帯電話機５２に装着させるだけで、必要に応じて、カード ID を書き換えることができ、さらに、その携帯電話機を利用して、上述したようなピコネット内同期の確立処理を実行させることができる。

以上においては、カード ID とブルートゥースアドレスが記憶されるメモリがそれぞれ設けられるとしたが、非接触 IC カード２４６とブルートゥースモジュール２４７により共有される、物理的に１つのメモリに、これらの情報が記憶されるようにしてもよい。この共有されるメモリは、メモリースティック２２３に組み込まれていてもよいし、携帯電話機５２に内蔵されていてもよい。

また、以上においては、パーソナルコンピュータ５１をマスタとし、携帯電話機５２をスレーブとした場合について説明したが、当然、双方が逆の役割を有するようにしてもよい。また、リーダライタが携帯電話機５２にも設けられている場合、携帯電話機５２がパーソナルコンピュータ５１の存在を検出し、パーソナルコンピュータ５１の非接触 IC カードから通知されたカード ID に基づいて、ピコネット内同期を確立させるようにしてもよい。

なお、非接触 IC カードとリーダライタとの通信によりブルートゥースアドレスを取得し、それに基づいてピコネット内同期を確立する通信システムは、上述

したようなパーソナルコンピュータ５１と携帯電話機５２との間だけでなく、様々な機器間においても適用可能である。

例えば、携帯電話機５２や PDA５３などの携帯端末と、テレビジョン受像機、カーナビゲーション、自動販売機、ATM(automatic teller machine)などの装置間でも、上述したような通信システムを構成することもできる。この場合、携帯電話機５２や PDA５３には、ブルートゥースモジュールと非接触 IC カードが少なくとも設けられていればよく、テレビジョン受像機、カーナビゲーション、自動販売機、ATM には、それぞれ、ブルートゥースモジュールと、非接触 IC カードのリーダライタが少なくとも設けられていればよい。

また、いずれか一方がリーダライタを有していれば、携帯電話機同士、または PDA 同士、PDA とデジタルカメラ、或いは PDA とデジタルビデオカメラなどによるピコネット内同期の確立処理にも、本発明は適用することができる。

さらに、単に機器と機器との接続だけに限らず、電磁誘導通信部（リーダライタ、および非接触 IC カード）とブルートゥースモジュールが、例えば、自動車、電車、船、飛行機などの移動体や、建物内、或いは街中の至る所に設けられ、そのブルートゥースモジュールを介して、例えば、インターネットや、LAN(Local Area Network)、或いは WAN(Wide Area Network)などのネットワークに接続することにより、いわゆるユビキタス（Ubiquitous）社会（Ubiquitous Network 社会、または Ubiquitous Computing 社会）を構成するようにしてもよい。

図３０は、本発明を適用した通信システムにより構成する、ユビキタス社会の概念を示す図である。

図においては、インターネット３５４には、アクセスポイント３５１および３５２、サーバ３５５および３５６、クライアント PC３５７が接続されており、各種の情報を送受信することが可能とされている。

アクセスポイント３５１には、非接触 IC カード３７１、ブルートゥースモジュール３７２、およびリーダライタ３７３が設けられており、携帯電話機５２のユーザは、このアクセスポイント３５１に携帯電話機５２を近接させるだけで、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 758

上述したような通信相手を特定する処理が行われ、その後に、ブルートゥースを介してインターネット３５４にアクセスすることができる。

アクセスポイント３５２には、リーダライタ３８１と無線 LAN アクセスポイント３８２が設けられている。従って、非接触 IC カード３９１と無線 LAN クライアント３９２が内蔵されている PDA３５３のユーザが PDA３５３をアクセスポイント３５２に近接させるだけで、上述したような通信相手を特定する処理が行われ、その後に、無線 LAN を介してインターネット３５４にアクセスすることができる。

例えば、携帯電話機５２のユーザは、町中に設置されているアクセスポイント３５１に携帯電話機５２を近接させるだけで、サーバ３５５から所望するコンテンツを取得したり、サーバ３５６に展開されているコミュニティに参加したり、或いは、遠隔にあるクライアント PC３５７を操作したりすることを、いつでも、かつ、容易に行うことができる。

また、個々のデバイスにブルートゥースアドレスと同様の固有のアドレスが設定されている場合、図３３のアクセスポイント３５２と PDA３５３との間で行われているような無線 LAN（IEEE(Institute of Electrical and Electronics Engineers)802.11b）などの、ブルートゥース以外の通信においても、本発明は適用することができる。

具体的には、PDA３５３に設定されている、例えば、１２８ビットからなる IPv6(Internet Protocol version 6)をアクセスポイント３５２のリーダライタ３８１に通知させるようにすることにより、PDA３５３のユーザは、それをアクセスポイント３５２に近接させるだけで、無線 LAN を介してインターネット３５４にアクセスすることができる。

また、ブルートゥース以外の通信としては、例えば、IrDA、HomeRF(SWAP)、Wireless1394 などがあり、これらの通信においても、本発明は適用することができる。

また、上述したような非接触 IC カードのようにループアンテナを用いて電力

PGR2023-00016 - Home Depot
Ex. 1003 - Page 759

伝送およびデータ伝送を行う通信方式に代えて、出力を抑え、ブルートゥースなどの通信方式より通信可能な距離が短くなるように予め設定されている通信方式であれば、いずれの通信方式を用いるようにしてもよい。

上述したように、通常、ブルートゥースによる通信においては、同期の確立がなされ、その同期を確立した相手の端末が初めて通信を行う端末である場合、双方の機器に同一の PIN コードを入力する必要がある。しかしながら、本発明を適用し、例えば、電磁誘導を利用した通信により提供された識別情報等に基づいて、通信相手を特定し、ブルートゥース通信が行えるようになった場合においては、その PIN コードの入力を不要とするように予め設定されていてもよい。この場合、例えば、電磁誘導を利用した通信により、所定の PIN コードが双方の端末間で共有される。

また、例えば、電磁誘導を利用した通信により提供された識別情報等に基づいて、通信相手を特定し、ブルートゥース通信が行えるようになった場合においては、所定のプロファイルで通信が行われるように予め設定されていてもよい。この場合、例えば、電磁誘導を利用した通信により、自分自身が提供できるプロファイルが双方の端末間で共有され、その中から、所定のプロファイルが選択される。

さらに、上述したメモリースティック２２３に代えて、所定のスロットに挿入可能な形状であれば如何なるものであってもよい。例えば、メモリースティック２２３に代わるものとして、SD カード（登録商標）規格のものや、CF カード（登録商標）規格のものなどがある。

なお、上述した例においては、リーダライタ１０５と、非接触 IC カード２４６が個々に構成されるとしたが、それらの双方の機能を有するものを、パーソナルコンピュータ５１と携帯電話機５２にそれぞれ設けるようにしてもよい。さらに、この双方の機能を有するものを、例えば、上述したようなメモリースティック２２３などに格納し、パーソナルコンピュータ５１と携帯電話機５２の機能を拡張するようにしてもよい。

また、リーダライタを有する機器（例えば、上述したパーソナルコンピュータ５１）が、過去にブルートゥースによる通信を行ったことがある機器に関する情報を履歴情報として記憶しておくようにしてもよい。これにより、電磁誘導を用いた通信により、近接された機器のブルートゥースアドレス等が通知されたとき、その履歴情報を参照することで、近接されている機器を特定することができる。

例えば、機器のブルートゥースアドレスやブルートゥースデバイス名、或いは、図２を参照して説明した、その機器のカテゴリ、機器が提供できるプロファイルなどが履歴情報として記憶される。

上述した一連の処理は、ハードウェアにより実行させることもできるが、ソフトウェアにより実行させることもできる。

一連の処理をソフトウエアにより実行させる場合には、そのソフトウエアを構成するプログラムが、専用のハードウエアに組み込まれているコンピュータ、または、各種のプログラムをインストールすることで、各種の機能を実行することが可能な、例えば、汎用のパーソナルコンピュータなどに、ネットワークや記録媒体からインストールされる。

この記録媒体は、図１１に示すように、装置本体とは別に、ユーザにプログラムを提供するために配布される、プログラムが記録されている磁気ディスク１０１（フロッピディスクを含む）、光ディスク１０２（CD-ROM(Compact Disk-Read Only Memory), DVD(Digital Versatile Disk)を含む）、光磁気ディスク１０３（MD（登録商標）(Mini-Disk)を含む）、もしくは半導体メモリ１０４などよりなるパッケージメディアにより構成されるだけでなく、装置本体に予め組み込まれた状態でユーザに提供される、プログラムが記録されている HDD １１４やROM１１８などで構成される。

なお、本明細書において、記録媒体に記録されるプログラムを記述するステップは、記載された順序に従って時系列的に行われる処理はもちろん、必ずしも時系列的に処理されなくとも、並列的あるいは個別に実行される処理をも含むものである。

また、本明細書において、システムとは、複数の装置により構成される装置全体を表すものである。

産業上の利用可能性

以上のように、本発明の通信システムおよび方法によれば、近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、通信端末の識別情報を取得し、データの送受信を行う第２の無線通信部を用いて通信端末を含む複数の通信端末から各々の属性情報を取得し、識別情報と、属性情報とを用いて通信相手を特定する。そして、特定した通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立する。また、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、情報処理装置に自身の識別情報を提供し、第２の無線通信部を介して送信された情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の属性情報を提供し、第２の無線通信部を用いた無線通信の同期の確立に伴い情報処理装置からの要求に応じて、第４の無線通信部を介して所定の信号の送受信を行い同期を確立するようにしたので、通信相手の端末を特定でき、より簡単に、かつ迅速に通信を開始することができる。

本発明の第１の情報処理装置および方法、並びにプログラムによれば、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得し、所望のデータの送受信を行う第２の無線通信部を用いて、通信端末を含む複数の通信端末から各々の属性情報を取得し、取得した識別情報と、属性情報とを用いて通信相手を特定する。また、特定した通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立するようにしたので、通信相手の端末を特定でき、より簡単に、かつ迅速に通信を開始することができる。

本発明の通信端末および方法、並びにプログラムによれば、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて

PGR2023-00016 - Home Depot
Ex. 1003 - Page 762

自身の識別情報を提供し、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の属性情報を提供する。また、第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立するようにしたので、より簡単に、かつ迅速に通信を開始することができる。

本発明の第１の拡張装置によれば、情報処理装置に電気的に接続し所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得し、所望のデータの送受信を行う第２の無線通信部を用いて、複数の通信端末から各々の属性情報を取得する。また、取得した識別情報と、前記複数の通信端末から取得した属性情報とを用いて通信相手を特定し、特定した通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立するようにしたので、第１、および第２の無線通信部が情報処理装置に設けられていない場合であっても、その機能を第１の拡張装置により拡張させることができ、より簡単に、かつ迅速に通信を開始することができる。

本発明の第２の拡張装置によれば、通信端末に電気的に接続しデータの授受を行うための接続端子と、所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの要求に応じて自身の識別情報を提供し、データの送受信を行う第２の無線通信部を用いて、情報処理装置からの要求に応じて自身の属性情報を提供する。そして、第２の無線通信部を用いた無線通信の同期確立に伴い情報処理装置からの要求に応じて、第２の無線通信部を介して所定の信号の送受信を行い同期を確立するようにしたので、第１、および第２の無線通信部が通信端末に設けられていない場合であっても、第２の拡張装置によりその機能を拡張させることができ、より簡単に、かつ迅速に通信を開始することができる。

本発明の第２の情報処理装置によれば、所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得し、所望のデータの送受信を行う第２の無線通信部を用いて通信を行ったことのある複数の通信端末に関する情報を履歴情報として記憶し、取得した識別情報と履歴情報とを用いて通信相手を特

PGR2023-00016 - Home Depot
Ex. 1003 - Page 763

定する。また、特定した通信端末と第２の無線通信部を用いた無線通信を行うための同期を確立するようにしたので、第２の無線通信部を用いて通信を行う際に、過去に通信を行ったことのある通信機器に関する情報を取得するまでもなく、容易に通信を開始することができる。

請求の範囲

1． 情報処理装置と複数の通信端末からなるユビキタスネットワークにおける通信システムにおいて、

前記情報処理装置は、

近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、前記通信端末の識別情報を取得する第１の取得処理手段と、

データの送受信を行う第２の無線通信部を用いて前記通信端末を含む前記複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第１の取得処理手段により取得された前記識別情報と、前記第２の取得処理手段により取得された前記属性情報とを用いて通信相手を特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する第１の同期確立処理手段と

を備え、

前記通信端末は、

ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、前記情報処理装置に自身の前記識別情報を提供する第１の提供処理手段と、

前記第２の無線通信部を介して送信された前記情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の前記属性情報を提供する第２の提供処理手段と、

前記第２の無線通信部を用いた無線通信の同期の確立に伴い前記情報処理装置からの要求に応じて、前記第４の無線通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理手段と

を備えることを特徴する通信システム。

2． 情報処理装置と複数の通信端末からなるユビキタスネットワークにおける

PGR2023-00016 - Home Depot
Ex. 1003 - Page 765

通信システムの通信方法において、

前記情報処理装置の情報処理方法は、

近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、前記通信端末の識別情報を取得する第１の取得処理ステップと、

データの送受信を行う第２の無線通信部を用いて前記通信端末を含む前記複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第１の取得処理ステップにより取得された前記識別情報と、前記第２の取得処理ステップにより取得された前記属性情報とを用いて通信相手を特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する第１の同期確立処理ステップとを備え、

前記通信端末の情報処理方法は、

ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、前記情報処理装置に自身の前記識別情報を提供する第１の提供処理ステップと、

前記第２の無線通信部を介して送信された前記情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の前記属性情報を提供する第２の提供処理ステップと、

前記第２の無線通信部を用いた無線通信の同期の確立に伴い前記情報処理装置からの要求に応じて、前記第４の通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理ステップと

を備えることを特徴する通信方法。

３．　所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む

PGR2023-00016 - Home Depot
Ex. 1003 - Page 766

複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第１の取得処理手段により取得された前記識別情報と、前記第２の取得処理手段により取得された前記属性情報とを用いて通信相手を特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする情報処理装置。

４．　前記第１の無線通信部による無線通信可能な距離が、前記第２の無線通信部による無線通信可能な距離より短いこと

を特徴とする請求の範囲第３項に記載の情報処理装置。

５．　前記第１の取得処理手段は、近接された前記通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う前記第１の無線通信部を用いて、前記通信端末の前記識別情報を取得すること

を特徴とする請求の範囲第３項に記載の情報処理装置。

６．　前記属性情報には、前記複数の通信端末を各々識別可能にするアドレス情報と前記通信端末が管理するクロック情報が含まれていること

を特徴とする請求の範囲第３項に記載の情報処理装置。

７．　前記第１の取得処理手段により前記識別情報が取得されたことに応じて、前記第２の無線通信部を起動させる起動処理手段を更に備える

ことを特徴とする請求の範囲第３項に記載の情報処理装置。

８．　前記識別情報には、前記通信端末のブルートゥースアドレスが少なくとも含まれており、

前記第２の取得処理手段では、前記第２の無線通信部を用いて送信した IQ パケットに応答して前記複数の通信端末が各々返信した複数の FHS パケットを取得し、

前記同期確立処理手段では、前記特定処理手段により特定された前記通信端末に対し、前記第２の無線通信部を用いて ID パケットの送信を行い、該 ID パケ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 767

ットの送信に対する前記通信端末からの応答があったときは自身の FHS パケットを更に送信すること

を特徴とする請求の範囲第３項に記載の情報処理装置。

９．　所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第１の取得処理ステップにより取得された前記識別情報と、前記第２の取得処理ステップにより取得された前記属性情報とを用いて通信相手を特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップと

を備えることを特徴とする情報処理方法。

１０．　前記第１の無線通信部による無線通信可能な距離が、前記第２の無線通信部による無線通信可能な距離より短いこと

を特徴とする請求の範囲第９項に記載の情報処理方法。

１１．　前記第１の取得処理ステップは、近接された前記通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う前記第１の無線通信部を用いて、前記通信端末の前記識別情報を取得すること

を特徴とする請求の範囲第９項に記載の情報処理方法。

１２．　前記属性情報には、前記複数の通信端末を各々識別可能にするアドレス情報と前記通信端末が管理するクロック情報が含まれていること

を特徴とする請求の範囲第９項に記載の情報処理方法。

１３．　前記第２の取得処理ステップでは、前記第２の無線通信部を用いて送信した IQ パケットに応答して前記複数の通信端末が各々返信した複数の FHS パケットを取得し、

前記同期確立処理ステップでは、前記特定処理ステップにより特定された前記

通信端末に対し、前記第２の無線通信部を用いて ID パケットの送信を行い、該 ID パケットの送信に対する前記通信端末からの応答があったときは自身の FHS パケットを更に送信すること

を特徴とする請求の範囲第９項に記載の情報処理方法。

１４．　所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処理手段と、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理手段と、

前記第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理手段と

を備えることを特徴とする通信端末。

１５．　前記第１の無線通信部による無線通信可能な距離が、前記第２の無線通信部による無線通信可能な距離より短いこと

を特徴とする請求の範囲第１４項に記載の通信端末。

１６．　前記第１の提供処理手段は、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータ送受信を行う前記第１の無線通信部を用いて、前記情報処理装置からの所定の要求に応じて自身の前記識別情報を提供すること

を特徴とする請求の範囲第１４項に記載の通信端末。

１７．　前記識別情報は、自身の端末を識別可能にするアドレス情報を少なくとも含んでいること

を特徴とする請求の範囲第１４項に記載の通信端末。

１８．　前記属性情報には、前記アドレス情報と自身の端末が管理するクロック情報とが含まれていること

を特徴とする請求の範囲第１７項に記載の通信端末。

１９．　前記第１の提供処理手段により前記識別情報を提供したことに応じて、前記第２の無線通信部を起動させる起動処理手段を更に備える

ことを特徴とする請求の範囲第１４項に記載の通信端末。

２０．　前記識別情報は、ブルートゥースアドレス情報を少なくとも含んでおり、

前記第２の提供処理手段では、前記第２の無線通信部を用いて受信した IQ パケットに応答して FHS パケットを返信し、

前記同期確立処理手段では、前記第２の無線通信部を用いて受信した ID パケットに応答して前記 ID パケットを返信し、更に FHS パケットを受信したときは再度前記 ID パケットを返信すること

を特徴とする請求の範囲第１４項に記載の通信端末。

２１．　所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処理ステップと、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理ステップと、

前記第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理ステップと

を備えることを特徴とする通信方法。

２２．　前記第１の提供処理ステップは、ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータ送受信を行う前記第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の前記識別情報を提供すること

を特徴とする請求の範囲第２１項に記載の通信方法。

２３．　前記識別情報は、自身の端末を識別するアドレス情報を少なくとも含んでいること

を特徴とする請求の範囲第２１項に記載の通信方法。

２４．　前記属性情報には、前記アドレス情報と自身の端末が管理するクロック情報とが含まれていること

を特徴とする請求の範囲第２３項に記載の通信方法。

２５．　前記第１の提供処理ステップにより前記識別情報を提供したことに応じ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 770

て、前記第２の無線通信部を起動させる起動処理ステップを更に備える

ことを特徴とする請求の範囲第２１項に記載の通信方法。

２６．　前記識別情報は、ブルートゥースアドレス情報を少なくとも含んでおり、

前記第２の提供処理ステップでは、前記第２の無線通信部を用いて受信したＩＱパケットに応答してFHSパケットを返信し、

前記同期確立処理ステップでは、前記第２の無線通信部を用いて受信したIDパケットに応答して前記IDパケットを返信し、更にFHSパケットを受信したときは再度前記IDパケットを返信すること

を特徴とする請求の範囲第２１項に記載の通信方法。

２７．　情報処理装置に取付け可能な拡張装置において、

前記情報処理装置に電気的に接続しデータの授受を行うための接続端子と、

所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて、複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第１の取得処理手段により取得された前記識別情報と、前記複数の通信端末から取得した前記属性情報とを用いて通信相手を特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする拡張装置。

２８．　通信端末に取付け可能な拡張装置において、

前記通信端末に電気的に接続しデータの授受を行うための接続端子と、

所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの要求に応じて自身の識別情報を提供する第１の提供処理手段と、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの要求に応じて自身の属性情報を提供する第２の提供処理手段と、

前記第２の無線通信部を用いた無線通信の同期確立に伴い前記情報処理装置か

らの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理手段と

を備えることを特徴とする拡張装置。

２９．　所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第１の取得処理ステップにより取得された前記識別情報と、前記第２の取得処理ステップにより取得された前記属性情報とを用いて通信相手を特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップと

を情報処理装置に実行させるプログラム。

３０．　所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処ステップと、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理ステップと、

前記第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理ステップと

を通信端末に実行させるプログラム。

３１．　所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて通信を行ったことのある複数の通信端末に関する情報を履歴情報として記憶する記憶処理手段と、

前記第１の取得処理手段により取得された前記識別情報と前記履歴情報とを用いて通信相手を特定する特定処理手段と、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 772

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする情報処理装置。

３２．　前記履歴情報は、少なくともブルートゥースアドレス情報を含み、

前記同期確立処理手段では、前記ブルートゥースアドレス情報に基づいて生成された ID パケットを前記特定処理手段により特定された前記通信端末に対して送信し、該 ID パケットに対する前記通信端末からの応答があったときは自身の FHS パケットを更に送信すること

を特徴とする請求の範囲第３１項に記載の情報処理装置。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 773

補正書の請求の範囲

[2002年11月7日（07.11.02）国際事務局受理：出願当初の請求の範囲1,2,3,9,27,29,30及び31は補正された；新しい請求の範囲33,34が加えられた；他の請求の範囲は変更なし。（7頁）]

1．（補正後） 情報処理装置と複数の通信端末からなるユビキタスネットワークにおける通信システムにおいて、

前記情報処理装置は、

近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、前記通信端末の識別情報を取得する第１の取得処理手段と、

データの送受信を行う第２の無線通信部を用いて前記通信端末を含む前記複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第２の取得処理手段により取得された前記属性情報を検索し、前記第１の取得処理手段により取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する第１の同期確立処理手段と

を備え、

前記通信端末は、

ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、前記情報処理装置に自身の前記識別情報を提供する第１の提供処理手段と、

前記第２の無線通信部を介して送信された前記情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の前記属性情報を提供する第２の提供処理手段と、

前記第２の無線通信部を用いた無線通信の同期の確立に伴い前記情報処理装置からの要求に応じて、前記第４の無線通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理手段と

を備えることを特徴する通信システム。

2．（補正後） 情報処理装置と複数の通信端末からなるユビキタスネットワー

PGR2023-00016 - Home Depot
Ex. 1003 - Page 774

クにおける通信システムの通信方法において、

前記情報処理装置の情報処理方法は、

近接された通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う第１の無線通信部を用いて、前記通信端末の識別情報を取得する第１の取得処理ステップと、

データの送受信を行う第２の無線通信部を用いて前記通信端末を含む前記複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第２の取得処理ステップにより取得された前記属性情報を検索し、前記第１の取得処理ステップにより取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する第１の同期確立処理ステップと

を備え、

前記通信端末の情報処理方法は、

ループアンテナを介して得られた誘起電力の少なくとも一部を利用しデータの送受信を行う第３の無線通信部を用いて、前記情報処理装置に自身の前記識別情報を提供する第１の提供処理ステップと、

前記第２の無線通信部を介して送信された前記情報処理装置からの要求に応じて、データの送受信を行う第４の無線通信部を用いて、自身の前記属性情報を提供する第２の提供処理ステップと、

前記第２の無線通信部を用いた無線通信の同期の確立に伴い前記情報処理装置からの要求に応じて、前記第４の通信部を介して所定の信号の送受信を行い同期を確立する第２の同期確立処理ステップと

を備えることを特徴する通信方法。

３．（補正後）　所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む

複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第２の取得処理手段により取得された前記属性情報を検索し、前記第１の取得処理手段により取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする情報処理装置。

４．　前記第１の無線通信部による無線通信可能な距離が、前記第２の無線通信部による無線通信可能な距離より短いこと

を特徴とする請求の範囲第３項に記載の情報処理装置。

５．　前記第１の取得処理手段は、近接された前記通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う前記第１の無線通信部を用いて、前記通信端末の前記識別情報を取得すること

を特徴とする請求の範囲第３項に記載の情報処理装置。

６．　前記属性情報には、前記複数の通信端末を各々識別可能にするアドレス情報と前記通信端末が管理するクロック情報が含まれていること

を特徴とする請求の範囲第３項に記載の情報処理装置。

７．　前記第１の取得処理手段により前記識別情報が取得されたことに応じて、前記第２の無線通信部を起動させる起動処理手段を更に備える

ことを特徴とする請求の範囲第３項に記載の情報処理装置。

８．　前記識別情報には、前記通信端末のブルートゥースアドレスが少なくとも含まれており、

前記第２の取得処理手段では、前記第２の無線通信部を用いて送信した IQ パケットに応答して前記複数の通信端末が各々返信した複数の FHS パケットを取得し、

前記同期確立処理手段では、前記特定処理手段により特定された前記通信端末に対し、前記第２の無線通信部を用いて ID パケットの送信を行い、該 ID パケ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 776

ットの送信に対する前記通信端末からの応答があったときは自身の FHS パケットを更に送信すること

を特徴とする請求の範囲第３項に記載の情報処理装置。

９．（補正後） 所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第２の取得処理ステップにより取得された前記属性情報を検索し、前記第１の取得処理ステップにより取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップと

を備えることを特徴とする情報処理方法。

１０． 前記第１の無線通信部による無線通信可能な距離が、前記第２の無線通信部による無線通信可能な距離より短いこと

を特徴とする請求の範囲第９項に記載の情報処理方法。

１１． 前記第１の取得処理ステップは、近接された前記通信端末に対しループアンテナによる電力伝送及びデータ送受信を行う前記第１の無線通信部を用いて、前記通信端末の前記識別情報を取得すること

を特徴とする請求の範囲第９項に記載の情報処理方法。

１２． 前記属性情報には、前記複数の通信端末を各々識別可能にするアドレス情報と前記通信端末が管理するクロック情報が含まれていること

を特徴とする請求の範囲第９項に記載の情報処理方法。

１３． 前記第２の取得処理ステップでは、前記第２の無線通信部を用いて送信した IQ パケットに応答して前記複数の通信端末が各々返信した複数の FHS パケットを取得し、

前記同期確立処理ステップでは、前記特定処理ステップにより特定された前記

て、前記第２の無線通信部を起動させる起動処理ステップを更に備える

ことを特徴とする請求の範囲第２１項に記載の通信方法。

２６．　前記識別情報は、ブルートゥースアドレス情報を少なくとも含んでおり、

前記第２の提供処理ステップでは、前記第２の無線通信部を用いて受信した IQ パケットに応答して FHS パケットを返信し、

前記同期確立処理ステップでは、前記第２の無線通信部を用いて受信した ID パケットに応答して前記 ID パケットを返信し、更に FHS パケットを受信したときは再度前記 ID パケットを返信すること

を特徴とする請求の範囲第２１項に記載の通信方法。

２７．（補正後）　情報処理装置に取付け可能な拡張装置において、

前記情報処理装置に電気的に接続しデータの授受を行うための接続端子と、

所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて、複数の通信端末から各々の属性情報を取得する第２の取得処理手段と、

前記第２の取得処理手段により取得された前記属性情報を検索し、前記第１の取得処理手段により取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする拡張装置。

２８．　通信端末に取付け可能な拡張装置において、

前記通信端末に電気的に接続しデータの授受を行うための接続端子と、

所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの要求に応じて自身の識別情報を提供する第１の提供処理手段と、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの要求に応じて自身の属性情報を提供する第２の提供処理手段と、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 778

前記第２の無線通信部を用いた無線通信の同期確立に伴い前記情報処理装置からの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理手段と

を備えることを特徴とする拡張装置。

２９．（補正後） 所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理ステップと、

所望のデータの送受信を行う第２の無線通信部を用いて、前記通信端末を含む複数の通信端末から各々の属性情報を取得する第２の取得処理ステップと、

前記第２の取得処理ステップにより取得された前記属性情報を検索し、前記第１の取得処理ステップにより取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理ステップと、

前記特定処理ステップにより特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理ステップと

を情報処理装置に実行させるプログラム。

３０．（補正後） 所定のデータの送受信を行う第１の無線通信部を用いて、情報処理装置からの所定の要求に応じて自身の識別情報を提供する第１の提供処理ステップと、

データの送受信を行う第２の無線通信部を用いて、前記情報処理装置からの所定の要求に応じて自身の属性情報を提供する第２の提供処理ステップと、

前記第２の無線通信部を用いた無線通信の同期確立に伴い前期情報処理装置からの要求に応じて、前記第２の無線通信部を介して所定の信号の送受信を行い同期を確立する同期確立処理ステップと

を通信端末に実行させるプログラム。

３１．（補正後） 所定データの送受信を行う第１の無線通信部を用いて、通信端末から識別情報を取得する第１の取得処理手段と、

所望のデータの送受信を行う第２の無線通信部を用いて通信を行ったことのある複数の通信端末に関する情報を履歴情報として記憶する記憶処理手段と、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 779

前記記憶処理手段により記憶された前記履歴情報を検索し、前記第１の取得処理手段により取得された前記識別情報をもつ通信端末を通信相手として特定する特定処理手段と、

前記特定処理手段により特定された前記通信端末と前記第２の無線通信部を用いた無線通信を行うための同期を確立する同期確立処理手段と

を備えることを特徴とする情報処理装置。

３２．　前記履歴情報は、少なくともブルートゥースアドレス情報を含み、

前記同期確立処理手段では、前記ブルートゥースアドレス情報に基づいて生成された ID パケットを前記特定処理手段により特定された前記通信端末に対して送信し、該 ID パケットに対する前記通信端末からの応答があったときは自身の FHS パケットを更に送信すること

を特徴とする請求の範囲第３１項に記載の情報処理装置。

３３．（追加）　前記第１の取得処理手段は、前記第１の無線通信部の負荷変化に基づき、通信端末が近接されたことが検出された場合に動作する

ことを特徴とする請求の範囲第３項に記載の情報処理装置。

３４．（追加）　前記第１の取得処理ステップによる処理は、前記第１の無線通信部の負荷変化に基づき、通信端末が近接されたことが検出された場合に行われる

ことを特徴とする請求の範囲第９項に記載の情報処理方法。

条約第１９条（１）の規定に基づく説明書

請求の範囲第１項乃至第３項、第９項、第２７項、第２９項は、図２１と、図２１のステップＳ１０５の説明である明細書第４１頁第１６行目乃至第２２行目の記載に基づき、第２の無線通信部を用いた通信により取得された属性情報を検索し、属性情報を提供してきた通信端末の中から、第１の無線通信部を用いた通信により取得された識別情報をもつ通信端末を通信相手として特定することを明確にした。

この特徴的な構成は、いずれの引用例にも開示されていない。例えば、特開２００１－１５６７０４号公報には、通信可能な端末をリストアップし、接続することが選択された通信端末と無線通信を開始することが開示されており、通信を開始させるためには、ユーザは、リストアップされた通信端末の中から所定の端末を選択する必要がある（[００２５]、[００３９]、[００４９]、[００６０]、[００７０]の段落の記載）。

本発明は、通信相手の端末を選択することなく、単に、近接させるだけで、その端末との間で通信を開始させることができる効果を得たものである。

なお、請求の範囲第３３項、および第３４項の追加は、明細書第２７頁第１６行目乃至第１９行目の記載に基づくものである。

図１

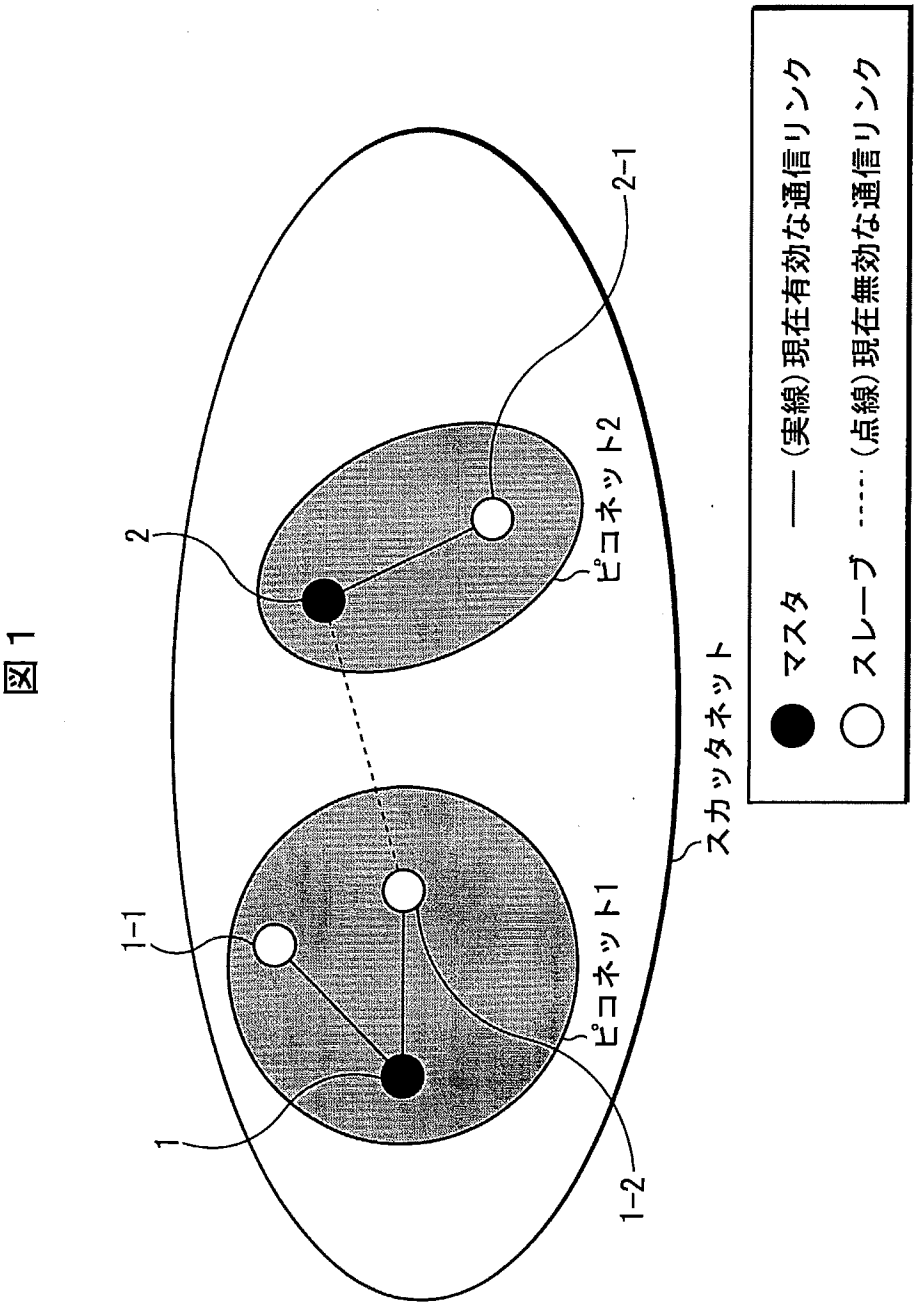

● マスタ ── (実線)現在有効な通信リンク
○ スレーブ ----- (点線)現在無効な通信リンク
スカッタネット
ピコネット1
ピコネット2
1
1-1
1-2
2
2-1

図2

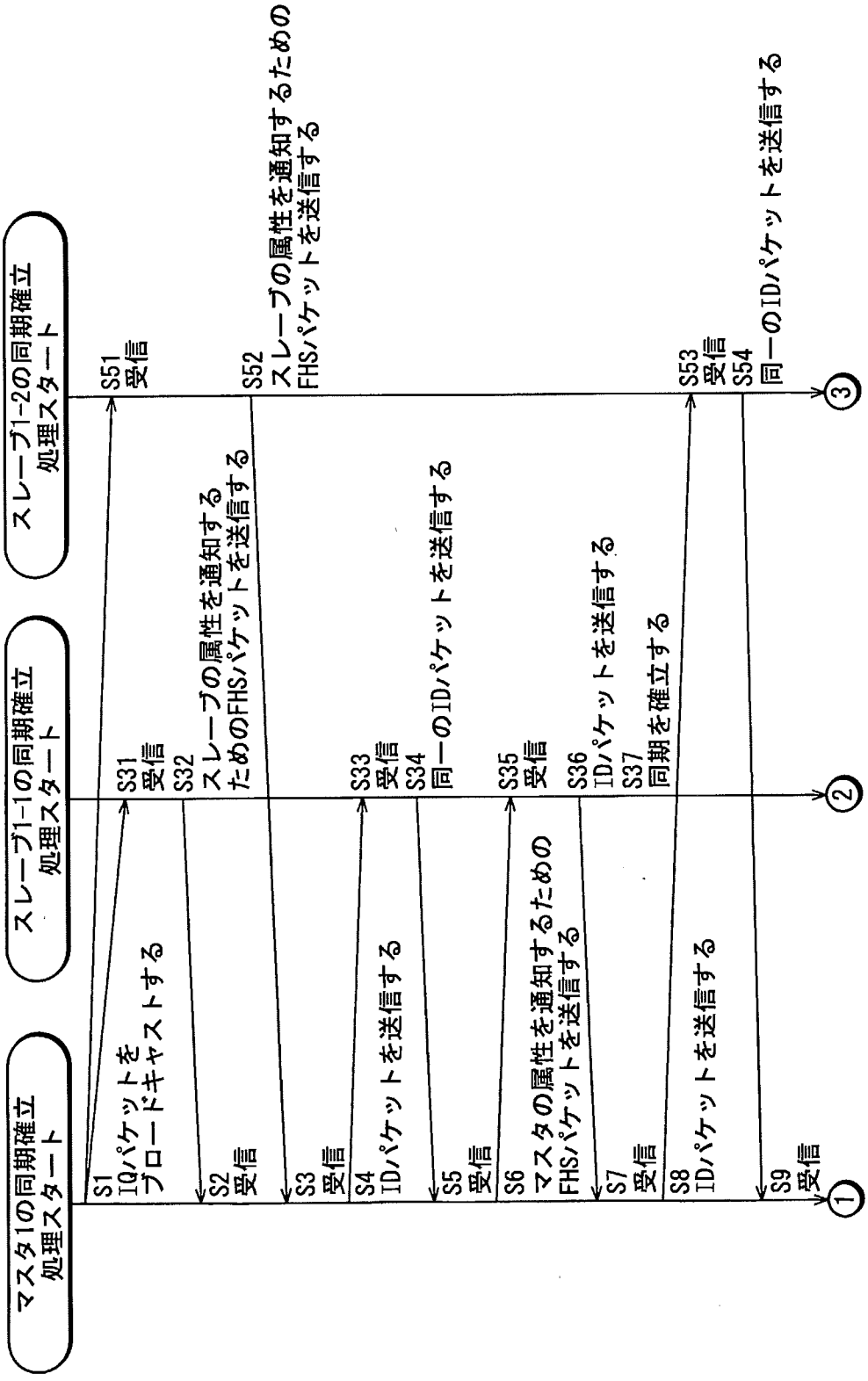

マスタ1の同期確立処理スタート
スレーブ1-1の同期確立処理スタート
スレーブ1-2の同期確立処理スタート
S1 IQパケットをブロードキャストする
S2 受信
S31 受信
S32 スレーブの属性を通知するためのFHSパケットを送信する
S3 受信
S4 IDパケットを送信する
S33 受信
S34 同一のIDパケットを送信する
S5 受信
S6 マスタの属性を通知するためのFHSパケットを送信する
S35 受信
S36 IDパケットを送信する
S7 受信
S37 同期を確立する
S8 IDパケットを送信する
S51 受信
S52 スレーブの属性を通知するためのFHSパケットを送信する
S53 受信
S54 同一のIDパケットを送信する
S9 受信
①
②
③

図3

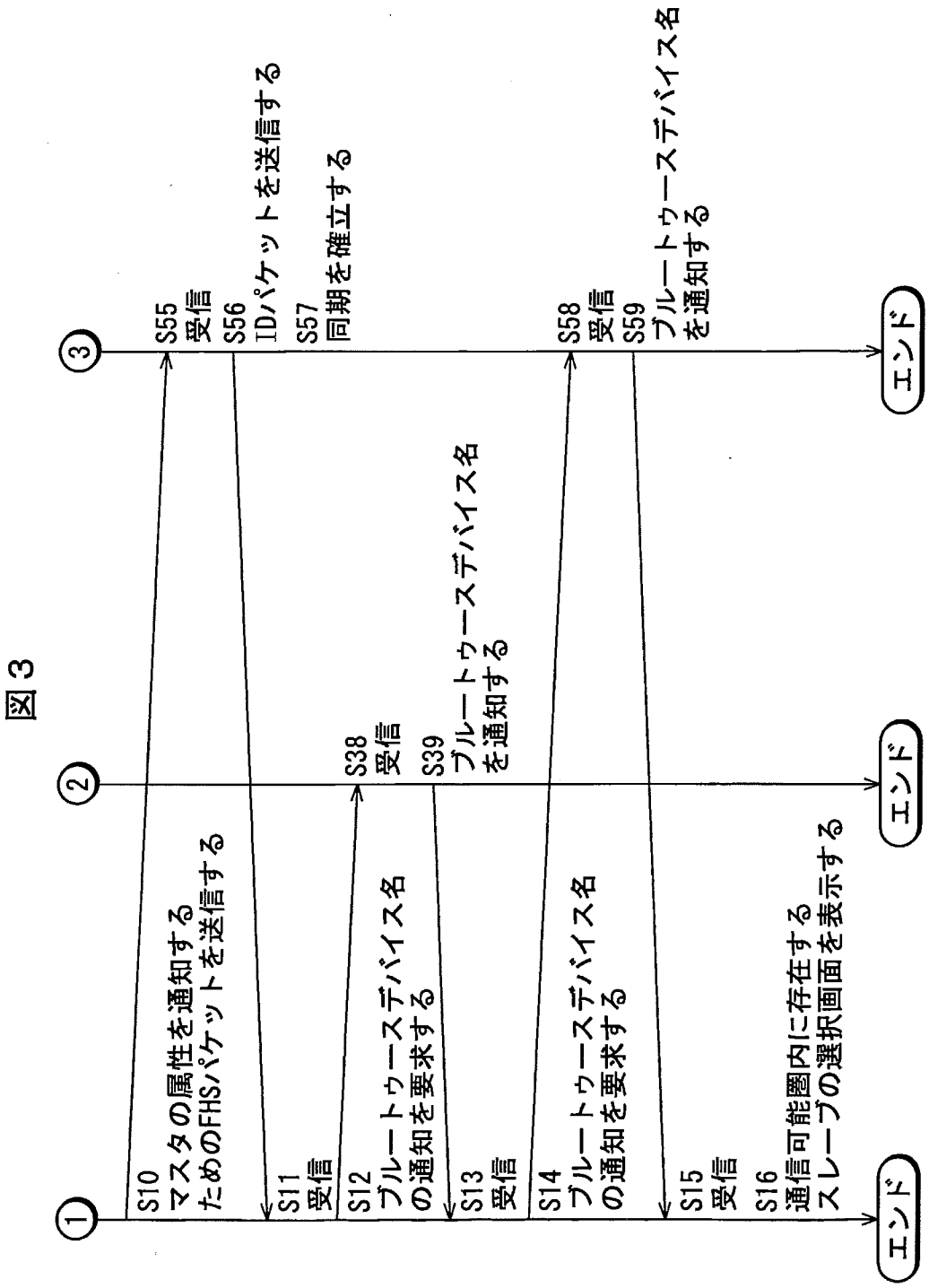

①
②
③
S10
マスタの属性を通知する
ためのFHSパケットを送信する
S11
受信
S12
ブルートゥースデバイス名
の通知を要求する
S13
受信
S14
ブルートゥースデバイス名
の通知を要求する
S15
受信
S16
通信可能圏内に存在する
スレーブの選択画面を表示する
エンド
エンド
エンド
S38
受信
S39
ブルートゥースデバイス名
を通知する
S55
受信
S56
IDパケットを送信する
S57
同期を確立する
S58
受信
S59
ブルートゥースデバイス名
を通知する

図4

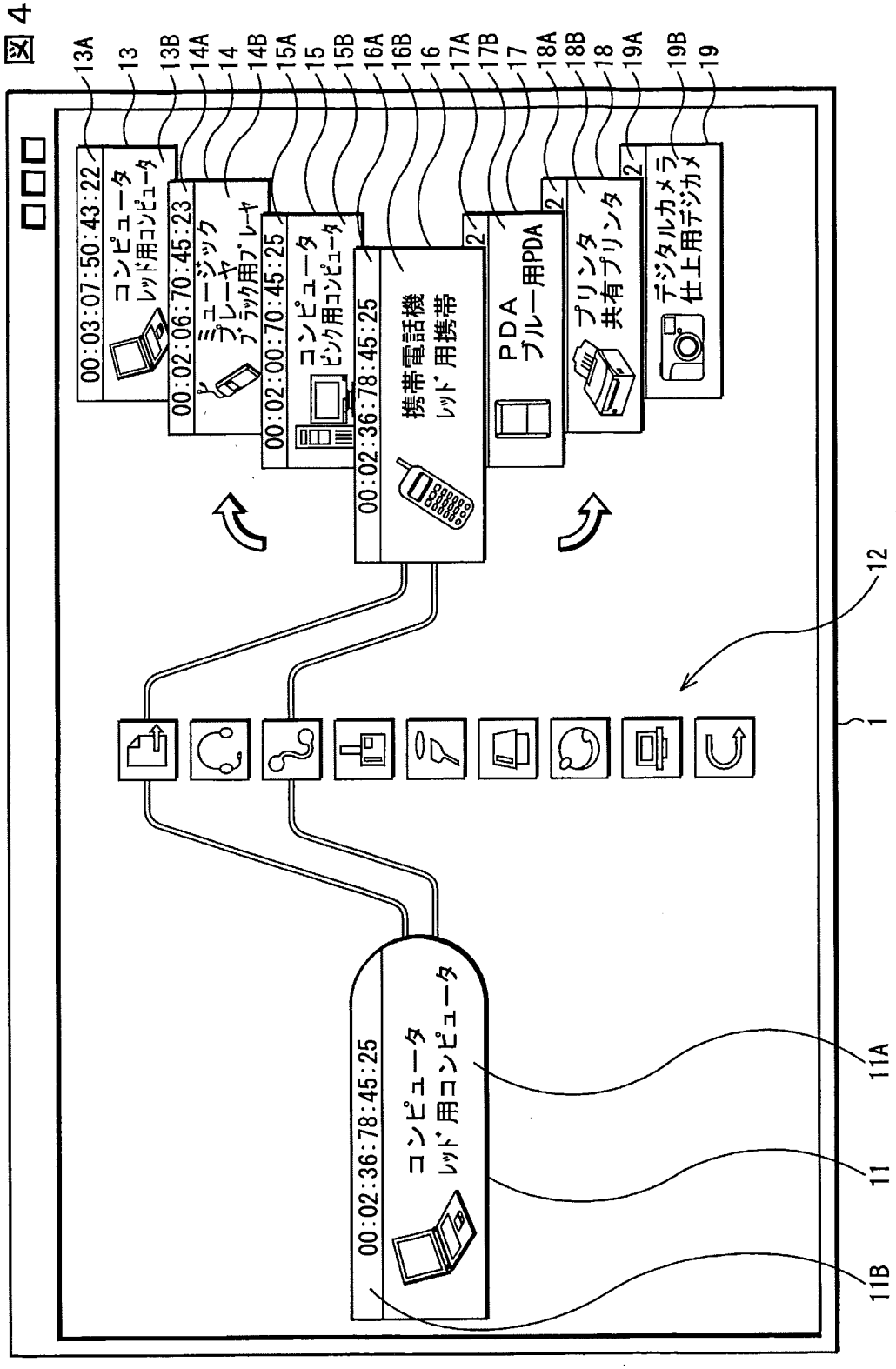

13A
13
13B
14A
14
14B
15A
15
15B
16A
16B
16
17A
17B
17
18A
18B
18
19A
19B
19
00:03:07:50:43:22
コンピュータ
レッド用コンピュータ
00:02:06:70:45:23
ミュージック
プレーヤ
ブラック用プレーヤ
00:02:00:70:45:25
コンピュータ
ピンク用コンピュータ
00:02:36:78:45:25
携帯電話機
レッド用携帯
PDA
ブルー用PDA
プリンタ
共有プリンタ
デジタルカメラ
仕上用デジカメ
12
1
00:02:36:78:45:25
コンピュータ
レッド用コンピュータ
11A
11
11B

図5

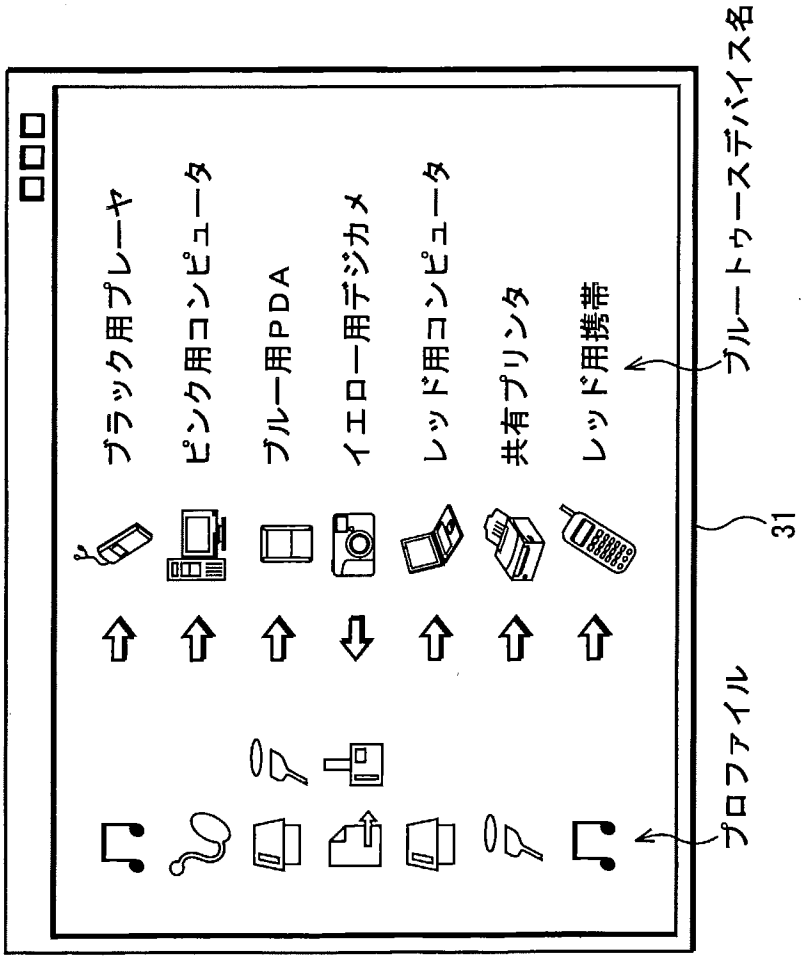

ブラック用プレーヤ
ピンク用コンピュータ
ブルー用ＰＤＡ
イエロー用デジカメ
レッド用コンピュータ
共有プリンタ
レッド用携帯
ブルートゥースデバイス名
31
プロファイル

図6

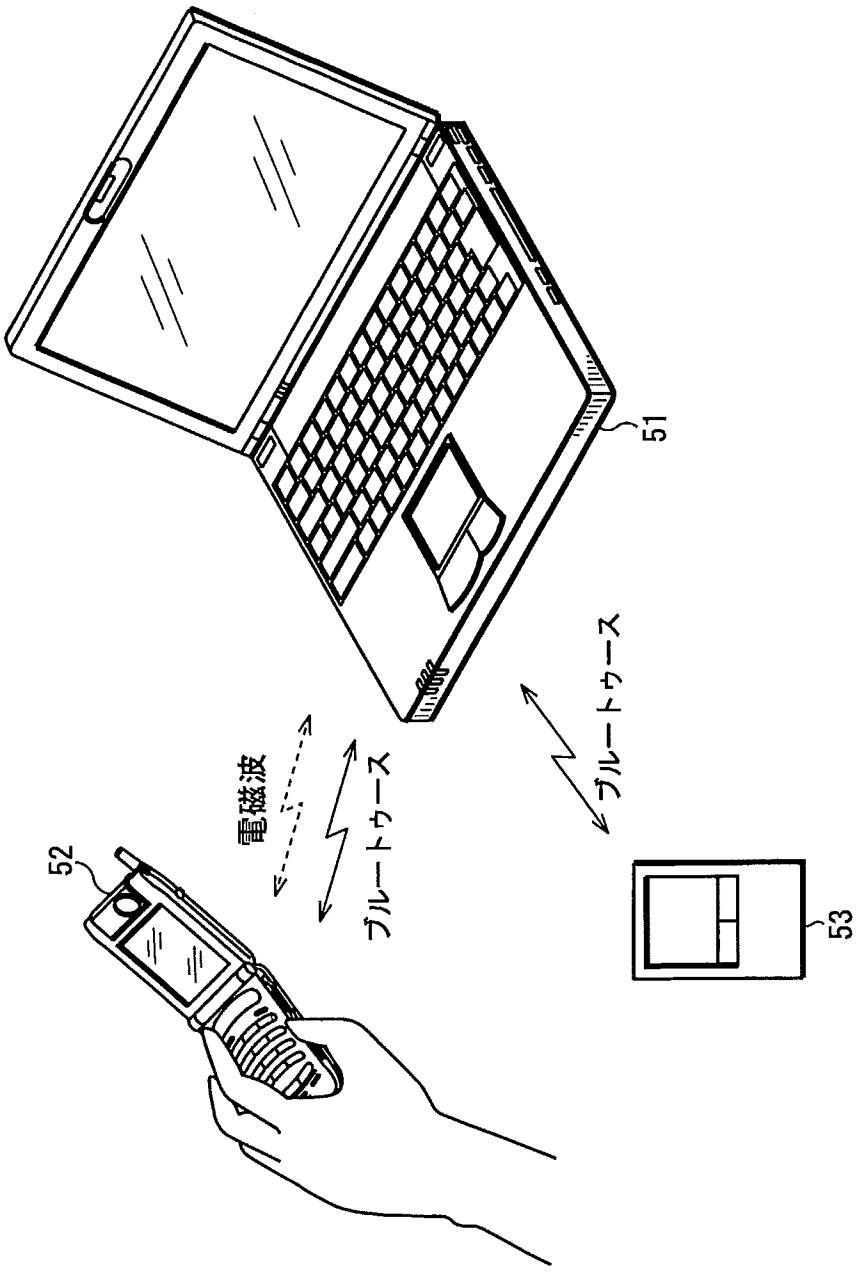


図 7

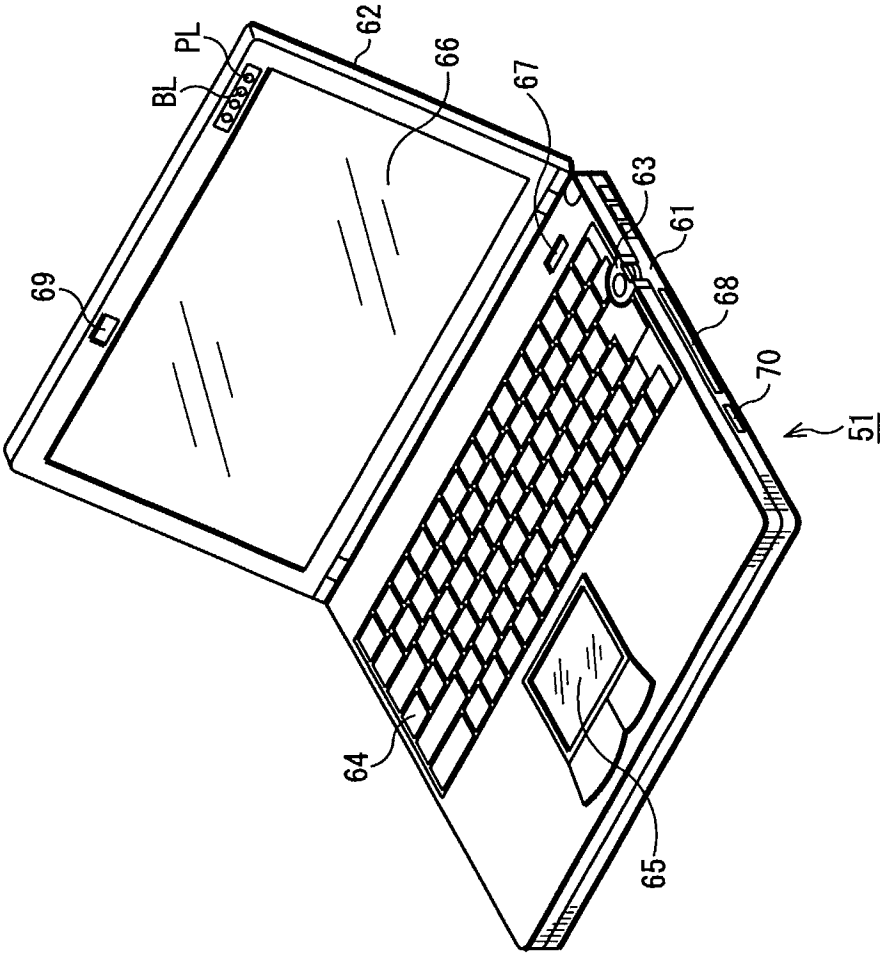


図 8

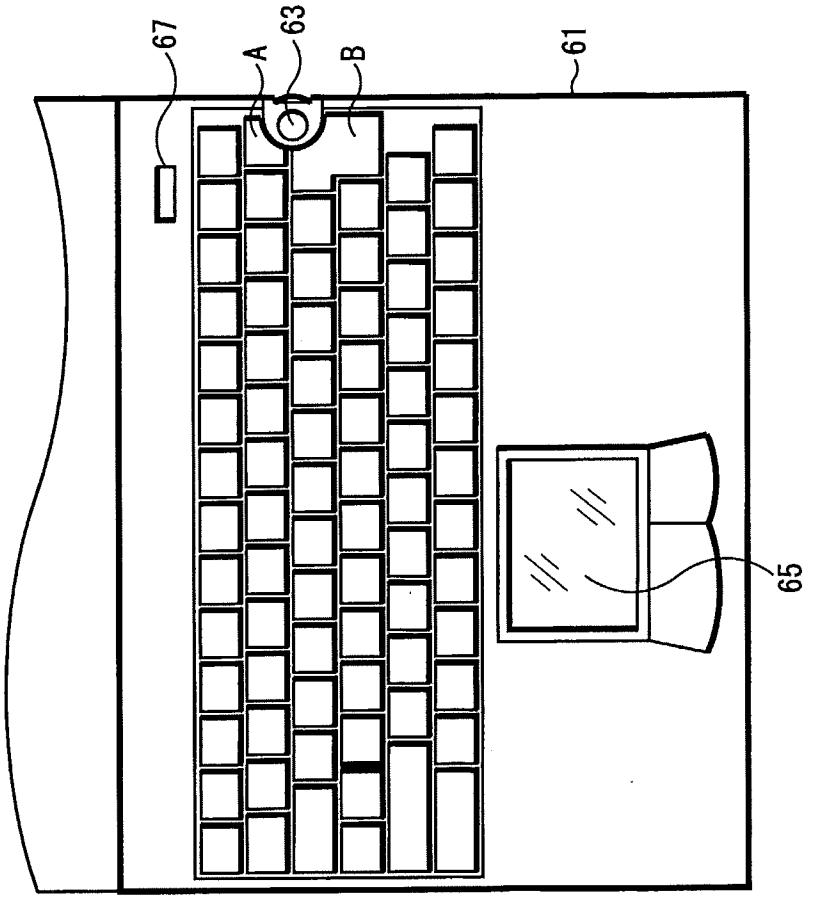


図9

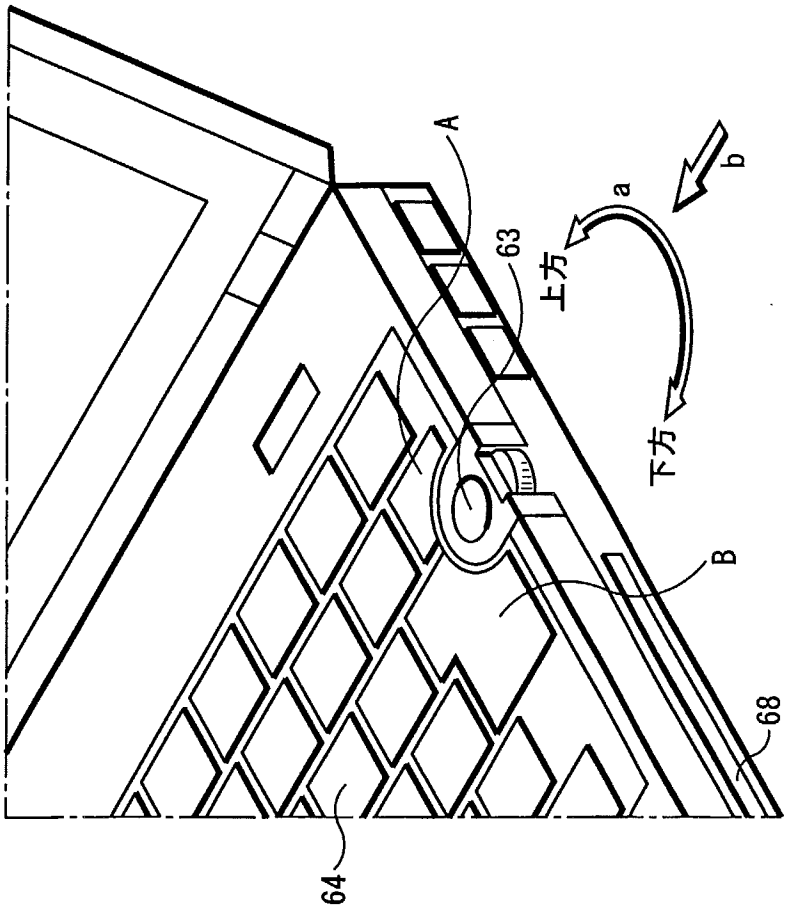
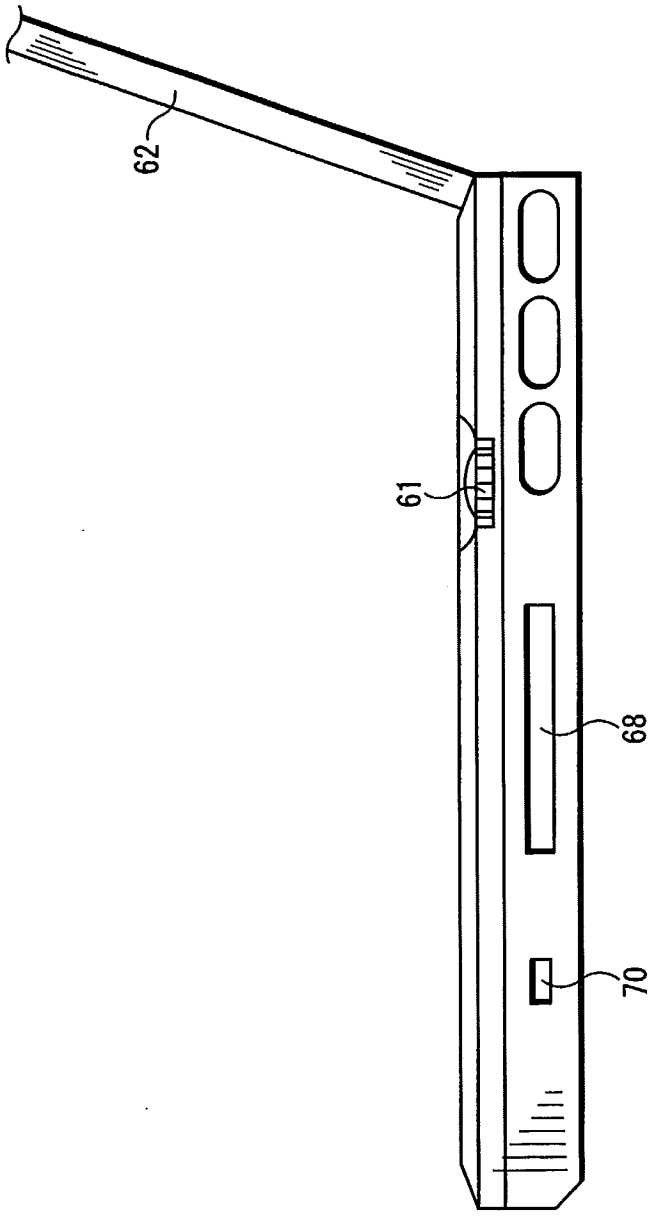


図10



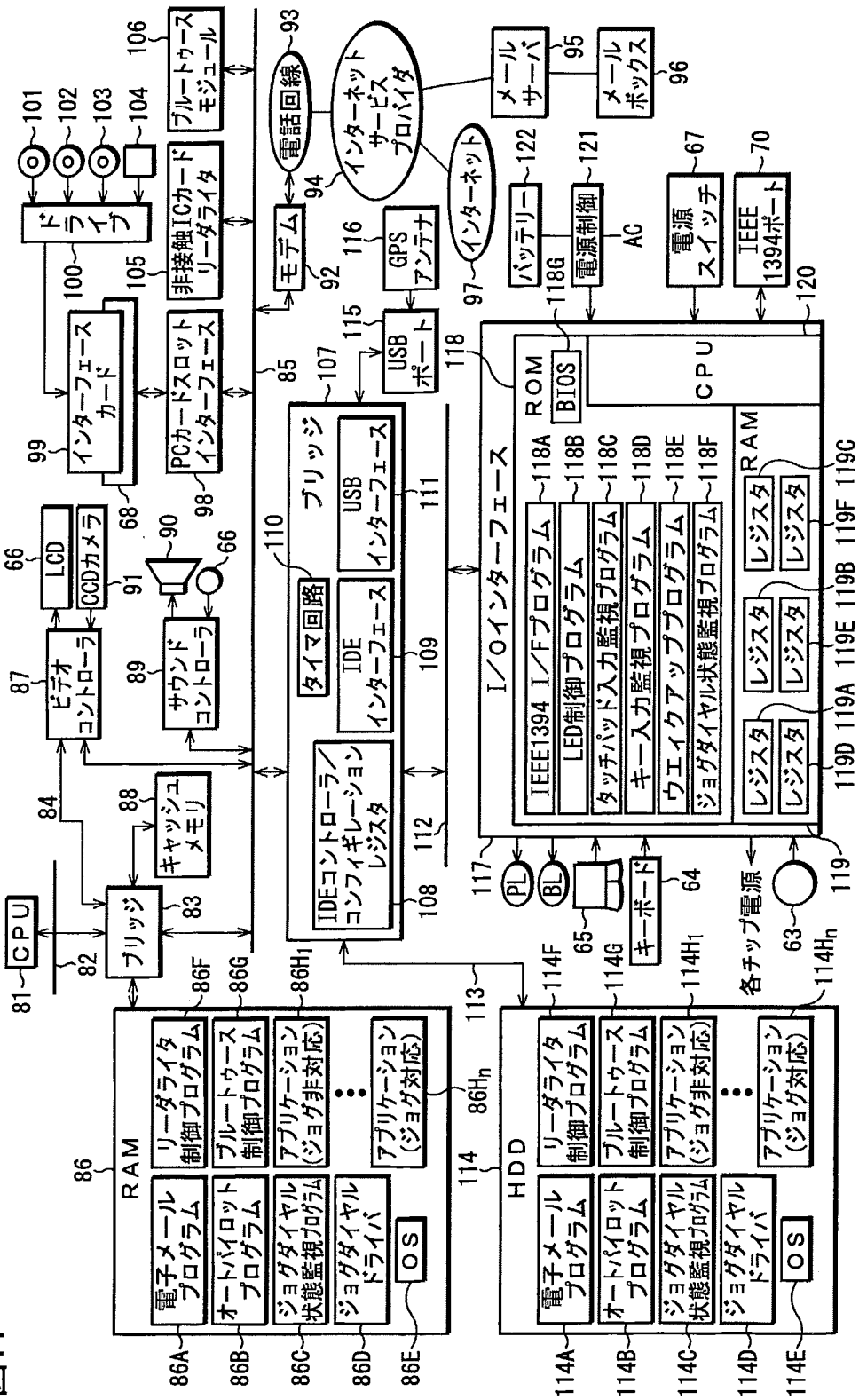


図11

PGR2023-00016 - Home Depot
Ex. 1003 - Page 792

図12

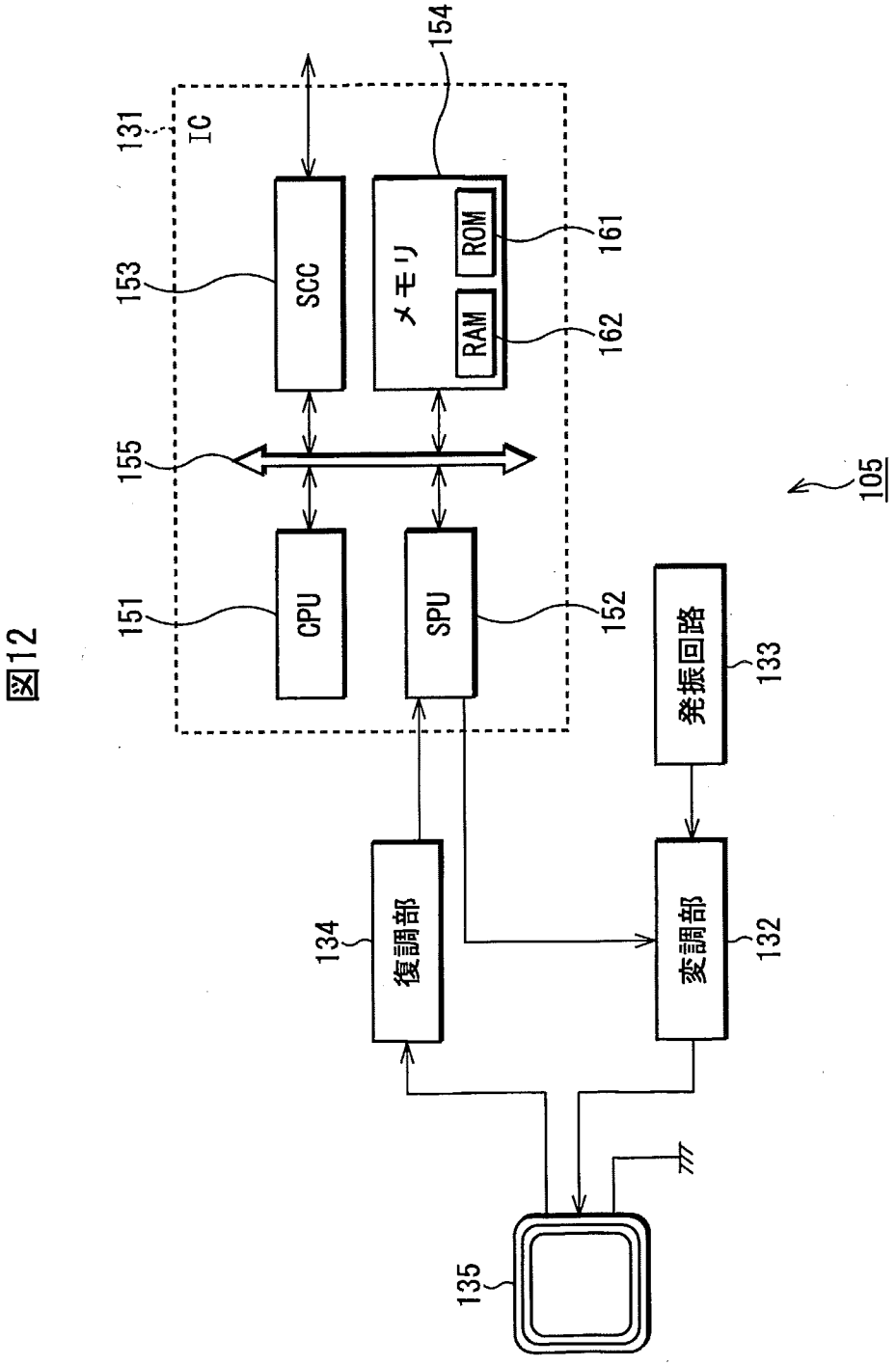

105
131
IC
154
153
SCC
メモリ
ROM
161
RAM
162
155
151
CPU
SPU
152
発振回路
133
134
復調部
変調部
132
135

図13

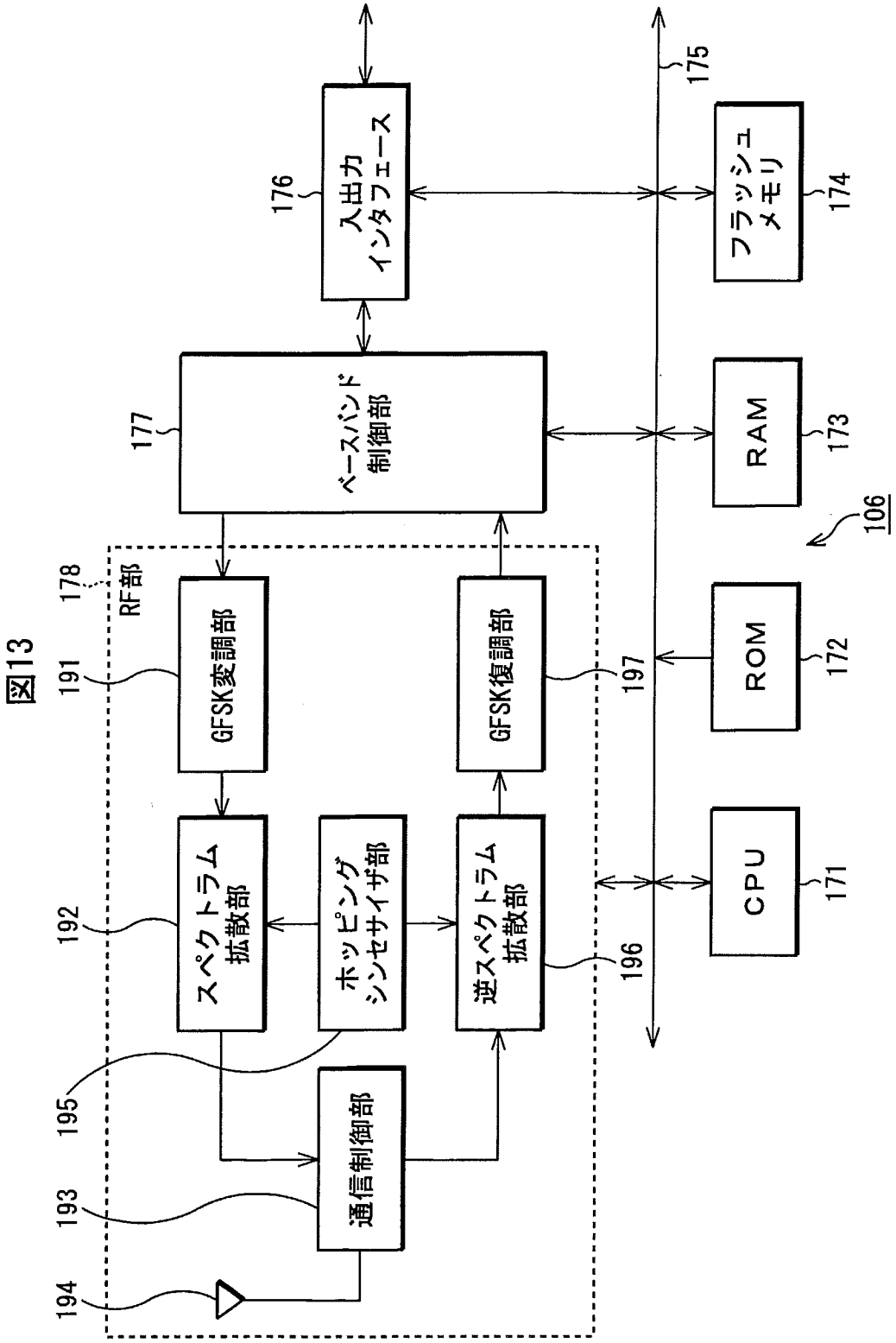

106
RF部
178
191
192
193
194
195
196
197
GFSK変調部
スペクトラム拡散部
通信制御部
ホッピングシンセサイザ部
逆スペクトラム拡散部
GFSK復調部
ベースバンド制御部
177
入出力インタフェース
176
175
フラッシュメモリ
174
RAM
173
ROM
172
CPU
171

図14

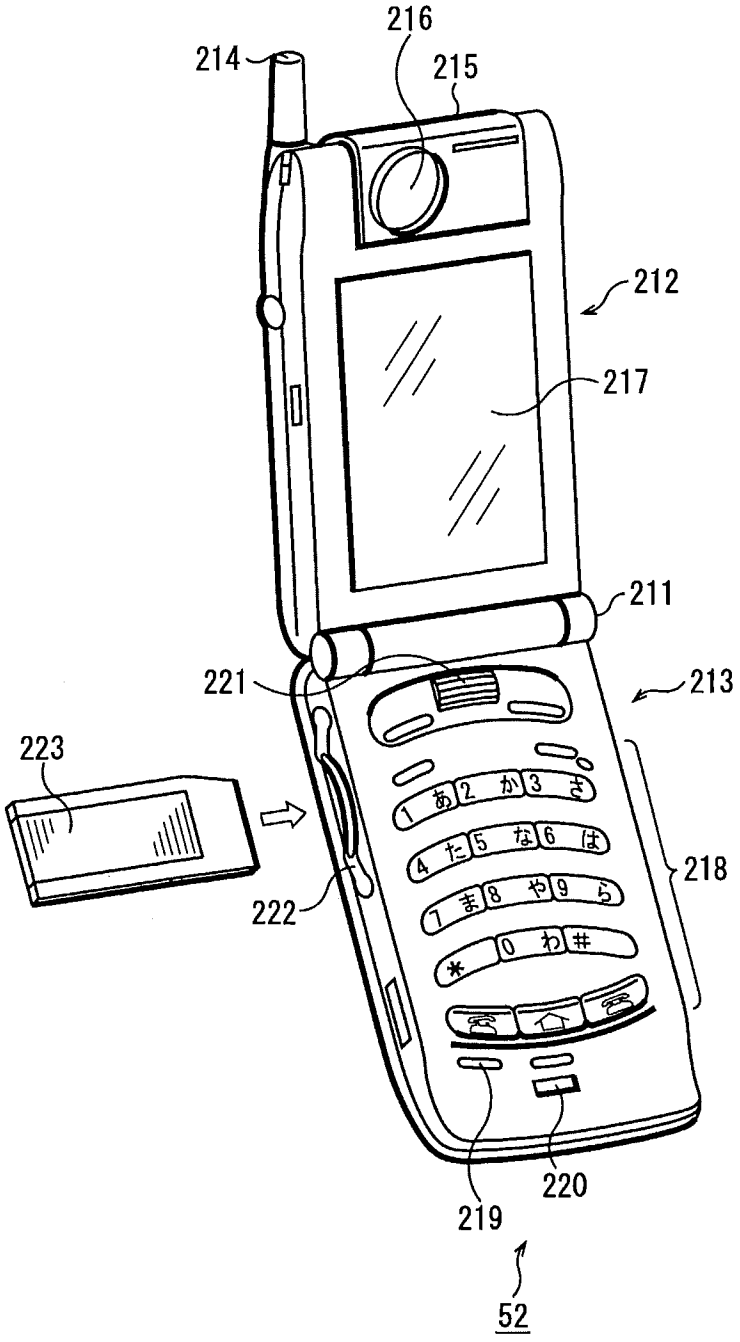


図15

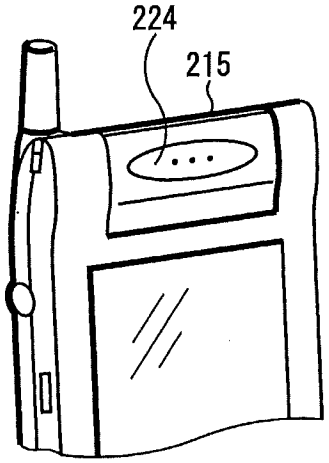


図16

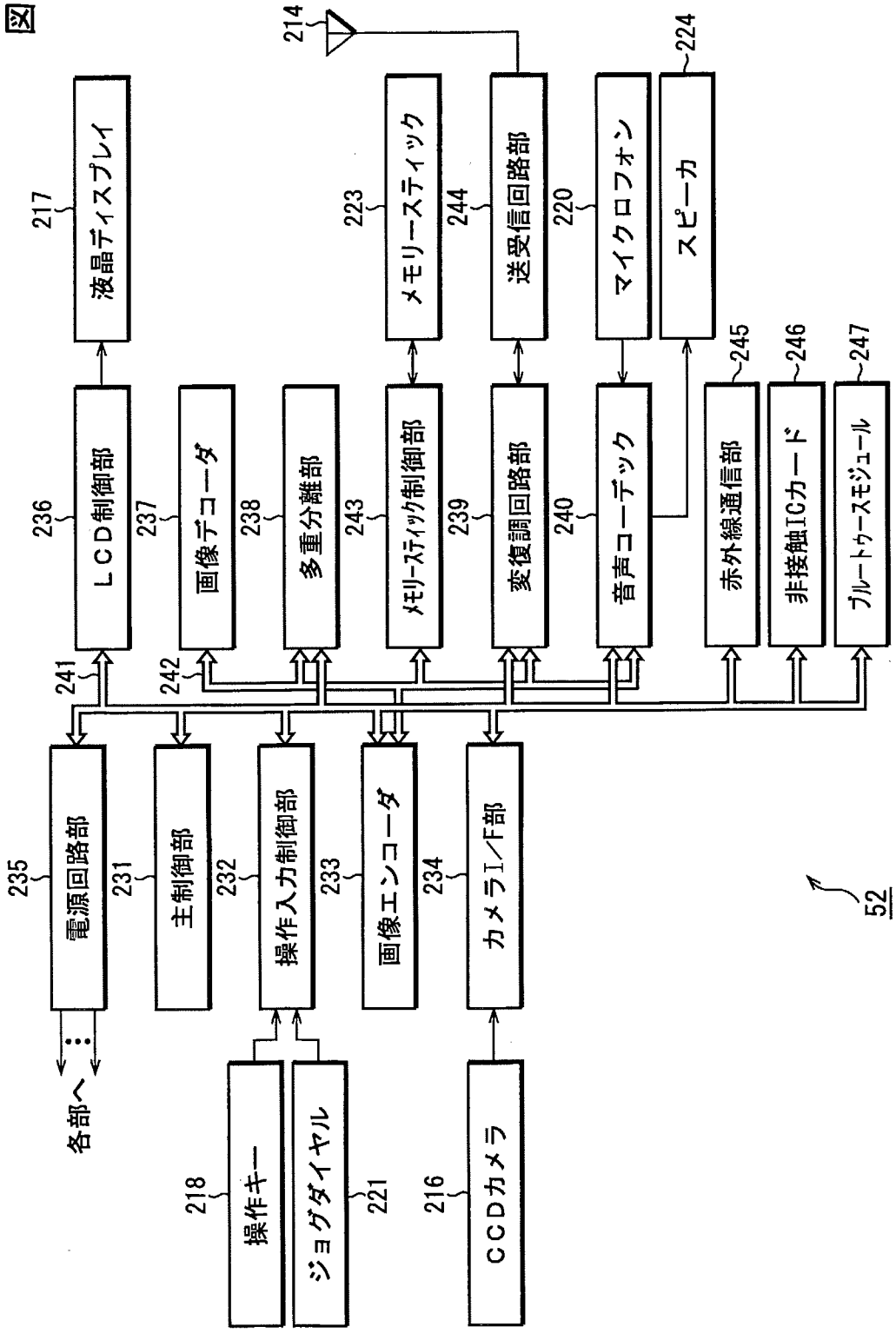

214
液晶ディスプレイ
217
メモリースティック
223
244
送受信回路部
220
マイクロフォン
224
スピーカ
LCD制御部
236
画像デコーダ
237
多重分離部
238
メモリースティック制御部
243
239
変復調回路部
240
音声コーデック
赤外線通信部
245
非接触ICカード
246
ブルートゥースモジュール
247
241
242
電源回路部
235
主制御部
231
操作入力制御部
232
画像エンコーダ
233
カメラI／F部
234
52
各部へ
操作キー
218
ジョグダイヤル
221
CCDカメラ
216

図17

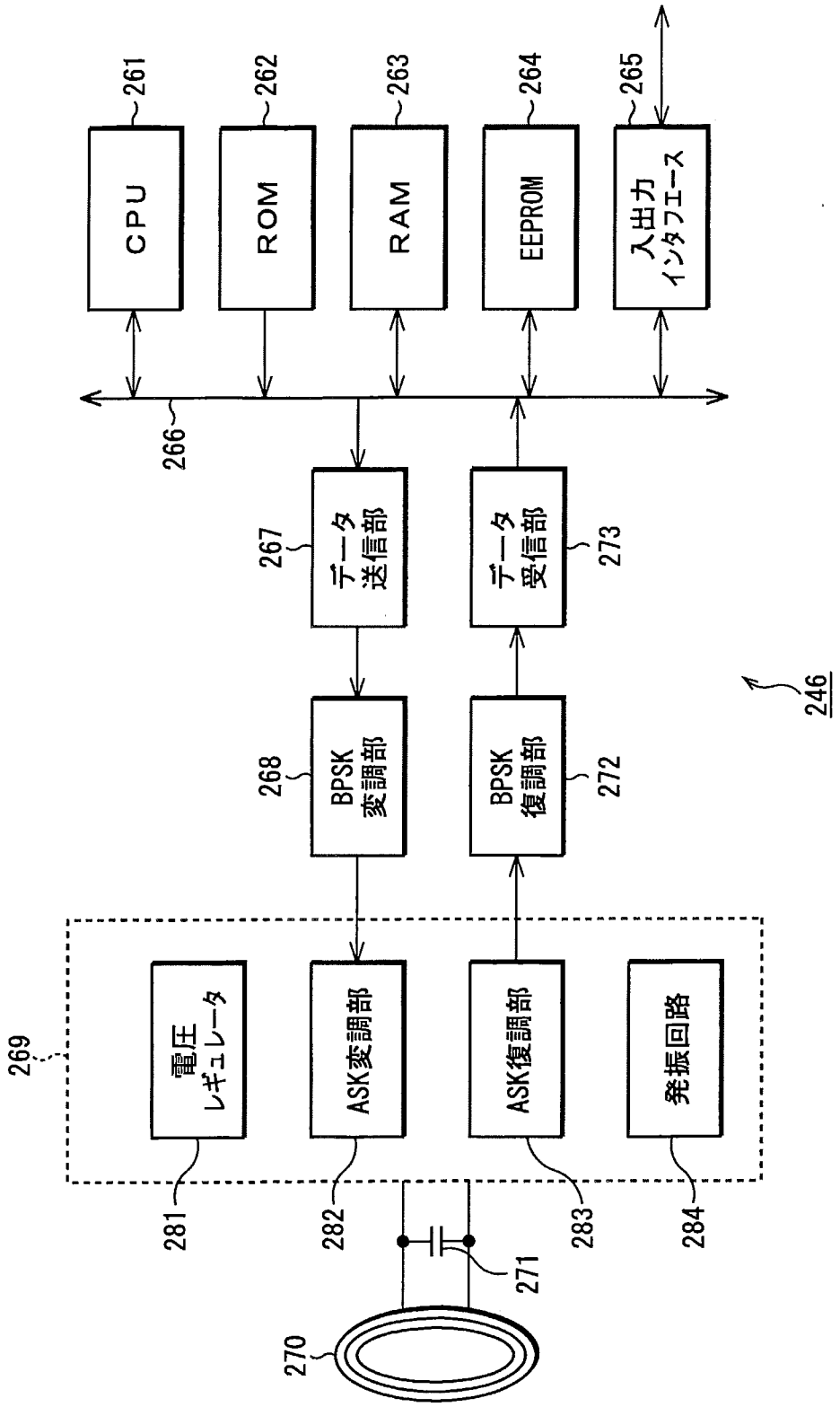

261
CPU
262
ROM
263
RAM
264
EEPROM
265
入出力
インタフェース
266
267
データ
送信部
273
データ
受信部
246
268
BPSK
変調部
272
BPSK
復調部
269
電圧
レギュレータ
ASK変調部
ASK復調部
発振回路
281
282
283
284
271
270

図18

仕様項目			
通信速度			211.875kbps
電力電送		中心周波数	13.56MHz
		出力	350mW
データ転送	R/W→Card	中心周波数	13.56MHz
		変調方式	ASK
	Card→R/W	中心周波数	13.56MHz
		変調方式	ロードスイッチング

図19

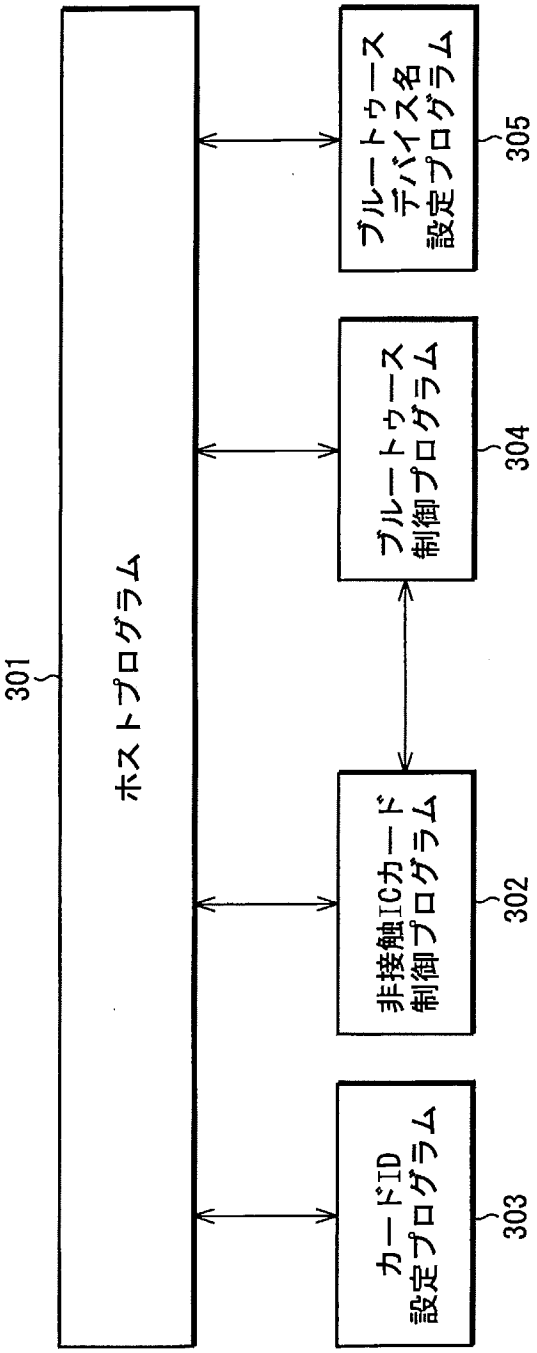

ホストプログラム
301
非接触ICカード
制御プログラム
302
カードID
設定プログラム
303
ブルートゥース
制御プログラム
304
ブルートゥース
デバイス名
設定プログラム
305

図20

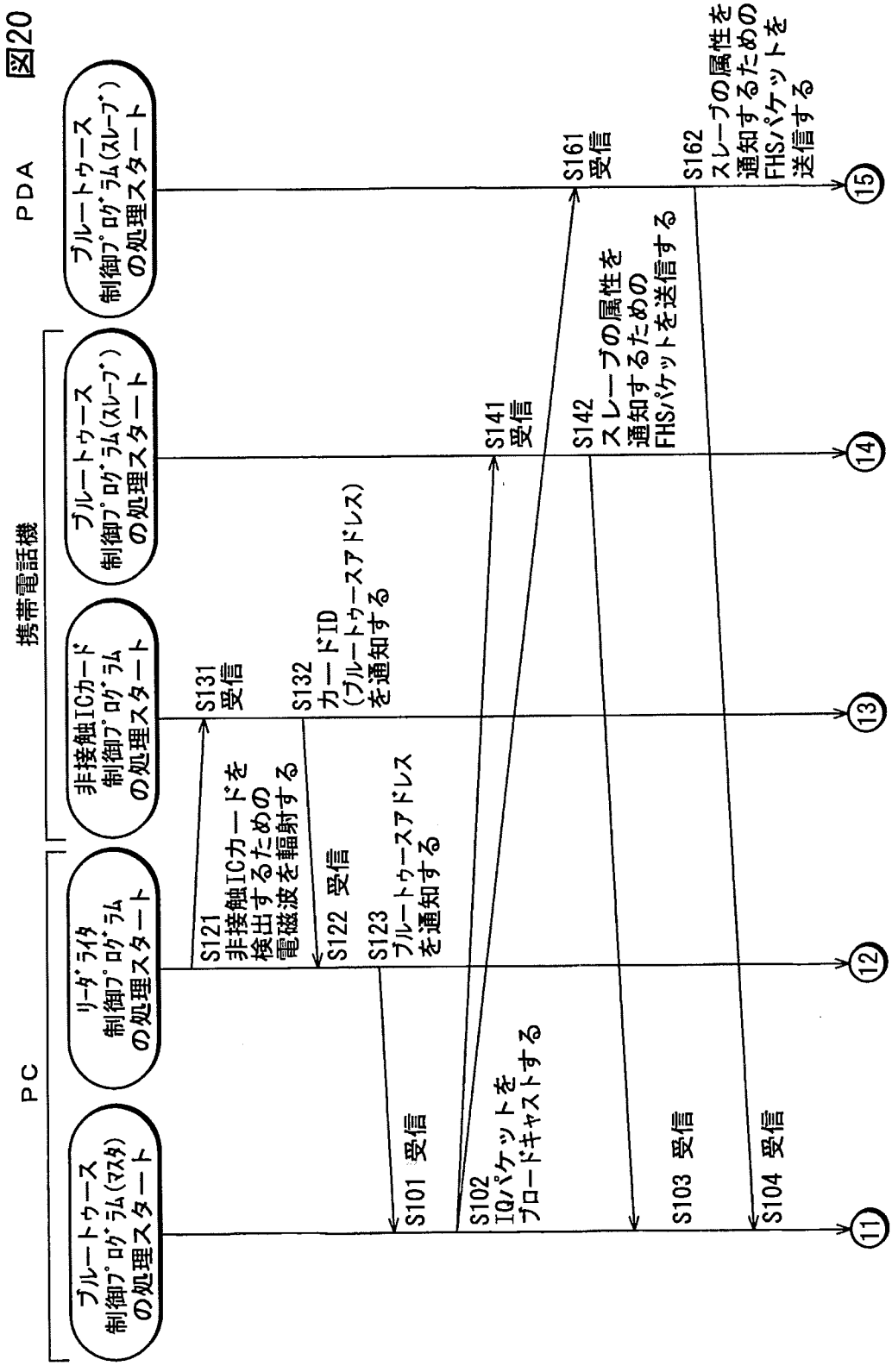

PC
携帯電話機
PDA
ブルートゥース制御ﾌﾟﾛｸﾞﾗﾑ(マスタ)の処理スタート
リーダライタ制御ﾌﾟﾛｸﾞﾗﾑの処理スタート
非接触ICカード制御ﾌﾟﾛｸﾞﾗﾑの処理スタート
ブルートゥース制御ﾌﾟﾛｸﾞﾗﾑ(スレーブ)の処理スタート
ブルートゥース制御ﾌﾟﾛｸﾞﾗﾑ(スレーブ)の処理スタート
S121 非接触ICカードを検出するための電磁波を輻射する
S131 受信
S132 カードID (ブルートゥースアドレス)を通知する
S122 受信
S123 ブルートゥースアドレスを通知する
S101 受信
S102 IQパケットをブロードキャストする
S141 受信
S142 スレーブの属性を通知するためのFHSパケットを送信する
S161 受信
S162 スレーブの属性を通知するためのFHSパケットを送信する
S103 受信
S104 受信
11
12
13
14
15

図21

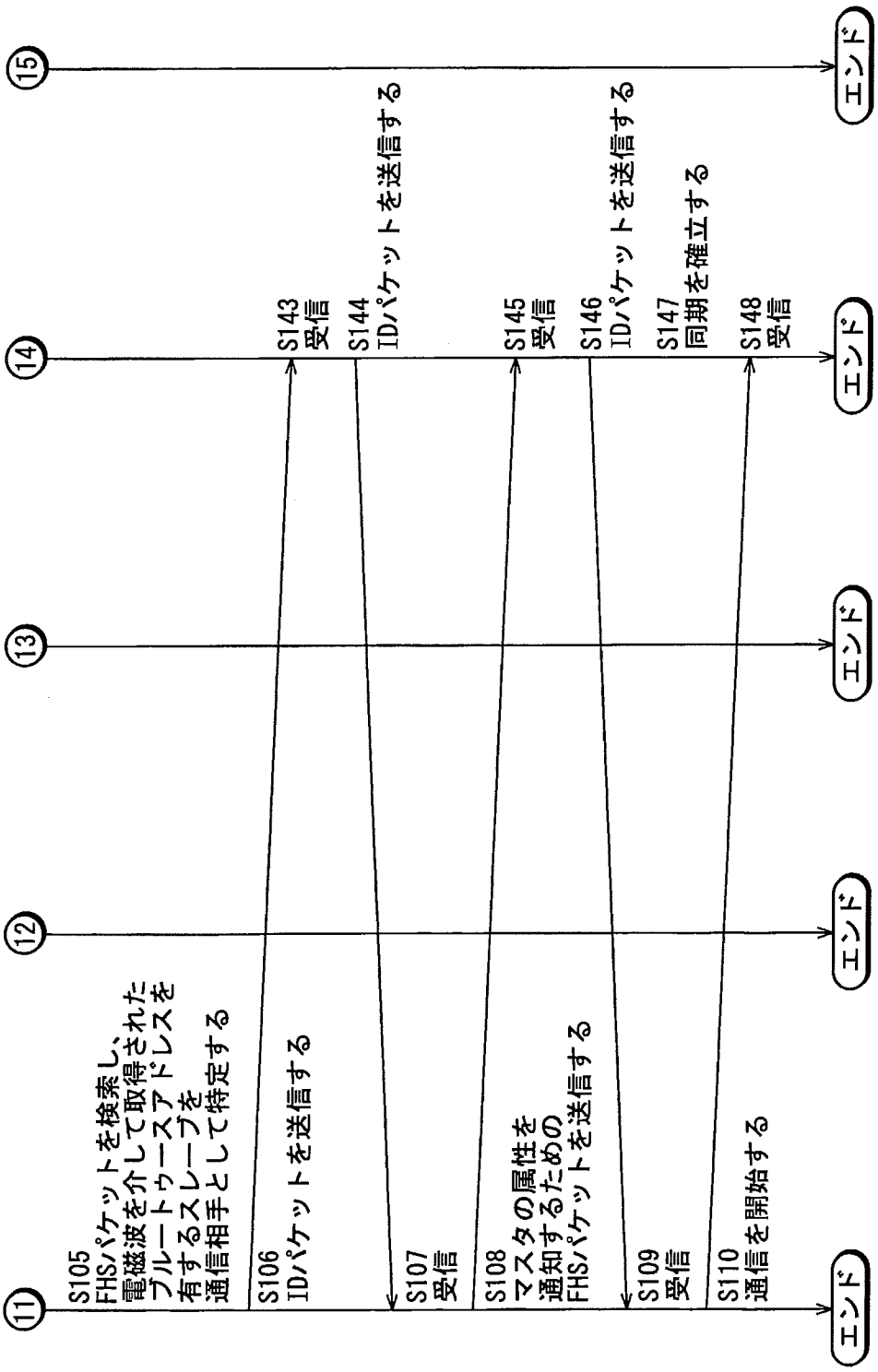

⑪
⑫
⑬
⑭
⑮
S105
FHSパケットを検索し、
電磁波を介して取得された
ブルートゥースアドレスを
有するスレーブを
通信相手として特定する
S106
IDパケットを送信する
S107
受信
S108
マスタの属性を
通知するための
FHSパケットを送信する
S109
受信
S110
通信を開始する
S143
受信
S144
IDパケットを送信する
S145
受信
S146
IDパケットを送信する
S147
同期を確立する
S148
受信
エンド
エンド
エンド
エンド
エンド

図22

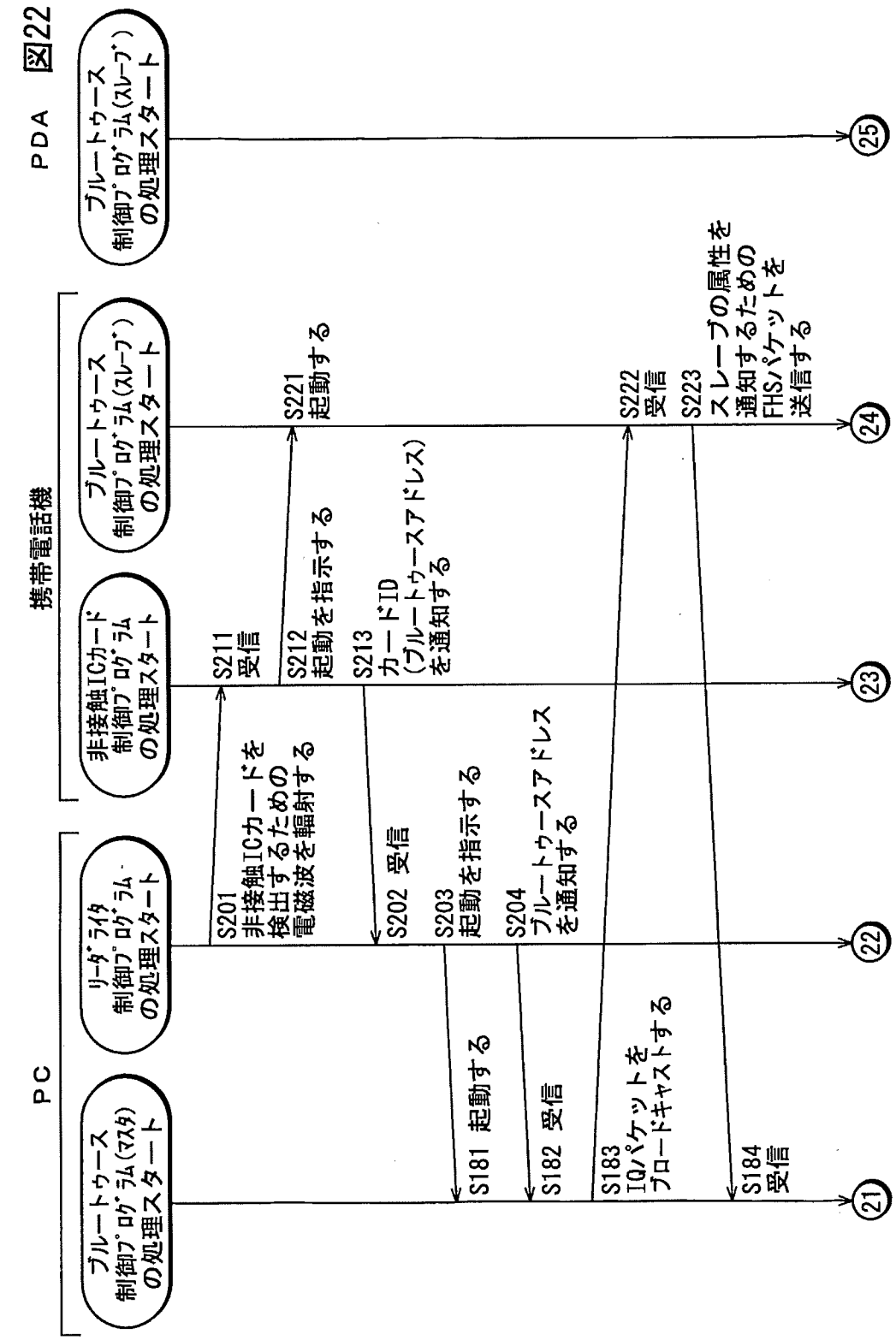

PC
携帯電話機
PDA
ブルートゥース制御プログラム(マスタ)の処理スタート
リーダライタ制御プログラムの処理スタート
非接触ICカード制御プログラムの処理スタート
ブルートゥース制御プログラム(スレーブ)の処理スタート
ブルートゥース制御プログラム(スレーブ)の処理スタート
S201 非接触ICカードを検出するための電磁波を輻射する
S211 受信
S212 起動を指示する
S221 起動する
S213 カードID(ブルートゥースアドレス)を通知する
S202 受信
S203 起動を指示する
S204 ブルートゥースアドレスを通知する
S222 受信
S223 スレーブの属性を通知するためのFHSパケットを送信する
S181 起動する
S182 受信
S183 IQパケットをブロードキャストする
S184 受信
21
22
23
24
25

図23

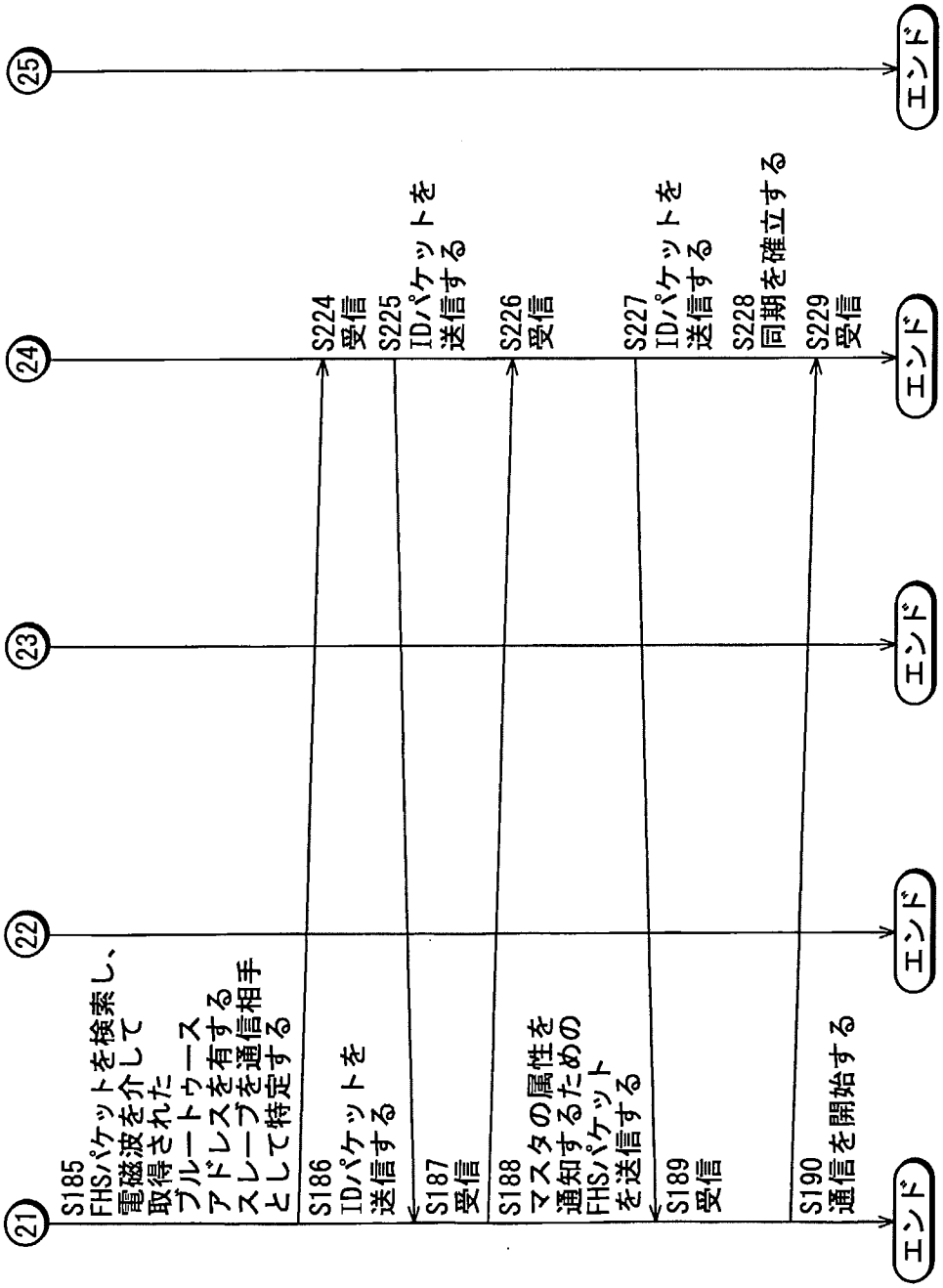

21
22
23
24
25
S185
FHSパケットを検索し、
電磁波を介して
取得された
ブルートゥース
アドレスを有する
スレーブを通信相手
として特定する
S186
IDパケットを
送信する
S187
受信
S188
マスタの属性を
通知するための
FHSパケット
を送信する
S189
受信
S190
通信を開始する
S224
受信
S225
IDパケットを
送信する
S226
受信
S227
IDパケットを
送信する
S228
同期を確立する
S229
受信
エンド
エンド
エンド
エンド
エンド

図24A

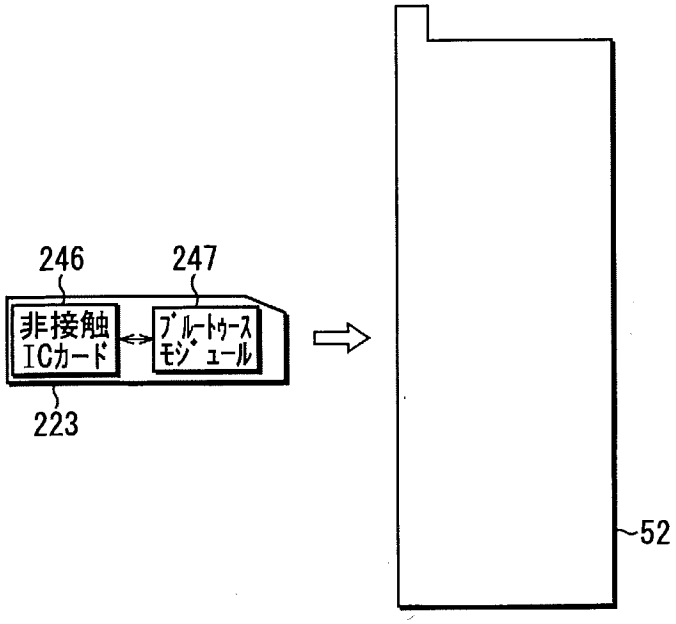

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ICカード
ブルートゥース
モジュール
223
52

図24B

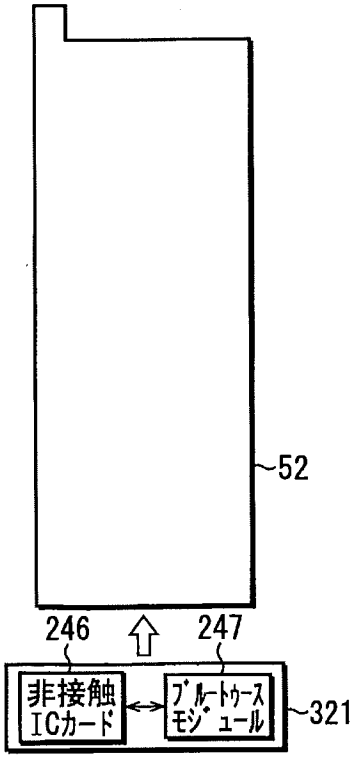

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ブルートゥース
モジュール
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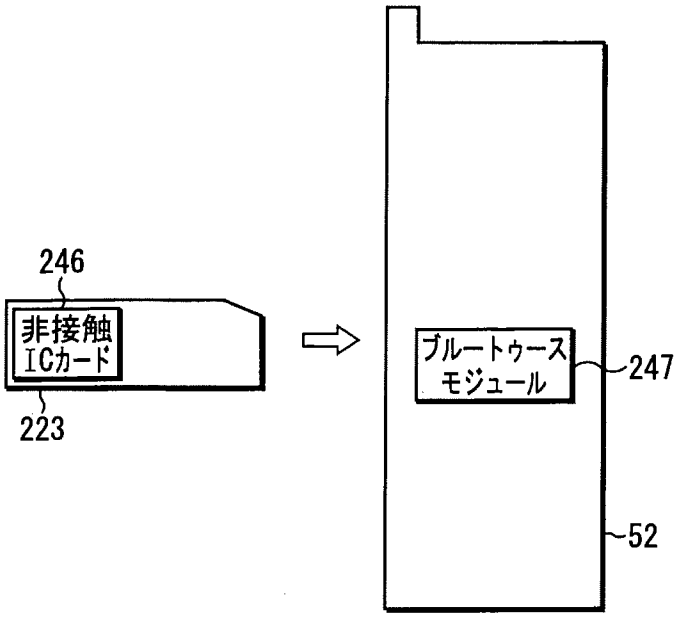

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ICカード
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ブルートゥース
モジュール
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図25B

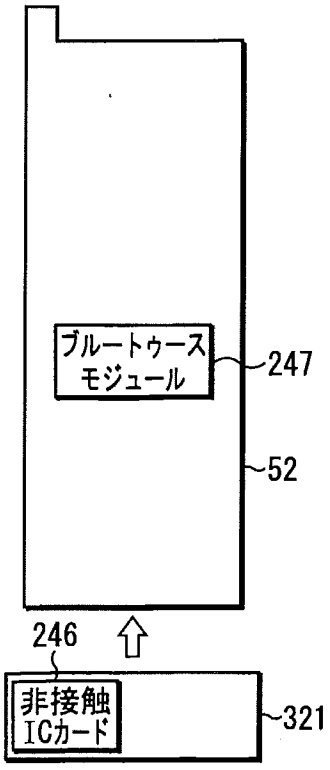

ブルートゥース
モジュール
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ICカード
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図26A

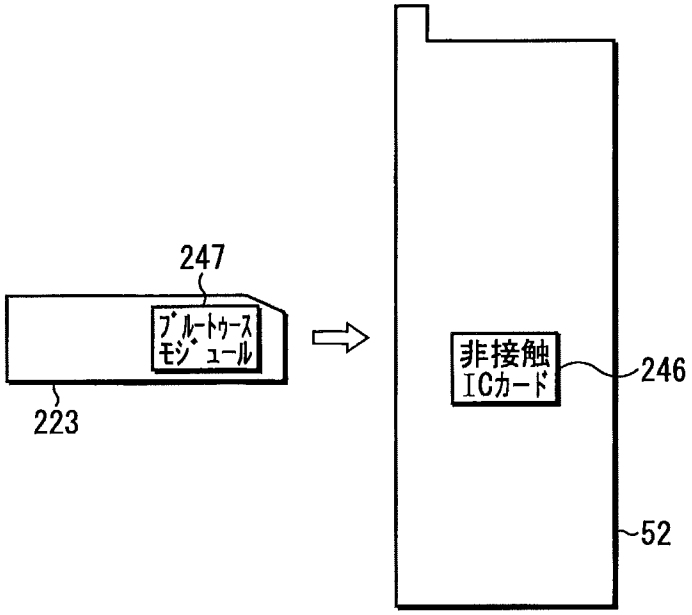

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非接触 ICカード
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図26B

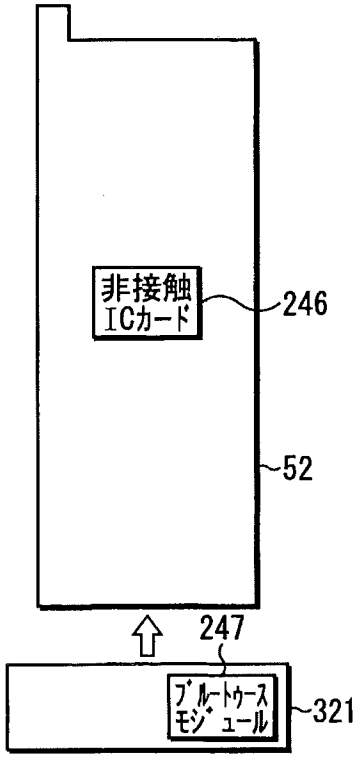

非接触 ICカード
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247
ブルートゥース モジュール
321

図27

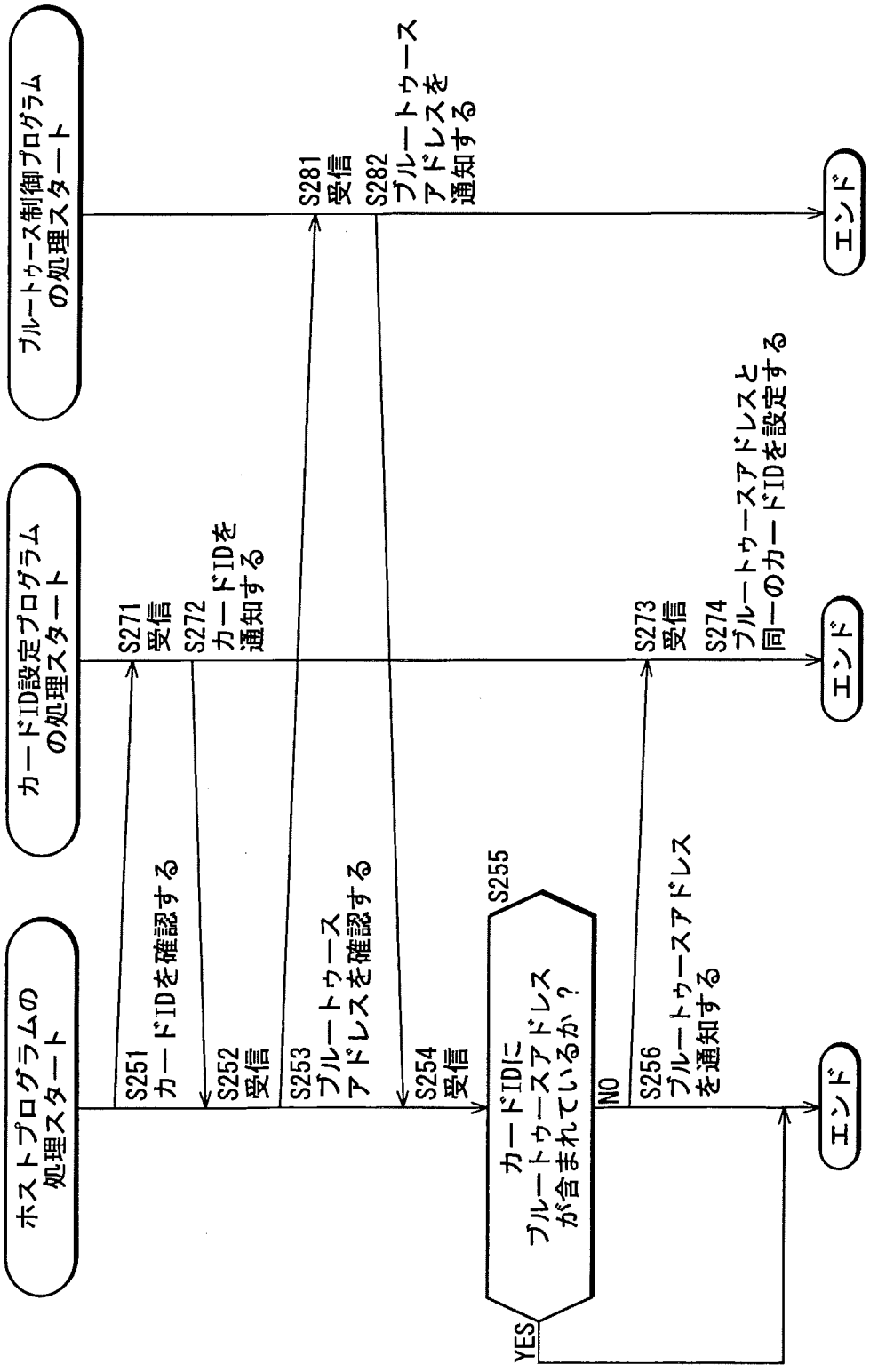
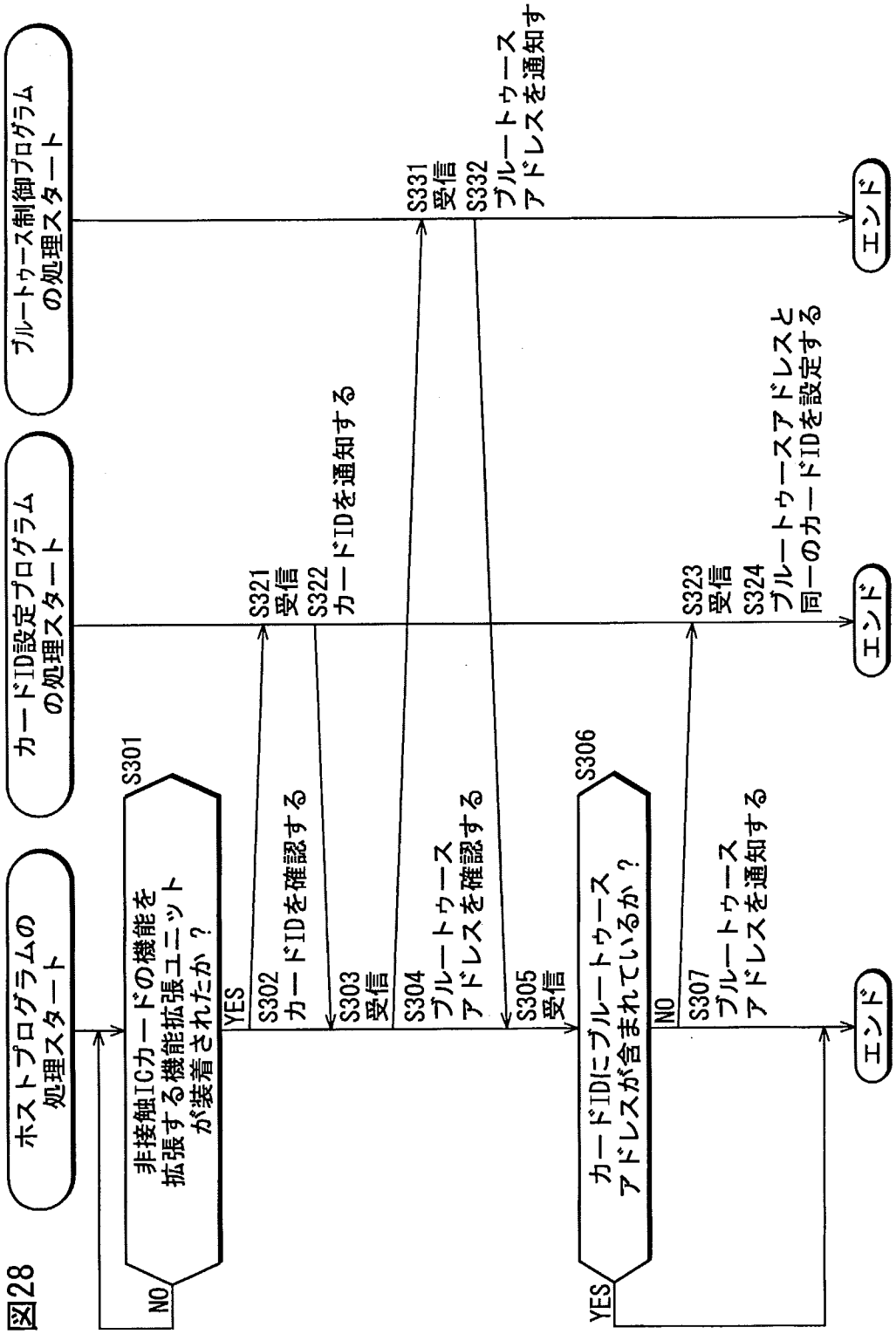

ホストプログラムの処理スタート
カードID設定プログラムの処理スタート
ブルートゥース制御プログラムの処理スタート
S251 カードIDを確認する
S252 受信
S253 ブルートゥースアドレスを確認する
S254 受信
S255 カードIDにブルートゥースアドレスが含まれているか？
YES
NO
S256 ブルートゥースアドレスを通知する
S271 受信
S272 カードIDを通知する
S273 受信
S274 ブルートゥースアドレスと同一のカードIDを設定する
S281 受信
S282 ブルートゥースアドレスを通知する
エンド
エンド
エンド

図28


ホストプログラムの処理スタート
カードID設定プログラムの処理スタート
ブルートゥース制御プログラムの処理スタート
S301
非接触ICカードの機能を拡張する機能拡張ユニットが装着されたか？
NO
YES
S302
カードIDを確認する
S303
受信
S304
ブルートゥースアドレスを確認する
S305
受信
S306
カードIDにブルートゥースアドレスが含まれているか？
NO
YES
S307
ブルートゥースアドレスを通知する
S321
受信
S322
カードIDを通知する
S323
受信
S324
ブルートゥースアドレスと同一のカードIDを設定する
S331
受信
S332
ブルートゥースアドレスを通知する
エンド
エンド
エンド

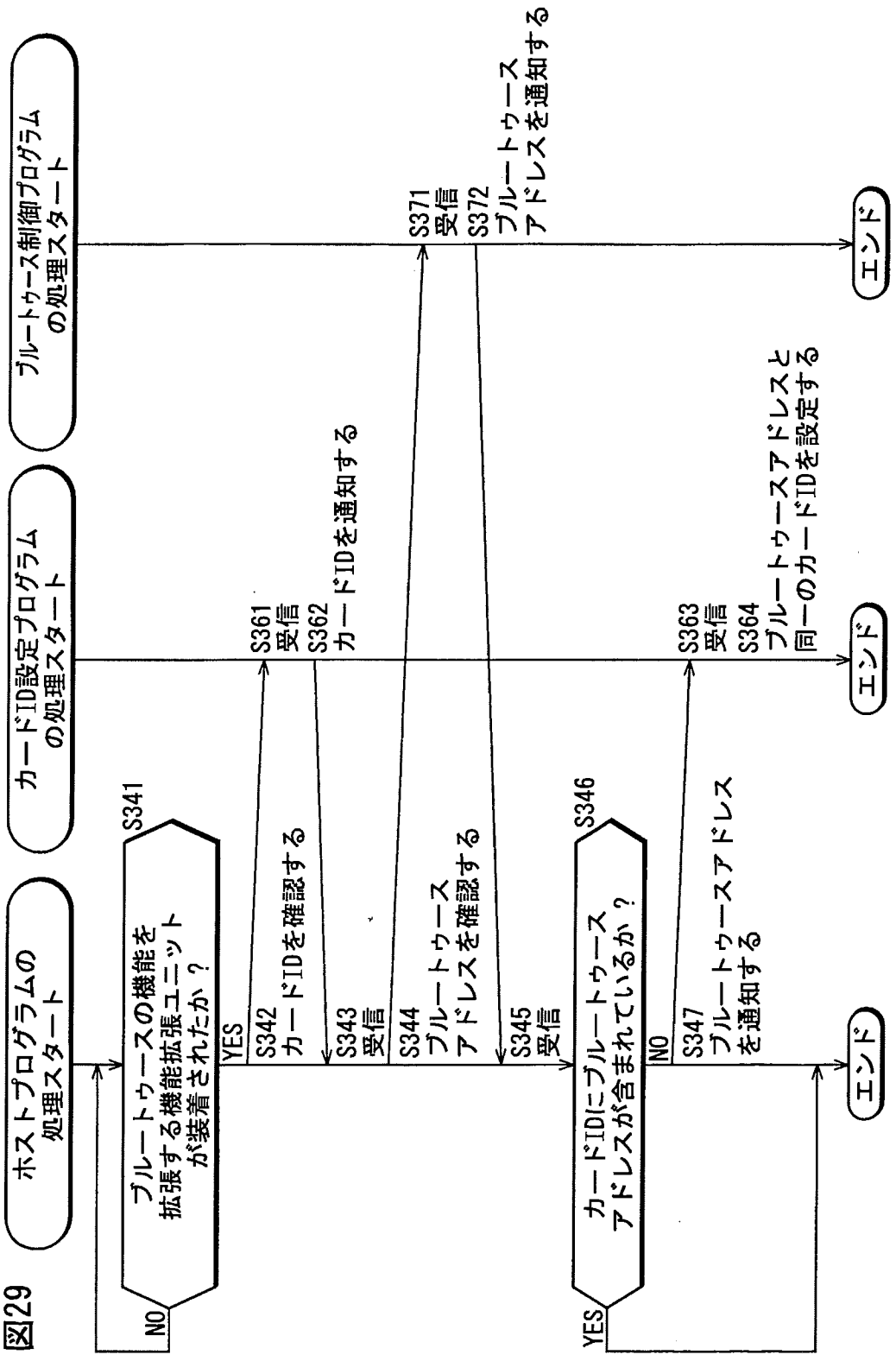
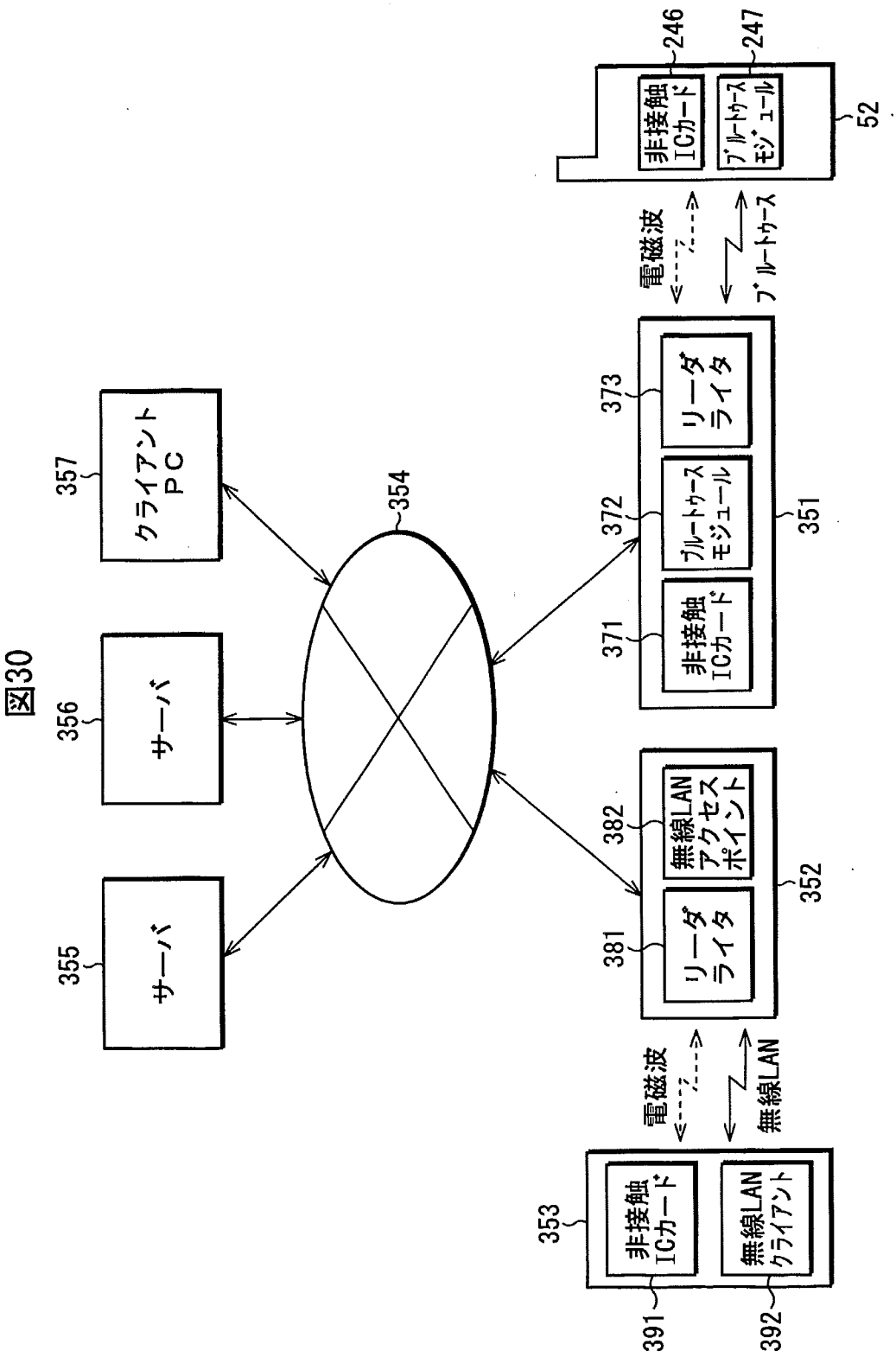


図29

PGR2023-00016 - Home Depot
Ex. 1003 - Page 810

図30


クライアントPC
サーバ
サーバ
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355
非接触ICカード
ブルートゥースモジュール
リーダライタ
371
372
373
351
無線LANアクセスポイント
リーダライタ
382
381
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非接触ICカード
無線LANクライアント
353
391
392
電磁波
ブルートゥース
無線LAN
非接触ICカード
ブルートゥースモジュール
246
247
52

Electronic Acknowledgement Receipt

EFS ID:	44099659
Application Number:	17181802
International Application Number:	
Confirmation Number:	5141
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Customer Number:	24573
Filer:	Dennis A. Majewski/US Patent Mail
Filer Authorized By:	Dennis A. Majewski
Attorney Docket Number:	3725194.00146 14US07
Receipt Date:	22-OCT-2021
Filing Date:	22-FEB-2021
Time Stamp:	13:18:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	JP-7177-A.pdf	169429 9c208c2b7bd7c19cf63ab676a2bf4999701ae2a4	no	1

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2	Foreign Reference	JP-8383-A.pdf	164201 841359ff1e981499b83ce327ab5d299a1e06f279	no	1
Warnings:					
Information:					
3	Foreign Reference	JP-9063-A.pdf	159606 ffb77d08f2707ecc59f064eab80ab3a29972f219	no	1
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4	Non Patent Literature	K110687400vACOMRound.pdf	257376 e0a02f76228f0646c455809883b6e2be30218eea	no	9
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8	Non Patent Literature	Light-Emitting-Diodes-15SAMS3070125870Part3.pdf	6680667 4bbb3e264bed3e64ecb84c0b95342fd09fcb8e4c	no	104
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9	Non Patent Literature	Light-Emitting-Diodes-Schubert-15SAMS3070125870Part1.pdf	7286164 656b129afbbe633f5858b9845b0434b9f7086c89	no	114
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11	Non Patent Literature	Walding-High-Current-LED19SAMS3070106826.pdf	652328 42d8e0bd16b28f633393ebde236c3c6b395c0e26	no	12
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13	Non Patent Literature	7-21-21-Infringe-Conten-Charts-US10492252.pdf	1813240 7dc0b9adee0cd7fc3f1ed182a9b34ea7a6a6167b	no	53
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14	Non Patent Literature	252-Mandatory-Notice.pdf	132431 01dc2ddf3361a801f2fddfa0c18f91c60c1c8f5d	no	5
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15	Non Patent Literature	252-Notice-Filing.pdf	208196 6151979a3c2026c91e67e87f2b8db07e8a9bd179	no	5
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16	Non Patent Literature	252-Petition-Inter.pdf	1132573 1fe54917729c702675b4bac7cafd5d92426f59e5	no	85
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19	Non Patent Literature	Answer-to-First-Amended-Complaint.pdf	1431145 5f822655791e6bdc6ed21e9f465e5c31026b4629	no	67
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		Total Files Size (in bytes):	137980132		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: QPIDS.REQ
Document Description: QuickPath Information Disclosure Statement

PTO/SB/09 (09-18)

CERTIFICATION AND REQUEST FOR CONSIDERATION OF AN INFORMATION DISCLOSURE STATEMENT FILED AFTER PAYMENT OF THE ISSUE FEE UNDER THE QPIDS PROGRAM

Non-Provisional Application Number: 17181802	Filing Date: 2021-02-22
First Named Inventor: Miskin	Title of Invention: MULTI-VOLTAGE AND MULTI-BRIGHTNES LED LIGHTING DEVICES AND METHODS OF USING S

THE UNDERSIGNED HEREBY CERTIFIES AND REQUESTS THE FOLLOWING FOR THE ABOVE-IDENTIFIED APPLICATION.

1. Consideration is requested of the information disclosure statement (IDS) submitted herewith, which is being filed after payment of the issue fee.
2. Check the box next to the appropriate selection:

   ☑ Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(1).

   OR

   ☐ No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the IDS was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(2).

   OR

   ☐ See attached certification statement in compliance with 37 CFR 1.97(e).
3. Please charge the IDS fee set forth in 37 CFR 1.17(p) to Deposit Account No. 02-1818.
4. A Petition to Withdraw from Issue After Payment of the Issue Fee (37 CFR 1.313(c)(2)), including the petition fee set forth in 37 CFR 1.17(h), is submitted herewith as a **Web-based ePetition**. **WARNING:** Do not submit the petition as a follow-on paper via EFS-Web. Submit the petition as a Web-based ePetition by signing on to EFS-Web as a registered user, selecting the radio button next to "Existing application/patent," and then selecting the radio button next to "ePetition (for automatic processing and immediate grant, if all petitions requirements are met)." Failure to use the Web-based ePetition interface will result in automatic entry of the RCE.
5. A request for continued examination (RCE) under 37 CFR 1.114 and the RCE fee under 37 CFR 1.17(e) are submitted herewith.
6. The RCE will be treated as a "conditional" RCE. In the event the examiner determines that any item of information contained in the IDS necessitates the reopening of prosecution in the application, the undersigned understands that (i) the RCE will be processed and treated as an RCE under 37 CFR 1.114 and therefore (ii) the IDS fee under 37 CFR 1.17(p) will be returned in accordance with 37 CFR 1.97(b)(4). In the event that no item of information in the IDS necessitates reopening prosecution, the undersigned understands that the RCE will not be processed and the RCE fee under 37 CFR 1.17(e) will be returned.
7. This certification and request is being filed as a **Web-based ePetition** and is not accompanied by an amendment to the application. Inclusion of an amendment will result in automatic entry of the RCE.

Signature /Dennis A. Majewski/	Date October 22, 2021
Name (Print/Typed) Dennis A. Majewski	Practitioner Registration Number (If applicable) 65,578

Note: *Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.**

☑ *Total of 1 forms are submitted.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17181802
Filing Date	2021-02-22
First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond Crystal L.
Attorney Docket Number	3725194.00146 14US07

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6965205		2005-11-15	Piepgras et al.	
	2	5963012		1999-10-05	Garcia et al.	
	3	6246862		2001-06-12	Grivas et al.	
	4	6211626		2001-04-03	Lys et al.	
	5	6307757		2001-10-23	Porter et al.	
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	Attorney Docket Number	3725194.00146 14US07

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040130909		2004-07-08	Mueller et al.	
	2	20070273299		2007-11-29	Miskin et al.	

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	1	2003047177	JP	A	2003-02-14	Hitachi		
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	8	2004055654	WO	A2	2004-07-01	SPLASH-POWER LIMITED	Corresponds to US9112957 also cited	
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	1	Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc. v. Lynk Labs, Inc. Case No. 1:21-cv-02665, Samsung's Initial Non-Infringement, Unenforceability, and Invalidity Contentions dated September 21, 2021 - 85 pages	
	2	U.S. Patent No. 10,492,251 ('251 Patent") - Exhibit A-01 - Lys '262	
	3	U.S. Patent No. 10,492,251 ('251 Patent") - Exhibit A-02 - KR '747	
	4	U.S. Patent No. 10,492,251 ('251 Patent") - Exhibit A-03 - KR '215	
	5	U.S. Patent No. 10,492,251 ('251 Patent") - Exhibit A-04 - iColor System	

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	Attorney Docket Number	3725194.00146 14US07

	6	U.S. Patent No. 10,492,251 ('251 Patent") - Exhibit A-05 - Miskin '299	
	7	U.S. Patent No. 10,492,252 ('252 Patent") - Exhibit B-01 - Piepgrass	
	8	U.S. Patent No. 10,492,252 ('252 Patent") - Exhibit B-02 - Hitachi	
	9	U.S. Patent No. 10,492,252 ('252 Patent") - Exhibit B-03 - Mueller	
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	13	U.S. Patent No. 10,492,252 ('252 Patent") - Exhibit B-07 - iPod G3	
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	15	U.S. Patent No. 10,499,466 ('466 Patent") - Exhibit C-01 - Piepgrass	
	16	U.S. Patent No. 10,499,466 ('466 Patent") - Exhibit C-02 - HItachi	

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	30	U.S. Patent No. 10,506,674 ('674 Patent") - Exhibit D-08 - iPAQ H5500	
	31	U.S. Patent No. 10,517,149 ('149 Patent") - Exhibit E-01 - Lys '626	
	32	U.S. Patent No. 10,517,149 ('149 Patent") - Exhibit E-02 - KR '747	
	33	U.S. Patent No. 10,517,149 ('149 Patent") - Exhibit E-03 - KR '215	
	34	U.S. Patent No. 10,517,149 ('149 Patent") - Exhibit E-04 - iColor System	
	35	U.S. Patent No. 10,517,149 ('149 Patent") - Exhibit E-05 - Miskin '299	
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	37	U.S. Patent No. 10,687,400 ('400 Patent") - Exhibit F-02 - KR '747	
	38	U.S. Patent No. 10,687,400 ('400 Patent") - Exhibit F-03 - CK LEDs	

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	43	U.S. Patent No. 10,750,583 ('583 Patent") - Exhibit G-04 - iColor System	
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	47	U.S. Patent No. 10,966,298 ('298 Patent") - Exhibit H-02 - Hitachi	
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Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-22
Name/Print	Dennis A. Majewski	Registration Number	65578

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Attorney Docket Number	3725194.00146 14US07

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	12	Macintosh PowerBook G3, 1999.
	13	Apple iPod Third Generation User's Guide, released April 29, 2003.
	14	"HP iPAQ Pocket PC H5500," GadgetSpeak, published Nov. 6, 2003
	15	Light-Emitting Diodes by E. Fred Schubert, published in 2003 ("Schubert")
	16	Fundamentals of LED Drivers by A. Hernandez et al., published in 2003 ("Hernandez")
	17	iColor System by Kinetics iColor MR Data Sheet
	18	WDS Wireless Dimming System Operator's Manual published in 2003 ("WDS-Manual")
	19	AND8137/D - High Current LED - Isolated Low Voltage AC Drive - Application Note by Carl Walding, published in Oct. 2003 ("AND8137/D")
	20	Characteristics of high-efficient InGaN-based white LED lighting by Yuji Uchida, published in 2011 ("Uchida")

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Name/Print	Dennis A. Majewski	Registration Number	65578

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Application Number	17181802
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First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond, Crystal L.
Attorney Docket Number	3725194.00146 14US07

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	Art Unit	2844
	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

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	Attorney Docket Number	3725194.00146 14US07

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

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	Attorney Docket Number	3725194.00146 14US07

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	Art Unit	2844
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	Attorney Docket Number	3725194.00146 14US07

	43	Samsung Electronics Co., Ltd., v. Lynk Labs, Inc., Case IPR2021-01346 , Patent No. 10,499,466 - Patent Owner's Mandatory Notices Pursuant to 37 C.F.R. Section 42.8 - dated September 28, 2021 -5 pages	
	44	Samsung Electronics Co., Ltd., v. Lynk Labs, Inc. Patent Owner - Power of Attorney for Petitioner Samsung Electronics Co., Ltd. Patent No. 11,019,697 dated July 21, 2021 - 3 pages	
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	Attorney Docket Number	3725194.00146 14US07

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

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First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond, Crystal L.
Attorney Docket Number	3725194.00146 14US07

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	19	SAMSUNG ELECTRONICS CO., LTD. v. LYNK LABS, INC. Patent Owner - Patent No. 10,652,979 Declaration of R. Jacob Baker, PH.D., P.E. In support of Petition For Inter Partes Review of U.S. Patent No. 10,652,979 - 174 pages - Ex. 1002	
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	21	Declaration of R. Jacob Baker. Ph.D., P.E. US Patent No. 10,154,551, Inter Partes Review of U.S. Patent No. 10,154,551, 176 pages - Ex 1002	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17181802
	Filing Date	2021-02-22
	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

CERTIFICATION STATEMENT

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☒ See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-22
Name/Print	Dennis A. Majewski	Registration Number	65578

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	1	6501100		2002-12-31	Srivastava et al.	IPR2021-01346 Ex 1052
	2	6510995		2003-01-28	Muthu et al.	IPR2021-01345 Ex 1008
	3	4170018		1979-10-02	Runge	IPR2021-01345 Ex 1009
	4	6303238		2001-10-16	Thompson et al.	IPR2021-01345 Ex 1015
	5	5874803		1999-02-23	Garbuzov et al.	IPR2021-01345 Ex 1016
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	8	6323652		2001-11-27	Collier et al.	IPR2021-01345 Ex 1044

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	9	6307757		2001-10-23	Porter et al.	IPR2021-01345 Ex 1045
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	17	11019697		2021-25-05	Miskin et al.	IPR2021-01300 Ex 1001

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	1	20020080010		2002-06-27	Zhang	IPR2021-01346 Ex 1051, IPR2021-01300 Ex 1072
	2	20030085621		2003-05-08	Potega	IPR2021-01345 Ex 1007
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	5	20040263084		2004-12-30	Mor et al.	IPR2021-01300 Ex 1005

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(12) UK Patent Application (19) GB (11) 2 202 414 (13) A

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(21) Application No 8705583

(22) Date of filing 10 Mar 1987

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(52) Domestic classification (Edition J):
H4L CX
H2H LL3
U1S 1926 2124 H2H H4L

(56) Documents cited
GB 1319412 **GB 0778072** **EP A2 0179536**
EP A2 0145430 **WO A1 84/04212**

(58) Field of search
H4L
H2H
Selected US specifications from IPC sub-classes
H04B H05B

(54) Transmission of power and/or data

(57) A system in which power or data is transmitted across a panel/bulkhead (14) by means of a low frequency magnetic coupling between a pair of transmission and receiving coils (12,16) disposed on the two sides of the panel/bulkhead (14), respectively. The system can include a panel mounting lamp unit (22) comprising the receiving coil (16) in series with a diode (18) and an LED (20), the latter components being mounted together in or on a common housing which is adapted to be fitted to the panel/bulkhead (14) at a position opposite to the transmission coil (12). Data from a computer (28, Fig 5) may be coupled to a transmitter (38) via a modulator (32) for reception by a receiver (42).

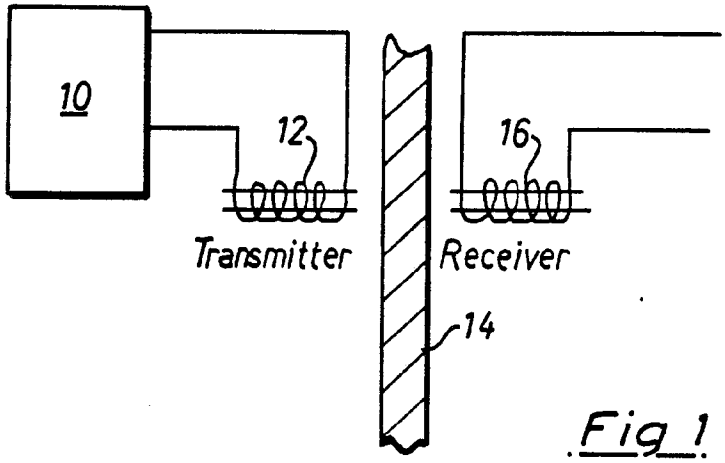


Fig 1

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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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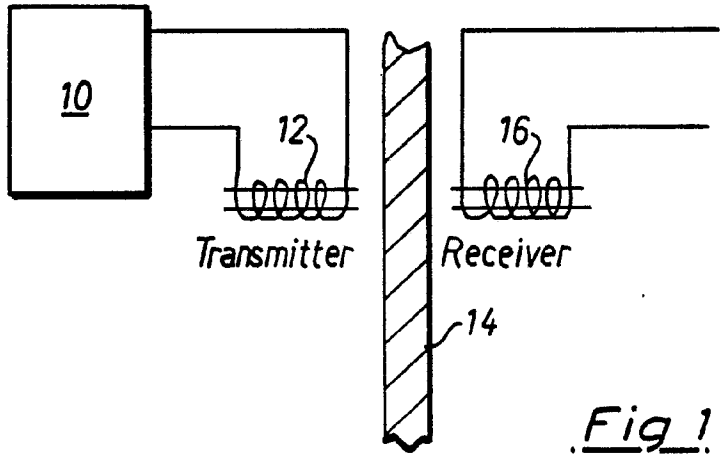


Fig 1

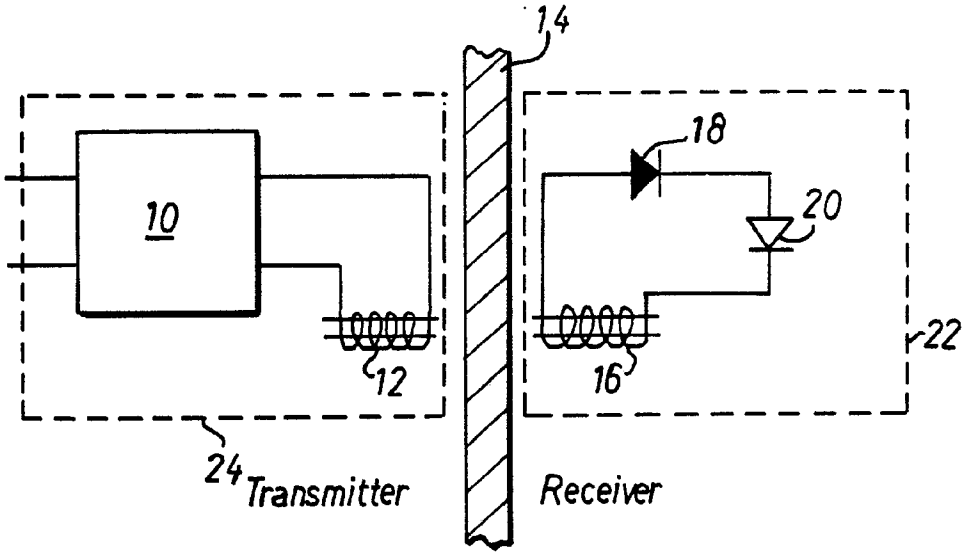
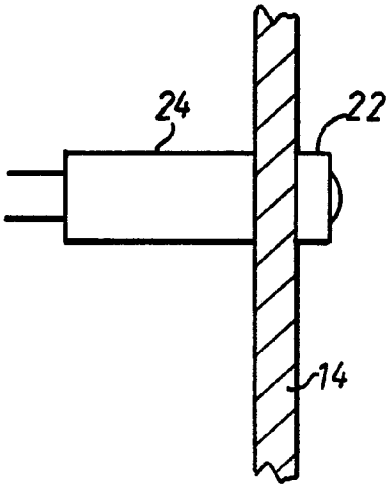
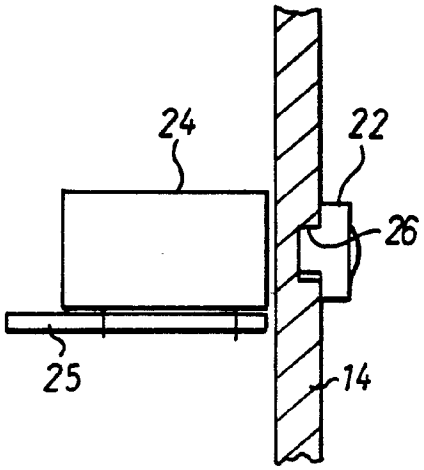
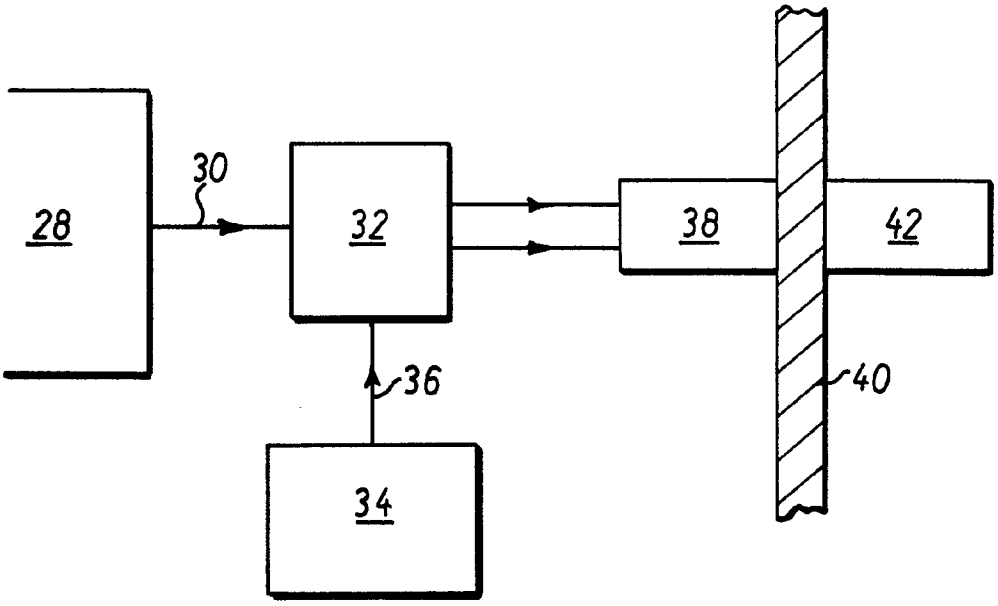


Fig 2


24
22
14


24
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40
34

Transmission of power and/or data

The present invention is concerned with a means of transmitting power and/or data through a solid member, such as an instrument panel or bulkhead.

There exist many engineering situations where it would be very advantageous if power and/or data could be transmitted locally between two adjacent positions which are separated by a solid wall, such as a metal plate forming an instrument panel or bulkhead. It is, of course, known in principle to transmit power and data using radio waves. However, where a number of transmissions are to be made in closely adjacent positions, radio transmissions have the disadvantage that interference between separate transmission is virtually impossible to avoid with very costly and complex filtering circuitry.

It is one object of the present invention to provide a system which avoids the above-discussed disadvantage of radio waves and which enables large numbers of individual transmitter/receiver pairs to be positioned in relatively close proximity to each other without mutual interference between adjacent channels.

It is another object of the present invention to provide a panel mountable indicator lamp which can be energised from within a housing structure without requiring any wiring connection through the housing wall.

In accordance with the present invention in its broadest aspect, there is provided a system in which power or data is transmitted across a panel/bulkhead by means of a low frequency magnetic coupling between a pair of transmission and receiving coils disposed on the two sides of the panel/bulkhead, respectively.

Preferably, the coils are iron-cored so as to produce a concentrated magnetic field. A typical operating frequency is of the order of 200 Hz.

In one type of embodiment, the receiving coil is mounted in series with a rectifier and an LED lamp to form a lamp unit. Preferably, the latter components are encapsulated to form said lamp unit.

Such a lamp unit can be mounted on a panel/bulkhead by any convenient means, e.g. by adhesive or by the use of a blind, screw-threaded hole in the panel/bulkhead.

In accordance with a second aspect of this invention, there is provided a panel mounting lamp unit comprising a magnetic pick-up coil in series with a diode and an LED, the latter components being mounted together in or on a common housing which is adapted to be fitted to a panel/bulkhead at a position opposite to a magnetic transmission coil disposed on the other side of the panel/bulkhead and capable of emitting a low-frequency magnetic field.

By arranging for the lamp unit to be fitted to the panel/bulkhead without penetrating right through

it, the lamp unit can be powered and controlled from the transmission coil side of the panel/bulkhead without requiring any mechanical through-connection.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a basic arrangement in accordance with the present invention;

Fig. 2 is a circuit diagram of a second arrangement in accordance with the present invention for transmitting power through a panel;

Figs. 3 and 4 show diagrammatically two possible forms of panel-mounted indicator lamps incorporating the present invention; and

Fig. 5 is a block circuit diagram of an arrangement in accordance with the present invention for the transmission of both power and data through a panel or bulkhead.

Referring first to Fig. 1, there is shown an osullator 10 energising a transmitter coil 12 to create an alternating electromagnetic flux. This flux penetrates through a panel/bulkhead 14 and induces an E.M.F. in a receiver coil 16.

The transmitter current may be modulated in order to convey information to a demodulator in the receiver. Alternatively, a basic sinusoidal transmitter could convey power to the receiver, which may be rectified (see below).

Such systems can operate with a wide variety of panel/bulkhead materials. For example, aluminium and its alloys, plastics and stainless steel are all suitable. Ferrous materials will also function, although with limitations on maximum panel thickness.

Panel mounted components, such as indicator lamps, of conventional design require a through mounting hole which must then be sealed to prevent the ingress of dust, liquids, gasses etc. In some instances the seal must be hermetic, which may be difficult to maintain in the event of bulb changing, rewiring etc.

In the arrangement of Fig. 2, the receiver includes a diode 18 in series with an indicator LED 20 and the receiver coil 16. The elements 16, 18 and 20 can be encapsulated to form a unitary component 22 which requires no through mounting hole. Panel sealing integrity is therefore maintained even if any of the elements of the component 22 or the component 22 itself, have to be changed. A zero leakage characteristic for the housing is therefore inherent in this system. The transmitter components can be similarly encapsulated in a transmitter unit 24.

The receiver unit 22 can be mounted by any convenient means, two examples being shown in Figures 3 and 4. In the example of Fig. 3, the transmitter and lamp/receiver units 24, 22 are mounted on the panel/bulkhead 14 by means of a suitable adhesive. In the example of Fig. 4, the lamp/receiver unit 22 is mounted

in a blind threaded hole 26 and the transmitter unit 24 is mounted on a printed circuit board 25. Typical panel thicknesses may be in the range of 3mm to 6mm but the invention is not limited to this range.

Using the aforegoing system, it will be appreciated that the following advantages can be obtained :-

1. Lamps may be replaced (either for repair or colour change) without breaking the panel seal. This can be of particular use in applications where the equipment is exposed to hazardous materials, e.g. in the chemical industry.

2. A lamp/receiver unit 22 can be used to interrogate an instrument's output state and then removed for security reasons.

3. Panel drilling is unnecessary and allows a manufacturer to change panel designs by moving the mounting position of lamps.

In further applications, data can be superimposed on a carrier and transmitted through a panel. This possiblity is illustrated in Fig. 5 where a data system 28, such as a computer, supplies a control signal on a line 30 to a modulator 32 in which a carrier signal (e.g. 200 Hz), provided by an oscillator 34 on a line 36, can be modified to form a modulated signal to a transmitter 38. Data superimposed on the carrier can thereby be transmitted through the panel 40. Carrier can then be demodulated to power and control a receiver

unit. Two-way transmission is possible with such a system.

It is preferred to use iron-cored transmission and pick-up coils 12, 16 in the present system so as to produce a concentrated magnetic field. Due to the concentrated and localised nature of the field, indicator lamps can be densely packed without interference problems arising since cross-talk between lamps sharing the same panel will not provide sufficient coil voltage to overcome the LED forward voltage of other receiver devices.

Preferably, the transmitted electromagnetic signal is of sinusoidal form but any other suitable waveshape may be used within the ambit of the invention.

.....

CLAIMS

1. A system in which power or data is transmitted across a panel/bulkhead by means of a low frequency magnetic coupling between a pair of transmission and receiving coils disposed on the two sides of the panel/bulkhead, respectively.

2. A system as claimed in claim 1, wherein the coils are iron-cored so as to produce a concentrated magnetic field.

3. A system as claimed in claim 1 or 2, wherein the receiving coil is mounted in series with a rectifier and an LED lamp to form a lamp unit.

4. A system as claimed in claim 3, wherein the receiving coil, the rectifier and the LED are encapsulated to form said lamp unit.

5. A system as claimed in claim 3 or 4, wherein the lamp unit is adapted to be mounted on the panel/bulkhead by an adhesive or by the use of a blind, screw-threaded recess in the panel/bulkhead.

6. A system as claimed in any of claims 1 to 5, wherein, in order to transmit data through the panel/bulkhead, the low frequency electromagnetic field transmitted by the transmission coil is modulated by a data signal, the corresponding signal generated in the receiving coil being correspondingly demodulated to recover the data.

7. A system as claimed in any of claims 1 to 5, wherein the transmission coil produces an alternating or electromagnetic field having a frequency of the order of 200Hz.

8. A panel mounting lamp unit comprising a magnetic pick-up coil in series with a diode and an LED, the latter components being mounted together in or on a common housing which is adapted to be fitted to a panel/bulkhead at a position opposite to a magnetic transmission coil disposed on the other side of the panel/bulkhead and capable of emitting a low-frequency magnetic field.

9. A panel mounting lamp unit as claimed in claim 6, wherein the pick-up coil, the diode and the LED are encapsulated to form said lamp unit.

10. A panel mounting lamp unit as claimed in claim 6 or 7, wherein the lamp unit is adapted to be mounted on the panel/bulkhead by an adhesive or by the use of a blind, screw-threaded recess in the panel/bulkhead.

11. A system for transmitting power or data across a panel/bulkhead, substantially as hereinbefore described with reference to the accompanying drawings.

12. A panel mounting lamp unit substantially as hereinbefore described with reference to and as illustrated in Fig. 2, 3 or 4 of the accompanying drawings.

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PGR2023-00016 - Home Depot
Ex. 1003 - Page 81

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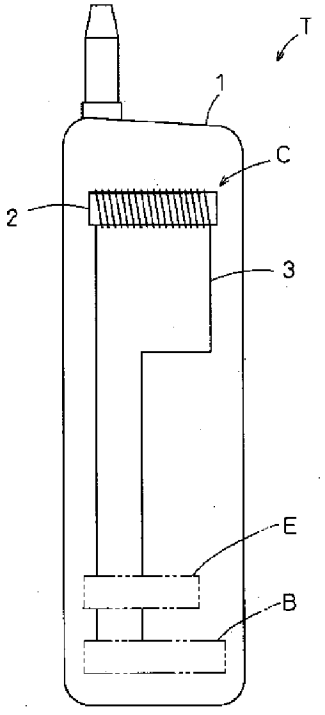
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最終頁に続く

(54)【発明の名称】　携帯電話機の充電装置

(57)【要約】
【課題】携帯電話機の二次電池が、電気機器等の電磁波発生源から放出される電磁波によって無電源で充電できるようにする。
【解決手段】携帯電話機Ｔに誘導コイルＣを内装させ、この誘導コイルＣが電気機器等の電磁波発生源から発生される電磁波を受けることによって生ずる磁界Ｗから交流の起電力ｅを誘導させ、該起電力ｅを直流の電流Ｉ₂に変換させて二次電池Ｂに流し込む。



【特許請求の範囲】
【請求項１】　携帯電話機に内装される充電装置であって、
電磁波によって発生する磁界から起電力を誘導させるための誘導コイルと、
前記誘導コイルによって生じた交流の起電力を、直流に変換させて二次電池に流し込むための充電回路と、
を備えたことを特徴とする携帯電話機の充電装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、二次電池を無電源で充電することができる携帯電話機に関するものである。
【０００２】
【従来の技術】携帯電話機には、電源として二次電池が内装されている。この二次電池が放電して電力が低下すると携帯電話機の使用に支障をきたし、そのままの状態で使用を続けることは極めて困難である。通常の場合、携帯電話機の二次電池が放電すると、別体の充電器によって二次電池の充電が行われる。図９に、従来の充電器５１を示す。この充電器５１は、商用の１００Ｖ交流電源によって作動される。充電器５１における携帯電話機装着部５２に、携帯電話機のフレーム１が装着される。この携帯電話機装着部５２には充電端子（図示せず）が設けられていて、この充電端子と携帯電話機の充電端子（図示せず）とを接触させることにより、携帯電話機に内装された二次電池が充電される。
【０００３】しかし、この充電器５１を使用する際には商用の１００Ｖ交流電源を必要とするため、携帯電話機の機動性が損なわれるばかりでなく、充電器５１がかさばるものであるため、携帯電話機と共に持ち歩く場合、その可搬性が著しく損なわれる。そのため、携帯電話機における緊急時の電力の低下に対して、市販の直流電池等を補助電源として用いる構成の携帯電話機も存している。また、市販の直流電池等による携帯型の充電器も公知である。しかし、これらはすべて携帯電話機と別体のものであり、携帯電話機の可搬性を損なうものである。
【０００４】携帯電話機の二次電池を充電するために、該携帯電話機に、充電器の充電端子と接触させるための外部端子を設けることが必要である。この外部端子は常に外部に露出されている。このため、携帯電話機の意匠が制限される。
【０００５】
【発明が解決しようとする課題】本発明は上記した不具合に鑑み、電磁波を利用して携帯電話機の二次電池が充電できるようにして、携帯電話機の可搬性を損なうことなく、無電源で充電ができるようにすることを課題としている。
【０００６】
【課題を解決するための手段】上記課題を解決するための本発明は、携帯電話機に内装される充電装置であって、電磁波によって発生する磁界から起電力を誘導させるための誘導コイルと、前記誘導コイルによって生じた交流の起電力を、直流に変換させて二次電池に流し込むための充電回路とを備えたことを特徴としている。
【０００７】携帯電話機の二次電池の電力が低下すると、該携帯電話機が電磁波発生源の近傍に設置される。携帯電話機に内装された誘導コイルの磁束が、前記電磁波発生源から放出される電磁波によって変化するため、起電力が誘導される。この起電力は交流であるため、充電回路によって直流に変換される。そして、直流の電流が前記充電回路を介して二次電池に流し込まれ、該二次電池が充電される。前記電磁波発生源は、屋内外のほとんどの場所において存しているため、電磁波発生源の近傍に携帯電話機を設置するだけで無電源で二次電池が充電される。
【０００８】
【発明の実施の形態】以下、実施例を挙げて本発明を更に詳細に説明する。図１は本発明に係る携帯電話機Ｔの概略構成図である。図１に示されるように、本発明に係る携帯電話機の充電装置は、電磁波によって発生する磁界Ｗ（図８参照）から起電力を誘導させるための誘導コイルＣと、前記誘導コイルＣによって誘導された交流の起電力ｅを、直流の電流に変換させて二次電池Ｂに流し込むための充電回路Ｅとを備えている。そして、上記した誘導コイルＣ及び充電回路Ｅは、携帯電話機Ｔのフレーム１に内装されている。
【０００９】最初に、誘導コイルＣについて説明する。この誘導コイルＣは、円柱状の鉄芯２に極めて細い導線３を多数回巻回したものである。この誘導コイルＣが外部の電磁波を受けると、レンツの法則に従ってその磁束が変化し、起電力ｅが誘導される。磁界Ｗ中に配置された誘導コイルＣに誘導される起電力ｅを求める方法について説明する。Ｎ巻きの誘導コイルＣを貫く磁束φが、微小時間Δｔ（ｓｅｃ）の間にΔφ（Ｗｂ）だけ変化した場合、前記誘導コイルＣに誘導される起電力ｅ（Ｖ）は、ｅ＝－（Ｎ×Δφ）／Δｔで求められる。
【００１０】ここでは計算を簡単にするため、誘導コイルＣにおける導線３の巻数Ｎを１とする。数１より、例えば１秒間に磁束φが１Ｗｂだけ弱くなった場合、誘導コイルＣに誘導される起電力ｅは、ｅ＝－｛１×（－１）｝／１＝１（Ｖ）である。Δｔは磁界Ｗにおける磁束φが変化する時間の割合なので、前記磁界Ｗの周波数が高い程、波が１サイクル分だけ進行するために必要な時間が短くなる。その結果、単位時間内に発生する磁束φの変化の割合が大きくなって、誘導される起電力ｅが大きくなる。この磁界Ｗの周波数が６０Ｈｚの場合、図２に示されるように、波の進行方向は１秒間に１２０回変化する。領域P_1（０～1/240 秒の間）において誘導される起電力をe_1、領域P_2（1/240 ～1/120 秒の

間）において誘導される起電力をe_1、領域P_1（1/120～1/80秒の間）において誘導される起電力をe_3、領域P_4（1/80～1/60秒の間）において誘導される起電力をe_4とすると、各領域P_1～P_4において誘導される起電力e_1～e_4は、次の各式で求められる。$e_1=e_4=-1/(1/240)=-240$（V）、$e_2=e_3=-1/\{-(1/240)\}=240$（V）

【００１１】これを時間的に示すと、図３に示されるようなグラフとなる。次に、誘導コイルＣにおける導線３の巻数Ｎを１０００巻きとした場合、２４０Ｖの起電力ｅを誘導させるためにどれ位の磁束φが必要であるかを計算する。数１に各値を代入して計算すると、Δφ＝０．００１（Ｗｂ）である。即ち、周波数６０Ｈｚの場合、１０００巻きの誘導コイルＣに２４０Ｖの起電力ｅを誘導させるためには、０．００１Ｗｂの磁束φを発生させる磁界Ｗが必要である。

【００１２】このようにして誘導された起電力ｅは交流であるため、充電回路Ｅによって直流に変換される。この充電回路Ｅは、図４に示されるように、変圧器４、整流器５、コンデンサ６、抵抗７、トランジスタ８及び定電圧ダイオード９から構成されている。変圧器４の一次側（誘導コイルＣ側）に入力される電圧をV_1、同じく電流をI_1、変圧器４の二次側に出力される電圧をV_2、同じく電流をI_2として、この変圧器４の効率をμとすると、次の式が成立する。$\mu=(V_2\times I_2)/(V_1\times I_1)$

【００１３】起電力ｅを変圧器４の一次側に入力させると、その二次側には、電圧V_2が出力される。この電圧V_2が整流器５によって整流され、図５に示される脈動電圧V_2'が出力される。この脈動電圧V_2'が、コンデンサ６（図４参照）に蓄電されて平滑化されて直流に変換され、直流の電圧V_2''が出力される。この電圧V_2''から生じた直流の電流I_2を、充電回路Ｅを介して携帯電話機Ｔの二次電池Ｂに流し込む。このようにして、携帯電話機Ｔの二次電池Ｂが充電される。

【００１４】次に、上記した充電の原理を、携帯電話機Ｔの二次電池Ｂに応用した場合について説明する。携帯電話機Ｔの二次電池Ｂには、通常、電圧が３．６Ｖで、容量が４００ｍＡｈのリチウムイオン電池が使用されている。即ち、このリチウムイオン電池は、４００ｍＡの電流を１時間流し続けることができる容量を有している。このリチウムイオン電池が８～１５時間の普通充電によって充電される場合、０．２ＣｍＡ－４．１Ｖの定電流・定電圧充電が行われる。ここで、「Ｃ」は充放電係数であり、蓄電池を１時間で充電、或いは放電させるための電流が１ＣＡである。そのため、前記リチウムイオン電池を普通充電するためには、４００×０．２＝８０（ｍＡ）の電流が必要である。

【００１５】

【表１】

電気機器	5cm前後における磁界の強度（mG）
電話	2 ～ 10
蛍光灯	5 ～ 30
ACアダプタ	20 ～ 60
CDラジカセ	20 ～ 100
電気毛布	20 ～ 100
テレビ	30 ～ 50
電子レンジ	200 ～ 300

【００１６】近時、家庭内では各種の電気機器が使用されていて、これらの電気機器は動作中に電磁波を放出している。表１に、主な電気機器から放出される電磁波の強度を示す。１ｍＧ＝10^{-7}Ｗｂであるから、例えば電子レンジからは、約２００ｍＧ＝約2×10^{-4}Ｗｂの電磁波が放出されている。この電磁波による磁界Ｗ中に１００００巻きの誘導コイルＣを設置した場合、該誘導コイルＣに誘導される起電力ｅを計算する。なお、周波数は６０Ｈｚである。$e=-(10000\times2\times10^{-4})/(1/240)=-48$（V）

【００１７】なお、導線３（図１参照）を１００００回巻回した状態の誘導コイルＣを形成することは技術的に可能であり、その方法について説明する。図６に示されるように、薄い絶縁シート１１に、細い導線３を渦巻き状に密着させて貼り付ける。そして、図７に示されるように、この絶縁シート１１どうしを重ね合わせる。その際、１枚の絶縁シート１１における導線３の始端部３ａと、重ね合わせられる別の絶縁シート１１における終端部３ｂとが接続される。１枚の絶縁シート１１における導線３の巻数は、数千回の巻数に相当する。このようにして所定枚数の絶縁シート１１を積層させることによって、１００００回巻きの誘導コイルＣが得られる。なお、この場合の誘導コイルＣはシート状である。絶縁シート１１に導線３を渦巻き状に貼り付ける代わりに、エッチング、メッキ等の方法によって渦巻き状に成形した金属箔を貼り付けてもよい。

【００１８】上記した計算結果より、周波数６０Ｈｚで2×10^{-4}Ｗｂの磁界Ｗに１００００回巻きの誘導コイルＣを配置すると、４８Ｖの起電力ｅが誘導される。同時に、所定量の電流I_1が発生する。この電流I_1は、誘導コイルＣの抵抗等を調整することによってその値を調整することができる。そのため、変圧器４の効率μを０．８として、変圧器４の一次側に入力される電流I_1を０．０１Ａ、その二次側に発生する電圧V_2を４．１

PGR2023-00016 - Home Depot
Ex. 1003 - Page 884

Ｖとした場合、二次側に発生する電流Ｉ₂は数３より、Ｉ₂＝０．８×４８×０．０１／４．１＝０．０９３６（Ａ）である。即ち、約９４ｍＡの電流が発生する。

【００１９】この電流Ｉ₂が充電回路Ｅに送られ、該充電回路Ｅによって制御されながら、リチウムイオン電池が充電される。この電流Ｉ₂は、前記リチウムイオン電池を充電するために必要な電流（８０ｍＡ）よりも大きいため、該リチウムイオン電池の充電が可能である。

【００２０】この携帯電話機Ｔの作用について、図１及び図８を参照しながら説明する。携帯電話機Ｔの二次電池Ｂの電力が低下したことが通報されると、該携帯電話機Ｔが電気機器等の電磁波発生源の近傍に設置される。図８は、該携帯電話機Ｔを、電磁波発生源の一例であるパーソナルコンピュータ１２の近傍に設置した場合である。携帯電話機Ｔは、パーソナルコンピュータ１２によって発生される電磁波を受けるため、誘導コイルＣを貫く磁界Ｗ中の磁束φが変化して、起電力ｅが誘導される。この起電力ｅは交流であるため、変換回路Ｄにおける変圧器４で変圧され、同じく整流器５で整流されて直流の電流Ｉ₂に変換される。このようにして発生した直流の電流Ｉ₂が、充電回路Ｅにおいて制御されながら二次電池Ｂに流し込まれ、該二次電池Ｂが充電される。

【００２１】上記した実施例では、パーソナルコンピュータ１２から放出される電磁波が形成する磁界Ｗ中に携帯電話機Ｔを設置した場合であるが、電磁波の発生源はいかなるものであっても構わない。例えば、屋外においては高圧電線、鉄道の架線等であっても構わない。また、本明細書では、二次電池Ｂとしてリチウムイオン電池の場合について説明したが、他の二次電池、例えばニッケル・カドミウム電池、或いはニッケル・水素電池であっても構わない。更に、本発明に係る充電装置は、従来の携帯電話機に装着することも可能である。

【００２２】本発明に係る携帯電話機の充電構造は、携帯電話機にのみ使用されるものではなく、可搬性の情報機器、例えばノートパソコン、ビデオカメラ等に使用されても構わないのはもちろんである。

【００２３】

【発明の効果】本発明に係る携帯電話機は、主に家庭内の電気機器から放出されている電磁波によって発生する磁界内に設置するだけで、起電力が誘導される。この起＊電力が、充電回路を介して直流の電流に変換され、二次電池に流し込まれることによって充電が行われる。そのため、次の諸効果が奏される。（１）携帯電話機を電磁波発生源の近傍に設置するだけで、無電源で二次電池を充電することができる。しかも、前記電磁波発生源は、屋内屋外を問わずほとんどの場所において存しているため、いかなる場所においても充電が可能である。その結果、交流電源設備及び充電器が不要である。また、充電に必要な各回路を内装させても全体の重量、大きさは余り変わらないので、携帯電話機の可搬性を損なうことなく、その機動性を著しく向上させる。（２）携帯電話機に充電用の外部端子を設ける必要がない。そのため、携帯電話機のフレームの形状を自由な形状とすることができ、意匠の向上が奏される。

【図面の簡単な説明】

【図１】本発明に係る携帯電話機Ｔの概略構成図である。

【図２】周波数が６０Ｈｚの磁束φの変化を示すグラフである。

【図３】各領域Ｐ₁～Ｐ₄において誘導された起電力ｅ₁～ｅ₄を示すグラフである。

【図４】充電回路Ｅの電気回路図である。

【図５】充電回路Ｅによって整流された電圧Ｖ₂"を示すグラフである。

【図６】絶縁シート１１に導線３を渦巻き状に貼り付けた状態の平面図である。

【図７】絶縁シート１１を積層させる状態の斜視図である。

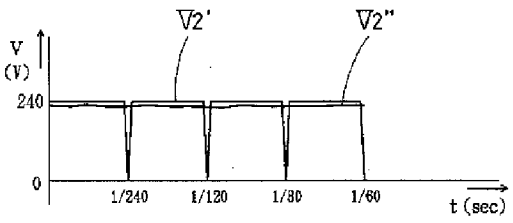
【図８】携帯電話機Ｔの作用説明図である。

【図９】従来の充電器５１によって、携帯電話機の二次電池が充電される状態の斜視図である。

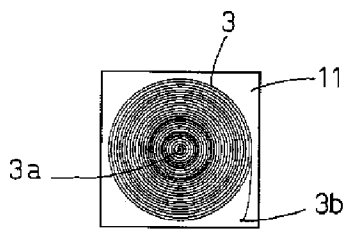
【符号の説明】

Ｂ：二次電池
Ｃ：誘導コイル
Ｅ：充電回路
ｅ，ｅ₁～ｅ₄：起電力
Ｉ₁，Ｉ₂：電流
Ｔ：携帯電話機
Ｗ：磁界

【図５】

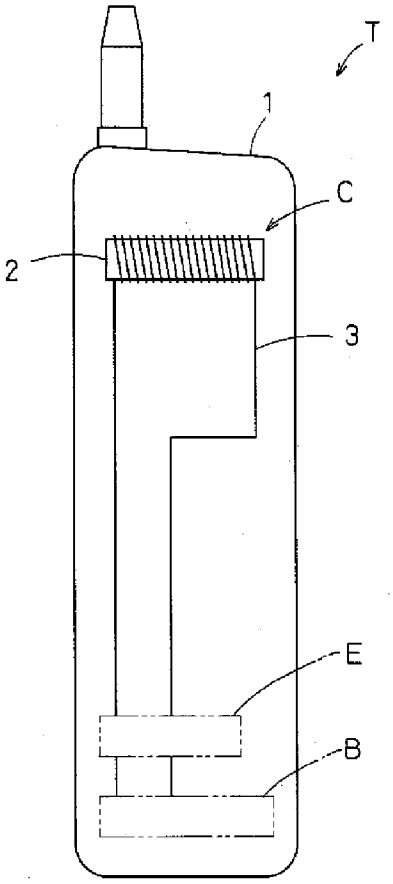


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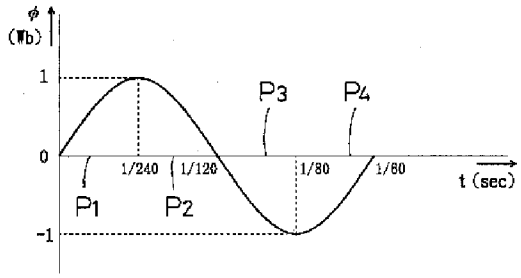


PGR2023-00016 - Home Depot
Ex. 1003 - Page 885

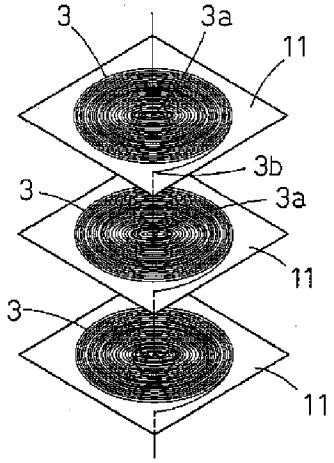
【図１】


T
1
C
2
3
E
B

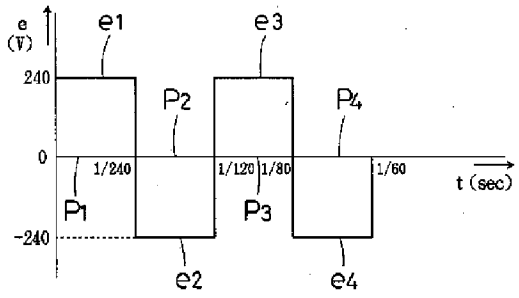
【図２】


φ
(Wb)
1
0
-1
P3
P4
1/240
1/120
1/80
1/60
t (sec)
P1
P2

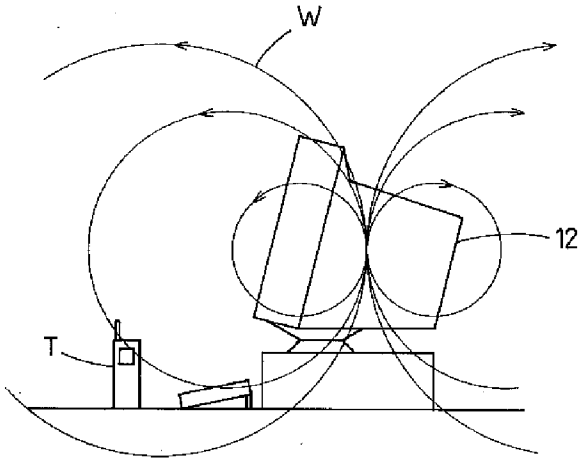
【図７】


3
3a
11
3b
3
3a
11
3
11

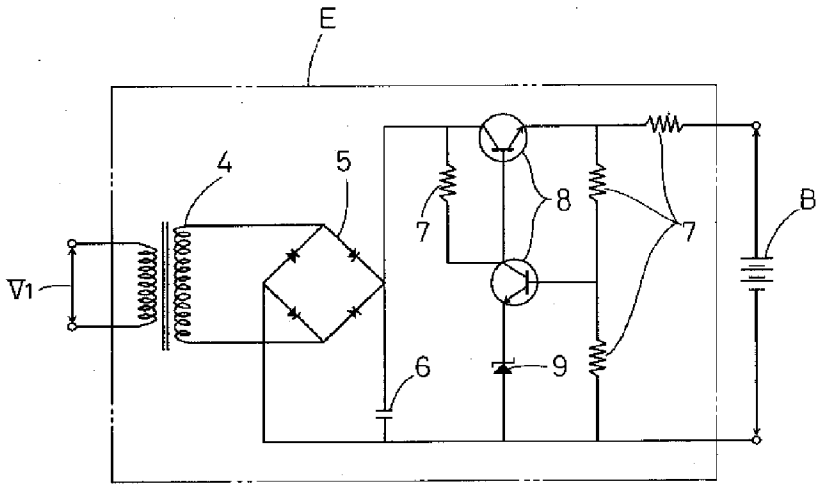
【図３】


e
(V)
e1
e3
240
P2
P4
0
1/240
1/120
1/80
1/60
t (sec)
P1
P3
-240
e2
e4

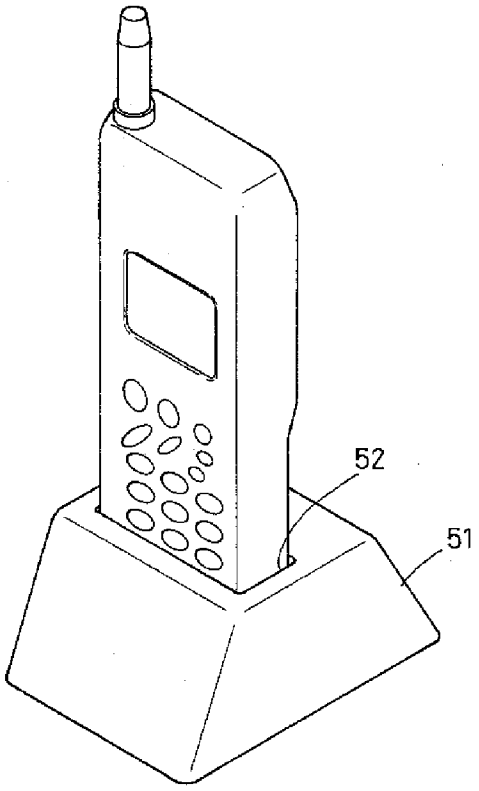
【図８】


W
12
T

【図４】



【図９】



フロントページの続き

Ｆターム(参考) 5G003 AA08 BA01 DA18 GB08
5K027 AA11 GG04
5K067 AA43 BB04 EE02 KK06 KK17

Espacenet

Bibliographic data: JP2002050798 (A) — 2002-02-15

WHILE LED LAMP

Inventor(s): MORITA YASUMASA; NAGANO TOSHIAKI ± (MORITA YASUMASA, ; NAGANO TOSHIAKI)

Applicant(s): STANLEY ELECTRIC CO LTD ± (STANLEY ELECTRIC CO LTD)

Classification: **- international:** ***C09K11/08; C09K11/80; H01L21/56; H01L23/28; H01L33/32; H01L33/34; H01L33/50; H01L33/56; H01L33/58;*** (IPC1-7): C09K11/08; C09K11/80; H01L21/56; H01L23/28; H01L33/00

- cooperative: H01L2224/45144 (EP); H01L2224/48091 (EP); H01L2224/48465 (EP) more

Application number: JP20000237224 20000804

Priority number(s): JP20000237224 20000804

Abstract of JP2002050798 (A)

PROBLEM TO BE SOLVED: To solve the problem that conventionally white LED lamps are not acceptable for lighting since its color rendering property is poor, except the use as a marker lamp, since its output on a long wavelength side is small. SOLUTION: A while LED lamp 1 is provided where a blue LED chip 3 is covered with a resin lens 4, in which a YAG phosphor 5 is diffused. Here, by making the white LED lamp 1, which is a double-dope phosphor where the YAG phosphor 5 to be doped with two kinds of chemicals, Ce and Pr, resulting in a peak near 610 nm and spectral distribution at emission result, for improved color rendering property.

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	17181802
Filing Date	22-Feb-2021
First Named Inventor	Michael Miskin
Art Unit	2844
Examiner Name	
Attorney Docket Number	3725194.00146 14US07
Title	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

○	Small Entity
○	Micro Entity
◉	Regular Undiscounted

Reason for withdrawal from issue

○ One or more claims are unpatentable ◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees) ○ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).	
RCE request,submission, and fee. ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on ☒ Are attached.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application. ○ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity. ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this e-petition	
Signature	/Dennis A. Majewski/
Name	Dennis A. Majewski
Registration Number	65578

Electronic Patent Application Fee Transmittal

Application Number:	17181802
Filing Date:	22-Feb-2021
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Filer:	Dennis A. Majewski/US Patent Mail
Attorney Docket Number:	3725194.00146 14US07

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
RCE- 1ST REQUEST	1801	1	1360	1360
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1500**

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : October 22, 2021

In re Application of :

Michael Miskin

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 17181802

Filed : 22-Feb-2021

Attorney Docket No : 3725194.00146 14US07

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed October 22, 2021 , to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2844 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt

EFS ID:	44098675
Application Number:	17181802
International Application Number:	
Confirmation Number:	5141
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Customer Number:	24573
Filer:	Dennis A. Majewski/US Patent Mail
Filer Authorized By:	Dennis A. Majewski
Attorney Docket Number:	3725194.00146 14US07
Receipt Date:	22-OCT-2021
Filing Date:	22-FEB-2021
Time Stamp:	13:14:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1500
RAM confirmation Number	E20210LD14351299
Deposit Account	021818
Authorized User	US Patent Mail

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.16 (National application filing, search, and examination fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	00146-RCE.pdf	697670 2f769a5a22c640ce6f1d59aaf319db02e4c00af8	no	3
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2	Quick Path Information Disclosure Statement	00146-Request-QPIDS.pdf	195441 83c5748bb14f186483fcb1631fb30f9a5421b43c	no	2
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3	Information Disclosure Statement (IDS) Form (SB08)	00146-SB08-Invalidity-SAM-Part-1.pdf	614736 8eff7debeca8c93a90bfd19213be087476cfc563	no	13
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A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
5	Information Disclosure Statement (IDS) Form (SB08)	00146-SB08-IPR-SAM-Part-1.pdf	616750 5f5cfb745975e08a733c690eec101a3efaf7a88b	no	13
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41	Non Patent Literature	G510966298vFlexSmartRefrigerator.pdf	190779 157e1d4d237b31c1946ee9f3bb495df8c099f58f	no	8
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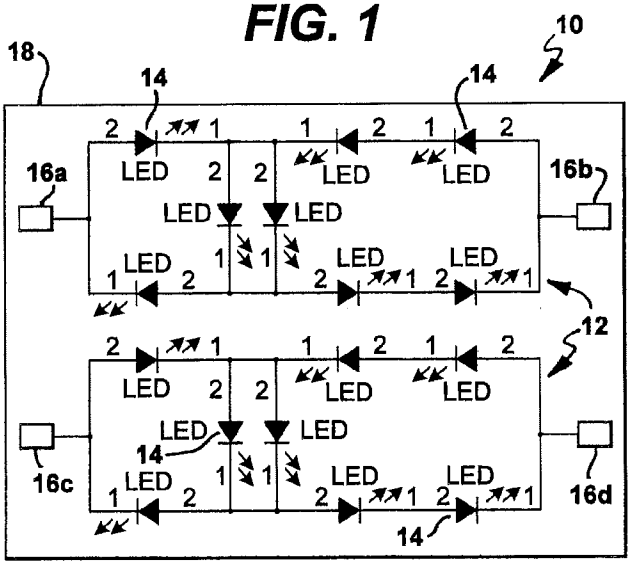
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[Continued on next page]

(54) Title: HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

(57) Abstract: A system and method transforming AC voltage to a high-frequency AC voltage and providing the high-frequency AC voltage to an AC LED circuit or rectifying the high-frequency circuit to a DC voltage and providing the DC voltage to a DC LED circuit.

FIG. 1



12/24 VAC SINGLE CHIP

WO 2011/082168 A1

SAMSUNG EXHIBIT 1030
PGR2023-00016 - Home Depot
Ex. 1003 - Page 905

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HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

RELATED APPLICATIONS

[Para 1] The application is a continuation-in-part of U.S. Patent Application No. 12/287,267, filed October 6, 2008, which claims priority to U.S. Provisional Application No. 60/997,771, filed October 6, 2007; this application is also a continuation-in-part of U.S. Patent Application No. 12/364,890 filed February 3, 2009 which is a continuation of U.S. Application No. 11/066,414 (now U.S. Patent No. 7,489,086) filed February 25, 2005 which claims priority to U.S. Provisional Application No. 60/547,653 filed February 25, 2004 and U.S. Provisional Application No. 60/559,867 filed April 6, 2004; this application is also a continuation in part of International Application No. PCT/US2010/001597 filed May 28, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/217,215, filed May 28, 2009; this application is also a continuation-in-part of International Application No. PCT/US2010/001269 filed April 30, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/215,144, filed May 1, 2009; this application also claims priority to U.S. Provisional Application No. 61/284,927 filed December 28, 2009 and U.S. Provisional Application No. 61/335,069 filed December 31, 2009; the contents of each of these applications are expressly incorporated herein by reference.

TECHNICAL FIELD

[Para 2] The present invention generally relates to light emitting diodes ("LEDs") for AC operation. The present invention specifically relates to multiple voltage level, multiple brightness level, and voltage selectable LED devices, packages and lamps, high frequency driven LED circuits and high frequency drivers and drive methods for LEDs.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[Para 3] None.

BACKGROUND OF THE INVENTION

[Para 4] Field of the Invention

[Para 5] The present invention generally relates to light emitting diodes ("LEDs") for high frequency and selectable voltage, multi-voltage level and/or multi-brightness level operation. The present invention specifically relates to high frequency operation, voltage selectable, multiple voltage level and multiple brightness level light emitting diode circuits, single chips, packages and lamps "devices" for direct AC voltage power source operation or bridge rectified AC voltage power source operation..

[Para 6] Description of the Related Art

[Para 7] LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED. Some LEDs have resistors built into the LED package providing a higher voltage LED typically driven with 5V DC or 12V DC.

[Para 8] Some standard AC voltages in the world include 12VAC, 24VAC, 100VAC, 110VAC, 120VAC, 220VAC, 230VAC, 240VAC and 277VAC. Therefore, it would be advantageous to have a single chip LED or multi-chip single LED packages and/or devices that could be easily configured to operate at multiple voltage levels and/or multiple brightness levels by simply selecting a voltage and/or current level when packaging the multi-voltage and/or multi-current single chip LEDs or by selecting a specific voltage and/or current level when integrating the LED package onto a printed circuit board or within a finished lighting product. It would also be advantageous to have multi-current LED chips and/or packages for LED lamp applications in order to provide a means of increasing brightness in LED lamps by switching in additional circuits just as additional filaments are switched in for standard incandescent lamps.

[Para 9] US 7,525,248 discloses a ***chip***-scale LED lamp including discrete LEDs capable of being built upon electrically insulative, electrically conductive, or electrically semi conductive substrates. Further, the construction of the LED lamp enables the lamp to be configured for high voltage AC or DC power operation. The LED based solid-state light

emitting device or lamp is built upon an electrically insulating layer that has been formed onto a support surface of a substrate. Specifically, the insulating layer may be epitaxially grown onto the substrate, followed by an LED buildup of an n-type semiconductor layer, an optically active layer, and a p-type semiconductor layer, in succession. Isolated mesa structure of individual, discrete LEDs are formed by etching specific portions of the LED buildup down to the insulating layer, thereby forming trenches between adjacent LEDs. Thereafter, the individual LEDs are electrically coupled together through conductive elements or traces being deposited for connecting the n-type layer of one LED and the p-type layer of an adjacent LED, continuing across all of the LEDs to form the solid-state light emitting device. The device may therefore be formed as an integrated AC/DC light emitter with a positive and negative lead for supplied electrical power. For instance, the LED lamp may be configured for powering by high voltage DC power (e.g., 12V, 24V, etc.) or high voltage AC power (e.g., 110/120V, 220/240V, etc.).

[Para 10] US 7,213,942 discloses a single-***chip*** LED device through the use of integrated circuit technology, which can be used for standard high AC voltage (110 volts for North America, and 220 volts for Europe, Asia, etc.) operation. The single-***chip AC LED*** device integrates many smaller LEDs, which are connected in series. The integration is done during the LED fabrication process and the final product is a single-***chip*** device that can be plugged directly into house or building power outlets or directly screwed into incandescent lamp sockets that are powered by standard AC voltages. The series connected smaller LEDs are patterned by photolithography, etching (such as plasma dry etching), and metallization on a single ***chip***. The electrical insulation between small LEDs within a single-***chip*** is achieved by etching light emitting materials into the insulating substrate so that no light emitting material is present between small LEDs. The voltage crossing each one of the small LEDs is about the same as that in a conventional DC operating LED fabricated from the same type of material (e.g., about 3.5 volts for blue LEDs).

[Para 11] Accordingly, single chip LEDs have been limited and have not been integrated circuits beyond being fixed series, fixed parallel or series parallel circuit configurations until the development of AC LEDs. The AC LEDs have still however been single circuit or parallel circuit fixed single voltage designs.

[Para 12] LED packages have historically not been integrated circuits beyond being fixed series, fixed parallel or fixed series parallel LED circuit configurations.

[Para 13] The art is deficient in that it does not provide a multi-voltage and/or multi-current circuit monolithically integrated on a single substrate which would be advantageous.

[Para 14] It would further be advantageous to have a multi-voltage and/or multi-brightness circuit that can provide options in voltage level, brightness level and/or AC or DC powering input power preference.

[Para 15] It would further be advantageous to provide multiple voltage level and/or multiple brightness level light emitting LED circuits, chips, packages and lamps "multi-voltage and/or multi-brightness LED devices" that can easily be electrically configured for at least two forward voltage drive levels with direct AC voltage coupling, bridge rectified AC voltage coupling or constant voltage DC power source coupling. This invention comprises circuits and devices that can be driven with more than one AC or DC forward voltage "multi-voltage" at 6V or greater based on a selectable desired operating voltage level that is achieved by electrically connecting the LED circuits in a series or parallel circuit configuration and/or more than one level of brightness "multi-brightness" based on a switching means that connects and/or disconnects at least one additional LED circuit to and/or from a first LED circuit. The desired operating voltage level and/or the desired brightness level electrical connection may be achieved and/or completed at the LED packaging level when the multi-voltage and/or multi-brightness circuits and/or single chips are integrated into the LED package, or the LED package may have external electrical contacts that match the integrated multi-voltage and/or multi-brightness circuits and/or single chips within, thus allowing the drive voltage level and/or the brightness level select-ability to be passed on through to the exterior of the LED package and allowing the voltage level or brightness level to be selected at the LED package user, or the PCB assembly facility, or the end product manufacturer.

[Para 16] It would further be advantageous to provide at least two integrated circuits having a forward voltage of at least 12VAC or 12VDC or greater on a single chip or within a single LED package that provide a means of selecting a forward voltage when packaging a multi-voltage and/or multi-brightness circuit using discrete die (one LED chip at a time) and wire bonding them into a circuit at the packaging level or when packaging one or more multi-voltage and/or multi-brightness level single chips within a LED package.

[Para 17] It would further be advantageous to provide multi-voltage and/or multi-brightness level devices that can provide electrical connection options for either AC or DC voltage operation at preset forward voltage levels of 6V or greater.

[Para 18] It would further be advantageous to provide multi-brightness LED devices that can be switched to different levels of brightness by simply switching additional circuits on or off in addition to a first operating circuit within a single chip and or LED package. This

would allow LED lamps to switch to higher brightness levels just like 2-way or 3-way incandescent lamps do today.

[Para 19] The benefits of providing multi-voltage circuits of 6V or greater on a single chip is that an LED packager can use this single chip as a platform to offer more than one LED packaged product with a single chip that addresses multiple voltage levels for various end customer design requirements. This also increase production on a single product for the chip maker and improves inventory control. This also improves buying power and inventory control for the LED packager when using one chip.

[Para 20] It would further be advantageous to have a LED lighting assembly which includes LED circuitry for AC or DC drive and a high frequency AC voltage transformer or inverter that could be used to convert low frequency voltages, like for example mains voltage or some other low voltage at 50/60 Hz, to a high frequency without a change in the voltage provided. For example, it would be advantageous to have a LED lighting power supply and/or driver capable of receiving 120 VAC at 60 Hz and be able to provide a high frequency AC output directly to an AC driven LED circuit(s), or alternatively to a DC driven LED circuit(s) through an AC-to-DC rectifier at a voltage equal to or different from the original input voltage to the power supply and/or driver.

[Para 21] It would be further advantageous to combine multiple-voltage LED chips, packages, circuits, lamps, etc., high frequency AC voltage power supplies and/or transformers to drive LEDs by either directly connecting a high frequency transformer or inverter to an AC driven LED circuit(s), or by operably connecting an AC-to-DC rectifier between the high frequency transformer or inveter and a DC driven LED circuit. With proper design considerations LEDs may be driven more efficiently with direct AC or rectified AC than with constant voltage or constant current DC drive schemes. High frequency AC transformers or inverters can be made smaller and more cost effective than constant current or constant voltage DC drivers or power supplies currently being used to power LEDs. The higher the frequency, the smaller the transformer can be made. With proper design consideration and based on the wattage and the frequency of the AC voltage output of the power supply, a high frequency AC voltage transformer can be made small enough to be mounted directly onto a LED lighting PCB assembly.

[Para 22] The present invention provides for these advantages and solves the deficiencies in the art.

SUMMARY OF THE INVENTION

[Para 23] According to one aspect of the invention at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage AC LED device for direct AC power operation. Each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation.

[Para 24] According to another aspect of the invention, each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit.

[Para 25] According to another aspect of the invention, each multi-voltage AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. By way of example, the second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 26] According to another aspect of the invention, at least two single voltage series LED circuits, each of which have at least two serially connected LEDs, are formed on a single chip or on a substrate providing a multi-voltage AC or DC operable LED device.

[Para 27] According to another aspect of the invention, each single voltage series LED circuit is designed to be driven with a predetermined forward voltage of at least 6V AC or DC and preferably each single voltage series LED circuit has a matching forward voltage of 6V, 12V, 24V, 120V, or other AC or DC voltage levels. By way of example, each multi-voltage AC or DC LED device would be able to be driven with at least two different AC or DC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage series LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level series LED circuits in series. The second forward voltage drive level of the serially connected series LED circuits would be

approximately twice the level of the first forward voltage drive level of the parallel connected series LED circuits. The at least two parallel connected series LED circuits would be twice the current of the at least two serially connected series LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage series LED device.

[Para 28] According to another aspect of the invention, at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness AC LED device for direct AC power operation.

[Para 29] According to another aspect of the invention, each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation. Each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit. The at least two AC LED circuits within each multi-voltage and/or multi current AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. The second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 30] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of LEDs is formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in

parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 31] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VAC, 24VAC, 120VAC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 32] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of standard diodes, LEDs or some combination thereof is provided separate of the LED circuit or formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 33] According to another aspect of the invention a multi-voltage and/or multi-current AC LED circuit is integrated within a single chip LED. Each multi-voltage and/or multi-current single chip AC LED comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation. Each single voltage AC LED circuit may have may have at least one voltage input electrical contact at each opposing end of the circuit or the at least two single voltage AC LED circuits may be electrically connected together in series on the single chip and have at least one voltage input electrical contact at each

opposing end of the two series connected single voltage AC LED circuits and one voltage input electrical contact at the center junction of the at least two single voltage AC LED circuits connected in series. The at least two single voltage AC LED circuits are integrated within a single chip to form a multi-voltage and/or multi-current single chip AC LED.

[Para 34] According to another aspect of the invention, at least one multi-voltage and/or multi-brightness LED devices may be integrated within a LED lamp. The at least two individual LED circuits within the multi-voltage and/or multi-brightness LED device(s) may be wired in a series or parallel circuit configuration by the LED packager during the LED packaging process thus providing for at least two forward voltage drive options, for example 12VAC and 24VAC or 120VAC and 240VAC that can be selected by the LED packager.

[Para 35] According to another aspect of the invention a multi-voltage and/or multi-current AC LED package is provided, comprising at least one multi-voltage and/or multi-current single chip AC LED integrated within a LED package. The multi-voltage and/or multi-current AC LED package provides matching electrical connectivity pads on the exterior of the LED package to the electrical connectivity pads of the at least one multi-voltage and/or multi-current single chip AC LED integrated within the LED package thus allowing the LED package user to wire the multi-voltage and/or multi-current AC LED package into a series or parallel circuit configuration during the PCB assembly process or final product integration process and further providing a AC LED package with at least two forward voltage drive options.

[Para 36] According to another aspect of the invention multiple individual discrete LED chips are used to form at least one multi-voltage and/or multi-current AC LED circuit within a LED package thus providing a multi-voltage and/or multi current AC LED package. Each multi-voltage and/or multi-current AC LED circuit within the package comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation The LED package provides electrical connectivity pads on the exterior of the LED package that match the electrical connectivity pads of the at least two single voltage AC LED circuits integrated within the multi-voltage and/or multi-current AC LED package thus allowing the LED package to be wired into a series or parallel circuit configuration during the PCB assembly process and further providing a LED package with at least two forward voltage drive options.

[Para 37] According to another aspect of the invention a multi-voltage and/or multi-current single chip AC LED and/or multi-voltage and/or multi current AC LED package is integrated within an LED lamp. The LED lamp having a structure that comprises a heat sink,

a lens cover and a standard lamp electrical base. The multi-voltage and/or multi-current single chip AC LED and/or package is configured to provide a means of switching on at least one additional single voltage AC LED circuit within multi-voltage and/or multi-current AC LED circuit to provide increased brightness from the LED lamp.

[Para 38] According to anther broad aspect of the invention at least one multi-current AC LED single chip is integrated within a LED package.

[Para 39] According to another aspect of the invention, at least one single chip multi-current bridge circuit having standard diodes, LEDs, or some combination thereof is integrated within a LED lamp having a standard lamp base. The single chip multi-current bridge circuit may be electrically connected together in parallel configuration but left open to accommodate switching on a switch to the more than one on the single chip and have at least one accessible electrical contact at each opposing end of the two series connected circuits and one accessible electrical contact at the center junction of the at least two individual serially connected LED circuits. The at least two individual circuits are integrated within a single chip.

[Para 40] According to another aspect of the invention when the at least two circuits are left unconnected on the single chip and provide electrical pads for connectivity during the packaging process, the LED packager may wire them into series or parallel connection based on the desired voltage level specification of the end LED package product offering.

[Para 41] According to another aspect of the invention, a high frequency transformer or inverter may provide power to at least one multi-voltage and/or multi-brightness LED device or chip. The high frequency transformer or inverter may be either packaged with the LED device or chip and may provide direct AC voltage to the LED device or chip, or as a separate driver or power supply for the LED device or chip capable of being electrically connected to the LED device or chip. The high frequency transformer or inverter is designed to receive a voltage at a low frequency, like for example a voltage at 50/60 Hz like a mains voltage, and output a voltage at a high frequency. The high frequency transformer or inverter may also be configured to step-up or step-down the voltage provided to the transformer or inverter from a source voltage.

[Para 42] According to another aspect of the invention, a high-frequency transformer or inverter may provide power to a DC driven-LED circuit, chip, or device or an LED circuit, chip or device containing one or more series strings of LEDs through a rectifier having standard diodes, LEDs, or some combination thereof may be electrically connected between the high-frequency transformer or inverter and. The rectifier may be provided independently

from the high-frequency transformer or inverter and the LED circuit, chip, or device and electrically connected at its input to the high-frequency transformer or inverter and at its output to the LED circuit, chip or device. Alternatively, the rectifier may be packaged with the high-frequency transformer or inverter forming a power supply or driver for the LED circuit, chip, or device. The rectifier may likewise be packaged directly with, or as part of, an LED circuit, chip, or device. As should be appreciated by those having skill in the art, packaging the rectifier directly with the LED circuit, chip, or device allows for an LED package containing a DC-driven LED circuit, chip, or device, or one or more series strings of LEDs, to be directly plugged into any power supply or driver providing an AC voltage output and operate. As a further alternative, a high-frequency inverter, rectifier, and LED circuit, chip, or device may be packaged into a single lighting device capable of being directly incorporated into a lighting element, or may be incorporated directly into a lamp or other OEM product utilizing LED light.

[Para 43] According to another aspect of the invention, a two-way or three-way switch may be provided directly between a high-frequency inverter providing power to a LED circuits, chip, or device and the LED circuits, chip or device, or in the alternative between a LED circuits, chip, or device and a rectifier having standard diodes, LEDs, or some combination thereof electrically connected to a high-frequency transformer or inverter.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 44] FIG. 1 shows a schematic view of a preferred embodiment of the invention;

[Para 45] FIG. 2 shows a schematic view of a preferred embodiment of the invention;

[Para 46] FIG. 3 shows a schematic view of a preferred embodiment of the invention;

[Para 47] FIG. 4 shows a schematic view of a preferred embodiment of the invention;

[Para 48] FIG. 5 shows a schematic view of a preferred embodiment of the invention;

[Para 49] FIG. 6a shows a schematic view of a preferred embodiment of the invention;

[Para 50] FIG. 6b shows a schematic view of a preferred embodiment of the invention;

[Para 51] FIG. 7a shows a schematic view of a preferred embodiment of the invention;

[Para 52] FIG. 7b shows a schematic view of a preferred embodiment of the invention;

[Para 53] FIG. 8 shows a schematic view of a preferred embodiment of the invention;

[Para 54] FIG. 9 shows a schematic view of a preferred embodiment of the invention;

[Para 55] FIG. 10 shows a schematic view of a preferred embodiment of the invention;

[Para 56] FIG. 11 shows a schematic view of a preferred embodiment of the invention;

[Para 57] FIG. 12 shows a schematic view of a preferred embodiment of the invention;

[Para 58] FIG. 13 shows a schematic view of a preferred embodiment of the invention;

[Para 59] FIG. 14 shows a schematic view of a preferred embodiment of the invention;

[Para 60] FIG. 15 shows a schematic view of a preferred embodiment of the invention;

[Para 61] FIG. 16 shows a block diagram of a preferred embodiment of the invention;

[Para 62] FIG. 17 shows a block diagram of a preferred embodiment of the invention;

[Para 63] FIG. 18 shows a block diagram of a preferred embodiment of the invention;

[Para 64] FIG. 19 shows a block diagram of a preferred embodiment of the invention; and,

[Para 65] FIG. 20 shows a block diagram of a preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[Para 66] FIG. 1 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 10. The multi-voltage and/or multi-brightness LED lighting device 10 comprises at least two AC LED circuits 12 configured in an imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 16a and 16c are electrically connected together and 16b and 16d are electrically connected together and one side of the AC voltage input is applied to 16a and 16c and the other side of the AC voltage input is applied to 16b and 16d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 16a and 16c are electrically connected and the AC voltage inputs are applied to electrical contacts 16b and 16d, a second operating forward voltage is required to drive the single chip 18. The single chip 18 may also be configured to operate at more than one brightness level "multi-brightness" by electrically connecting for example 16a and 16b and applying one side of the line of an AC voltage source to 16a ad 16b and individually applying the other side of the line from the AC voltage source a second voltage to 26b and 26c.

[Para 67] FIG. 2 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 20 similar to the multi-voltage and/or multi-brightness LED lighting device 10 described above in FIG. 1 . The at least two AC LED circuits 12 are integrated onto a substrate 22. The at least two AC LED circuits 12 configured in a imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d on the exterior of the substrate 22 and can be used to electrically configure and/or control the operating voltage and/or brightness level of the multi-voltage and/or multi-brightness LED lighting device.

[Para 68] FIG. 3 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 30 similar to the multi-voltage and/or multi-brightness LED lighting device 10 and 20 described in FIGs. 1 and 2. The multi-voltage and/or multi-brightness LED lighting device 30 comprises at least two AC LED circuits 32 having at least two LEDs 34 connected in series and anti-parallel configuration. The at least two AC LED circuits 32 have electrical contacts 36a, 36b, 36c, and 36d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 36a and 36c are electrically connected together and 36b and 36d are electrically connected together and one side of the AC voltage input is applied to 36a and 36c and the other side of the AC voltage input is applied to 36b and 36d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 36a and 36c are electrically connected and the AC voltage inputs are applied to electrical contacts 36b and 36d, a second operating forward voltage is required to drive the multi-voltage and/or multi-brightness lighting device 30. The multi-voltage and/or multi-brightness lighting device 30 may be a monolithically integrated single chip 38, a monolithically integrated single chip integrated within a LED package 38 or a number of individual discrete die integrated onto a substrate 38 to form a multi-voltage and/or multi-brightness lighting device 30.

[Para 69] FIG. 4 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in parallel configuration to an AC voltage source and operating at a first forward voltage. A resistor 40 may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device 30.

[Para 70] FIG. 5 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in series configuration to an AC voltage source and operating at a second forward voltage that is approximately two times greater than the first forward voltage of the parallel circuit as described in FIG. 4. A resistor may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device.

[Para 71] FIGs. 6a and 7a disclose schematic diagrams of a multi-voltage and/or multi-brightness LED lighting devices 50. The multi-voltage and/or multi-brightness LED lighting devices 50 comprises at least two AC LED circuits 52, each of which have at least two LEDs 54 in series and anti-parallel relation. The at least two AC LED circuits 52 have at least three electrical contacts 56a, 56b and 56c, and in the case of FIG. 7a a fourth electrical contact 56d. The at least two AC LED circuits 52 are electrically connected together in parallel at one end

56a and left unconnected at the opposing ends of the electrical contacts 56b and 56c, and in the case of FIG. 7a, 56d. One side of an AC voltage source line is electrically connected to 56a and the other side of an AC voltage source line is individually electrically connected to 56b, 56c, and 56d with either a fixed connection or a switched connection thereby providing a first brightness when AC voltage is applied to 56a and 56b and a second brightness when an AC voltage is applied to 56a, 56b and 56c, and a third brightness when an AC voltage is applied to 56a, 56b, 56c, and 56d. It is contemplated that the multi-voltage and/or multi-brightness LED lighting devices 50 are a single chip, an LED package, an LED assembly or an LED lamp.

[Para 72] FIGs. 6b and 7b disclose a schematic diagram similar to the multi-voltage and/or multi-brightness LED device 50 shown in FIGs. 6a and 7a integrated within a lamp 58 and connected to a switch 60 to control the brightness level of the multi-voltage and/or multi-brightness LED lighting device 50.

[Para 73] FIG. 8 discloses a schematic diagram of a multi-brightness LED lighting device 62 having at least two bridge rectifiers 68 in series with LED circuits 69. Each of the at least two bridge rectifiers 68 in series with LED circuits 69 comprise four LEDs 70 configured in a bridge circuit 68. LED circuits 69 have at least two LEDs 71 connected in series and electrical contacts 72a, 72b and 72c. When one side of an AC voltage is applied to 72a and the other side of an AC voltage line is applied to 72b and 72c individually, the brightness level of the multi-brightness LED lighting device 62 can be increased and/or decreased in a fixed manner or a switching process.

[Para 74] FIG. 9 discloses a schematic diagram the multi-brightness LED lighting device 62 as shown above in FIG. 8 with a switch 74 electrically connected between the multi-brightness LED lighting device 62 and the AC voltage source 78.

[Para 75] FIG. 9 discloses a schematic diagram of at least two single voltage LED circuits integrated with a single chip or within a substrate and forming a multi-voltage and/or multi-brightness LED device.

[Para 76] FIG. 10 discloses a schematic diagram of a single chip LED bridge circuit 80 having four LEDs 81 configured into a bridge circuit and monolithically integrated on a substrate 82. The full wave LED bridge circuit has electrical contacts 86 to provide for AC voltage input connectivity and DC voltage output connectivity.

[Para 77] FIG. 11 discloses a schematic diagram of another embodiment of a single chip multi-voltage and/or multi-brightness LED lighting device 90. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of

which have at least two LEDs 94 connected in series. The at least two series LED circuits 92 have electrical contacts 96 at opposing ends to provide a means of electrical connectivity. The at least two series LED circuits are monolithically integrated into a single chip 98. The electrical contacts 96 are used to wire the at least two series LEDs circuit 92 into a series circuit, a parallel circuit or an AC LED circuit all within a single chip.

[Para 78] FIG. 12 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED lighting device 90 as shown above in FIG. 11. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of which have at least two LEDs 94 connected in series. The at least two series LED circuits can be monolithically integrated within a single chip or discrete individual die can be integrated within a substrate to form an LED package 100. The LED package 100 has electrical contacts 102 that are used to wire the at least two series LEDs circuit into a series circuit, a parallel circuit or in anti-parallel to form an AC LED circuit all within a single LED package.

[Para 79] As seen in FIGs. 13-15, a single rectifier 110 may be provided for two or more LED circuits 92, each containing at least two LEDs 94 connected in series. The single rectifier 110 comprises standard diodes 112 connected to an AC voltage source 116, or in the alternative may be connected to a driver or power supply which ultimately provides an AC voltage, like for example a high frequency AC driver 118. The single rectifier 110 is electrically connected to the LED circuits 92. Specifically, the rectifier 110 connects to a common junction of an anode of at least one LED 94 in each LED circuit 92, and to the cathode of at least one LED 94 in each LED circuit 92. As shown in FIG. 15, the rectifier may instead be connected to a switch, allowing for either one or both of LED circuits 92 to be operative at any given time.

[Para 80] It is contemplated by the invention that diodes 112 in FIGs. 13-15 are interchangeable with LEDs 70 in rectifiers 68 in FIGs. 8 and 9 and vice versa. As should be appreciated by those having skill in the art, any combination of LEDs 70 and diodes 112 can be used in rectifiers 68 and 110, so long as rectifiers 68 and 110 provide DC power from an AC source.

[Para 81] As shown in FIGs. 13 and 14, and further shown in FIGs. 16-20, any lighting devices, chips, or AC LED or DC LED circuits contemplated by the present invention may be powered through a high-frequency AC driver, inverter or transformer 118. As shown in FIG. 13, any AC source 116 may be connected to the high-frequency driver or inverter or transformer 118, however, as shown in Figs. 16-20 it is contemplated that low frequency

voltage 124, like for example a mains voltage, is provided to the high-frequency driver or transformer or inverter 118.

[Para 82] FIGs. 16 and 17 show two embodiments of an AC LED lighting system 140 wherein a high-frequency AC driver, inverter, or transformer 118 for provides a high-frequency voltage to an AC LED circuit, lighting device, or chip 126. AC LED circuit, lighting device, or chip 126 may be any of the devices, circuits, or chips shown and described in FIGs. 1-7, like for example LED lighting devices 10, 20, 30 and/or AC LED circuits 12, 32, or any combination thereof. When multiple AC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such AC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship.

[Para 83] As shown in FIG. 16, the high-frequency AC driver, inverter or transformer 118 may be packaged separately from an (or multiple) AC LED circuit, device, or chip 126. In such embodiments a power source 128 provides voltage to the high-frequency AC driver, inverter or transformer 118 which steps up the frequency of the voltage to a higher frequency and provides the higher-frequency voltage to the AC LED circuit(s), device(s), or chip(s) 126. High-frequency AC driver, inverter, or transformer 118 may further include necessary circuitry, for example a transformer, for stepping-up or stepping-down the AC voltage provided by the power source 128.

[Para 84] As shown in FIG. 17, high-frequency AC driver, inverter, or transformer 118 may be packaged with AC LED circuit(s), device(s), or chip(s) 126 in a unitary AC LED light bulb, lighting element 130. It is contemplated by the invention that a switch may be configured between the high-frequency driver, inverter, or transformer 118 and the AC LED circuit(s), device(s), or chip(s) 126 for selectively operating one or more AC LED circuit, lighting device, or chip. For example, as shown in FIGS. 6A, 6B, 7A, and 7B a 2-way or 3-way switch may be attached at the input side of the AC LED circuit(s), lighting device(s), or chip(s). Such a switch may be located between the high-frequency AC driver, inverter, or transformer 118, and the AC LED circuit(s), lighting device(s), or chip(s).

[Para 85] FIGs. 14 and 18-20 show a DC LED lighting system 142 having a DC LED circuit(s), device(s), or chip(s) 92, 132 being powered by a high-frequency AC driver, inverter, or transformer 118 through a rectifier 110. In operation, the combination of AC sources 116, 128, high-frequency AC driver, inverter or transformer 118, and DC LED circuit, device, or chip 92, 132 operate in substantially the same manner as that described with respect to FIGs. 16 and 17. However, in each system shown in FIGs. 14 and 18-20,

rectifier 110 rectifies the high-frequency AC voltage output of the high-frequency AC driver, inverter, or transformer before a voltage is provided to the DC LED circuit(s), device(s), or chip(s) 92, 132. DC LED circuit(s), device(s), or chip(s) 132 are not limited in form to just circuit 92, and instead may take the form of any of the lighting devices, circuits, or chips shown and described, for example, in FIGs. 8-12. When multiple DC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such DC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship. Additionally, as shown in FIG. 15, a switch, like for example a 2-way switch or a 3-way switch, may also be attached at the input side of DC LED circuit(s), device(s), or chip(s).

[Para 86] As shown in FIGs. 18-20, like in an AC embodiment, AC driver, inverter, or transformer 118, rectifier 110, and DC LED circuit(s), device(s), or chip(s) 132 may be packaged in any number of ways. As shown in FIG. 18, each element may be packaged separately and electrically connected together in series. Alternatively, as shown in FIG. 19, a DC LED driver 134 may be formed by combining the high-frequency AC driver, inverter, or transformer 118 with rectifier 110. As shown in FIG. 20, an additional alternative contemplated by the invention is forming a DC LED lighting element 136, which may be embodied as a light bulb, lighting system, lamp, etc., wherein the DC LED lighting element 136 includes each of a high-frequency AC driver, inverter, or transformer 118, a rectifier 110, and a DC LED circuit(s), lighting device(s), or chip(s) 132. It should be appreciated by those having skill in the art that a lighting element containing only rectifier 110 and a DC LED circuit(s), lighting device(s), or chip(s) 132 may also be designed. Such lighting elements have the advantage of being able to be plugged into any AC source, whether it is a high-frequency AC driver, inverter, or transformer, or a simple mains voltage, and provide a light output in the same manner as the imbalanced circuit shown in, for example FIGs. 1-7.

CLAIMS

What is claimed is:

1. A lighting system powered by an AC voltage source, the lighting system comprising:
    a. a high-frequency AC driver which outputs a relatively constant voltage at a relatively constant frequency, wherein the relatively constant frequency output is substantially higher than the frequency of an input voltage; and,
    b. at least two LED circuits each of which have at least two LEDs connected in series, electrically connected to the high-frequency AC driver.
2. The lighting system of claim 1 wherein each of the at least two LED circuits include:
    a. at least two LEDs connected in an opposing series relationship such that the anode of each of the at least two LEDs form a first node;
    b. at least two LEDs connected in an opposing series relationship such that the cathode of each of the at least two LEDs form a second node; and,
    c. a cross connecting LED connecting the first node to the second node such that the cathode of the cross connecting LED is connected to the first node, and the anode of the cross connecting LED is connected to the second node.
3. The lighting system of claim 2 wherein each of the at least two LED circuits are capable of being connected to the high-frequency AC driver in either a series relationship or a parallel relationship.
4. The lighting system of claim 3 wherein each of the two LED circuits have substantially identical forward operating voltages.
5. The lighting system of claim 4 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.
6. The lighting system of claim 5 wherein the switch is a two-way switch.
7. The lighting system of claim 5 wherein the switch is a three-way switch.
8. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged separately.
9. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged together forming an AC LED lighting device.

10. The lighting system of claim 1 further comprising a bridge rectifier electrically connected between the high-frequency AC driver and the at least two LED circuits.

11. The lighting system of claim 10 wherein the at least two LED circuits include at least two LEDs connected in series.

12. The lighting system of claim 10 wherein the bridge rectifier is formed using diodes.

13. The lighting system of claim 10 wherein the bridge rectifier is formed using LEDs.

14. The lighting system of claim 10 wherein the bridge rectifier is formed using a combination of diodes and LEDs.

15. The lighting system of claim 11 wherein each of the at least two LED circuits are capable of being connected in either a series relationship or a parallel relationship.

16. The lighting system of claim 15 wherein each of the at least two LED circuits have a substantially identical forward operating voltage.

17. The lighting system of claim 16 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.

18. The lighting system of claim 17 wherein the switch is a two-way switch.

19. The lighting system of claim 17 wherein the switch is a three-way switch.

20. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and at least two LED circuits are packaged separately.

21. The lighting system of claim 10 wherein the high-frequency AC driver and the bridge rectifier are packaged together forming a DC LED driver.

22. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and the at least two LED circuits are packaged together forming a DC LED lighting device.

23. The lighting system of claim 10 wherein the rectifier and the at least two LED circuits are packaged together.

24. A LED lighting device comprising:

a. at least one LED circuit;

b. the at least one LED circuit having at least two LEDs connected in series;

c. a bridge rectifier wherein the at least one LED circuit being electrically connected to the bridge rectifier.

25. The LED lighting device of claim 24 further comprising at least one additional LED circuit wherein the at least one additional LED circuit includes two LEDs connected in series.

26. The LED lighting device of claim 25 wherein a second bridge rectifier is electrically connected to the at least one additional LED circuit.

27. The LED lighting device of claim 25 wherein the at least one additional LED circuit is electrically connected to the bridge rectifier.

28. The LED lighting device of claim 27 wherein a switch is electrically connected between:

a. the bridge rectifier and,

b. the at least one LED circuit and the at least one additional LED circuit.

29. The LED lighting device of claim 26 wherein a switch is electrically connected to the inputs of each of the bridge rectifier and the second bridge rectifier.

30. The LED lighting device of claims 28 and 29 wherein the at least one LED circuit and the at least one additional LED circuit have a substantially identical forward voltage.

31. The LED lighting device of claim 30 wherein the at least LED circuit and the at least one additional LED circuit are capable of being connected in either a series relationship or a parallel relationship.

32. The LED lighting device of claims 24-31 further comprising a high-frequency AC driver attached to one or more of the bridge rectifier and the second bridge rectifier.

33. A LED lighting device comprising:

a. at least two LED circuits;

b. each of the at least two LED circuits having at least two LEDs connected in series;

c. a bridge rectifier wherein each of the at least two LED circuits are electrically connected to the bridge rectifier in a parallel relationship.

34. A method of providing light, the method comprising the steps of:

    a. providing an AC voltage at a first frequency;

    b. transforming the AC voltage at a first frequency to a provided voltage at a second frequency;

    c. supplying the provided voltage at the second frequency to at least two LED circuits.

35. The method of claim 34 wherein a high-frequency AC driver transforms the AC voltage at the first frequency to the provided voltage at the second frequency.

36. The method of claim 35 wherein the AC voltage and the provided voltage are substantially identical AC voltages.

37. The method of claim 35 wherein the provided voltage is a second AC voltage less than the AC voltage.

38. The method of claim 35 wherein the provided voltage is a second AC voltage greater than the AC voltage.

39. The method of claim 35 further comprising the step of rectifying the provided voltage at the second frequency prior to supplying the provided voltage to the at least two LED circuits.

40. The method of claim 39 wherein a bridge rectifier rectifies the provided voltage at the second frequency.

41. The method of claims 35-40 further comprising the step of selecting how many of the at least two LED circuits receive the provided AC voltage.

42. The method of claim 41 wherein one of a two-way switch or a three-way switch is used to select how many of the at least two LED circuits are supplied with the provided voltage.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 928

FIG. 2

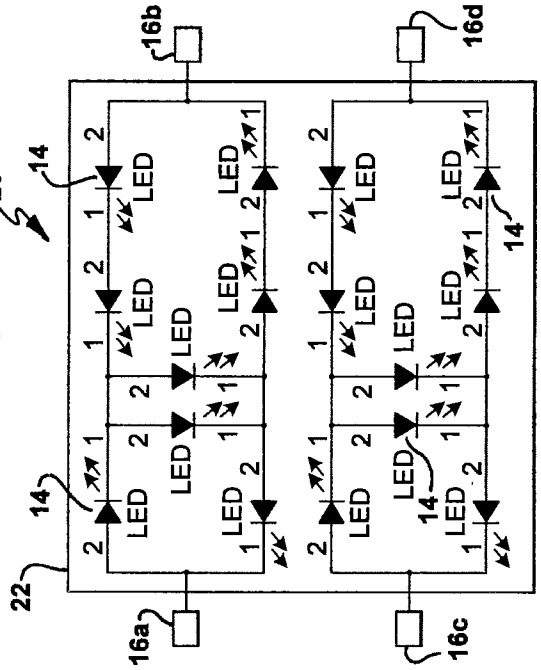
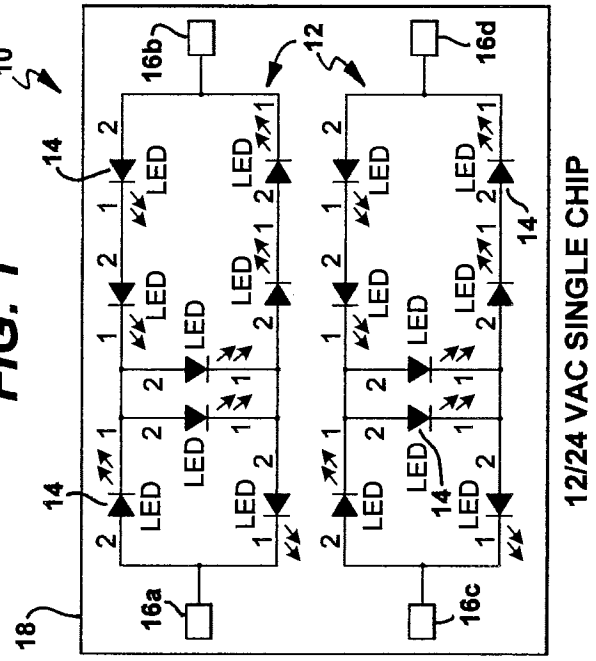


FIG. 1



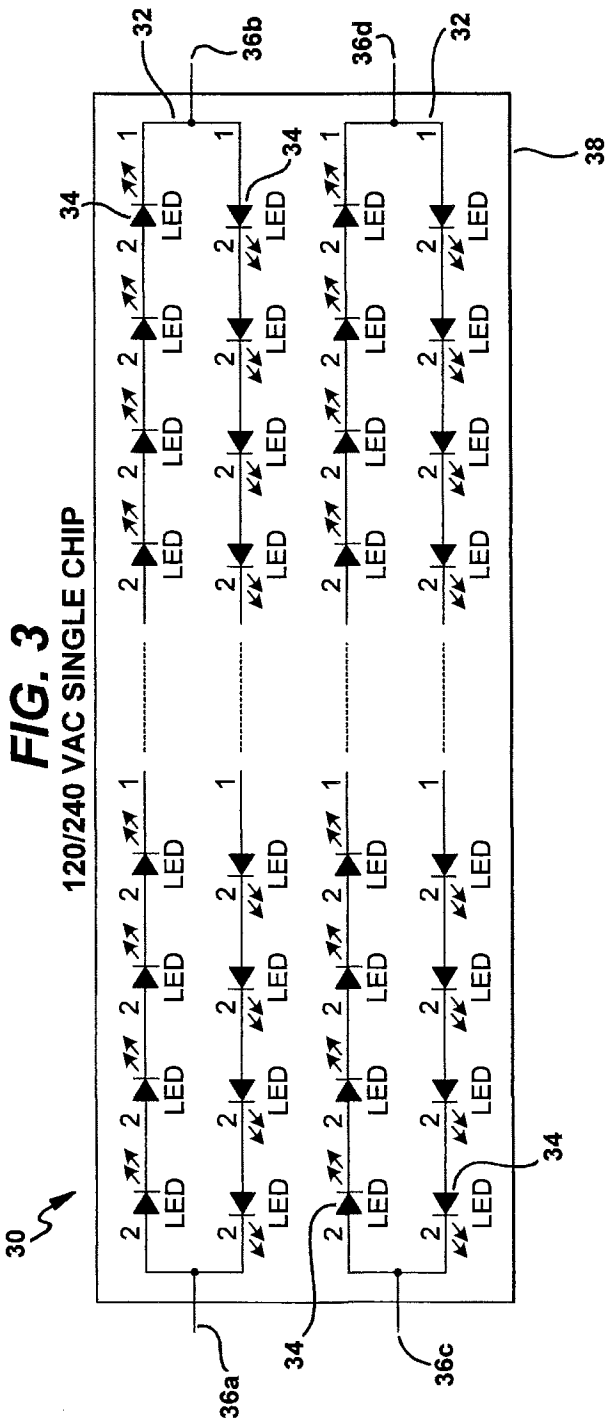
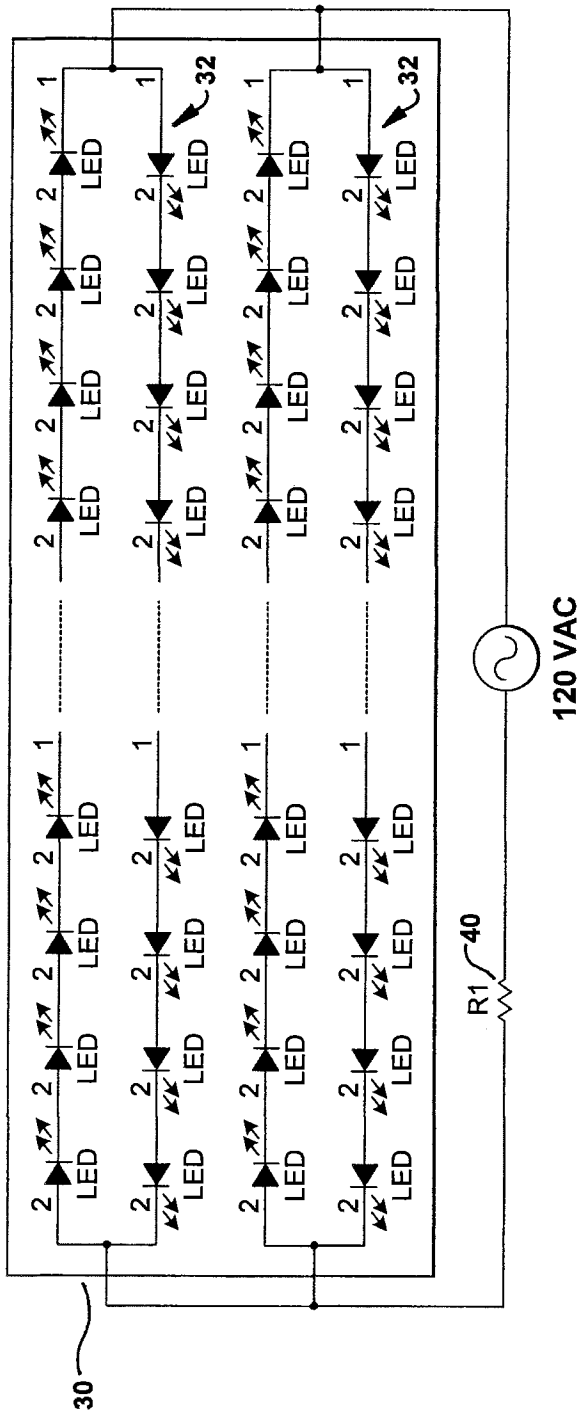

120/240 VAC SINGLE CHIP
30
32
36b
36d
32
38
34
34
34
34
36a
36c
LED
1
2

FIG. 3

FIG. 4



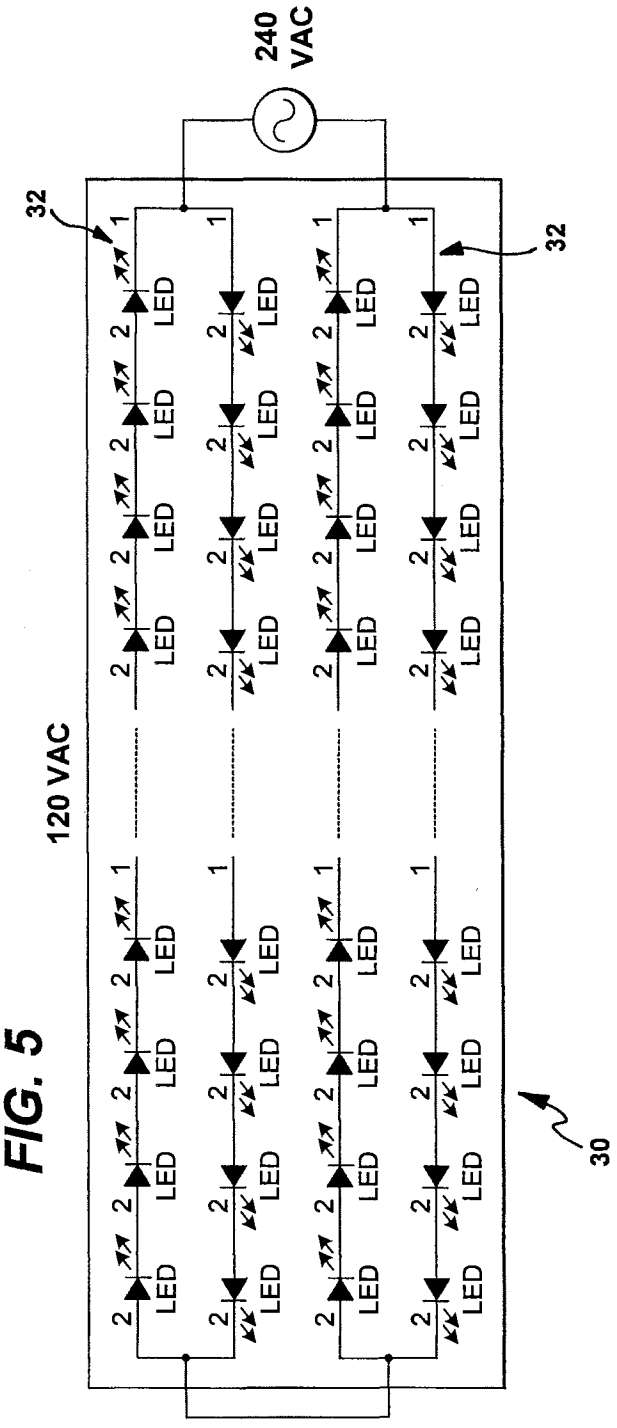


FIG. 5

PGR2023-00016 - Home Depot
Ex. 1003 - Page 932

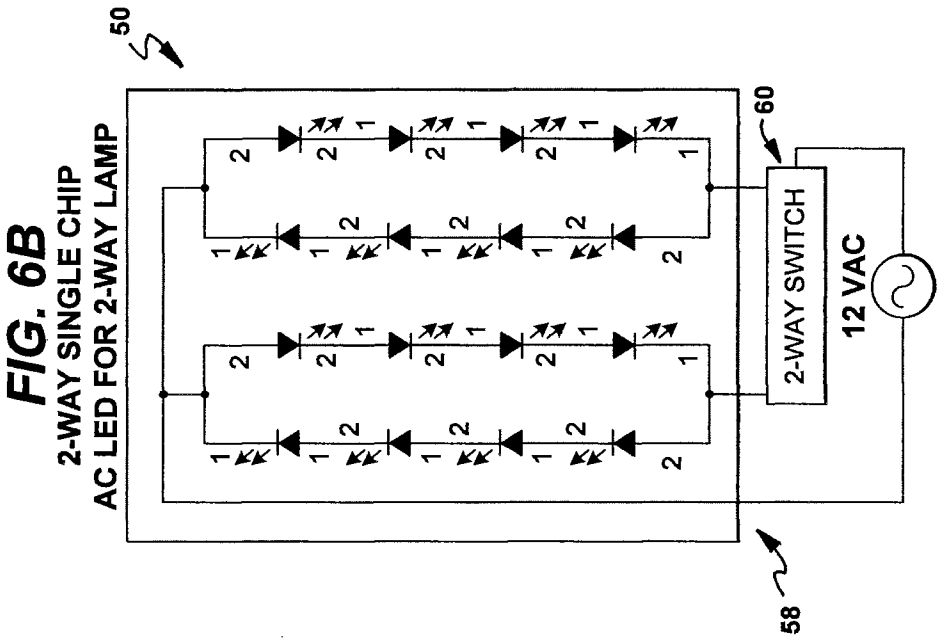


FIG. 6B
2-WAY SINGLE CHIP
AC LED FOR 2-WAY LAMP

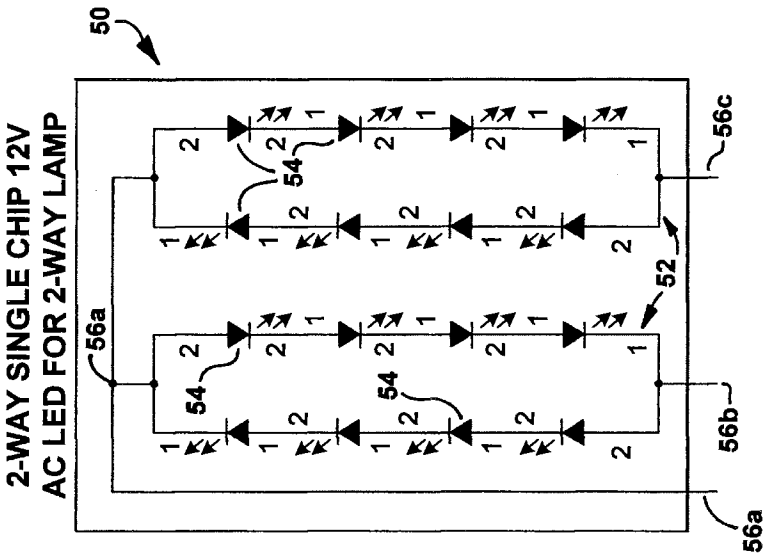


FIG. 6A
2-WAY SINGLE CHIP 12V
AC LED FOR 2-WAY LAMP

FIG. 7A

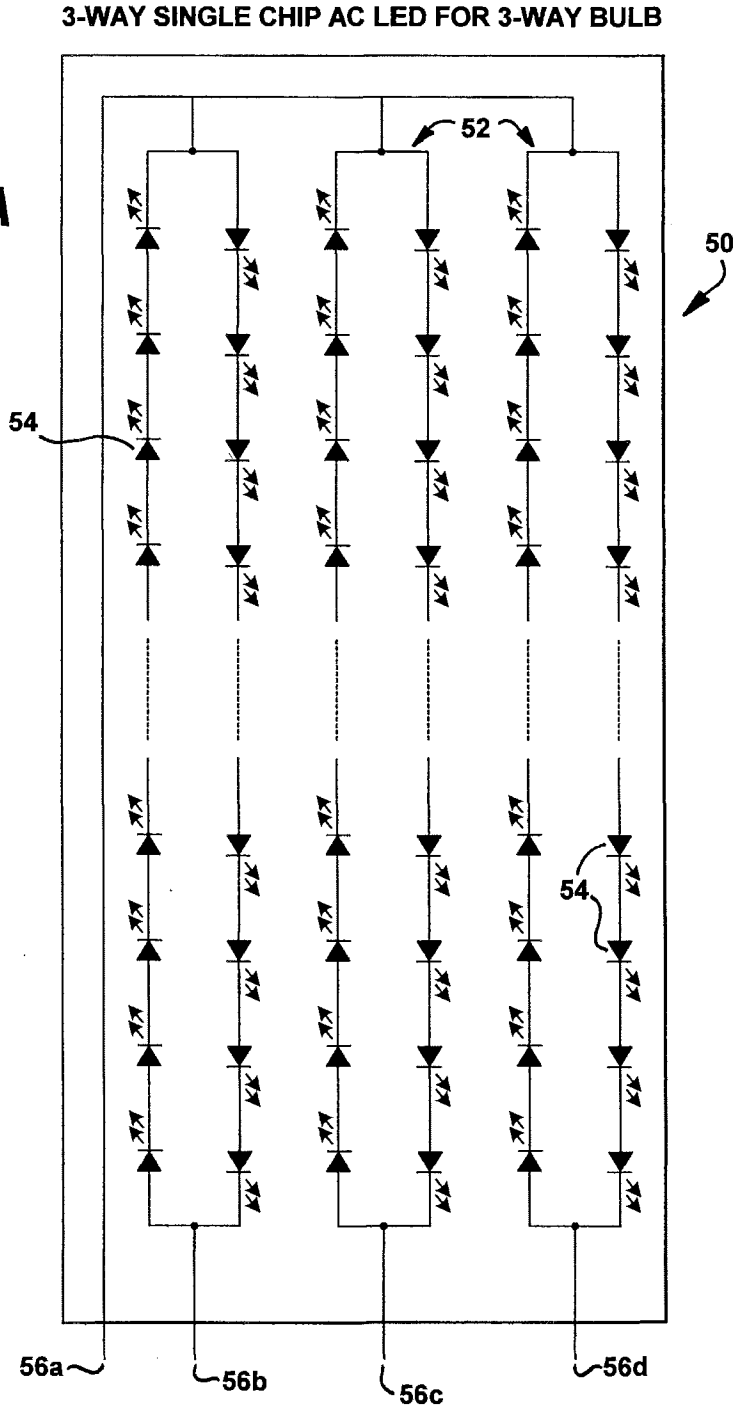

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
52
50
54
54
56a
56b
56c
56d

FIG. 7B

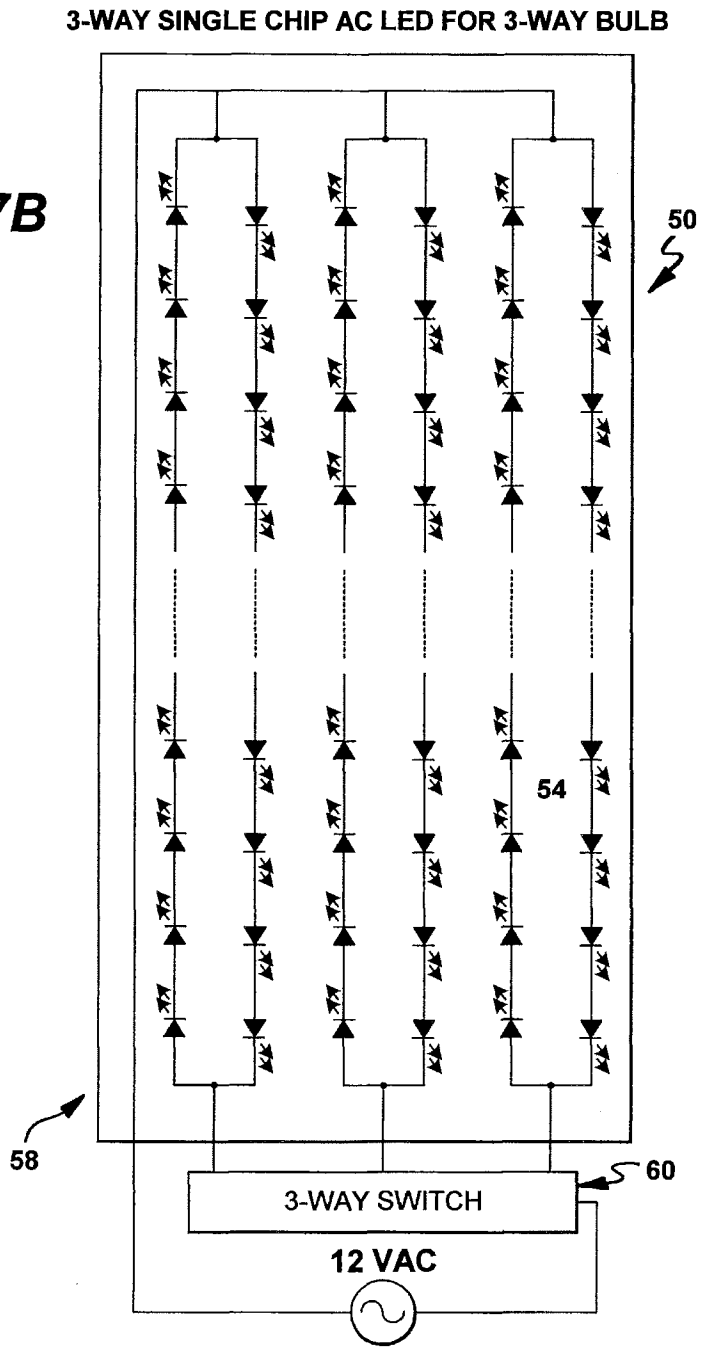
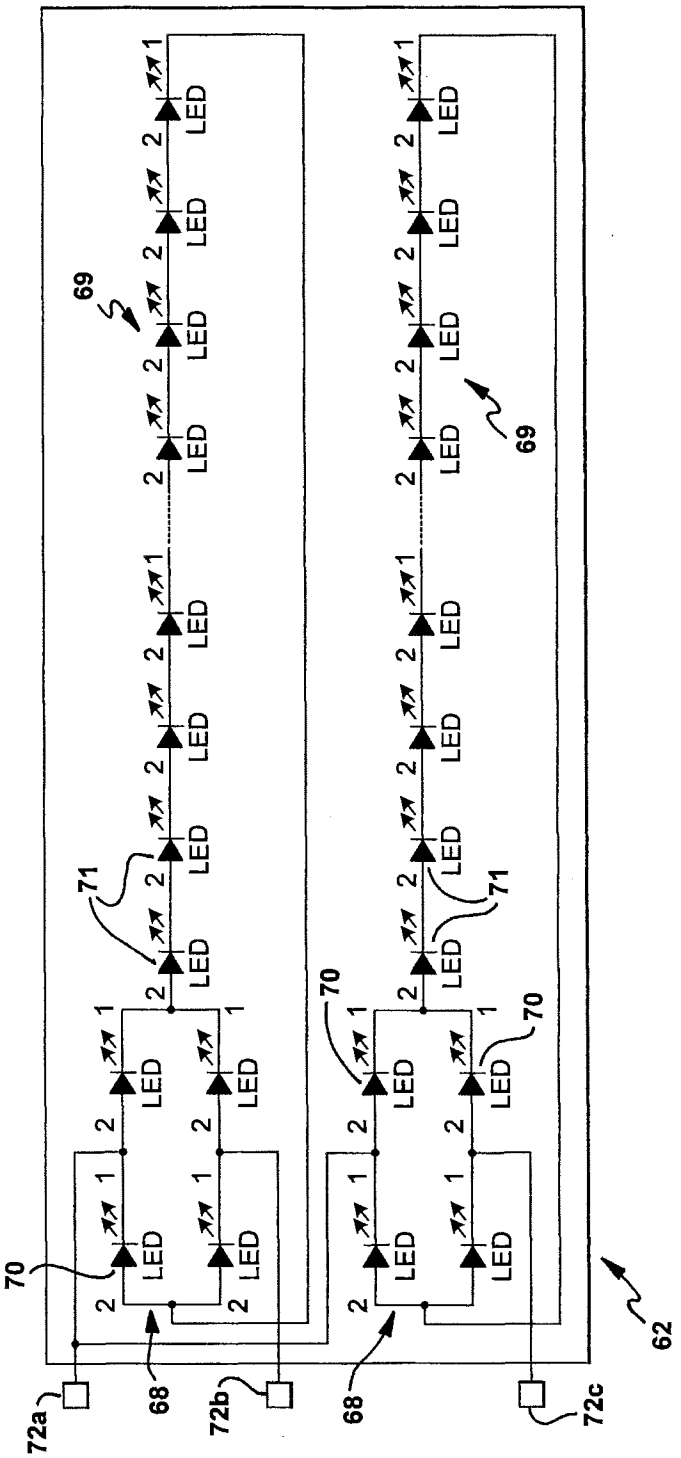
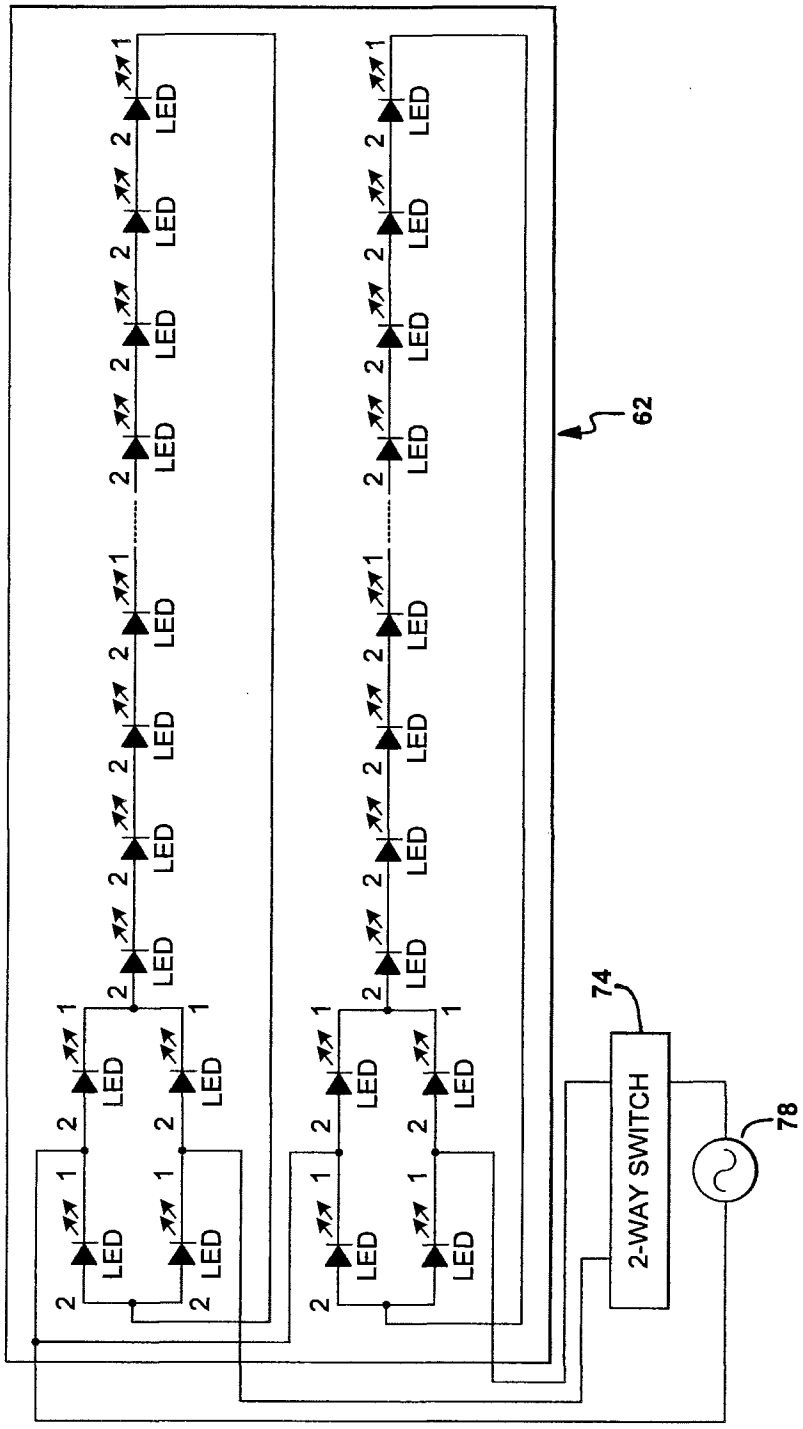

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
50
54
58
60
3-WAY SWITCH
12 VAC

FIG. 8



PGR2023-00016 - Home Depot
Ex. 1003 - Page 936

FIG. 9



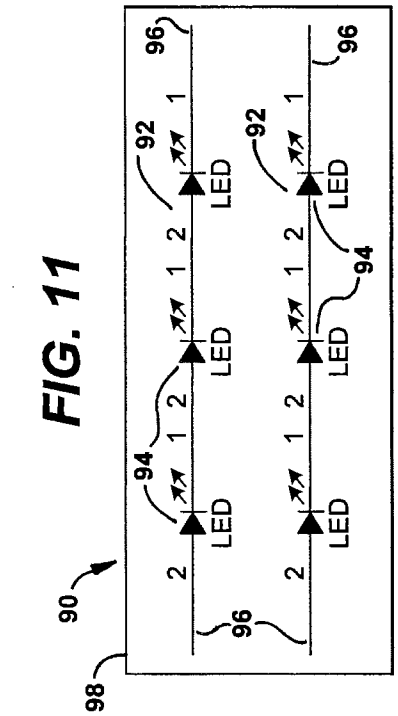


FIG. 11

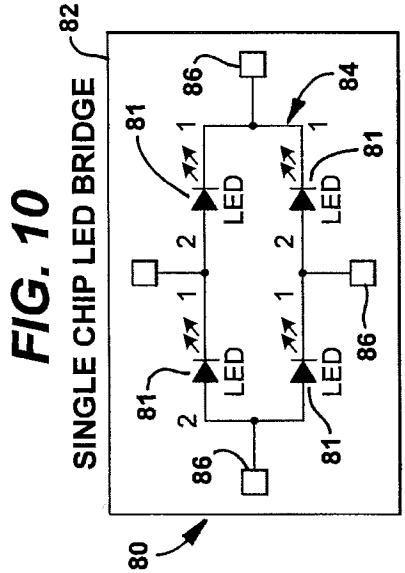


FIG. 10

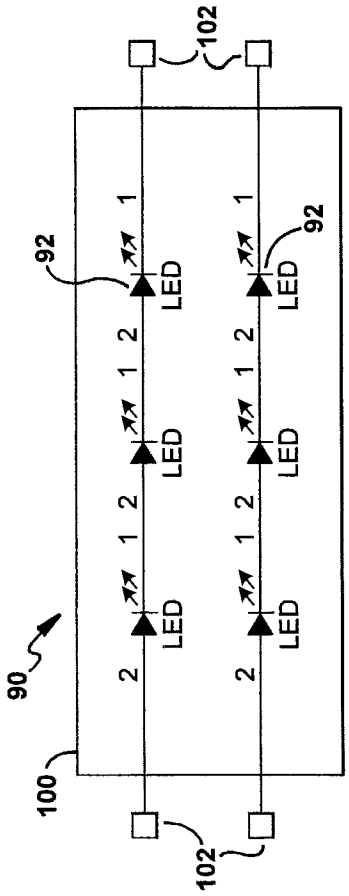


FIG. 12

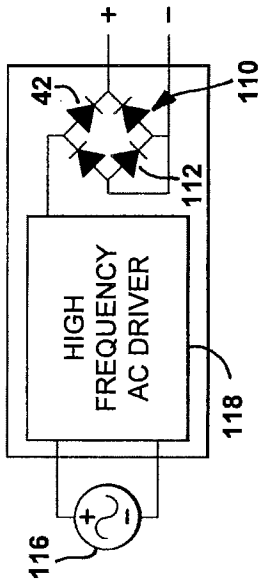


FIG. 13

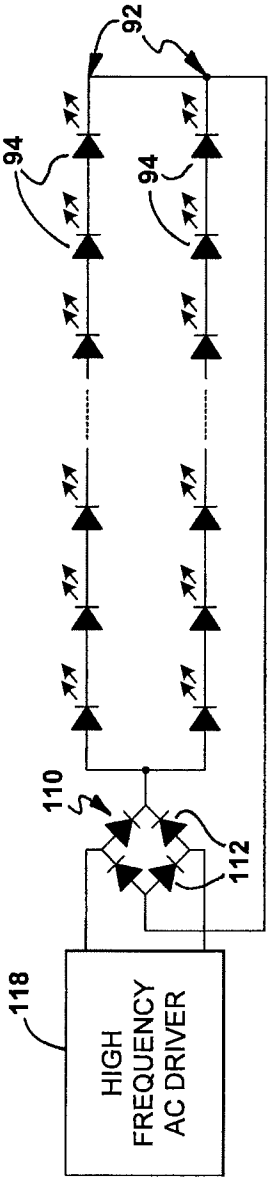


FIG. 14

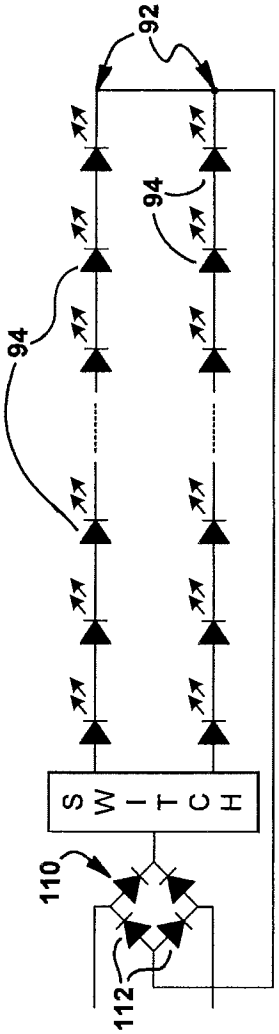


FIG. 15

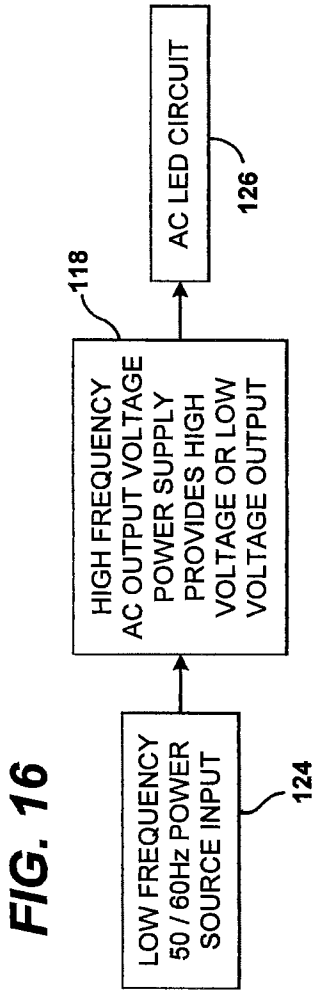

LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
PROVIDES HIGH
VOLTAGE OR LOW
VOLTAGE OUTPUT
118
AC LED CIRCUIT
126

FIG. 16

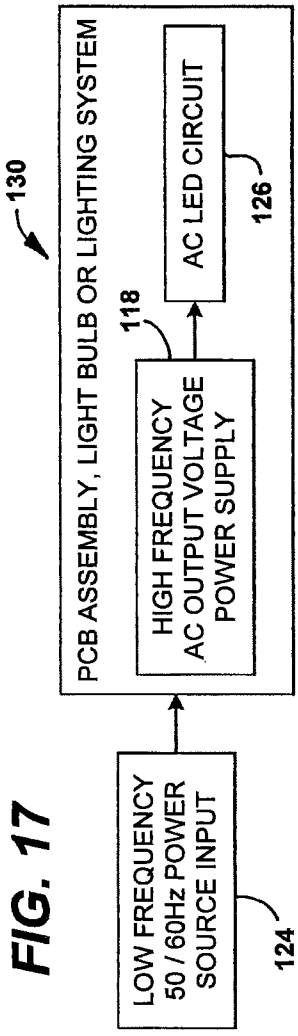

130
PCB ASSEMBLY, LIGHT BULB OR LIGHTING SYSTEM
LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
118
AC LED CIRCUIT
126

FIG. 17

PGR2023-00016 - Home Depot
Ex. 1003 - Page 940

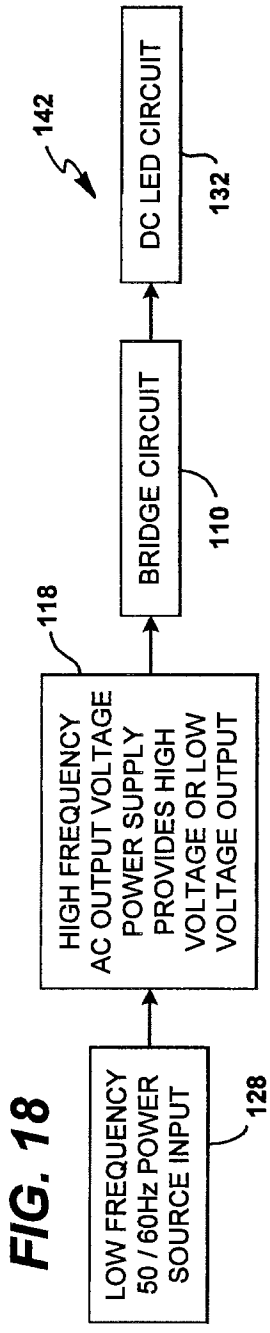


FIG. 18

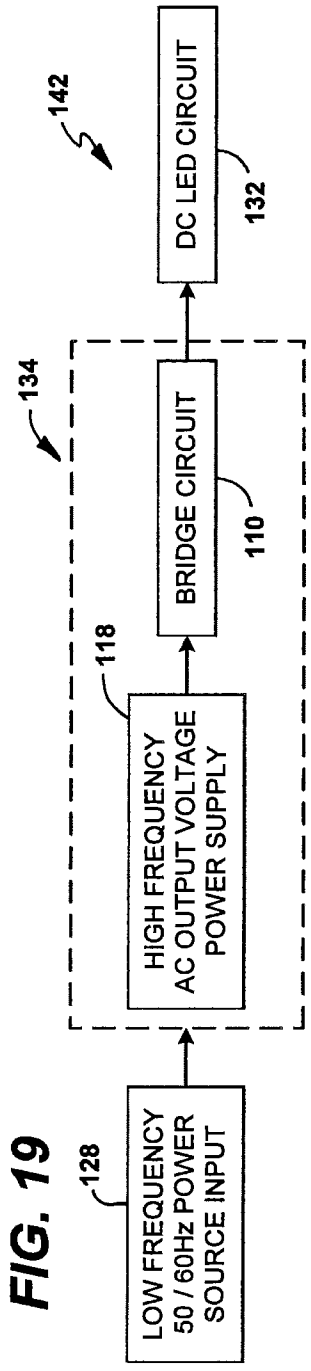


FIG. 19

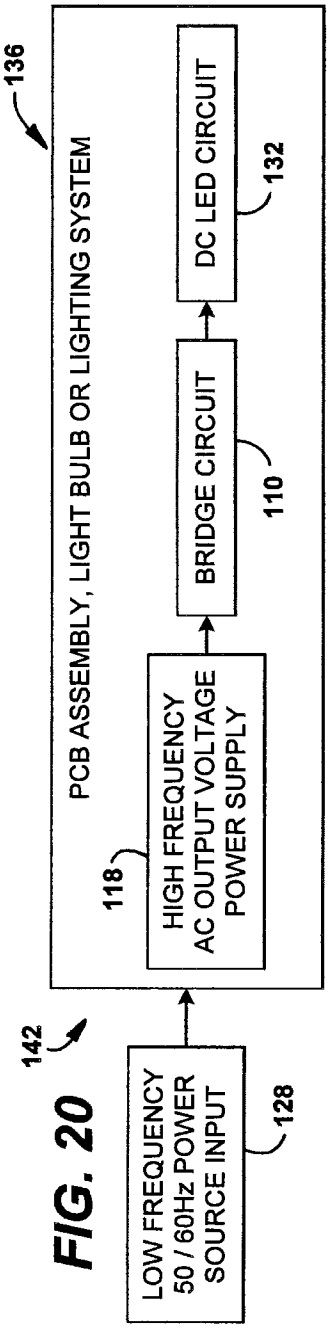


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H05B 37/00 (2011.01)
USPC - 315/185R
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 315/185R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 362/800; 315/185R, 200R, 246, 250, 291 (keyword limited - see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; Google Scholar
Terms: lighting, led, transformer, voltage, frequency, ac, dc, rectifier, driver, bridge, constant, cathode, anode, port, node, switch, series, input.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2009/0295300 A1 (King) 03 December 2009 (03.12.2009), entire document, especially abstract, para [0009], [0015], [0031], [0033], [0035], [0053], [0059], [0060], [0061], [0065], [0069], [0070], [0082], [0086], [0089], [0092], [0101], [0108].	24-31, 33-42 --- 1-23
Y	US 2008/0203936 A1 (Mariyama et al.) 28 August 2008 (28.08.2008), entire document, especially abstract, para [0012], [0015], [0017], [0018], [0019], [0053], [0129], [0133], [0136].	1-23
A	US 2008/0158915 A1 (Williams) 03 July 2008 (03.07.2008), entire document, especially abstract, para [0008], [0009], [0010], [0050].	1-31, 33-42

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2011 (14.02.2011)	08 MAR 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 32
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

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(21) International Application Number: PCT/US02/29453

(22) International Filing Date:
17 September 2002 (17.09.2002)

(25) Filing Language: English

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(30) Priority Data:

60/322,765	17 September 2001 (17.09.2001)	US
60/329,202	12 October 2001 (12.10.2001)	US
60/335,679	23 October 2001 (23.10.2001)	US
60/341,476	30 October 2001 (30.10.2001)	US
60/341,898	19 December 2001 (19.12.2001)	US
60/353,569	1 February 2002 (01.02.2002)	US

(71) Applicant: COLOR KINETICS INCORPORATED [US/US]; 10 Milk Street, Suite 1100, Boston, MA 02108 (US).

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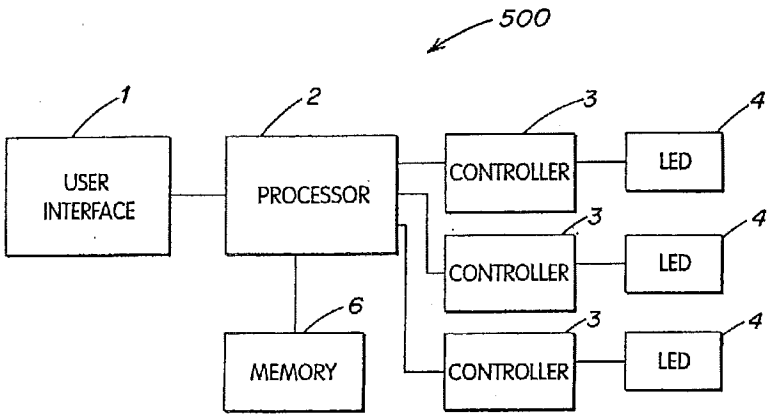
(74) Agent: TEJA, Joseph, Jr.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: LIGHT EMITTING DIODE BASED PRODUCTS



(57) Abstract: Various exemplary implementations of light emitting diode (LED) based illumination products and methods are disclosed including, but not limited to, glow sticks, key chains, toys, balls, various game accessories, light bulbs, night lights, wall lights, wall switches, wall sockets, wall panels, modular lights, flexible lights, automotive lights, wearable accessories, light ropes, decorative lights such as icicles and icicle strings, light tubes, insect control lights and methods, and lighted air fresheners/scent dispensers. Any of the foregoing devices may be equipped with various types of user interfaces (both "local" and "remote") to control light generated from the device. Additionally, devices may be controlled via light control information or programs stored in device memory and/or transmitted or downloaded to the devices (e.g., devices may be controlled individually or collectively in groups via a network, glow sticks or other products may be downloaded with programming information that is stored in memory , etc.). Devices also may include sensors so that the generated light may change in response to various operating and/or environmental conditions or a user input. Various optical processing devices which may be used with any of the devices (e.g., reflectors, diffusers, etc.) also are disclosed.

WO 03/026358 A1

PGR2023-00016 - Home Depot
SAMSUNG EXHIBIT 1031
Ex. 1003 - Page 943



European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:
— *with international search report*

LIGHT EMITTING DIODE BASED PRODUCTS

Cross-references to Related Applications

The present application claims priority to the following U.S. Provisional Applications:

Serial No. 60/322,765, filed September 17, 2001, entitled "Light Emitting Diode Illumination Systems and Methods;"

Serial No. 60/329,202, filed October 12, 2001, entitled "Light Emitting Diode Illumination Systems and Methods;"

Serial No. 60/341,476, filed October 30, 2001, entitled "Systems and Methods for LED Lighting;"

Serial No. 60/335,679, filed October 23, 2001, entitled "Systems and Methods for Programmed LED Devices;"

Serial No. 60/341,898, filed December 19, 2001, entitled "Systems and Methods for LED Lighting;" and

Serial No. 60/353,569, filed February 1, 2002, entitled "LED Systems and Methods."

Background

Lighting elements are sometimes used to illuminate a system, such as a consumer product, wearable accessory, novelty item, or the like. Existing illuminated systems, however, are generally only capable of exhibiting fixed illumination with one or more light sources. An existing wearable accessory, for example, might utilize a single white-light bulb as an illumination source, with the white-light shining through a transparent colored material. Such accessories only exhibit an illumination of a single type (a function of the color of the transparent material) or at best, by varying the intensity of the bulb output, a single-colored illumination with some range of controllable brightness. Other existing systems, to provide a wider range of colored illumination, may utilize a combination of differently colored bulbs. Such accessories, however, remain limited to a small number of different colored states, for example, three distinct illumination colors: red (red bulb illuminated); blue (blue bulb illuminated); and purple (both red and blue

bulbs illuminated). The ability to blend colors to produce a wide range of differing tones of color is not present.

Techniques are known for producing multi-colored lighting effects with LED's. Some such techniques are shown in, for example, U.S. Patent No. 6,016,038, U.S. Patent Application No. 09/215,624, and U.S. Patent No. 6,150,774. While these references teach systems for producing lighting effects, they do not address some applications of programmable, multi-colored lighting systems.

For example, many toys, such as balls, may benefit from improved color illumination processing, and/or networking attributes. There are toy balls that have lighted parts or balls where the entire surface appears to glow; however there is no ball available that employs dynamic color changing effects. Moreover, there is no ball available that responds to data signals provided from a remote source. As another example, ornamental devices are often lit to provide enhanced decorative effects. United States Patents 6,086,222 and 5,975,717, for example, disclose lighted ornamental icicles with cascading lighted effects. As a significant disadvantage, these systems apply complicated wiring harnesses to achieve dynamic lighting. Other examples of crude dynamic lighting may be found in consumer products ranging from consumer electronics to home illumination (such as night lights) to toys to clothing, and so on.

Thus, there remains a need for existing products to incorporate programmable, multi-colored lighting systems to enhance user experience with sophisticated color changing effects, including systems that operate autonomously and systems that are associated with wired or wireless computer networks.

Summary Of The Invention

High-brightness LEDs, combined with a processor for control, can produce a variety of pleasing effects for display and illumination. Systems disclosed herein use high-brightness, processor-controlled LEDs in combination with diffuse materials to produce color-changing effects. The systems described herein may be usefully employed to bring autonomous color-changing ability and effects to a variety of consumer products and other household items. The systems may also include sensors so that the illumination of the LEDs may change in response to environmental conditions or a user

input. Additionally, the systems may include an interface to a network, so that the illumination of the LEDs may be controlled via the network.

Brief Description Of Drawings

Fig. 1 is a block diagram of a device according to the principles of the invention;

Figs 2A-2B are state diagrams showing operation of a device according to the principles of the invention;

Fig. 3 shows a glow stick according to the principles of the invention;

Fig. 4 shows a key chain according to the principles of the invention;

Fig. 5 shows a spotlight according to the principles of the invention;

Fig. 6 shows a spotlight according to the principles of the invention;

Fig. 7 shows an Edison mount light bulb according to the principles of the invention;

Fig. 8 shows an Edison mount light bulb according to the principles of the invention;

Fig. 9 shows a light bulb according to the principles of the invention;

Fig. 10 shows a wall socket mounted light according to the principles of the invention;

Fig. 11 shows a night light according to the principles of the invention;

Fig. 12 shows a night light according to the principles of the invention;

Fig. 13 shows a wall washing light according to the principles of the invention;

Fig. 14 shows a wall washing light according to the principles of the invention;

Fig. 15 shows a light according to the principles of the invention;

Fig. 16 shows a lighting system according to the principles of the invention;

Fig. 17 shows a light according to the principles of the invention;

Fig 18 shows a light and reflector arrangement according to the principles of the invention;

Fig. 19 shows a light and reflector arrangement according to the principles of the invention;

Fig. 20 shows a light and reflector arrangement according to the principles of the invention;

Fig. 21 shows a light and reflector arrangement according to the principles of the invention;

Fig. 22 is a block diagram of an embodiment of a device according to the principles of the invention having internal illumination circuitry;

Fig. 23 is a block diagram of an embodiment of a device according to the principles of the invention having external illumination circuitry;

Fig. 24 depicts an autonomous color-changing shoe according to the principles of the invention;

Fig. 25 depicts a device for use with color-changing icicles;

Figs. 26-30 depict color-changing icicles;

Fig. 31 depicts a color-changing rope light;

Figs. 32A and 32B illustrate an illuminated wall panel device according to one embodiment of the invention;

Fig. 33 illustrates a modified faceplate of the device shown in Figs. 32A and 32B;

Fig. 34 illustrates an illuminated panel according to another embodiment of the invention;

Fig. 35 illustrates an illuminated panel using fiber optics according to another embodiment of the invention;

Fig. 36 illustrates an illuminated wall switch/plate according to another embodiment of the invention;

Fig. 37 illustrates an illuminated wall socket/plate according to another embodiment of the invention;

Fig. 38 illustrates an illuminated wall socket/plate having a user interface according to another embodiment of the invention;

Fig. 39 illustrates an illumination device having a flexible neck according to another embodiment of the invention;

Fig. 40 illustrates a junction box for various illumination devices according to another embodiment of the invention;

Figs. 41A, 41B, and 41C illustrate various illumination devices for automotive applications according to other embodiments of the invention;

Fig. 42 illustrates a lighting device having an elongated optic element, according to another embodiment of the invention;

PGR2023-00016 - Home Depot
Ex. 1003 - Page 948

Figs. 43A, 43B, and 43C illustrate various arrangements of a reflector implemented with the optic element of Fig. 42, according to another embodiment of the invention;

Fig. 44 illustrates one example of a modified shape of the optic element of Fig. 42, according to another embodiment of the invention;

Fig. 45 illustrates an example of non-uniform imperfections implemented with the optic element of Fig. 42, according to another embodiment of the invention;

Fig. 46 illustrates an exemplary housing and accessories for the lighting device of Fig. 42, according to another embodiment of the invention;

Fig. 47 illustrates one example of a reflector for the optic element of Fig. 42, according to another embodiment of the invention;

Fig. 48 illustrates one example of a shaped reflector according to another embodiment of the invention;

Fig. 49 illustrates a lighting device programming system and method according to one embodiment of the present invention;

Fig. 50 illustrates a lighting device with an optical element according to another embodiment of the invention;

Fig. 51 illustrates an example of a directional reflector as the optical element in the device of Fig. 50, according to one embodiment of the invention;

Fig. 52 illustrates a mechanical coupling of an optical element and an enclosure of the device of Fig. 50, according to one embodiment of the invention;

Fig. 53 illustrates a lighting device with an diffusing optical element according to another embodiment of the invention; and

Fig. 54 illustrates one example of the diffusing optical element of Fig. 53, according to one embodiment of the invention.

Detailed Description

Various exemplary implementations of light emitting diode (LED) based illumination products and methods are disclosed including, but not limited to, glow sticks, key chains, toys, balls, various game accessories, light bulbs, night lights, wall lights, wall switches, wall sockets, wall panels, modular lights, flexible lights, automotive lights, wearable accessories, light ropes, decorative lights such as icicles and

icicle strings, light tubes, insect control lights and methods, and illuminated air fresheners/scent dispensers. Any of the foregoing devices may be equipped with various types of user interfaces (both "local" and "remote") to control light generated from the device. Additionally, devices may be controlled via light control information or programs stored in device memory and/or transmitted or downloaded to the devices (e.g., devices may be controlled individually or collectively in groups via a network, glow sticks or other products may be downloaded with programming information that is stored in memory, etc.). Devices also may include sensors so that the generated light may change in response to various operating and/or environmental conditions or a user input. Various optical processing devices which may be used with any of the devices (e.g., reflectors, diffusers, etc.) also are disclosed.

To provide an overall understanding of the invention, certain illustrative embodiments will now be described, including various applications for programmable LED's. However, it will be understood by those of ordinary skill in the art that the methods and systems described herein may be suitably adapted to other environments where programmable lighting may be desired, and that some of the embodiments described herein may be suitable to non-LED based lighting.

As used herein, the term "LED" means any system that is capable of receiving an electrical signal and producing a color of light in response to the signal. Thus, the term "LED" should be understood to include light emitting diodes of all types, including white LEDs, infrared LEDs, ultraviolet LEDs, visible color LEDs, light emitting polymers, semiconductor dies that produce light in response to current, organic LEDs, electro-luminescent strips, silicon based structures that emit light, and other such systems. In an embodiment, an "LED" may refer to a single light emitting diode package having multiple semiconductor dies that are individually controlled. It should also be understood that the term "LED" does not restrict the package type of the LED. The term "LED" includes packaged LEDs, non-packaged LEDs, surface mount LEDs, chip on board LEDs and LEDs of all other configurations. The term "LED" also includes LEDs packaged or associated with phosphor wherein the phosphor may convert energy from the LED to a different wavelength.

An LED system is one type of illumination source. As used herein "illumination source" should be understood to include all illumination sources, including LED

systems, as well as incandescent sources, including filament lamps, pyro-luminescent sources, such as flames, candle-luminescent sources, such as gas mantles and carbon arch radiation sources, as well as photo-luminescent sources, including gaseous discharges, fluorescent sources, phosphorescence sources, lasers, electro-luminescent sources, such as electro-luminescent lamps, light emitting diodes, and cathode luminescent sources using electronic satiation, as well as miscellaneous luminescent sources including galvano-luminescent sources, crystallo-luminescent sources, kine-luminescent sources, thermo-luminescent sources, triboluminescent sources, sonoluminescent sources, and radioluminescent sources. Illumination sources may also include luminescent polymers capable of producing primary colors.

The term "illuminate" should be understood to refer to the production of a frequency of radiation by an illumination source with the intent to illuminate a space, environment, material, object, or other subject. The term "color" should be understood to refer to any frequency of radiation, or combination of different frequencies, within the visible light spectrum. The term "color," as used herein, should also be understood to encompass frequencies in the infrared and ultraviolet areas of the spectrum, and in other areas of the electromagnetic spectrum where illumination sources may generate radiation.

Figure 1 is a block diagram of a lighting system or device 500 according to the principles of the invention. The device may include a user interface 1, a processor 2, one or more controllers 3, one or more LEDs 4, and a memory 6. In general, the processor 2 may execute a program stored in the memory 6 to generate signals that control stimulation of the LEDs 4. The signals may be converted by the controllers 3 into a form suitable for driving the LEDs 4, which may include controlling the current, amplitude, duration, or waveform of the signals impressed on the LEDs 4.

As used herein, the term processor may refer to any system for processing electronic signals. A processor may include a microprocessor, microcontroller, programmable digital signal processor or other programmable device, along with external memory such as read-only memory, programmable read-only memory, electronically erasable programmable read-only memory, random access memory, dynamic random access memory, double data rate random access memory, Rambus direct random access memory, flash memory, or any other volatile or non-volatile

memory for storing program instructions, program data, and program output or other intermediate or final results. A processor may also, or instead, include an application specific integrated circuit, a programmable gate array programmable array logic, a programmable logic device, a digital signal processor, an analog-to-digital converter, a digital-to-analog converter, or any other device that may be configured to process electronic signals. In addition, a processor may include discrete circuitry such as passive or active analog components including resistors, capacitors, inductors, transistors, operational amplifiers, and so forth, as well as discrete digital components such as logic components, shift registers, latches, or any other separately packaged chip or other component for realizing a digital function. Any combination of the above circuits and components, whether packaged discretely, as a chip, as a chipset, or as a die, may be suitably adapted to use as a processor as described herein. Where a processor includes a programmable device such as the microprocessor or microcontroller mentioned above, the processor may further include computer executable code that controls operation of the programmable device.

The controller 3 may be a pulse width modulator, pulse amplitude modulator, pulse displacement modulator, resistor ladder, current source, voltage source, voltage ladder, switch, transistor, voltage controller, or other controller. The controller 3 generally regulates the current, voltage and/or power through the LED, in response to signals received from the processor 2. In an embodiment, several LEDs 4 with different spectral output may be used. Each of these colors may be driven through separate controllers 3. The processor 2 and controller 3 may be incorporated into one device, e.g., sharing a single semiconductor package. This device may drive several LEDs 4 in series where it has sufficient power output, or the device may drive single LEDs 4 with a corresponding number of outputs. By controlling the LEDs 4 independently, color mixing can be applied for the creation of lighting effects.

The memory 6 may store algorithms or control programs for controlling the LEDs 4. The memory 6 may also store look-up tables, calibration data, or other values associated with the control signals. The memory 6 may be a read-only memory, programmable memory, programmable read-only memory, electronically erasable programmable read-only memory, random access memory, dynamic random access memory, double data rate random access memory, Rambus direct random access

memory, flash memory, or any other volatile or non-volatile memory for storing program instructions, program data, address information, and program output or other intermediate or final results. A program, for example, may store control signals to operate several different colored LEDs 4.

A user interface 1 may also be associated with the processor 2. The user interface 1 may be used to select a program from the memory 6, modify a program from the memory 6, modify a program parameter from the memory 6, select an external signal for control of the LEDs 4, initiate a program, or provide other user interface solutions. Several methods of color mixing and pulse width modulation control are disclosed in U.S. Patent No. 6,016,038 "Multicolored LED Lighting Method and Apparatus". The processor 2 can also be addressable to receive programming signals addressed to it via a network connection (not shown in Fig. 1).

The '038 patent discloses LED control through a technique known as Pulse-Width Modulation (PWM). This technique can provide, through pulses of varying width, a way to control the intensity of the LED's as seen by the eye. Other techniques are also available for controlling the brightness of LED's and may be used with the invention. By mixing several hues of LED's, many colors can be produced that span a wide gamut of the visible spectrum. Additionally, by varying the relative intensity of LED's over time, a variety of color-changing and intensity-varying effects can be produced. Other techniques for controlling the intensity of one or more LEDs are known in the art, and may be usefully employed with the systems described herein. In an embodiment, the processor 2 is a Microchip PIC processor 12C672 that controls LEDs through PWM, and the LEDs 4 are red, green and blue.

Figures 2A-2B are a state diagram of operation of a device according to the principles of the invention. The terms 'mode' and 'state' are used in the following description interchangeably. When the device is powered on, it may enter a first mode 8, for example, under control of a program executing on the processor 2 of Fig. 1. The first mode 8 may provide a color wash, in which the LEDs cycle continuously through the full color spectrum, or through some portion of the color spectrum. In the first mode 8, a rate of the color wash may be determined by a parameter stored, for example, in the memory 6 shown in Fig. 1A. Through a user interface such as a button, dial, slider, or the like, a user may adjust the rate of the color wash. Within each mode, the parameter

may correspond to a different aspect of the lighting effect created by the mode, or each mode may access a different parameter so that persistence is maintained for a parameter during subsequent returns to that mode.

A second mode 9 may be accessed from the first mode 8. In the second mode 9, the device may randomly select a sequence of colors, and transition from one color to the next. The transitions may be faded to appear as continuous transitions, or they may be abrupt, changing in a single step from one random color to the next. The parameter may correspond to a rate at which these changes occur.

A third mode 10 may be accessed from the second mode 9. In the third mode, the device may provide a static, i.e., non-changing, color. The parameter may correspond to the frequency or spectral content of the color.

A fourth mode 11 may be accessed from the third mode 10. In the fourth mode 11, the device may strobe, that is, flash on and off. The parameter may correspond to the color of the strobe or the rate of the strobe. At a certain value, the parameter may correspond to other lighting effects, such as a strobe that alternates red, white, and blue, or a strobe that alternates green and red. Other modes, or parameters within a mode, may correspond to color changing effects coordinated with a specific time of the year or an event such as Valentine's Day, St. Patrick's Day, Easter, the Fourth of July, Halloween, Thanksgiving, Christmas, Hanukkah, New Years or any other time, event, brand, logo, or symbol.

A fifth mode 12 may be accessed from the fourth mode 11. The fifth mode 12 may correspond to a power-off state. In the fifth mode 12, no parameter may be provided. A next transition may be to the first mode 8, or to some other mode. It will be appreciated that other lighting effects are known, and may be realized as modes or states that may be used with a device according to the principles of the invention.

A number of user interfaces may be provided for use with the device. Where, for example, a two-button interface is provided, a first button may be used to transition from mode to mode, while a second button may be used to control selection of a parameter within a mode. In this configuration, the second button may be held in a closed position, with a parameter changing incrementally until the button is released. The second button may be held, and a time that the button is held (until released) may be captured by the device, with this time being used to change the parameter. Or the parameter may change

once each time that the second button is held and released. Some combination of these techniques may be used for different modes. For example, it will be appreciated that a mode having a large number of parameter values, such as a million or more different colors available through color changing LEDs, individually selecting each parameter value may be unduly cumbersome, and an approach permitting a user to quickly cycle through parameter values by holding the button may be preferred. By contrast, a mode with a small number of parameter values, such as five different strobe effects, may be readily controlled by stepping from parameter value to parameter value each time the second button is depressed.

A single button interface may instead be provided, where, for example, a transition between mode selections and parameter selections are signaled by holding the button depressed for a predetermined time, such as one or two seconds. That is, when the single button is depressed, the device may transition from one mode to another mode, with a parameter initialized at some predetermined value. If the button is held after it is depressed for the transition, the parameter value may increment (or decrement) so that the parameter may be selected within the mode. When the button is released, the parameter value may be maintained at its last value.

The interface may include a button and an adjustable input. The button may control transitions from mode to mode. The adjustable input may permit adjustment of a parameter value within the mode. The adjustable input may be, for example, a dial, a slider, a knob, or any other device whose physical position may be converted to a parameter value for use by the device. Optionally, the adjustable input may only respond to user input if the button is held after a transition between modes.

The interface may include two adjustable inputs. A first adjustable input may be used to select a mode, and a second adjustable input may be used to select a parameter within a mode. In another configuration, a single dial may be used to cycle through all modes and parameters in a continuous fashion. It will be appreciated that other controls are possible, including keypads, touch pads, sliders, switches, dials, linear switches, rotary switches, variable switches, thumb wheels, dual inline package switches, or other input devices suitable for human operation.

In one embodiment, a mode may have a plurality of associated parameters, each parameter having a parameter value. For example, in a color-changing strobe effect, a

first parameter may correspond to a strobe rate, and a second parameter may correspond to a rate of color change. A device having multiple parameters for one or more modes may have a number of corresponding controls in the user interface.

The user interface may include user input devices, such as the buttons and adjustable controls noted above, that produce a signal or voltage to be read by the processor. The voltage may be a digital signal corresponding to a high and a low digital state. If the voltage is in the form of an analog voltage, an analog to digital converter (A/D) may be used to convert the voltage into a processor-useable digital form. The output from the A/D would then supply the processor with a digital signal. This may be useful for supplying signals to the lighting device through sensors, transducers, networks or from other signal generators.

The device may track time on an hourly, daily, weekly, monthly, or annual basis. Using an internal clock for this purpose, lighting effects may be realized on a timely basis for various Holidays or other events. For example, on Halloween the light may display lighting themes and color shows including, for example, flickering or washing oranges. On the Fourth of July, a red, white, and blue display may be provided. On December 25, green and red lighting may be displayed. Other themes may be provided for New Years, Valentine's Day, birthdays, etc. As another example, the device may provide different lighting effects at different times of day, or for different days of the week.

Figure 3 shows a glow stick according to the principles of the invention. The glow stick 15 may include the components described above with reference to Fig. 1, and may operate according to the techniques described above with reference to Figs. 2A-2B. The glow stick 15 may be any small, cylindrical device that may hang from a lanyard, string, chain, bracelet, anklet, key chain, or necklace, for example, by a clip 20. The glow stick 15, as with many of the lighting devices described herein, may also be used as a handheld device. The glow stick 15 may operate from a battery 30 within the glow stick 10, such as an A, AA, AAA sized battery other battery. The battery 30 may be covered by a detachable portion 35 which hides the battery from view during normal use. An illumination lens 40 may encase a plurality of LEDs and diffuse color emanating therefrom. The lens 40 may be a light-transmissive material, such as transparent material, translucent material, semitransparent material, or other material suitable for this

application. In general, the light-transmissive material may be any material that receives light emitted from one or more LEDs and displays one or more colors that are a combination the spectra of the plurality of LEDs. A user interface 45 may be included for providing user input to control operation of the glow stick 15. In the embodiment depicted in Fig. 2, the user interface 45 is a single button, however it will be appreciated that any of the interfaces discussed above may suitably be adapted to the glow stick 15. The user interface 45 may be a switch, button or other device that generates a signal to a processor that controls operation of the glow stick 15.

Figure 4 shows a key chain according to the principles of the invention. The key chain 50 may include a light-transmissive material 51 enclosing one or more LEDs and a system such as the system of Fig. 1 (not shown), a one-button user interface 52, a clip 53 suitable for connecting to a chain 54, and one or more batteries 55. The key chain 50 may be similar to the glow stick 15 of Fig. 2, although it may be of smaller size. To accommodate the smaller size, more compact batteries 55 may be used. The key chain 50 may operate according to the techniques described above with reference to Figs. 2A-2B.

Figure 5 shows a spotlight according to the principles of the invention. The spotlight 60 may include a system such as that depicted in Fig. 1 for controlling a plurality of LEDs within the spotlight 60, and may operate according to the techniques described above with reference to Figs. 2A-2B. The spotlight 60 may include a housing 65 suitable for use with conventional lighting fixtures, such as those used with AC spotlights, and including a light-transmissive material on one end to permit LEDs to illuminate through the housing 65. The spotlight configurations may be provided to illuminate an object or for general illumination, for example, and the material may not be required. The mixing of the colors may take place in the projection of the beam, for example. The spotlight 60 may draw power for illumination from an external power source through a connection 70, such as an Edison mount fixture, plug, bi-pin base, screw base, base, Edison base, spade plug, and power outlet plug or any other adapter for adapting the spotlight 60 to external power. The connection 70 may include a converter to convert received power to power that is useful for the spotlight. For example, the converter may include an AC to DC converter to convert one-hundred twenty Volts at sixty Hertz into a direct current at a voltage of, for example, five Volts or twelve Volts.

The spotlight 60 may also be powered by one or more batteries 80, or a processor in the spotlight 60 may be powered by one or more batteries 80, with LEDs powered by electrical power received through the connection 70. A battery case 90 may be integrated into the spotlight 60 to contain the one or more batteries 80.

The connector 70 may include any one of a variety of adapters to adapt the spotlight 60 to a power source. The connector 70 may be adapted for, for example, a screw socket, socket, post socket, pin socket spade socket, wall socket, or other interface. This may be useful for connecting the lighting device to AC power or DC power in existing or new installations. For example, a user may want to deploy the spotlight 60 in an existing one-hundred and ten VAC socket. By incorporating an interface to this style of socket into the spotlight 60, the user can easily screw the new lighting device into the socket. U.S. Patent No. 6,292,901, entitled "Power/Data Protocol," describes techniques for transmitting data and power along the same lines and then extracting the data for use in a lighting device. The methods and systems disclosed therein could also be used to communicate information to the spotlight 60 of Fig. 5, through the connector 70.

Figure 6 shows a spotlight according to the principles of the invention. The spotlight 10 may be similar to the spotlight of Fig. 5. A remote user interface 102 may be provided, powered by one or more batteries 120 that are covered by a removable battery cover 125. The remote user interface 102 may include, for example, one or more buttons 130 and a dial 140 for selecting modes and parameters. The remote user interface 102 may be remote from the spotlight 100, and may transmit control information to the spotlight 100 using, for example, an infrared or radio frequency communication link, with corresponding transceivers in the spotlight 100 and the remote user interface 102. The information could be transmitted through infrared, RF, microwave, electromagnetic, or acoustic signals, or any other transmission medium. The transmission could also be carried, for its complete path or a portion thereof, through a wire, cable, fiber optic, network or other transmission medium.

Figure 7 shows an Edison mount light bulb according to the principles of the invention. The light bulb 150 may include a system such as that depicted in Fig. 1 for controlling a plurality of LEDs within the light bulb 150, and may operate according to the techniques described above with reference to Figs. 2A-2B. The light bulb 150 may include a housing 155 suitable for use with conventional lighting fixtures, such as those

used with AC light bulbs, and including a light-transmissive material on one end to permit LEDs to illuminate through the housing 155. In the embodiment of Fig. 7, the light bulb 150 includes a screw base 160, and a user interface 165 in the form of a dial integrated into the body of the light bulb 150. The dial may be rotated, as indicated by an arrow 170, to select modes and parameters for operation of the light bulb 150.

Figure 8 shows an Edison mount light bulb according to the principles of the invention. The light bulb 180 is similar to the light bulb 150 of Fig. 7, with a different user interface. The user interface of the light bulb 180 includes a thumbwheel 185 and a two-way switch 190. In this embodiment, the switch 190 may be used to move forward and backward through a sequence of available modes. For example, if the light bulb 180 has four modes numbered 1-4, by sliding the switch 190 to the left in Fig. 7, the mode may move up one mode, i.e., from mode 1 to mode 2. By sliding the switch 190 to the right in Fig. 7, the mode may move down one mode, i.e., from mode 2 to mode 1. The switch 190 may include one or more springs to return the switch 190 to a neutral position when force is not applied. The thumbwheel 185 may be constructed for endless rotation in a single direction, in which case a parameter controlled by the thumbwheel 185 may reset to a minimum value after reaching a maximum value (or vice versa). The thumbwheel may be constructed to have a predefined span, such as one and one-half rotations. In this latter case, one extreme of the span may represent a minimum parameter value and the other extreme of the span may represent a maximum parameter value. In an embodiment, the switch 190 may control a mode (left) and a parameter (right), and the thumbwheel 185 may control a brightness of the light bulb 180.

A light bulb such as the light bulb 180 of Fig. 8 may also be adapted for control through conventional lighting control systems. Many incandescent lighting systems have dimming control that is realized through changes to applied voltages, typically either through changes to applied voltages or chopping an AC waveform. A power converter can be used within the light bulb 180 to convert the received power, whether in a form of a variable amplitude AC signal or a chopped waveform, to the requisite power for the control circuitry and the LEDs, and where appropriate, to maintain a constant DC power supply for digital components. An analog-to-digital converter may be included to digitize the AC waveform and generate suitable control signals for the LEDs. The light bulb 180 may also detect and analyze a power supply signal and make suitable adjustments to

LED outputs. For example, a light bulb 180 may be programmed to provide consistent illumination whether connected to a one-hundred and ten VAC, 60 Hz power supply or a two-hundred and twenty VAC, 50 Hz power supply.

Control of the LEDs may be realized through a look-up table that correlates received AC signals to suitable LED outputs for example. The look-up table may contain full brightness control signals and these control signals may be communicated to the LEDs when a power dimmer is at 100%. A portion of the table may contain 80% brightness control signals and may be used when the input voltage to the lamp is reduced to 80% of the maximum value. The processor may continuously change a parameter with a program as the input voltage changes. The lighting instructions could be used to dim the illumination from the lighting system as well as to generate colors, patterns of light, illumination effects, or any other instructions for the LEDs. This technique could be used for intelligent dimming of the lighting device, creating color-changing effects using conventional power dimming controls and wiring as an interface, or to create other lighting effects. In an embodiment both color changes and dimming may occur simultaneously. This may be useful in simulating an incandescent dimming system where the color temperature of the incandescent light becomes warmer as the power is reduced.

Three-way light bulbs are also a common device for changing illumination levels. These systems use two contacts on the base of the light bulb and the light bulb is installed into a special electrical socket with two contacts. By turning a switch on the socket, either contact on the base may be connected with a voltage or both may be connected to the voltage. The lamp includes two filaments of different resistance to provide three levels of illumination. A light bulb such as the light bulb 180 of Fig. 8 may be adapted for use with a three-way light bulb socket. The light bulb 180 could have two contacts on the base and a look-up table, a program, or another system within the light bulb 180 could contain control signals that correlate to the socket setting. Again, this could be used for illumination control, color control or any other desired control for the LEDs.

This system could be used to create various lighting effects in areas where standard lighting devices where previously used. The user can replace existing incandescent light bulbs with an LED lighting device as described herein, and a dimmer

on a wall could be used to control color-changing effects within a room. Color changing effects may include dimming, any of the color-changing effects described above, or any other color-changing or static colored effects.

Figure 9 shows a light bulb according to the principles of the invention. As seen in Fig. 8, the light bulb 200 may operate from fixtures other than Edison mount fixtures, such as an MR-16, low voltage fixture 210 that may be used with direct current power systems.

Figure 10 shows a wall socket mounted light according to the principles of the invention. The light 210 may include a plug adapted to, for example, a one-hundred and ten volt alternating current outlet 220 constructing according to ANSI specifications. The light 210 may include a switch and thumbwheel as a user interface 230, and one or more spades 240 adapted for insertion into the outlet 220. The body of the light 210 may include a reflective surface for directing light onto a wall for color changing wall washing effects.

Figure 11 shows a night light according to the principles of the invention. The night light 242 may include a plug 230 adapted to, for example, a one-hundred and ten volt alternating current outlet 246. The night light 242 may include a system such as that depicted in Fig. 1 for controlling a plurality of LEDs within the night light 242, and may operate according to the techniques described above with reference to Figs. 2A-2B. The night light 242 may include a light-transmissive material 248 for directing light from the LEDs, e.g., in a downward direction. The night light 242 may also include a sensor 250 for detecting low ambient lighting, such that the night light 242 may be activated only when low lighting conditions exist. The sensor 250 may generate a signal to the processor to control activation and display type of the night light 242. The night light 242 may also include a clock/calendar, such that the seasonal lighting displays described above may be realized. The night light 242 may include a thumbwheel 260 and a switch 270, such as those described above, for selecting a mode and a parameter. As with several of the above embodiments, the night light 242 may include a converter that generates DC power suitable to the control circuitry of the night light 242.

Figure 12 shows a night light according to the principles of the invention. The night light 320 may include a plug 330 adapted to, for example, a one-hundred and ten volt alternating current outlet 340. The night light 320 may include a system such as that

depicted in Fig. 1 for controlling a plurality of LEDs within the night light 320, and may operate according to the techniques described above with reference to Figs. 2A-2B. The night light 320 may include a light-transmissive dome 345. The night light 320 may also include a sensor within the dome 345 for detecting low ambient lighting, such that the night light 320 may be automatically activated when low lighting conditions exist. The night light 320 may also include a clock/calendar, such that the seasonal lighting displays described above may be realized. In the embodiment of Fig. 12, the dome 345 of the night light 320 may also operate as a user interface. By depressing the dome 345 in the direction of a first arrow 350, a mode may be selected. By rotating the dome 345 in the direction of a second arrow 355, a parameter may be selected within the mode. As with several of the above embodiments, the night light 220 may include a converter that generates DC power suitable to the control circuitry of the night light 220.

As will be appreciated from the foregoing examples, an LED system such as that described in reference to Figs. 1 & 2A-2B may be adapted to a variety of lighting applications, either as a replacement for conventional light bulbs, including incandescent light bulbs, halogen light bulbs, tungsten light bulbs, fluorescent light bulbs, and so forth, or as an integrated lighting fixture such as a desk lamp, vase, night light, lantern, paper lantern, designer night light, strip light, cove light, MR light, wall light, screw based light, lava lamp, orb, desk lamp, decorative lamp, string light, or camp light. The system may have applications to architectural lighting, including kitchen lighting, bathroom lighting, bedroom lighting, entertainment center lighting, pool and spa lighting, outdoor walkway lighting, patio lighting, building lighting, façade lighting, fish tank lighting, or lighting in other areas where light may be employed for aesthetic effect. The system could be used outdoors in sprinklers, lawn markers, pool floats, stair markers, in-ground markers, or door bells, or more generally for general lighting, ornamental lighting, and accent lighting in indoor or outdoor venues. The systems may also be deployed where functional lighting is desired, as in brake lights, dashboard lights, or other automotive and vehicle applications.

Color-changing lighting effects may be coordinated among a plurality of the lighting devices described herein. Coordinated effects may be achieved through conventional lighting control mechanisms where, for example, each one of a plurality of lighting devices is programmed to respond differently, or with different start times, to a

power-on signal or dimmer control signal delivered through a conventional home or industrial lighting installation.

Each lighting device may instead be addressed individually through a wired or wireless network to control operation thereof. The LED lighting devices may have transceivers for communicating with a remote control device, or for communicating over a wired or wireless network.

It will be appreciated that a particular lighting application may entail a particular choice of LED. Pre-packaged LEDs generally come in a surface mount package or a T package. The surface mount LEDs have a very large beam angle, the angle at which the light intensity drops to 50% of the maximum light intensity, and T packages may be available in several beam angles. Narrow beam angles project further with relatively little color mixing between adjacent LEDs. This aspect of certain LEDs may be employed for projecting different colors simultaneously, or for producing other effects. Wider angles can be achieved in many ways such as, but not limited to, using wide beam angle T packages, using surface mount LEDs, using un-packaged LEDs, using chip on board technology, or mounting the die directly on a substrate as described in U.S. Prov. Patent App. No. 60/235,966, entitled "Optical Systems for Light Emitting Semiconductors." A reflector may also be associated with one or more LEDs to project illumination in a predetermined pattern. One advantage of using the wide-beam-angle light source is that the light can be gathered and projected onto a wall while allowing the beam to spread along the wall. This accomplishes the desired effect of concentrating illumination on the wall while colors projected from separate LEDs mix to provide a uniform color.

Figure 13 illustrates a lighting device 1200 with at least one LED 1202. There may be a plurality of LEDs 1202 of different colors, or a plurality of LEDs 1202 of a single color, such as to increase intensity or beam width of illumination for that color, or a combination of both. A reflector including a front section 1208 and a rear section 1210 may also be included in the device 1200 to project light from the LED. This reflector can be formed as several pieces or one piece of reflective material. The reflector may direct illumination from the at least one LED 1202 in a predetermined direction, or through a predetermined beam angle. The reflector may also gather and project illumination scattered by the at least one LED 1202. As with other examples, the

lighting device 1200 may include a light-transmissive material 1212, a user interface 1214, and a plug 1216.

As shown in Figure 13, the user interface 1214 may be in the form of a simple thumbscrew or set-screw which a user may rotate (e.g., using their fingers or a small calibration screwdriver or similar instrument) to change one or more parameters of the generated light (e.g., color, intensity, dynamic effect, etc.). Of course, the user interface 1214 may be implemented in various other ways as discussed herein. Furthermore, it should be appreciated that a simple thumbscrew or set-screw implementation for a user interface may be used in connection with any other of the lighting devices disclosed herein (e.g., various spotlights or bulbs, night lights, other wall lights or panel devices, toys, etc.).

Figure 14 shows another embodiment of a wall washing light according to the principles of the invention. The night light 1300 may include an optic 1302 formed from a light-transmissive material and a detachable optic 1304. The detachable optic 1304 may fit over the optic 1302 in a removable and replaceable fashion, as indicated by an arrow 1306, to provide a lighting effect, which may include filtering, diffusing, focusing, and so forth. The detachable optic 1304 may direct illumination from the night light 1300 into a predetermined shape or image, or spread the spectrum of the illumination in a prismatic fashion. The detachable optic 1304 may, for example, have a pattern etched into including, for example, a saw tooth, slit, prism, grating, squares, triangles, half-tone screens, circles, semi-circles, stars or any other geometric pattern. The pattern can also be in the form of object patterns such as, but not limited to, trees, stars, moons, sun, clovers or any other object pattern. The detachable optic 1304 may also be a holographic lens. The detachable optic 1304 may also be an anamorphic lens configured to distort or reform an image. These patterns can also be formed such that the projected light forms a non-distorted pattern on a wall, provided the geometric relationship between the wall and the optic is known in advance. The pattern could be designed to compensate for the wall projection. Techniques for applying anamorphic lenses are described, for example, in "Anamorphic Art and Photography - Deliberate Distortions That Can Be Easily Undone," *Optics and Photonics News*, November 1992. The detachable optic 1304 may include a multi-layered lens. At least one of the lenses in a multi-layered lens could also be adjustable to provide the user with adjustable illumination patterns.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 964

Figure 15 shows a lighting device according to the principles of the invention. The lighting device 1500 may be any of the lighting devices described above. The lighting device may include a display screen 1502. The display screen 1502 can be any type of display screen such as, but not limited to, an LCD, plasma screen, backlit display, edgelit display, monochrome screen, color screen, screen, or any other type of display. The display screen 1502 could display information for the user such as the time of day, a mode or parameter value for the lighting device 1500, a name of a mode, a battery charge indication, or any other information useful to a user of the lighting device 1500. A name of a mode may be a generic name, such as 'strobe', 'static', and so forth, or a fanciful name, such as 'Harvard' for a crimson illumination or 'Michigan' for a blue-yellow fade or wash. Other names may be given to, and displayed for, modes relating to a time of the year, holidays, or a particular celebration. Other information may be displayed, including a time of the day, days left in the year, or any other information. The display information is not limited to characters; the display screen 1502 could show pictures or any other information. The display screen 1502 may operate under control of the processor 2 of Fig. 1. The lighting device 1500 may include a user interface 1504 to control, for example, the display screen 1502, or to set a tine or other information displayed by the display screen 1502, or to select a mode or parameter value.

The lighting device 1500 may also be associated with a network, and receive network signals. The network signals could direct the lighting device to project various colors as well as depict information on the display screen 1502. For example, the device could receive signals from the World Wide Web and change the color or projection patterns based on the information received. The device may receive outside temperature data from the Web or other device and project a color based on the temperature. The colder the temperature the more saturated blue the illumination might become, and as the temperature rises the lighting device 1500 might project red illumination. The information is not limited to temperature information. The information could be any information that can be transmitted and received. Another example is financial information such as a stock price. When the stock price rises the projected illumination may turn green, and when the price drops the projected illumination may turn red. If the stock prices fall below a predetermined value, the lighting device 1500 may strobe red light or make other indicative effects.

It will be appreciated that systems such as those described above, which receive and interpret data, and generate responsive color-changing illumination effects, may have broad application in areas such as consumer electronics. For example, information may be obtained, interpreted, and converted to informative lighting effects in devices such as a clock radio, a telephone, a cordless telephone, a facsimile machine, a boom box, a music box, a stereo, a compact disk player, a digital versatile disk player, an MP3 player, a cassette player, a digital tape player, a car stereo, a television, a home audio system, a home theater system, a surround sound system, a speaker, a camera, a digital camera, a video recorder, a digital video recorder, a computer, a personal digital assistant, a pager, a cellular phone, a computer mouse, a computer peripheral, or an overhead projector.

Figure 16 depicts a modular unit. A lighting device 1600 may contain one or more LEDs and a decorative portion of a lighting fixture. An interface box 1616 could contain a processor, memory, control circuitry, and a power supply to convert the AC to DC to operate the lighting device 1600. The interface box 1616 may have standard power wiring 1610 to be connected to a power connection 1608. The interface box 1616 can be designed to fit directly into a standard junction box 1602. The interface box 1616 could have physical connection devices 1612 to match connections on a backside 1604 of the lighting device 1600. The physical connection devices 1612 could be used to physically mount the lighting device 1600 onto the wall. The interface box 1616 could also include one or more electrical connections 1614 to bring power to the lighting device 1600. The electrical connections 1614 may include connections for carrying data to the interface box 1616, or otherwise communicating with the interface box 1616 or the lighting device 1600. The connections 1614 and 1612 could match connections on the backside 1604 of the lighting device 1600. This would make the assembly and changing of lighting devices 1600 easy. These systems could have the connectors 1612 and 1614 arranged in a standard format to allow for easy changing of lighting devices 1600. It will be obvious to one with ordinary skill in the art that the lighting fixture 1600 could also contain some or all of the circuitry.

The lighting devices 1600 could also contain transmitters and receivers for transmitting and receiving information. This could be used to coordinate or synchronize several lighting devices 1600. A control unit 1618 with a display screen 1620 and interface 1622 could also be provided to set the modes of, and the coordination between,

several lighting devices 1600. This control unit 1618 could control the lighting device 1600 remotely. The control unit 1618 could be placed in a remote area of the room and communicate with one or more lighting devices 1600. The communication could be accomplished using any communication method such as, but not limited to, RF, IR, microwave, acoustic, electromagnetic, cable, wire, network or other communication method. Each lighting device 1600 could also have an addressable controller, so that each one of a plurality of lighting devices 1600 may be individually accessed by the control unit 1618, through any suitable wired or wireless network.

Figure 17 shows a modular topology for a lighting device. In this modular configuration, a light engine 1700 may include a plurality of power connectors 1704 such as wires, a plurality of data connectors 1706, such as wires, and a plurality of LEDs 1708, as well as the other components described in reference to Figs. 1 and 2A-2B, enclosed in a housing 1710. The light engine 1700 may be used in lighting fixtures or as a stand-alone device. The modular configuration may be amenable to use by lighting designers, architects, contractors, technicians, users or other people designing or installing lighting, who may provide predetermined data and power wiring throughout an installation, and locate a light engine 1700 at any convenient location therein.

Optics may be used to alter or enhance the performance of illumination devices. For example, reflectors may be used to redirect LED radiation, as described in US Patent Application No. 60/235,966 "Optical Systems for Light Emitting Semiconductors."

Figure 18 shows a reflector that may be used with the systems described herein. As shown in Fig. 18, a contoured reflective surface 1802 may be placed apart from a plurality of LEDs 1804, such that radiation from the LEDs 1804 is directed toward the reflective surface 1802, as indicated by arrows 1806. In this configuration, radiation from the LEDs 1804 is redirected out in a circle about the reflective surface 1802. The reflective surface 1802 may have areas of imperfections or designs to create projection effects. The LEDs 1804 can be arranged to uniformly project the light onto the reflector or they can be arranged with a bias to increase the illumination on certain sections of the reflector. The individual LEDs 1804 of the plurality of LEDs 1804 can also be independently controlled. This technique can be used to create light patterns or color effects.

Figure 19 illustrates a reflector design where an LED 1900 is directed toward a general parabolic reflector 1902, as indicated by an arrow 1903. The generally parabolic reflector 1902 may include a raised center portion 1904 to further focus or redirect radiation from the LED 1900. As shown by a second LED 1906, a second generally parabolic reflector 1908, and a second arrow 1910, the raised center portion 1904 may be omitted in some configurations. It will be appreciated that the LED 1900 in this configuration, or in the other configurations described herein using reflective surfaces, may be in any package or without a package. Where no package is provided, the LED may be electrically connected on an n-side and a p-side to provide the power for operation. As shown in Fig. 20, a line of LEDs 2000 may be directed toward a planar reflective surface 2002 that directs the line of LEDs 2000 in two opposite planar directions. As shown in Fig. 21, a line of LEDs 2100 may be directed toward a planar surface 2102 that directs the line of LEDs 2100 in one planar direction.

A system such as that described in reference to Fig. 1 may be incorporated into a toy, such as a ball. Control circuitry, a power supply, and LEDs may be suspended or mounted inside the ball, with all or some of the ball exterior formed of a light-transmissive material that allows LED color-changing effects to be viewed. Separate portions of the exterior may be formed from different types of light-transmissive material, or may be illuminated by different groups of LEDs to provide the exterior of the ball to be illuminated in different manners over different regions of its exterior.

The ball may operate autonomously to generate color-changing effects, or may respond to signals from an activation switch that is associated with a control circuit. The activation switch may respond to force, acceleration, temperature, motion, capacitance, proximity, Hall effect or any other stimulus or environmental condition or variable. The ball could include one or more activation switches and the control unit can be pre-programmed to respond to the different switches with different color-changing effects. The ball may respond to an input with a randomly selected color-changing effect, or with one of a predetermined sequence of color-changing effects. If two or more switches are incorporated into the ball, the LEDs may be activated according to individual or combined switch signals. This could be used, for example, to create a ball that has subtle effects when a single switch is activated, and dramatic effects when a plurality of switches are activated.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 968

The ball may respond to transducer signals. For example, one or more velocity or acceleration transducers could detect motion in the ball. Using these transducers, the ball may be programmed to change lighting effects as it spins faster or slower. The ball could also be programmed to produce different lighting effects in response to a varying amount of applied force. There are many other useful transducers, and methods of employing them in a color-changing ball.

The ball may include a transceiver. The ball may generate color-changing effects in response to data received through the transceiver, or may provide control or status information to a network or other devices using the transceiver. Using the transceiver, the ball may be used in a game where several balls communicate with each other, where the ball communicates with other devices, or communicates with a network. The ball could then initiate these other devices or network signals for further control.

A method of playing a game could be defined where the play does not begin until the ball is lighted or lighted to a particular color. The lighting signal could be produced from outside of the playing area by communicating through the transceiver, and play could stop when the ball changes colors or is turned off through similar signals. When the ball passes through a goal the ball could change colors or flash or make other lighting effects. Many other games or effects during a game may be generated where the ball changes color when it moves too fast or it stops. Color-changing effects for play may respond to signals received by the transceiver, respond to switches and/or transducers in the ball, or some combination of these. The game hot potato could be played where the ball continually changes colors, uninterrupted or interrupted by external signals, and when it suddenly or gradually changes to red or some other predefined color you have to throw the ball to another person. The ball could have a detection device such that if the ball is not thrown within the predetermined period it initiates a lighting effect such as a strobe. A ball of the present invention may have various shapes, such as spherical, football-shaped, or shaped like any other game or toy ball.

As will be appreciated from the foregoing examples, an LED system such as that described in reference to Figs. 1 & 2A-2B may be adapted to a variety of color-changing toys and games. For example, color-changing effects may be usefully incorporated into many games and toys, including a toy gun, a water gun, a toy car, a top, a gyroscope, a dart board, a bicycle, a bicycle wheel, a skateboard, a train set, an electric racing car

track, a pool table, a board game, a hot potato game, a shooting light game, a wand, a toy sword, an action figure, a toy truck, a toy boat, sports apparel and equipment, a glow stick, a kaleidoscope, or magnets. Color-changing effects may also be usefully incorporated into branded toys such as a View Master, a Super Ball, a Lite Brite, a Harry Potter wand, or a Tinkerbell wand.

Figure 22 is a block diagram of an embodiment of a device according to the principles of the invention having internal illumination circuitry. The device 2200 is a wearable accessory that may include a system such as that described with reference to Figs. 1 and 2A-2B. The device may have a body 2201 that includes a processor 2202, driving circuitry 2204, one or more LED's 2206, and a power source 2208. The device 2200 may optionally include input/output 2210 that serves as an interface by which programming may be received to control operation of the device 2200. The body 2201 may include a light-transmissive portion that is transparent, translucent, or translucent-diffusing for permitting light from the LEDs 2206 to escape from the body 2200. The LEDs 2206 may be mounted, for example, along an external surface of a suitable diffusing material. The LEDs 2206 may be placed inconspicuously along the edges or back of the diffusing material. Surface mount LED's may be secured directly to the body 2200 on an interior surface of a diffusing material.

The input/output 2210 may include an input device such as a button, dial, slider, switch or any other device described above for providing input signals to the device 2200, or the input/output 2210 may include an interface to a wired connection such as a Universal Serial Bus connection, serial connection, or any other wired connection, or the input/output 2210 may include a transceiver for wireless connections such as infrared or radio frequency transceivers. In an embodiment, the wearable accessory may be configured to communicate with other wearable accessories through the input/output 2210 to produce synchronized lighting effects among a number of accessories. For wireless transmission, the input/output 2210 may communicate with a base transmitter using, for example, infrared or microwave signals to transmit a DMX or similar communication signal. The autonomous accessory would then receive this signal and apply the information in the signal to alter the lighting effect so that the lighting effect could be controlled from the base transmitter location. Using this technique, several accessories may be synchronized from the base transmitter. Information could also then

be conveyed between accessories relating to changes of lighting effects. In one instantiation, the input/output 2210 may include a transmitter such as an Abacom TXM series device, which is small and low power and uses the 400Mhz spectrum. Using such a network, multiple accessories on different people can be synchronized to provide interesting effects including colors bouncing from person to person or simultaneous and synchronized effects across several people. A number of accessories on the same person may also be synchronized to provide coordinated color-changing effects. A system according to the principle of the invention may be controlled though a network as described herein. The network may be a personal, local, wide area or other network. The Blue Tooth standard may be an appropriate protocol to use when communicating to such systems although any protocol could be used.

The input/output 2210 may include sensors for environmental measurements (temperature, ambient sound or light), physiological data (heart rate, body temperature), or other measurable quantities, and these sensor signals may be used to produce color-changing effects that are functions of these measurements.

A variety of decorative devices can be used to give form to the color and light, including jewelry and clothing. For example, these could take the form of necklaces, tiaras, ties, hats, brooches, belt-buckles, cuff links, buttons, pins, rings, or bracelets, anklets etc. Some examples of shapes for the body 2201, or the light-transmissive portion of the body, may include icons, logos, branded images, characters, and symbols (such as ampersands, dollar signs, and musical notes). As noted elsewhere, the system may also be adapted to other applications such as lighted plaques or tombstone signs that may or may not be wearable.

Figure 23 is a schematic diagram of an embodiment of a device according to the principles of the invention having external illumination circuitry. As shown in Fig. 23, a wearable accessory 2300 may include a first housing 2302 such as a wearable accessory that includes one or more LED's 2304. Illumination circuitry including a processor 2306, controllers 2308, a power source 2310, and an input/output 2312 are external to the first housing 2302 and may be included in a second housing 2314. A link 2316 is provided so that the illumination circuitry may communicate drive signals to the LEDs 2304 within the first housing 2301. This configuration may be convenient for applications where the first housing 2302 is a small accessory or other wearable

PGR2023-00016 - Home Depot
Ex. 1003 - Page 971

accessory that may be connected to remote circuitry, as in, for example, the buttons of a shirt. It will be appreciated that while all of the illumination circuitry except for the LEDs 2304 are shown as external to the first housing 2302, one or more of the components may be included within the first housing 2302.

Figure 24 depicts an autonomous color-changing shoe according to the principles of the invention. A shoe 2400 includes a main portion 2402, a heel 2404, a toe 2406, and a sole 2408. The main portion 2402 is adapted to receive a human foot, and may be fashioned of any material suitable for use in a shoe. The heel 2402 may be formed of a translucent, diffusing material, and may have embedded therein a system such as that described with reference to Figs. 1 and 2A-2B. In addition to, or instead of a heel 2402 with autonomous color changing ability, another portion of the shoe 2400 may include an autonomous color changing system, such as the toe 2406, the sole 2408, or any other portion. A pair of shoes may be provided, each including an input/output system so that the two shoes may communicate with one another to achieve synchronized color changing effects. In an embodiment of the shoe 2400, circuitry may be placed within a sole 2408 of the shoe, with wires for driving LED's that are located within the heel 2404 or the toe 2406, or both.

As will be appreciated from the foregoing example, the systems disclosed herein may have wide application to a variety of wearable and ornamental objects. Apparel employing the systems may include coats, shirts, pants, clothing, shoes, footwear, athletic wear, accessories, jewelry, backpacks, dresses, hats, bracelets, umbrellas, pet collars, luggage, and luggage tags. Ornamental objects employing the systems disclosed herein may include picture frames, paper weights, gift cards, bows, and gift packages.

Color-changing badges and other apparel may have particular effect in certain environments. The badge, for example, can be provided with a translucent, semi-translucent or other material and one or more LEDs can be arranged to provide illumination of the material. In a one embodiment, the badge would contain at least one red, one blue and one green LED and the LEDs would be arranged to edge light the material. The material may have a pattern such that the pattern reflects the light. The pattern may be etched into the material such that the pattern reflects the light traveling through the material and the pattern appears to glow. When the three colors of LEDs are provided, many color changing effects can be created. This may create an eye-catching

effect and can bring attention to a person wearing the badge; a useful attention-getter in a retail environment, at a trade show, when selling goods or services, or in any other situation where drawing attention to one's self may be useful.

The principle of edge lighting a badge to illuminate etched patterns can be applied to other devices as well, such as an edge lit sign. A row of LEDs may be aligned to edge light a material and the material may have a pattern. The material may be lit on one or more sides and reflective material may be used on the opposing edges to prevent the light from escaping at the edges. The reflective material also tends to even the surface illumination. These devices can also be backlit or lit through the material in lieu of, or in addition to, edge lighting.

Figure 25 depicts an LED device according to the invention. The device 2500 may include a processor 2502 and one or more LEDs 2504 in a configuration such as that described with reference to Figs. 1 and 2A-2B. The device 2500 may be adapted for use with icicles formed from light-transmissive material. The icicles may be mock icicles formed from plastic, glass, or some other material, and may be rendered in a highly realistic, detailed fashion, or in a highly stylized, abstract fashion. A number of color-changing icicles are described below.

Figure 26 illustrates a lighted icicle 2600, where an LED lighting device 2602 such as that described in Figs. 1, 2A-2B, and 25 is used to provide the illumination for an icicle 2604. The icicle 2604 could be formed from a material such as a semi-transparent material, a semi-translucent material, a transparent material, plastic, paper, glass, ice, a frozen liquid or any other material suitable for forming into an icicle and propagating LED radiation. The icicle 2604 may be hollow, or may be a solid formed from light-transmissive material. The illumination from the lighting device 2602 is directed at the icicle 2604 and couples with the icicle 2604. The icicle material may have imperfections to provide various lighting effects. One such effect is created when a primarily transparent material contains a pattern of defects. The defects may redirect the light passing through or along the material, causing bright spots or areas to appear in the illuminated material. If these imperfections are set in a pattern, the pattern will appear bright while the other areas will not appear lighted. The imperfections can also substantially cover the surface of the icicle 2604 to produce a frosted appearance.

Imperfections that substantially uniformly cover the surface of the icicle 2604 may create an effect of a uniformly illuminated icicle.

The icicle 2604 can be lit with one or more LEDs to provide illumination. Where one LED is used, the icicle 2604 may be lit with a single color with varying intensity or the intensity may be fixed. In one embodiment, the lighted icicle 2600 includes more than one LED and in another embodiment the LEDs are different colors. By providing a lighted icicle 2600 with different colored LEDs, the hue, saturation and brightness of the lighted icicle 2600 can be changed. The two or more LEDs can be used to provide additive color. If two LEDs were used in the lighted icicle 2600 with circuitry to turn each color on or off, four colors could be produced including black when neither LED is energized. Where three LEDs are used in the lighted icicle 2600 and each LED has three intensity settings, 3^3 or 27 color selections are available. In one embodiment, the LED control signals would be PWM signals with eight bits (=128 combinations) of resolution. Using three different colored LEDs, this provides 128^3 or 16.7 million available colors.

Figure 27 illustrates a plurality of icicles sharing a network. A plurality of lighted icicles 2700 each includes a network interface to communicate over a network 2704, such as any of the networks mentioned above. The network 2704 may provide lighting control signals to each of the plurality of lighted icicles 2700, each of which may be uniquely addressable. Where the lighted icicles 2700 are not uniquely addressable, control information may be broadcast to all of the lighted icicles 2700. A control data source 2706, such as a computer or any of the other controls mentioned above, may provide control information to the lighted icicles 2700 through a network transceiver 2708 and the network 2704. One of the lighted icicles 2700 could also operate as a master icicle, providing control information to the other lighted icicles 2700, which would be slave icicles. The network 2704 may be used generally to generate coordinated or uncoordinated color-changing lighting effects from the plurality of lighted icicles.

One or more of the plurality of lighted icicles 2700 may also operate in a stand-alone mode, and generate color-changing effects separate from the other lighted icicles 2700. The lighted icicles 2700 could be programmed, over the network 2704, for example, with a plurality of lighting control routines to be selected by the user such as different solid colors, slowly changing colors, fast changing colors, stobing light, or any other lighting routines. The selector switch could be used to select the program. Another

PGR2023-00016 - Home Depot
Ex. 1003 - Page 974

method of selecting a program would be to turn the power to the icicle off and then back on within a predetermined period of time. For example, non-volatile memory could be used to provide an icicle that remembers the last program it was running prior to the power being shut off. A capacitor could be used to keep a signal line high for 10 seconds and if the power is cycled within this period, the system could be programmed to skip to the next program. If the power cycle takes more then 10 seconds, the capacitor discharges below the high signal level and the previous program is recalled upon re-energizing the system. Other methods of cycling through programs or modes of operation are known, and may be suitably adapted to the systems described herein.

Figure 28 depicts an icicle 2800 having a flange 2802. The flange 2802 may allow easy mounting of the icicle 2800. In one embodiment, the flange 2802 is used such that the flange couples with a ledge 2808 while the remaining portion of the icicle 2800 hangs through a hole formed by the ledge 2808. This method of attachment is useful where the icicles can hang through existing holes or holes can be made in the area where the icicles 2800 are to be displayed. Other attachment methods are known, and may be adapted to use with the invention.

Figure 29 shows an icicle according to the principles of the invention. A plurality of LEDs 2900 may be disposed in a ring 2902. The ring 2902 may be engaged to a flange 2904 of an icicle 2906. Arranged in this manner, the LEDs 2900 may radiate illumination that is transmitted through icicle 2906. If the ring 2902 is shaped and sized so that the LEDs 2900 directly couple to the flange 2904, then the icicle 2906 will be edge-lit. The ring 2902 may instead be smaller in diameter than the flange 2904, so that the LEDs 2900 radiate into a hollow cavity 2908 in the icicle 2906, or onto a top surface of the icicle 2906 if the icicle 2906 is formed of a solid material.

Figure 30 depicts a solid icicle 3000 which may be in the form or a rod or any other suitable form, with one or more LEDs 3002 positioned to project light into the solid icicle 3000.

Figure 31 depicts a rope light according to the principles of the invention. The rope light 3100 may include a plurality of LEDs or LED subsystems 3102 according to the description provided in reference to Figs. 1 and 2A-2B. In one embodiment, three LED dies of different colors may be packaged together in each LED subsystem 3102, with each die individually controllable. A plurality of these LED subsystems 3102 may

PGR2023-00016 - Home Depot
Ex. 1003 - Page 975

be disposed inside of a tube 3102 that is flexible and semi-transparent. The LED subsystems 3102 may be spaced along the tube 3104, for example, at even intervals of every six inches, and directed along an axis 3106 of the tube 3104. The LED subsystems 3102 may be controlled through any of the systems and methods described above. In one embodiment, a number of LED subsystems 3102 may be controlled by a common signal, so that a length of tube 3104 of several feet or more may appear to change color at once. The tube 3104 may be fashioned to resemble a rope, or other cylindrical material or object. The LED subsystems 3102 may be disposed within the tube 3104 in rings or other geometric or asymmetric patterns. The LED subsystems 3102 could also be aligned to edge light the tube 3104, as described above. A filter or film may be provided on an exterior surface or an interior surface of the tube 3104 to create pleasing visual effects.

Other consumer products may be realized using the systems and methods described herein. A hammer may generate color-changing effects in response to striking a nail; a kitchen timer may generate color-changing effects in response to a time countdown, a pen may generate color-changing effects in response to the act of writing therewith, or an electric can opener may generate color-changing effects when activated.

Another embodiment of the invention is directed to various implementations of illuminated wall panel apparatus. Generally, such apparatus include an essentially planar member that serves as either a portion of a wall itself, or that is adapted to be essentially flush-mounted on a wall. For example, in one aspect, the essentially planar member may be in the form of a common wallplate used for electrical switches and sockets. The apparatus also includes an LED-based light source adapted to be positioned with respect to the essentially planar member so as to be behind the essentially planar member when the essentially planar member is mounted on a wall. In one aspect, the LED-based light source is configured to generate light that is perceived by an observer while viewing the essentially planar member.

In particular, in various aspects of this embodiment, the apparatus may be implemented as a multicolored wall switch, plate, socket, data port, or the like, wherein the color of the system is generated by a multicolored LED-based light source, as described herein in various other embodiments. As discussed herein, the LED lighting system of this embodiment may be associated with interface devices such as a user interface, network interface, sensor, transducer or other signal generator to control the

PGR2023-00016 - Home Depot
Ex. 1003 - Page 976

color of the system. In another aspect, the lighting system may include more than one color of LEDs such that modulating the output of one or more of the LEDs can change the color of the device.

Figures 32A and 32B illustrate a lighting device 3200 according to the principles of the present invention. The lighting device 3200 may include a lighting system 500 as shown in Fig. 1, for example. LED(s) 3204 may be arranged to project light from a base member 3205. A faceplate 3206 may be provided in the device to cover the direct view of the LED(s) while allowing the projection of the light from the LED(s). Figure 32B illustrates the front view of the lighting device 3200 while Figure 32A illustrates the rear view of the lighting device 3200.

The lighting device 3200 may include a power adapter 3208. In an embodiment, the power adapter 3208 is an outlet plug designed to be attached to a standard power outlet. In an embodiment, there may be two or more power adapters 3208. The lighting device may also include a fastener 3202 to secure the attachment of the lighting device. In an embodiment, the fastener may be a screw that is designed to fasten the lighting device 3200 to a power outlet to prevent the device from being removed. This may be useful in situations where the lighting device is available to children and the children are attracted to the device to prevent them from removing the device.

In an embodiment, the lighting device 3200 may be provided with LEDs and a circuit or processor to produce a constant unchangeable light. In another embodiment, the lighting system 3200 may be arranged to provide color-changing effects. As with other embodiments described herein, the lighting device 3200 may be provided with a user interface, network or data port connections, sensors or other systems to control the light generated by the lighting device 3200.

Figure 33 illustrates another embodiment of the lighting device 3200 according to the principles of the present invention. In this embodiment, the faceplate 3206 may be shaped and or the LED(s) 3204 may be directed such that at least a portion of the light from the LED(s) is reflected off of the faceplate. By reflecting the light off of the surface, increased color mixing may be achieved as well as smoother effects may be generated. In an embodiment, the faceplate may be made of material that allows for partial transmission of the light to allow for certain lighting effects to be generated. In an embodiment, the faceplate may include a rough surface to increase the reflection

distribution of the light. In another embodiment, the faceplate surface may be smooth. In an embodiment, the edges of the faceplate 3206 may include a pattern to change the projected lighting effects. In an embodiment, the pattern may include projections from the faceplate such that the projections interfere with the light and cause a light pattern.

Figure 34 illustrates another lighting device 3400 according to the principles of the present invention. In an embodiment, the lighting device 3400 may include a lighting system 500 as shown in Fig. 1. The system may be designed to produce a single color light or it may be designed to generate color-changing effects or other lighting effects. The LEDs 3404 may be mounted on a base member 3405 and the base member 3405 may be arranged in an optic 3402. The optic 3402 may be transparent, translucent, semi-transparent or other material deigned to transmit a portion of the light emitted from the LEDs 3404. In an embodiment, several colors of LEDs may be used (e.g. red, green, blue, white) along with a processor that independently controls the LEDs such that mixtures of colors may be produced.

In an embodiment, the lighting device 3400 may be arranged to be mounted in or on a junction box or designed to replace a junction box. A power adapter 3408 may be provided with the lighting device 3400 such that it can be electrically connected with external power. In an embodiment, the power adapter 3408 may be a set of wires intended to be connected to power in a wall.

In an embodiment the optic 3402 may be transparent such that the light projected from the LEDs is directed out of the optic. This may be useful in providing a lighting device that will project light onto a wall for example. The sides of the optic 3402 may be etched or otherwise rough such that the sides appear to glow as a result of internally reflected light. The front of the optic may likewise be rough to provide a glowing panel. In an embodiment, the optic 3402 may be hollow or solid.

Figure 35 illustrates another lighting device 3500 according to the principles of the present invention. The lighting device in the illustrated embodiment may include LEDs 3504, 3506, and 3510 and/or a lighting system 500 as shown in Fig. 1. The LED illumination may be projected into a fiber, several fibers, a fiber bundle or other fiber arrangement 3502. The emitting sections of the fiber arrangement 3502 may be arranged to project light into, through, or from a faceplate 3508. The fiber may be arranged to emit light from the end of the fiber or the fiber may be side-emitting fiber.

Figure 36 illustrates another embodiment of a lighting device 3600 of the invention, including a wall switch 3602 with a wall cover plate 3604. One or more lighting systems 500 as shown for example in Fig. 1 may be included in the device 3600 to provide illumination to the switch 3602 and/or wall plate 3604. Figure 37 illustrates a similar device 3700 including an illuminated electrical socket 3708.

In Figures 36 and 37, the lighting system 500 may be arranged to illuminate the material of the switch, plate, socket, etc. from behind or through the edge of the material, for example. The material or portion thereof may be transparent, translucent, semi-transparent, semi-translucent or another material that will allow a portion of the light to be transmitted and or reflected. In an embodiment, the material may be etched or have other imperfections on the surface or in the bulk of the material to mix and or redirect the light. The imperfections may be provided to generate a uniform lighting effect on or in the material. For example, the surface of the material may be sand blasted and a lighting system 500 may be arranged to light the material. The light may then enter the material and scatter in many directions causing the material to be evenly illuminated. In an embodiment, imperfections may be introduced in a pattern such that the pattern appears to glow. For example, the material may include a pattern of imperfections wherein the area surrounding the pattern is opaque, transparent, or different than the patterned area. When the material is lit, the pattern will appear to glow.

In an embodiment, a lighting system 500 used in the devices 3600 or 3700, or a portion of the lighting system 500, may be located in a junction box and arranged to project light onto the wall plate 3604, switch 3602, socket 3708, or other section of the devices 3600 or 3700. In an embodiment, the lighting system 500, or portion thereof may be located in the switch 3602 itself, or other material to light the material.

Figure 38 illustrates another lighting device 3800 according to the principles of the present invention. In the illustrated embodiment, the lighting device 3800 may include a lighting system 500 as shown in Fig. 1, and also may include any of a variety of user interfaces 3818 as described herein (e.g., such that a user can adjust the color of the device 3800). In particular, as shown in Figure 38, the user interface may be a switch, button, dial, etc.

In general, any of the devices shown in Figures 32-38 as well as other figures may include a user interface that is provided as a dial such that changing the position of

the dial may change the color of the system. In the embodiment of Figure 36, for example, the user interface may be the switch 3602 itself, such that the switch not only operates power but also activates the lighting system 500 to produce the colored light to illuminate the panel or the switch. In another embodiment, one or more user interfaces may be provided through switches, dials, or the like that are not generally accessible to the user. For example, the installer of the switch or junction box may select the color by setting switches on the lighting system and when the lighting system is installed the switches are no longer accessible to the common user.

As discussed herein, user interfaces for any of the devices shown in Figures 32-38 as well as other figures may alternatively be implemented as a software driven graphical user interface, a personal digital assistant (PDA), a mobile remote-control interface, etc. In particular, the user interface may generate and communicate signals to various lighting devices through wired or wireless transmission.

Additionally, any of the lighting devices discussed in connection with Figs. 32-38 or other figures may be associated with a network, local area network, personal area network, wide area network or other network. For example, several devices described herein may be provided in a building (e.g., house, office, retail establishment, etc.) and the color of the devices may be controlled (e.g., coordinated, changed over time, etc.) through a central control system (e.g., connected to the network of lighting devices). The central control system may be a computer, PDA, web enabled interface, switch, dial, programmable controller or other network device.

As also discussed earlier, any of the lighting devices discussed in connection with Figs. 32-38 or other figures may be associated with a sensor or other system that generates a signal. For example, a proximity detector may be provided wherein one or more lighting devices changes color based on one or more signals provided by the detector. In such a system, the lighting device(s) may light to a particular color or produce a color changing effect based on the input from the sensor. In an embodiment, a hallway or other area may have several lighting devices where each of them is associated with a proximity detector. As a person walks down the hallway, the lighting devices activate, change colors or display lighting effects. Once the person has passed the lighting device, it may go back to a default mode an await further activation through the proximity detector.

Figure 39 illustrates another lighting device 3900 according to the principles of the present invention. The lighting device 3900 may include a lighting system 500 as shown for example in Fig. 1. As can be seen from the illustration, the lighting device may include a plug or other adapter 3908 to connect the lighting device to outlet power. In an embodiment, the lighting device may also include an AC/DC power converter to convert the received power to power for the lighting system 500. The lighting device 3900 may include a user interface 3918. In an embodiment, the user interface may be a dial encompassing the perimeter of the housing 3904 or another style of user interface. As with other lighting devices described herein, the lighting device 3900 may also be associated with an optional sensor 3922, network or data port interface 3920 or other element. The lighting device 3900 may also include a flexible neck member 3902 connecting the power adapter 3908 to the housing 3904.

Although the lighting device 3900 is illustrated with an easily removable power adapter, another useful embodiment may not have such an easily removable power adapter. For example, the flexible neck 3902 may be affixed to another device such that it is not intended to be removed. In another embodiment, the adapter 3908 may be designed to fit into another enclosure designed specifically for the application.

For example, Figure 40 illustrates a junction box 4002 wherein the junction box may include outlets for one or more lighting devices, such as the lighting devices 4000 or 3900 shown in Fig. 39. The box 4002 may be internally lighted itself and or the box may include outlets for various lighting devices. The box 4002 may include any combination of user interfaces, network connections or data outlets, sensors, or other devices or connections to allow the control of the lights in the box or connected to the box.

Figures 41A, 41B, and 41C illustrate other lighting devices according to the principles of the present invention that may be particularly implemented in vehicle-based (automotive) environments. For example, Figures 41A and 41B illustrate lighting devices 4100 and 4101, respectively, that may plug into an automobile power outlet (e.g., a cigarette lighter) through a power adapter 4108. The device 4100 includes a flexible neck 4102, and either of the devices 4100 or 4101 may be equipped with a user interface 4118, one or more sensors 4120, and lighting system 500 as discussed above. The lighting device 4101 is formed as a "plug" for a cigarette lighter, and may illuminate from an end as shown in Fig. 41B, or the entire body of the plug may glow with

PGR2023-00016 - Home Depot
Ex. 1003 - Page 981

illumination from the lighting system 500. Figure 41C illustrates a color changing stick (e.g., a gear shift) that may be internally powered (e.g. battery) or externally powered through the vehicles power supply.

While many of the embodiments described herein are intended for decorative lighting, there are other embodiments where the color of the light projected from the system or device is associated with providing information. The systems described herein may be used to monitor the power, inductive load, power factor, or other parameters for an associated device. The lighting system may change colors to indicate various conditions. For example, the system may indicate power consumption is nearing a critical point by emitting red light or flashing red light. The system may indicate an inductive load is high by emitting blue light.

As also discussed earlier, various lighting devices may also be associated with sensors, networks, or other sources of information wherein the lighting system is arranged to produce a color or pattern of light in response to received information. For example, an audio signal or other signal generators may control the lighting systems such that the lights change in response to the music. The lighting system may also be associated with other networks (e.g. local area network, world wide network, personal network, communication network) wherein the network provides data or a signal and the lighting system responds to the data by changing colors. For example, lighting conditions may change to red when the phone rings and the call is identified as a person you do not want to talk to. The lighting conditions may change green upon receipt of a phone call or email from your spouse or other loved one.

Additionally, while many of the embodiments described herein disclose useful illumination systems and devices, the same systems and devices may be used as communication devices. For example, a lighting device according to the principles of the present invention may be associated with fire sensors, smoke detectors, audio sensors or other sensors to effectuate communication of a condition or information. The information supplied to the lighting device may also come from networks or other signal generators. The lighting device may, for example, flash red when the smoke detector is activated or lighting devices that are in close proximity with exits may turn a particular color or display a light pattern. A detection system may also warn of exits that are not safe because of the proximity of smoke or other dangers. This warning signal may be

PGR2023-00016 - Home Depot
Ex. 1003 - Page 982

used to change the lighting pattern being displayed by the lighting devices near the dangerous exits as well as the safe exits.

Yet another lighting device according to the principles of the present invention may include an elongated shaped optic that is lit by one or both ends. The optic may also include a reflective material to reflect the light received from the ends out of the optic. Such a system may provide substantially uniform lighting along the body of the optic, giving the appearance the optic is glowing and or providing substantially uniform illumination from the optic. Such a lighting system may be used for the illumination of cove areas, under, over or in cabinetry, in displays or in other areas where such lighting is found useful. In an embodiment, such a lighting device may include one or more LED-based lighting systems 500 as shown for example in Fig. 1.

Figure 42 illustrates one example of such a lighting device 4200 according to the principles of the present invention. The lighting device 4200 may include an optic 4202 which may be an elongated optic, tubular optic, light guide, tubular light guide, elongated light guide, or other style of optic. The optic 4202 may be constructed of a transparent material, semitransparent material, translucent material, plastic, glass or other material that allows for the transmission or partial transmission of light. The wavelength of transmitted light is not limited to the visible spectrum and may include ultraviolet, infrared or other wavelengths in the electromagnetic spectrum. In another aspect, the material may be selected to purposefully filter one or more particular wavelengths, including ultraviolet and/or infrared.

The optic 4202 may be associated with another material 4204 designed to reflect at least a portion of the light transmitted through the optic 4202. The material 4204 may be a reflective material, partially reflective material, a strip of material, an opaque material, or other material designed to reflect at least a portion of the light that impinges upon its surface. The material 4204 may be associated with the optic 4202, co-extruded in the optic 4202, embedded in the optic 4202, proximate to the optic 4202, or otherwise arranged such that light may be reflected by the material 4204 through the optic.

The lighting device 4200 may also include one or more LED based illumination devices 500 as discussed, for example, in connection with Fig. 1. In an embodiment, an illumination device 500 may be arranged to project light through an end of an optic 4202. In one aspect of this embodiment, an illumination device may be associated and

PGR2023-00016 - Home Depot
Ex. 1003 - Page 983

control two illuminating sections at either end of the optic, with one processor 2 as shown in Fig. 1 controlling both ends. In another embodiment, two individual illumination devices 500 (each with their own processor 2) may be used to project light through opposite ends of the optic 4202. The light from the illumination devices 500 may be projected into the ends of the optic 4202 such that a portion of the light reflects off of the reflective material 4204 and then out of the optic 4202 in a direction away from the reflective material. In an embodiment, this system may be used to provide substantially uniform illumination from the lighting device 4200.

In an embodiment, the reflective material 4204 may be co-extruded with the optic 4202 such that the reflective material 4204 is embedded in the optic 4202. The reflective material 4204 may have a flat side that is used to reflect the light out of the optic 4202. The reflective material 4204 may also be non-flat. For example, the reflective material may follow the contour of the optic.

In particular, in an embodiment, the reflective material is arranged on the outer surface of the optic, as illustrated in the cross sectional view of Figure 43C. Figures 43A and 43B also illustrate some other useful reflector designs according to the principles of the present invention. Figure 43A illustrates a co-extruded reflector 4204 with a curved shape. Figure 43B illustrates a shaped reflector 4204 with a raceway 4206 to allow the passing of wires or other elements from one end of the optic to the other.

The reflector 4204 may also have a rough surface to increase the reflection and the rough surface may not be uniform throughout the surface. For example, the material may increase in roughness further from the ends of the material to increase reflection farther away from the ends as well as reducing the reflection close to the ends. In another embodiment, the optic may have a smooth surface towards the ends of the material and a rough surface towards the center. In another embodiment, the roughness or other surface condition may be applied uniformly. Figure 47 illustrates one example of a reflective material 4204 with a rough surface 4702 according to the principles of the present invention.

In an embodiment, the reflector 4204 may be a diffuse reflector dispersing the light in many directions. In an embodiment, the surface of the reflector 4204 may contain imperfections or the like that are arranged to reflect the light in a preferred direction or pattern. The imperfections may be arranged to reflect more or less incident

light in a particular direction depending on the distance the surface is from the illumination device(s) 500. A pattern of imperfections on the surface of the reflector 4204 may be arranged, for example, such that dispersion is diffuse near the illumination device(s) 500 and directional further from the illumination device(s). The reflector's surface near the illumination device(s) may be very smooth (e.g. specular) to prevent diffuse reflection and otherwise patterned further from the illumination device(s) 500 to increase the diffuse reflection or otherwise increase reflection out of the optic. These uneven patterned surfaces may be arranged to project a relatively uniform pattern of light from the optic 4202. In an embodiment, a reflector 4204 according to the present invention may also have a substantially uniform surface (e.g. diffuse surface).

An optic 4202 or reflector 4204 according to the principles of the present invention may be shaped to optimize the light output. Figure 44 illustrates such an optic 4402. The optic 4402 may be arranged with shaped sides such that the light will impinge the sides of the optic with greater frequency. Generally, the light projected into a uniformly shaped optic will be more intense at the ends of the optic and slowly reduce in intensity towards the middle of the optic. The tapered optic embodiment illustrated in Figure 44 allows less light to escape at the ends of the optic and more to escape towards the middle because of the increased reflection. The overall effect is a more uniform distribution of light output throughout the optic. A reflector may likewise be shaped to increase the light reflected from a portion of the reflector. Figure 48 illustrates a shaped reflector 4804 that complements the shaped optic 4402 shown in Figure 44, according to one embodiment of the invention.

In an embodiment, the optic may include imperfections, coatings or the like (collectively referred to herein as imperfections) that are not uniformly distributed along its length. For example, Figure 45 illustrates an optic 4502 with a greater frequency of imperfections 4506 in the middle of the optic as compared to the ends of the optic. The imperfections 4506 may be in the bulk of the optic material 4502 or on or near the surface of the material 4502. In an embodiment, the imperfections 4506 may be marks, bubbles, or other imperfections in or on the material. In an embodiment, the imperfections may be uniformly distributed but they may not be of similar size. For example, the imperfections towards the ends of the optic may be smaller than the ones towards the middle of the optic. In an embodiment, the imperfections may be the result

PGR2023-00016 - Home Depot
Ex. 1003 - Page 985

of a coating that is applied to the surface of the optic 4502. For example, 3M manufactures a material that includes imperfections and the size of imperfections in the material increases further away from the ends. The material is referred to as Conformable Lighting Element.

In an embodiment, the illumination devices 500 may be epoxied or otherwise attached to the various types of optics to minimize the loss of light or for other reasons. In an embodiment, the ends of the optic may also be coated with an anti-reflective coating to increase the light transmission efficiency and hence the overall efficiency of the lighting system. In an embodiment, a platform where the LED-based illumination devices are mounted may be made of or coated with a reflective material. The platform may be constructed of standard materials, or the platform may be constructed of materials designed to increase the reflection off of the platforms surface (e.g. a white platform, a platform coated with a reflective material).

An lighting device 4200 including an elongated optic according to the present invention may also include a housing 4208, as shown for example in Figures 42 or 46. The housing may be designed to hold the illumination devices 500 and the optic 4202 along with the reflective material 4204. In an embodiment, as shown in Figure 46, the housing may be arranged such that the optic can be rotated to direct the light emitted from the optic. In another embodiment, the optic may be arranged in a fixed position in the housing. As also shown in Figure 46, the lighting device 4200 may be associated with a user interface 4218 and one or more connectors for power and/or data connections.

The lighting device 4200 including an elongated optic as discussed above may have a number of applications. For example, the device may be used to provide illumination in any environment in which flourescent or other tubular shaped lighting elements formerly were used (e.g., various office, warehouse, and home spaces such as under cabinets in a kitchen). In this application, the devices 4200 may be aligned in much the same way as fluorescent systems are mounted. One strip of lighting may comprise a number of individual lighting devices 4200, for example, that may be controlled individually, collectively, or an any subset of groups, according to the various concepts discussed herein (e.g., a networked lighting system). In such a system, a central controller may be provided as a separate device or as an integral part of one of the

lighting devices 4200, making a master / slave relationship amongst the group of lighting devices.

Another embodiment of the present invention is directed to a lighting device (e.g., the glow sticks or key chains of Figs. 3 and 4) that can be pre-programmed to generate light and or lighting patterns, receive light control information in the form of one or more external signals, and/or receive light control information in the form of a downloaded lighting program. In particular, in one aspect of this embodiment, a method of programming such a device according to the principles of the present invention may involve the steps of downloading a lighting program from a programming device (e.g., a computer) to the lighting device, wherein the programming device may communicate with the lighting device through wired or wireless transmission.

For example, in an embodiment, a computer may be connected to a cradle arranged to accept a lighting device. When the lighting device is set in the cradle, electrical contacts of the lighting device may be connected with electrical contacts in the cradle allowing communication from the computer to the lighting device. Lighting programs or instructions may then be downloaded from the computer to the lighting device. In one embodiment, such a downloading system may be useful for providing custom generated lighting shows and/or lighting effects (e.g., "color of the day," "effect of the day," holiday effects, or the like) from a light programming authoring interface or web site, for example.

As discussed above, a lighting device according to the various concepts herein may include a display (e.g., an LCD, LED, plasma, or monitor; see Figs. 15 and 16), which may indicate various information. In one aspect, such a device with a display may be configured to indicate via the display various status information in connection with downloading lighting control programs or instructions.

Figure 49 illustrates a downloading system 4900 according to the principles of the present invention. The lighting device 4902 may include an LED-based illumination device 500 as shown in Fig. 1 or as described in other embodiments of this disclosure. The lighting device 4902 may include a housing 4920 where the electronics, including various processors, controllers, and other circuitry, are housed. The lighting device may also include an optic 4914 wherein the illumination device 500 is arranged to illuminate the optic 4914. The optic may be transparent, translucent, or have other properties to

PGR2023-00016 - Home Depot
Ex. 1003 - Page 987

allow a portion of the light to be transmitted. In an embodiment, the optic includes imperfections (e.g. a rough surface) to cause the light to be reflected in many directions to provide an optic that appears to glow uniformly when lit with the illumination device 500.

The lighting device 4902 may also include electrical contacts 4904. The electrical contacts 4904 may be electrically associated with the processor 2 and/or the memory 6 of the illumination device 500 (see Fig. 1) such that communication to the processor and/or memory can be accomplished. For example, in an embodiment, the contacts are electrically associated with the memory such that new lighting programs can be downloaded directly to the memory without requiring interaction with the lighting device's processor. In this embodiment, the processor may be idle while a programming device 4910 downloads control program and/or other information to the device 4902. The electrical contacts 4904 may be adapted to make electrical contact with contacts (not shown) in a cradle 4908. The contacts in the cradle in turn may be associated with data line(s) 4912 from the programming device 4910. With such an arrangement, lighting signals, programs, data and the like can be downloaded from the programming device 4910 to the lighting device 4902.

In one aspect, the programming device 4910 maybe a computer connected to a network (e.g., the Internet). A web page may contain various lighting programs that may be downloaded, such as a particular color or color changing effects (e.g., "color of the day," "effect of the day" or "holiday mode" lighting effects). The programming device 4910 may also be used to generate custom lighting shows to be downloaded to the lighting device 4902. For example, the programming device 4910 may include a program to assist a user in creating/generating a new lighting effect, and then the new lighting effect may be transferred to the lighting device 4902. A web site, or other remote platform, may be used to generate the lighting effect as well. A web site may include a section wherein the user can create/generate lighting effects and download them to the programming device 4910, to be in turn transferred to the lighting device (or the lighting effects may be transferred directly from the web site to the lighting device 4902).

While the programming device 4910 is described above as a conventional computer, it should be understood that the present invention encompasses all computing devices capable of performing the functions described herein. For example, the

programming device 4910 may be a personal digital assistant (PDA), palm top device, cellular phone, MP3 player, a hand held computing device, a stand-alone computing device, a custom tailored computing device, a desk top computing device, or other computing device.

In particular, in one embodiment, a PDA may be used as the programming device 4910. The PDA may be used to generate/author lighting programs or it may be used to receive lighting programs or otherwise download lighting programs. For example, one user may wish to share a particular lighting effect with another user. The first user may use wired or wireless transmission to transfer the lighting effect from her PDA to a second user's PDA. Then the second user can download the lighting effect to his lighting device 4902.

While many of the embodiments herein describe wired transfer of information from the programming device 4910 to the cradle 4908 and the lighting device 4902, it should be understood that wireless communication or combinations of wired and wireless communications may be used in a system according to the principles of the present invention. For example, the programming device 4910 may transfer information to the cradle 4908 using wireless transmission and the data is transferred to the lighting device 4902 through wired transmission. In another embodiment, the transmission from the cradle 4908, or other device, may be accomplished through wireless transmission. In yet another embodiment, the transfer of information from the programming device 4910 to the lighting device 4902 may be accomplished without the need of the cradle 4908. The information may be transferred directly from the programming device 4910 to the lighting device 4902 through wired or wireless transmission.

A lighting device 4902 according to the principles of the present invention may also include a transmitter or be capable of transmitting information through one or more of the LEDs. In an embodiment, the LED(s) may be arranged to provide both illumination as well as information transmission. The LEDs may also provide information transmission simultaneously with the illumination such that the illumination does not appear to be disrupted to an observer.

In an embodiment, the lighting device is capable of transmitting information and is used to transmit lighting effects, colors, or other information to another lighting device. In an embodiment, transferring lighting effects from device to device is provided

PGR2023-00016 - Home Depot
Ex. 1003 - Page 989

through a memory card, memory stick or other portable memory device. Information can be transferred to the portable memory device and then the portable memory device can be transferred to the lighting device 4902.

Although the lighting device 4902 is discussed in the above example as a hand held lighting device, it should be appreciated that other types of lighting devices according to the present invention, including but not limited to other portable or stationary lighting devices, modular lighting devices, table mount lighting devices, wall mount lighting devices, ceiling mount lighting devices, floor mount lighting devices, lighting devices incorporated into other apparatus such as toys or games, etc., may receive programmed lighting control information via the downloading techniques discussed herein.

Another embodiment of the invention is directed generally to LED-based lighting devices (e.g., as shown in Fig. 1) including one or more optical components that provide for broader directionality or spread in the light generated by the device. In one aspect of this embodiment, one or more LEDs generate radiation toward one or more optical components that are adapted to reflect and/or diffuse the radiation. The optical component(s) may be used to redirect the radiation such that the combination of the lighting device together with the optical component(s) projects light with a wider distribution than the original light projected by the device alone. The optical component(s) may also be arranged to direct the light to another direction while maintaining or changing the beam angle of the light. The optical components may also be used to help mix the light from more than one LED (e.g., differently colored LEDs). In one aspect, such optical components may be arranged as full or partial enclosures or housings for one or more LED-based lighting devices.

Figure 50 illustrates another lighting device 5000 according to the principles of the present invention. The lighting device 5000 may include an illumination device 500 as discussed in connection with Fig. 1, for example. The lighting device 5000 also may include a reflective surface 5002. The reflective surface 5002 may be any number of shapes including, but not limited to, conical, parabolic, curved conical, straight sided conical, or other shape designed to reflect the light impinging on the reflective surface in a different direction. The reflective surface may include a section that is transparent or translucent to allow at least a portion of the light to pass through the surface without

being deflected significantly. This may be useful when the desired light distribution pattern involves allowing a portion of the light to be projected in a direction similar to that of the originally-generated light. As illustrated in Figure 50, the reflective surface may be arranged with a narrow end towards the LEDs of the illumination device 500 and a wider end away from the LEDs. This may be useful when the reflective surface is symmetrical, as in the case of a conical reflector, for example, for reflecting light in many directions. Other reflector designs may be adapted to direct the light in a particular direction or with a maximum light in a particular direction. One example of a directional reflector 5102 according to the present invention is illustrated in Figure 51.

As shown in Fig. 50, the lighting device 5000 may also include a housing 5006. The housing 5006 may house the illumination device 500, including various electronics to drive the illumination device (as discussed for example in connection with Fig. 1) and optionally include a user interface 5018 according to the various concepts discussed herein. The LEDs of the illumination device 500 may be arranged on or in the housing such that the light emitted from the LEDs is projected from the housing. The housing may also be adapted with a power adapter 5008. The power adapter 5008 may be an Edison style screw base, spade adapter, bin-pin adapter, wedge based adapter or any other style of power adapter to adapt the lighting device 5000 to a power system. The power adapter 5008 may also be associated with an AC to DC power converter, AC power transformer, DC power supply or other system to convert received power to power levels used by the electronics and or the LEDs of the lighting device 5000. In an embodiment, the lighting device 5000 may include a power adapter 208 to connect the lighting device 5000 to a power source such as that found on a bicycle or other system for generating power (e.g. solar, generation through the Seebeck effect, wind, etc.).

The lighting device 5000 may also be provided with an enclosure 5004. The enclosure 5004 may be provided to protect the illumination device 500 and the reflector 5002 and / or to provide a mechanical means for holding the reflector 5002. In one aspect, the enclosure 5004 and reflector 5002 may be one integrated assembly. The enclosure 5004 may be transparent or translucent such that at least a portion of the light emitted from the illumination device 500 is transmitted through the enclosure 5004. For example, the enclosure may be made of clear plastic.

Figure 52 illustrates a mechanical attachment between the reflective surface 5002 and the enclosure 5004 of the lighting device 5000 according to one embodiment of the invention. The two pieces of material used for the reflector and enclosure may be adapted to mechanically attach to provide a means for hanging the reflector in the lighting device 5000. The enclosure 5004 may also have mechanical attachment points at the opposite end of the enclosure 5004 adapted to attach to the housing 5006.

Figure 53 illustrates that the lighting device 5000 may be provided alternatively or additionally with a diffusive surface 5302. The diffusive surface 5302 may be arranged to diffuse the light received from the illumination device 500. The material of the diffusive surface may be transparent or translucent such that at least a portion of the light passes through the material. The material may be adapted to diffuse light at one or more of the surfaces of the material or in the bulk of the material. There are many known diffusing materials with such properties. For example, the diffusing surface 5302 may be made of plastic material with a roughened surface or a surface or bulk that includes imperfections to redirect the light.

In an embodiment, the shape of the diffusing surface 5302 may be conical, tampered, or otherwise shaped. The diffusing surface 5302 may be three dimensionally shaped with straight or curved sides to optimize the desired lighting effect. For example, the diffusing surface 5302 may be conically shaped, or shaped as a pyramid or other three-dimensional shape, such that more light from the center of the light beam is captured towards the top of the diffusing surface. The light from the LEDs generally becomes less intense farther from the source due to the beam angle of the light. As the intensity diminishes, the surface is moved closer to the center of the beam to capture more light. This arrangement can provide a surface with substantially uniform light distribution. The surface itself may appear to be substantially uniformly illuminated and or the area around the surface may appear to be substantially uniformly illuminated.

In an embodiment, the LEDs of the illumination device 500 may be provided with varying beam angles, on a shaped platform, or the LEDs may be directed in various directions. The light from the LEDs may be projected through a diffusing surface or onto a reflective surface to attain the desired lighting effect. For example, the lighting system may be provided with a cylindrical diffusing surface and LEDs with differing beam angles may be provided on a platform. The varying beam angles may sum and

provide substantially uniform illumination of the surface or from the surface. In an embodiment, the LEDs may be provided in several directions or on a shaped platform to provide a desired lighting effect.

Figure 54 illustrates another embodiment of the present invention. The diffusing surface 5302 in this embodiment includes imperfections 5402 in the bulk or on the surface of the material. The imperfections may be arranged such that they get larger and or more frequent with distance from the illumination device 500. This arrangement may be used to generate substantially uniform illumination from the lighting device 5000. The imperfections may be bubbles in the material, for example, or the imperfections may form a pattern on the surface of the material. A pattern on the surface of the material may include areas where not much light is able to pass through and other areas where the light is allowed to pass with higher transmission. The relative ratio of transmitting area to non-transmitting area may change as a function of the distance from the illumination device 5000. For example, the transmitting area may increase as the distance from the LEDs increases. This arrangement may provide substantially uniform illumination from the lighting device 5000. The areas where light transmission is low may include areas of high reflectivity to maximize the overall lighting efficacy. Materials to obtain such lighting effects are available from 3M Corporation, for example, and are referred to as Conformable Lighting Element.

Another embodiment of the present invention is directed to lighting apparatus and methods for insect control. Insects are, by far, the most numerous of species on the planet and, as a result, also exhibit an extraordinary diversity of visual systems including wide variations in visual acuity, sensitivity, motion detection and more. Typically vertebrates, including humans, have much higher resolution vision, but insects exhibit extraordinary capabilities in other areas such as temporal resolution. While humans may perceive thirty images per second as continuous movement, the temporal resolution for many insects is as high as two hundred images/second. Additionally, their ability to sense movement is far better than that of other animals. Some insects can detect polarized light which is used for navigating in large open areas.

Insects are known to respond to certain wavelengths of electromagnetic radiation or light. As compared to humans, most insects have only two types of visual pigments and respond to wavelengths associated with those pigments. One pigment absorbs green

and yellow light (550 nm) and the other absorbs blue and ultraviolet light (<480 nm). Thus, insects cannot see red and have limited color vision and, unlike humans, can see into the ultraviolet. However some insects such as honeybees and butterflies have true trichromatic vision systems and a good ability to discriminate and see color.

Many nocturnal insects are attracted to certain forms of electromagnetic radiation or light and this is termed positive phototaxis. As a comparison, cockroaches are negatively phototactic and run from light. The UV-A range is known to be the most attractive to insects, especially nocturnal species. These species, especially mosquitoes, are often the focus of insect eradication efforts.

Conventional "bug lights" typically include yellow incandescent lights that do not repel bugs but simply attract them less, as compared to a normal white incandescent light bulb. Light traps, used widely in food processing applications, employ fluorescent-style UV sources to attract and then electrocute insects via charged plates or grids, and then collect the fried insect parts into a pan or other container.

In view of the foregoing, one embodiment of the invention is directed to methods and apparatus for insect control. For example, in one embodiment, a plurality of illumination units, each equipped with a light facility, are controlled by a processor or processors, wherein the illumination units are disposed about an area in which control of insects is desired. By disposing the illumination units about the area, it is possible to illuminate certain portions of the area with insect-attractive illumination and other areas with insect-repellant illumination. Thus, for example, the illumination units can illuminate the area about a door with light that is not as attractive to insects as illumination units that illuminate an area away from the door. The combination of attractive and repellent units can thus guide bugs into a desired location and away from an undesired location.

In another embodiment, an insect control device or system according to the present invention need not require a processor. In particular, a fixed control signal can be supplied to illumination units to provide a particular sequence of intensity change, flicker, or wavelength control without requiring a processor. In one aspect, a simple memory chip to store the sequence can be triggered in a manner similar to that employed in the circuit used in a 'singing card', whereby a small piece of memory is used to store and playback a sequence.

The insect control system can be dynamic; that is, because each illumination unit may be addressably controlled and networked, the illumination from that unit can be changed as desired by the user, instantaneously. Thus, at one time insects may be directed away from a given area, while at others they may be directed to that area, depending on what area the user wishes to use (e.g., a back porch that is in use only some of the time). Use of the 'flicker effect' can contribute to attraction or repulsion of the insects by using a flicker rate that is known to affect insect behavior.

In another embodiment, an insect control system of the present invention may be equipped with an insecticide, insect repellant, citronella candle, electric bug killer, carbon dioxide generating capture system or similar facility for killing, repelling, or disabling bugs. Thus, the insect control system can use illumination to direct insects to such a facility, increasing the effectiveness of such a facility without requiring, for example, widespread application of an insecticide which otherwise could have detrimental effects on non-insects including pets, children, birds and other small animals.

In embodiments, illumination may be designed to attract favorable insects (or other creatures, such as bats) that control other insects. Thus, if a preferred wavelength is known to attract the preying mantis, it may be displayed to attract that species in order to control other species. This can be a function of the visual system of that particular insect family and designed expressly to make it respond to the illumination and chemical system.

Like other devices discussed herein, an insect control system of the present invention may be equipped with other facilities, such as a communications facility for receiving data from an external source. The external source might be a user interface (allowing the user to turn the illumination system on or off, or to select particular configurations of illumination, perhaps through a graphical user interface on a wall mount or handheld device or a computer screen that shows the individual lights in a geometric configuration), or it might be an external device, such as a computer or sensor. If equipped with a sensor, the device may sense an environmental condition, such as temperature, humidity, presence of insects, light level, presence of carbon dioxide (known to attract may species of mosquito), or the like. Thus, the sensor may indicate an environmental condition that is favorable to insect activity, then activate, or control the mode of illumination operation of, the illumination system. Thus, the insect control

system can activate when the light levels are low and humidity is high, thus directing insects away from areas likely to be used by humans and toward areas that have insect-control facilities, such as insecticides.

In yet another embodiment of the present invention, an illumination system is disposed in combination with a scent-producing facility. Together with a processor or processors, this combination allows simultaneous or coordinated production of controlled scent and illumination. In embodiments, the scent/illumination device can be employed in conjunction with a network. In embodiments, the device may be provided with addressable control facilities. In embodiments, the devices can be employed using data delivery protocols such as DMX and power protocols such as pulse width modulation. In embodiments, the devices may be equipped with a communications facility, such as a transmitter, receiver, transceiver, wireless communications facility, wire, cable, or connector. Thus, the device can store, manipulate and otherwise handle data, including instructions that facilitate controlled illumination or controlled scent, or both. The device may also, in embodiments, receive control signals from another source, such as a user interface, an external computer, a sensor, or the like.

A wide variety of illumination and display effects can be employed in connection with the scent producing facility, ranging from color washes, to rainbow effects, to rapid changes in color, and the like. The scents can also be controlled whereby different chemicals are triggered to respond to an input signal (e.g. Digiscents Inc. multi-scent devices) and a 'smell wash' or smell sequence synchronous with a color wash or color sequence can be activated.

In other embodiments, the illumination can reflect a sensed condition, such as a condition sensed in the environment of the scent-producing facility. In other embodiments, the illumination can reflect a condition of the scent-producing facility, such as remaining life of the device, the remaining amount of scent-producing materials or chemicals, the quality of the scent, the strength of scent, battery life, or the like.

The scent-producing facility may be an air freshener or other scent-producing facility that may optionally plug into a room outlet. In embodiments, the scent may be varied in response to data received by the device, as controlled by a processor that also controls the illumination.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 996

The scent-producing facility can be programmed to produce scents in concert with the illumination; thus, a scent may be correlated with illumination that reflects a similar aesthetic condition, emotional state, environmental condition, data item, or other object or characteristic. For example, a pine scent could be coupled with green illumination, while a pumpkin scent could be coupled with orange illumination. Thus, a wide range of correlated colors and scents can be provided in a device where one or more processors controls both scent and illumination.

In an embodiment, the device is a combined air freshener and color-changing night-light, with a processor for control of the illumination condition of the night light, and with LEDs providing the source of illumination for the night light.

In an embodiment, a gel may be presented and a color changing illumination system may be directed to illuminate the gel. For example, there are many fragrances, deodorants, and the like that are made into gels. This gel can be made into most any shape and an illumination system may be used to project light through the gel. In an embodiment, the gel may appear to be glowing in colors.

In an embodiment, the gel or other material may evapaorate over time and as the material evaporates, the light levels captured by the material may diminish. This will result in the light levels decreasing as the material evaporates giving an indication of material life. In an embodiment, the light may actually appear when the evaporation, or other process, has removed a portion of the material.

In an embodiment, the illumination may be associated with a sensor. Such a sensor may measure or indicate germ, bacteria or other contamination levels and cause an illumination system to emit certain lighting conditions. An embodiment may be a color changing "germ alert sensors" that would hang in the toilet or trashcan, etc. Example: as your tidy bowl reached the terrifying point of not flooding the sewer lines with chlorine at every flush, your tiny tricolor LED would pulse RED hues to alert you.

While the invention has been disclosed in connection with a number of embodiments shown and described in detail, various modifications and improvements should be readily apparent to those skilled in the art.

CLAIMS

1. An illuminated wall panel apparatus, comprising:

an essentially planar member; and

an LED-based light source adapted to be positioned with respect to the essentially planar member so as to be behind the essentially planar member when the essentially planar member is mounted on a wall, the LED-based light source configured to generate light that is perceived by an observer while viewing the essentially planar member.

2. The apparatus of claim 1, wherein the LED-based light source is adapted to output at least first radiation having a first wavelength and second radiation having a second wavelength.

3. The apparatus of claim 2, wherein the LED-based light source includes a controller to independently control at least a first intensity of the first radiation and a second intensity of the second radiation.

4. The apparatus of claim 3, wherein the controller is configured to independently control at least the first intensity of the first radiation and the second intensity of the second radiation so as to vary an overall color of the light perceived by the observer.

5. The apparatus of claim 3, wherein the controller is configured to independently control at least the first intensity of the first radiation and the second intensity of the second radiation so as to vary an overall brightness of the light perceived by the observer.

6. The apparatus of any of the foregoing claims, wherein the essentially planar member is adapted to be essentially flush-mounted on the wall.

7. The apparatus of any of the foregoing claims, wherein the essentially planar member is adapted as a panel to form a portion of the wall.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 998

8. The apparatus of any of the foregoing claims, wherein the essentially planar member includes a shaped portion so as to direct at least some of the light generated by the LED-based light source.

9. The apparatus of any of the foregoing claims, wherein the essentially planar member is formed so as to optically alter at least some of the light generated by the LED-based light source.

10. The apparatus of any of the foregoing claims, further including at least one fiber optic to direct at least some of the light generated by the LED-based light source to the essentially planar member.

11. The apparatus of any of the foregoing claims, wherein the essentially planar member includes at least one switch mounted thereon, and wherein the LED-based light source is positioned so as to illuminate at least the at least one switch, such that at least some of the light is perceived by the observer via the at least one switch.

12. The apparatus of any of the foregoing claims, wherein the essentially planar member includes at least one socket mounted thereon, and wherein the LED-based light source is positioned so as to illuminate at least the at least one socket, such that at least some of the light is perceived by the observer via the at least one socket.

13. The apparatus of any of the foregoing claims, further including at least one user interface adapted to facilitate control of the LED-based light source.

14. The apparatus of any of the foregoing claims, wherein the at least one user interface is mounted on the essentially planar member.

15. The apparatus of any of the foregoing claims, wherein the LED-based light source is adapted to receive at least one control signal from an external or remote device or a network to facilitate control of the LED-based light source.

1/40

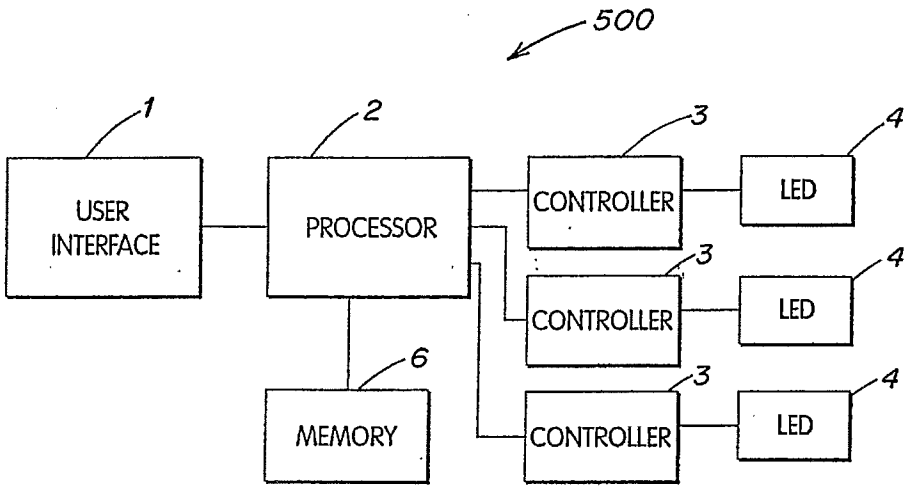

500
1
2
3
4
USER INTERFACE
PROCESSOR
CONTROLLER
LED
CONTROLLER
LED
6
MEMORY
CONTROLLER
LED

FIG. 1

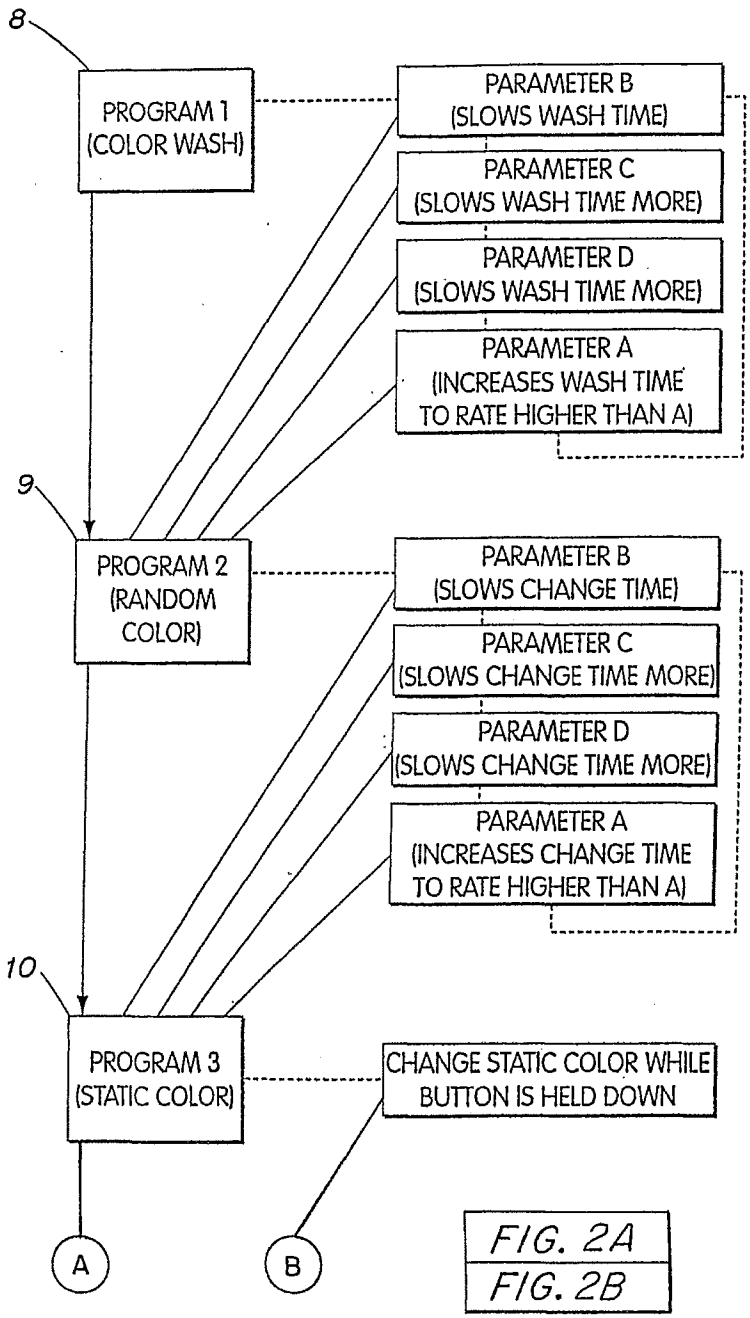


FIG. 2A
FIG. 2B

FIG. 2A

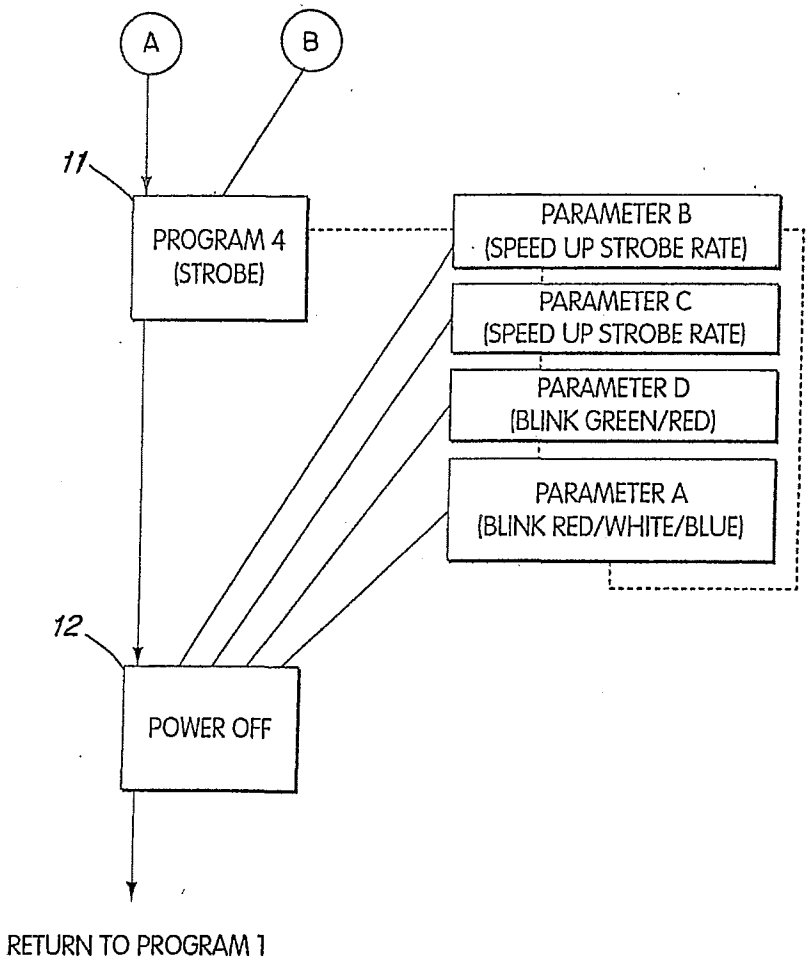

A
B
11
PROGRAM 4
(STROBE)
PARAMETER B
(SPEED UP STROBE RATE)
PARAMETER C
(SPEED UP STROBE RATE)
PARAMETER D
(BLINK GREEN/RED)
PARAMETER A
(BLINK RED/WHITE/BLUE)
12
POWER OFF
RETURN TO PROGRAM 1

FIG. 2B

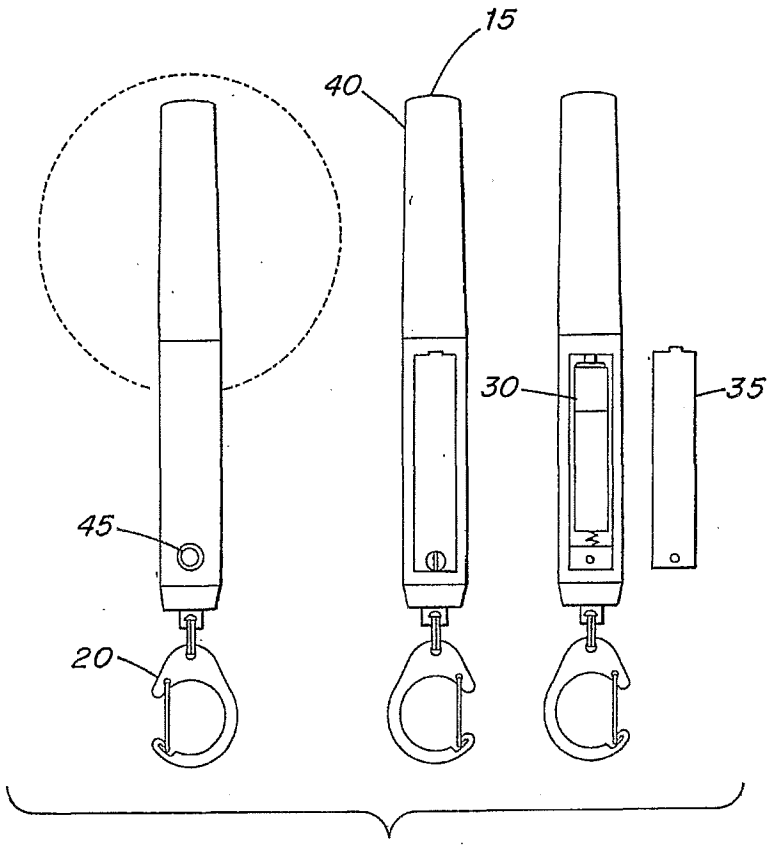


FIG. 3

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1003

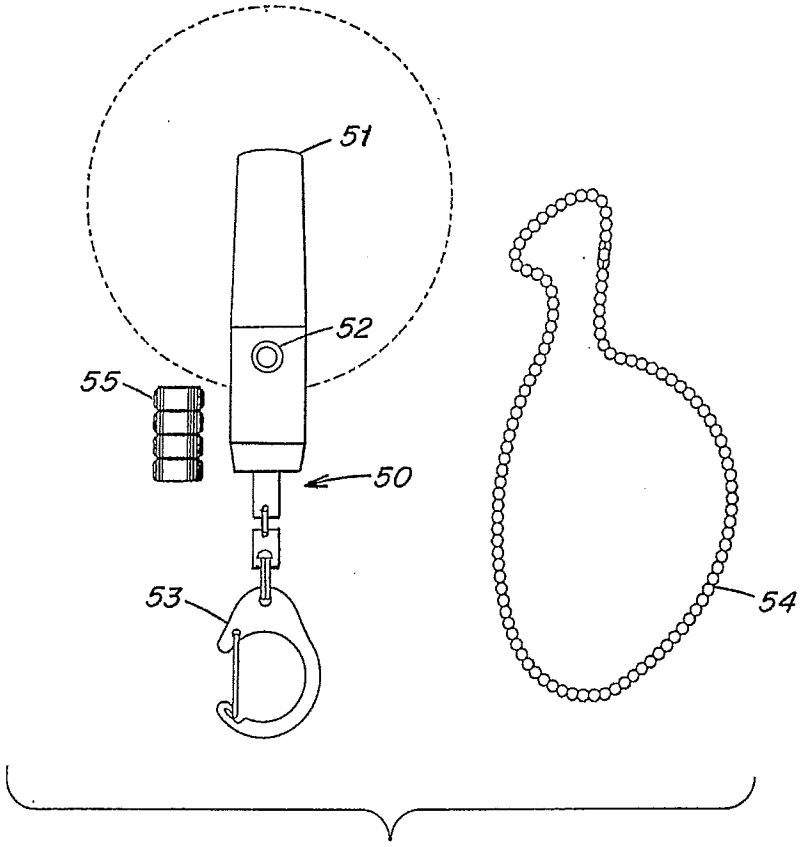


FIG. 4

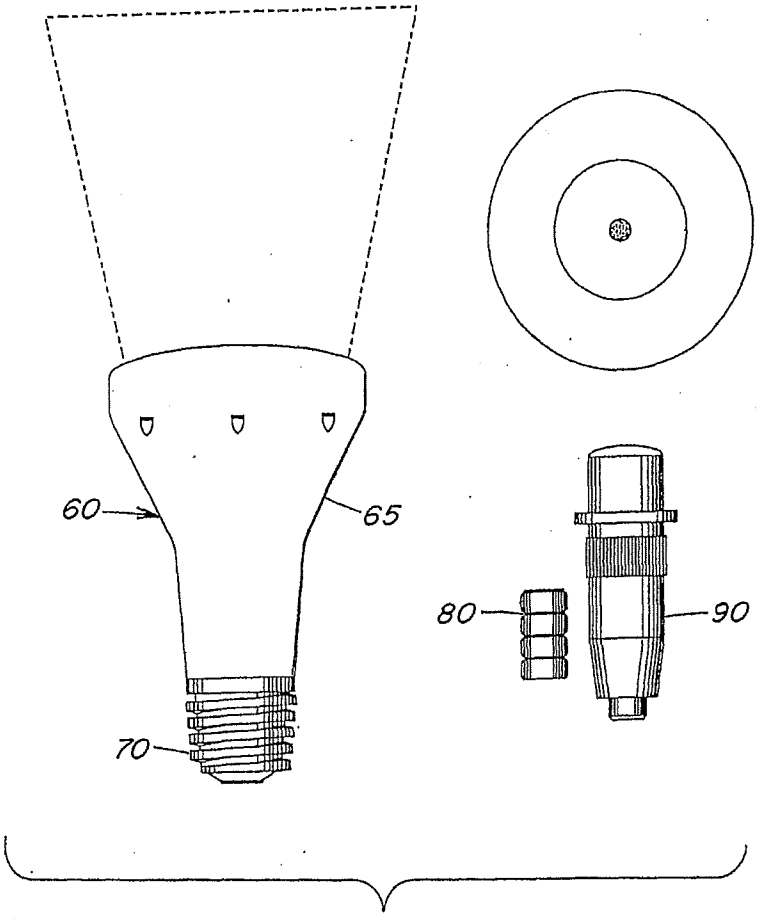


FIG. 5

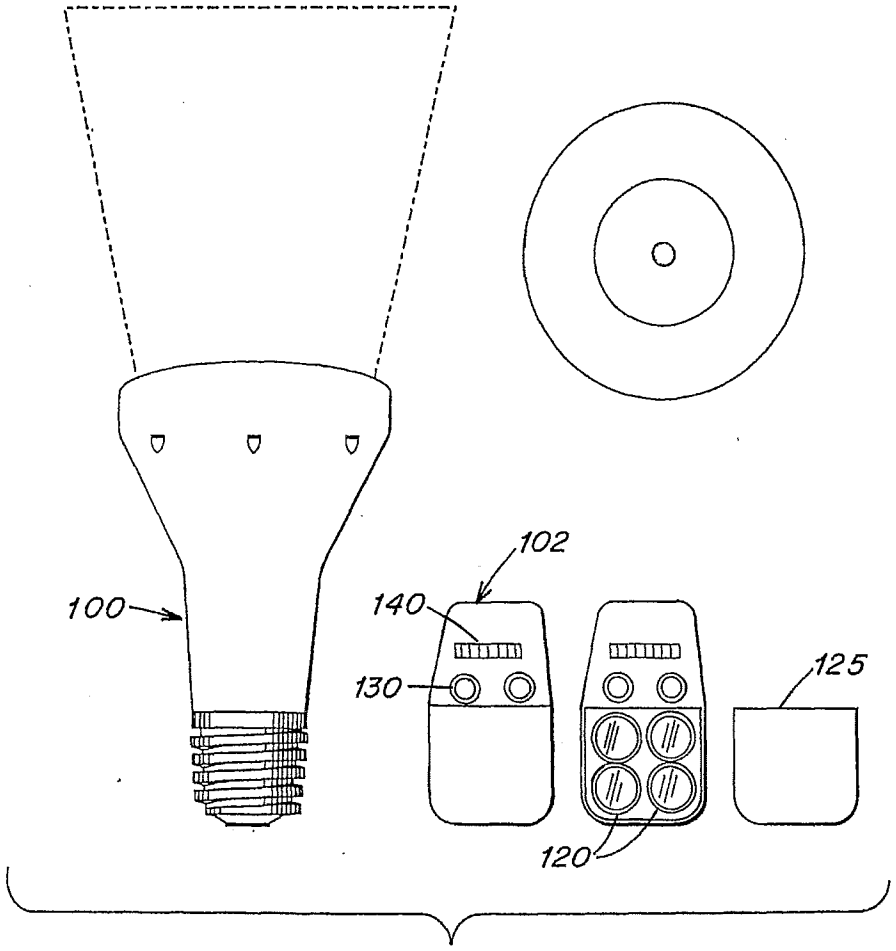


FIG. 6

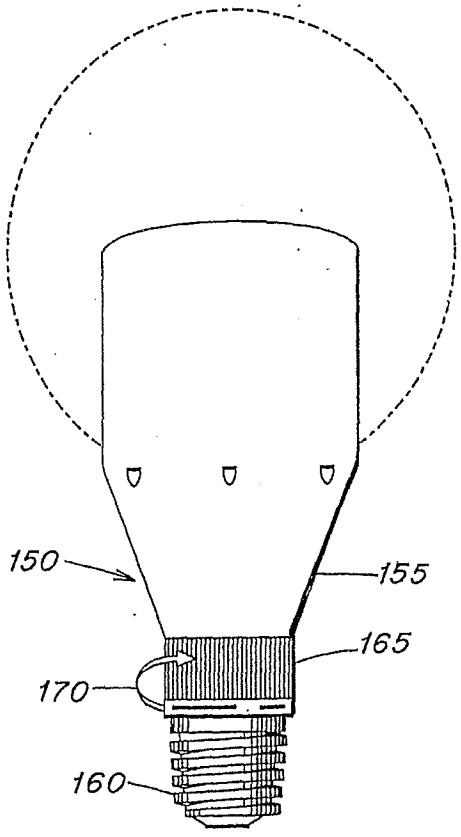


FIG. 7

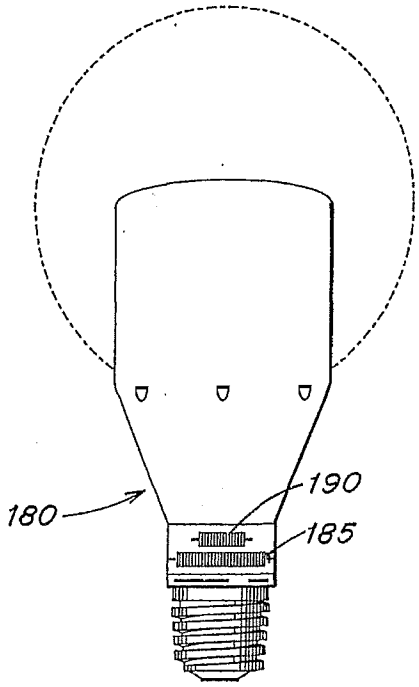


FIG. 8

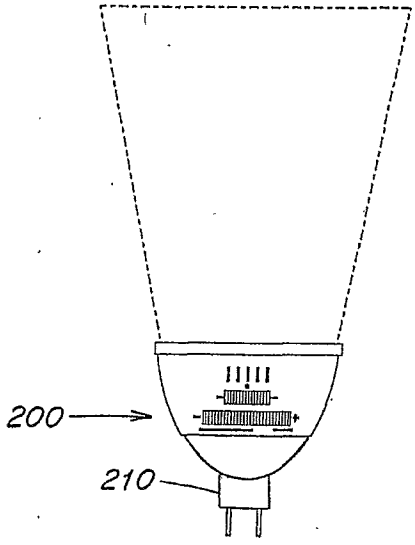


FIG. 9

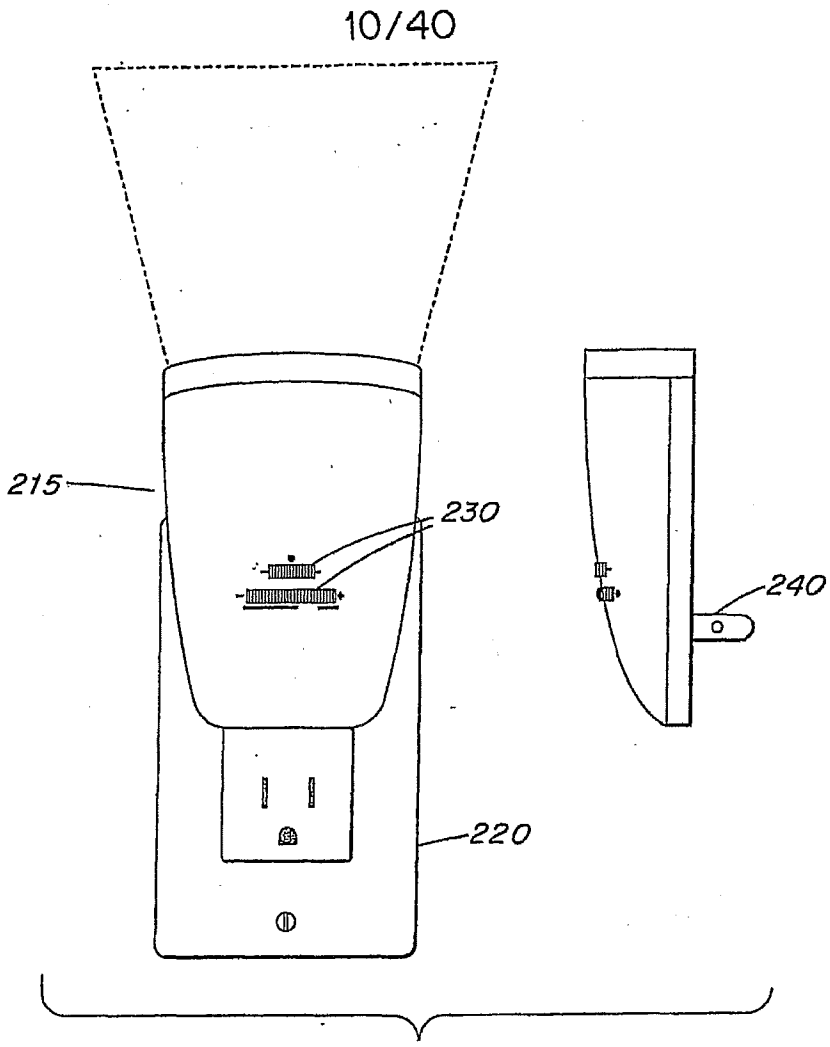


FIG. 10

RECTIFIED SHEET (RULE 91)

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1009

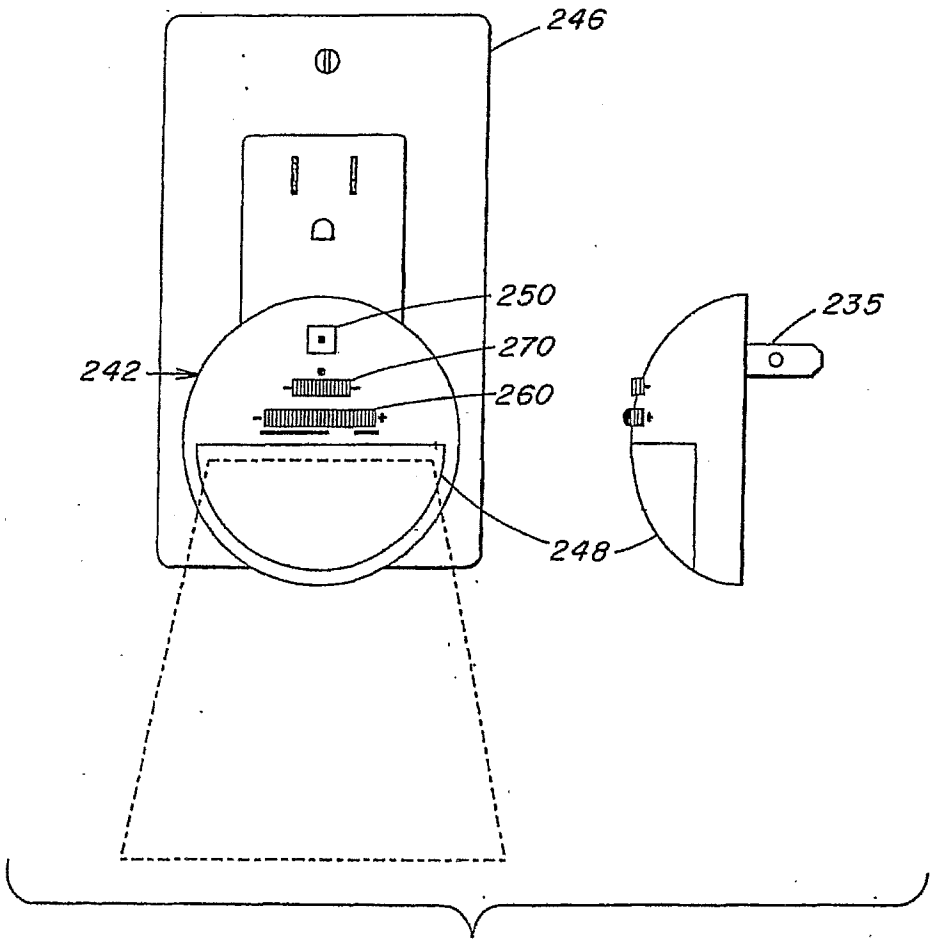


FIG. 11

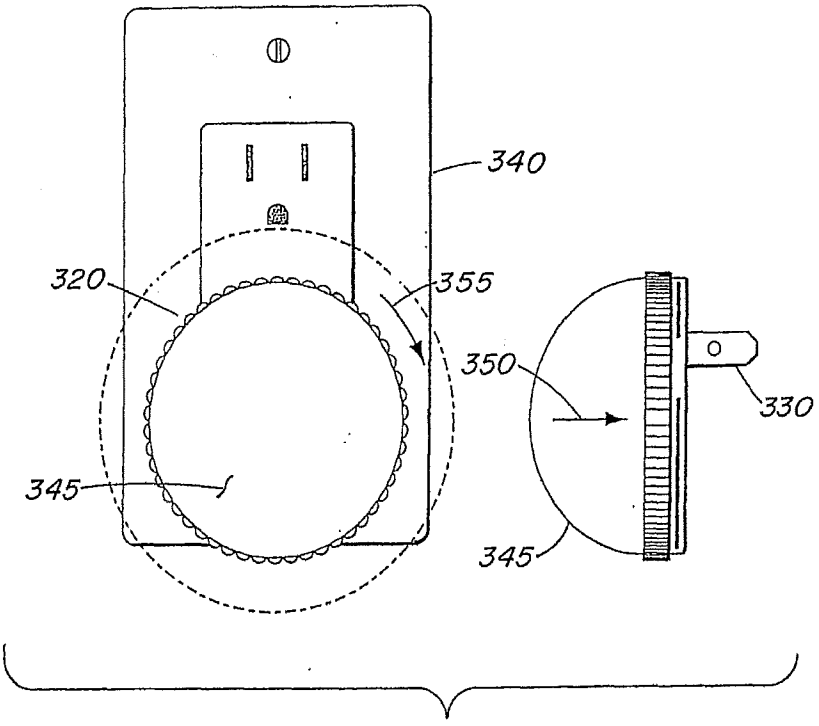


FIG. 12

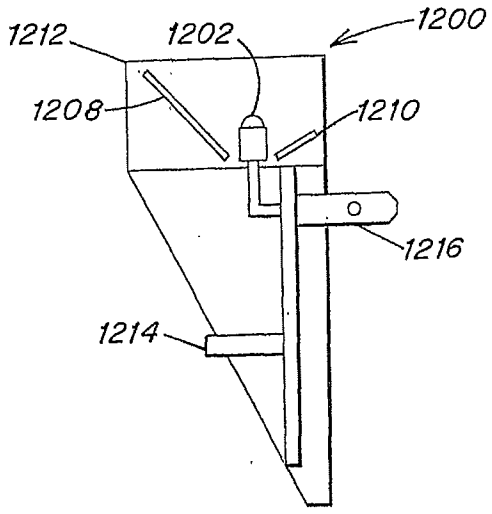


FIG. 13

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1011

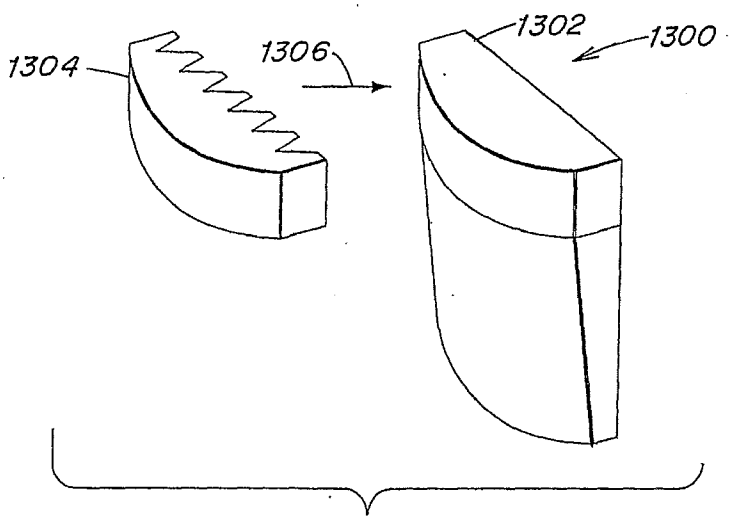


FIG. 14

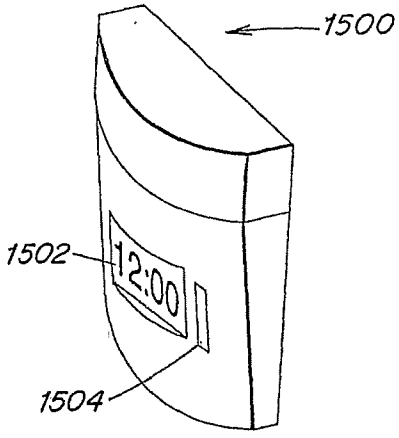


FIG. 15

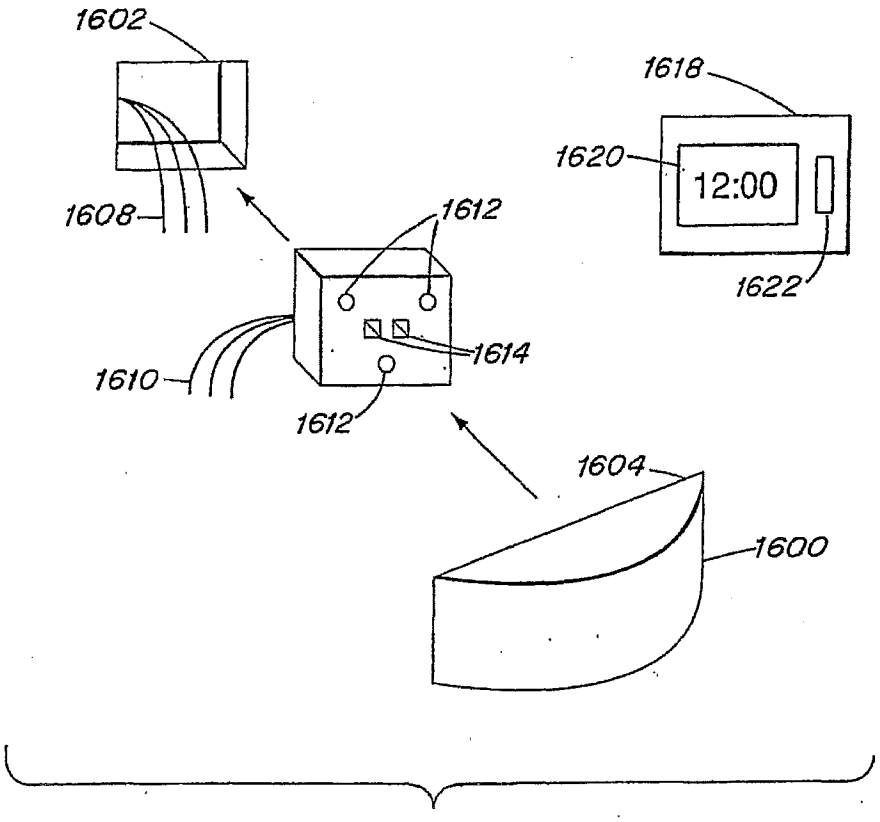


FIG. 16

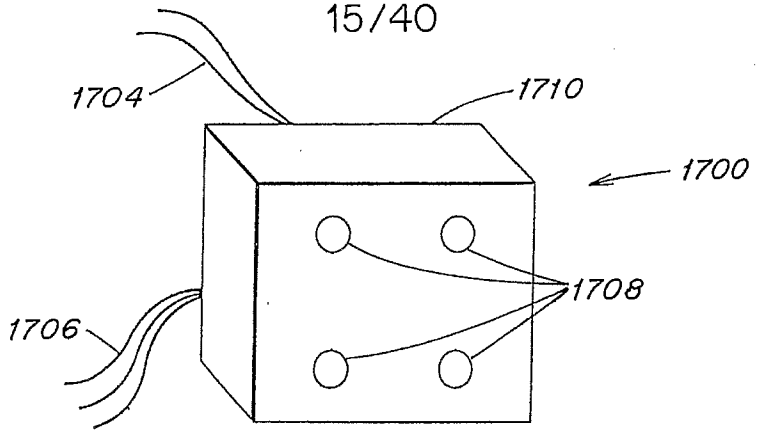


FIG. 17

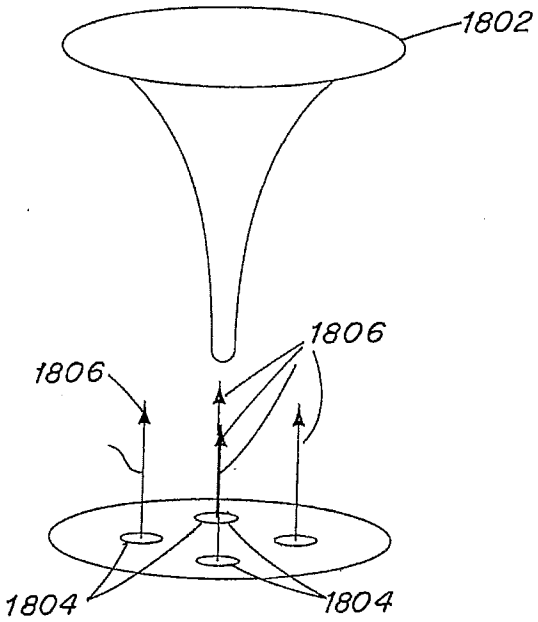


FIG. 18

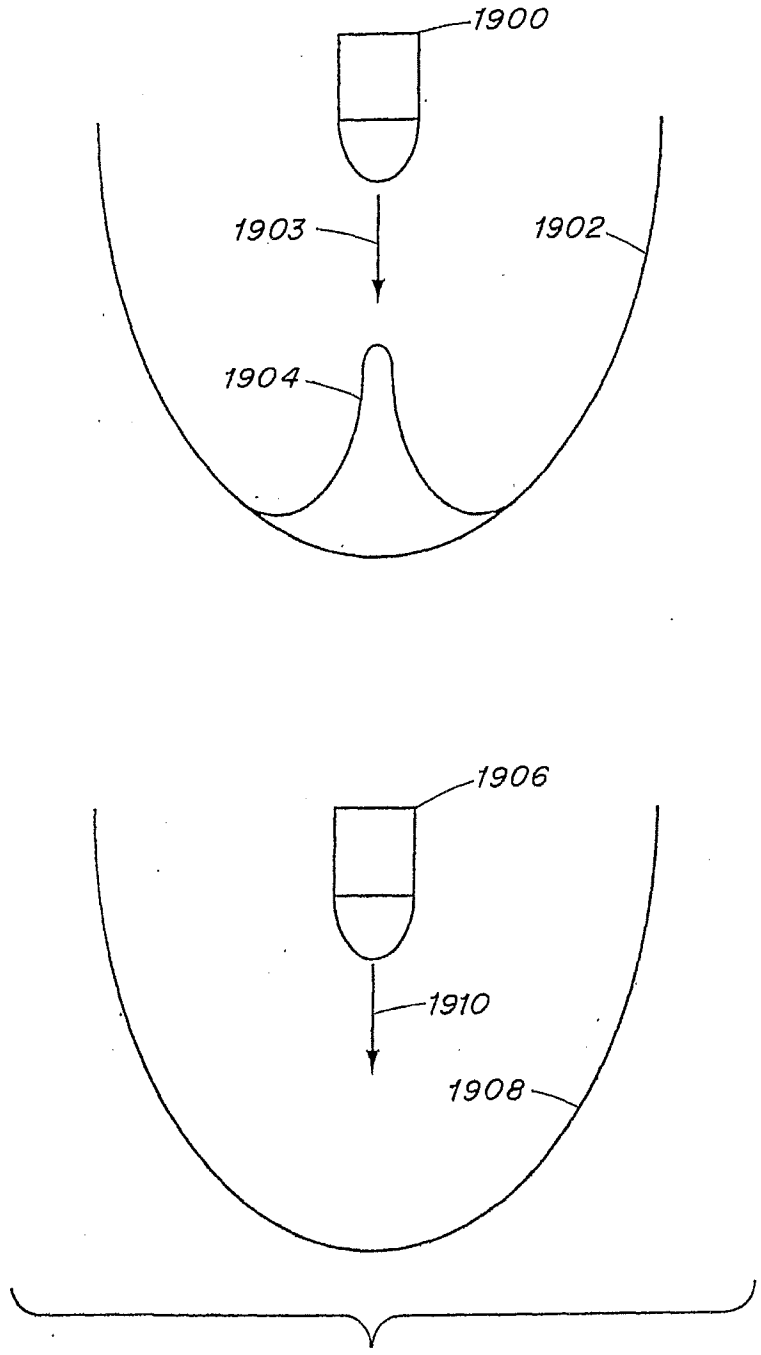


FIG. 19

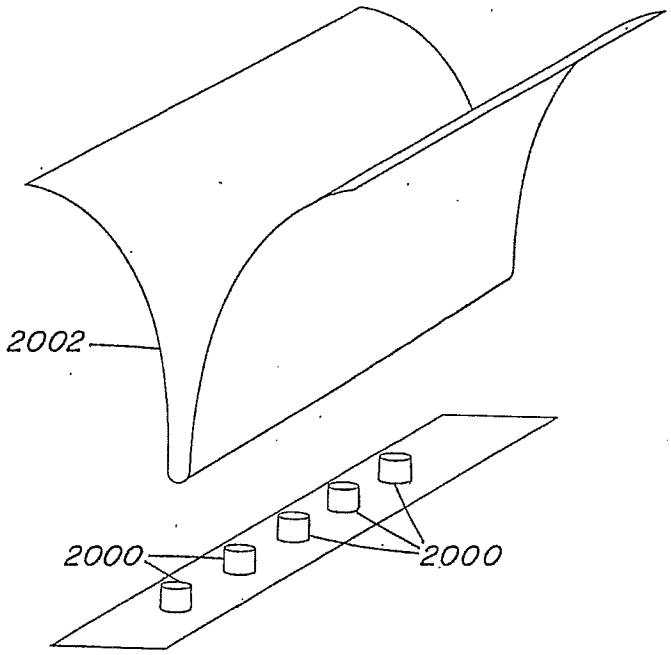


FIG. 20

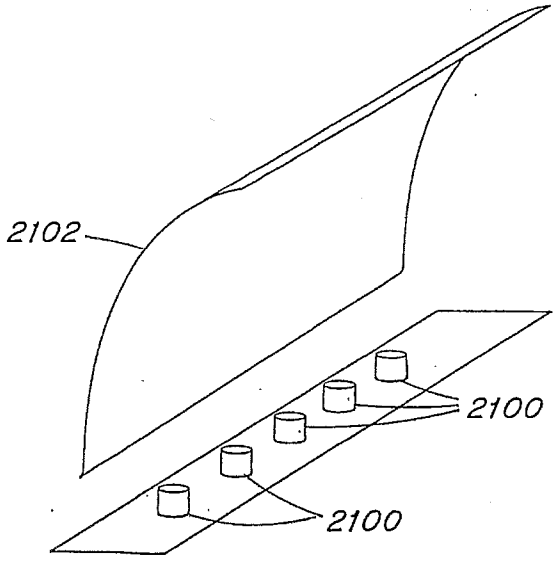


FIG. 21

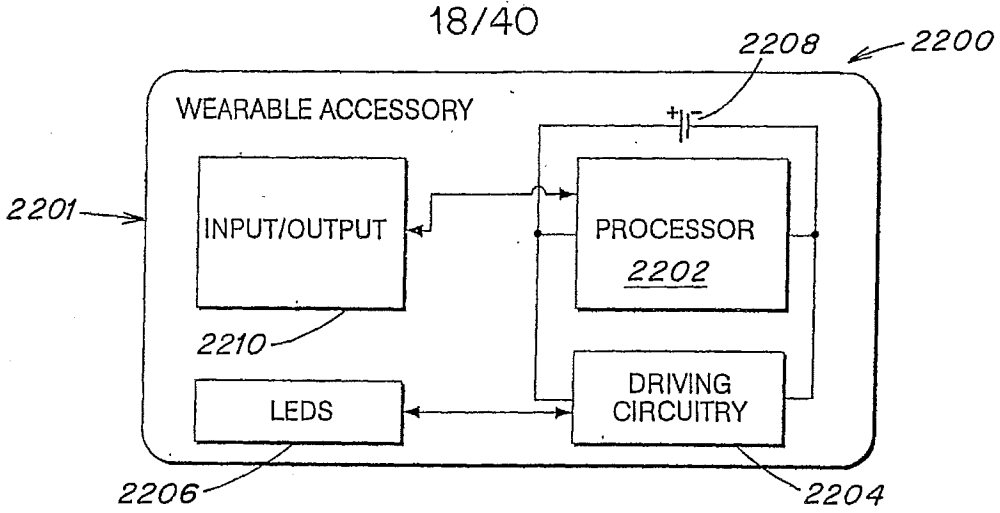

2208
2200
WEARABLE ACCESSORY
2201
INPUT/OUTPUT
PROCESSOR
2202
2210
LEDS
DRIVING
CIRCUITRY
2206
2204

FIG. 22

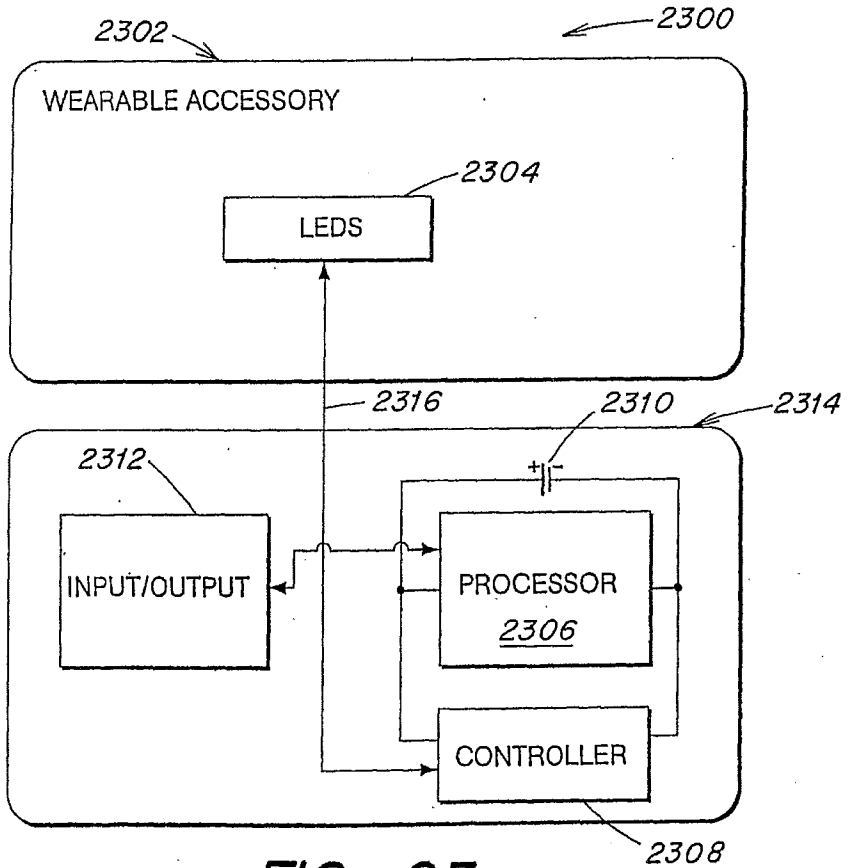

2302
2300
WEARABLE ACCESSORY
2304
LEDS
2316
2310
2314
2312
INPUT/OUTPUT
PROCESSOR
2306
CONTROLLER
2308

FIG. 23

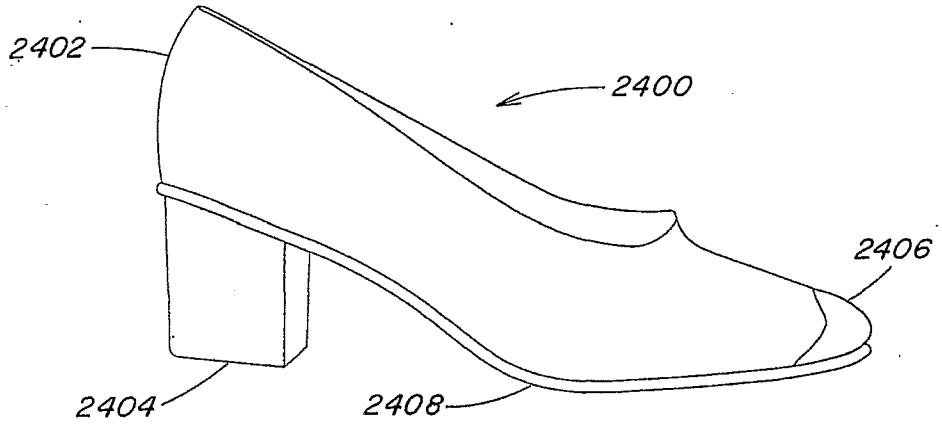


FIG. 24

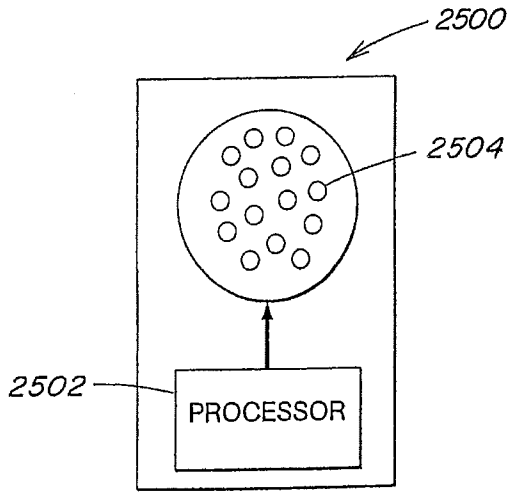


FIG. 25

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1018

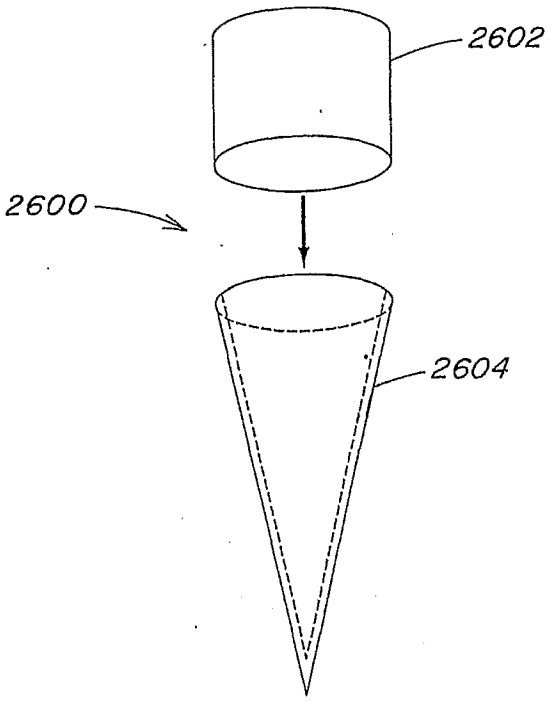

2602
2600
2604

FIG. 26

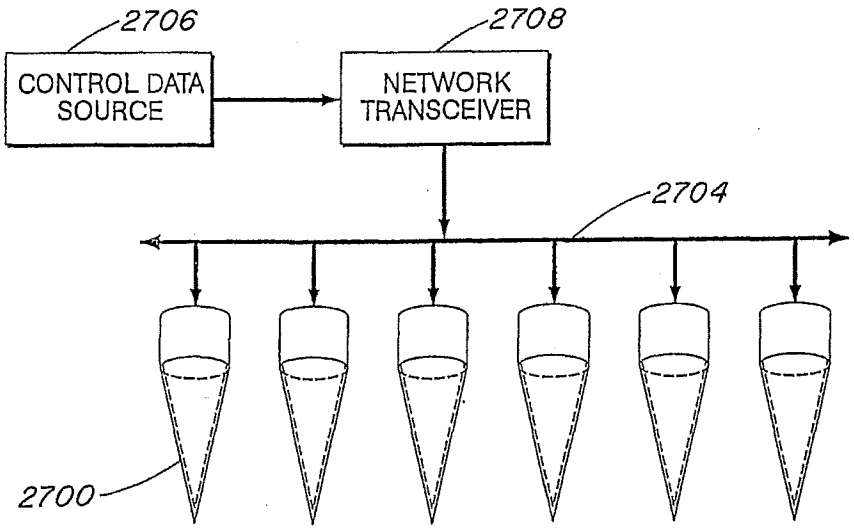

2706
2708
CONTROL DATA SOURCE
NETWORK TRANSCEIVER
2704
2700

FIG. 27

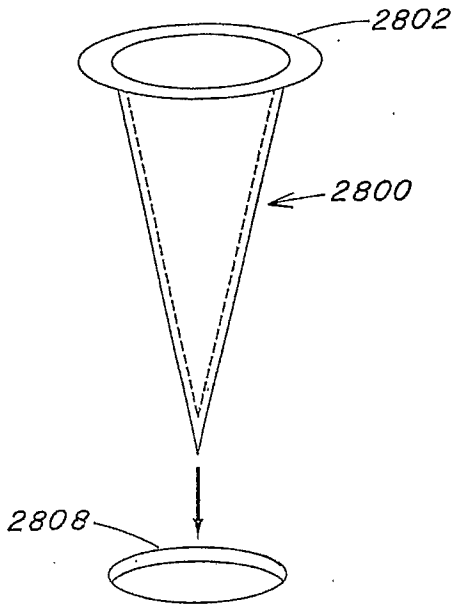


FIG. 28

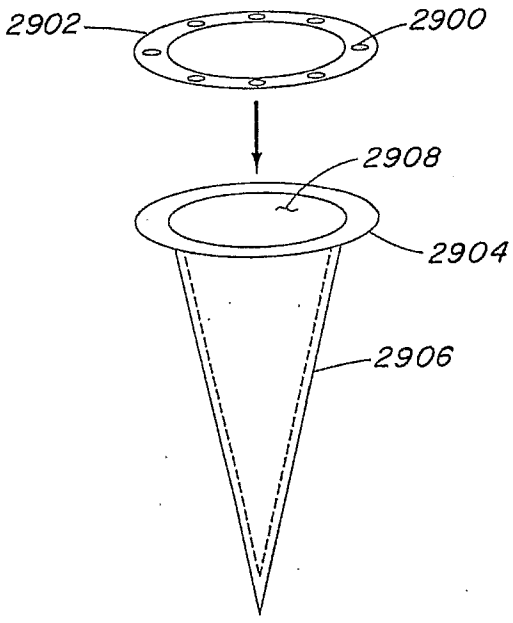


FIG. 29

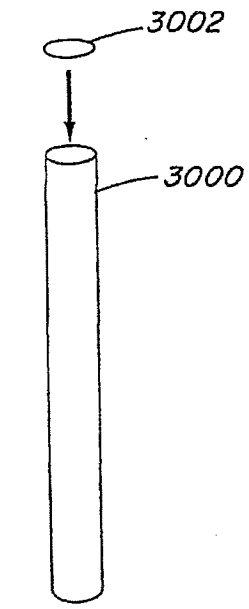


FIG. 30

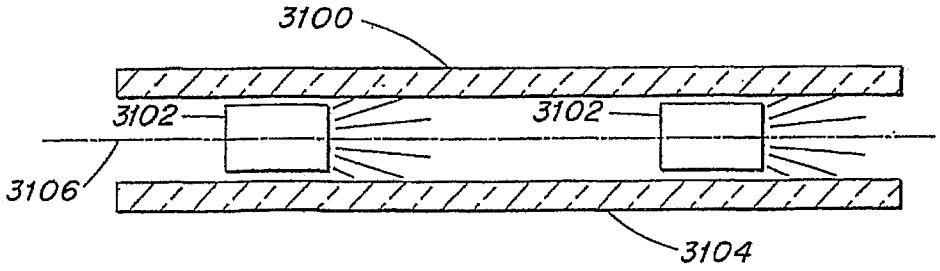


FIG. 31

RECTIFIED SHEET (RULE 91)

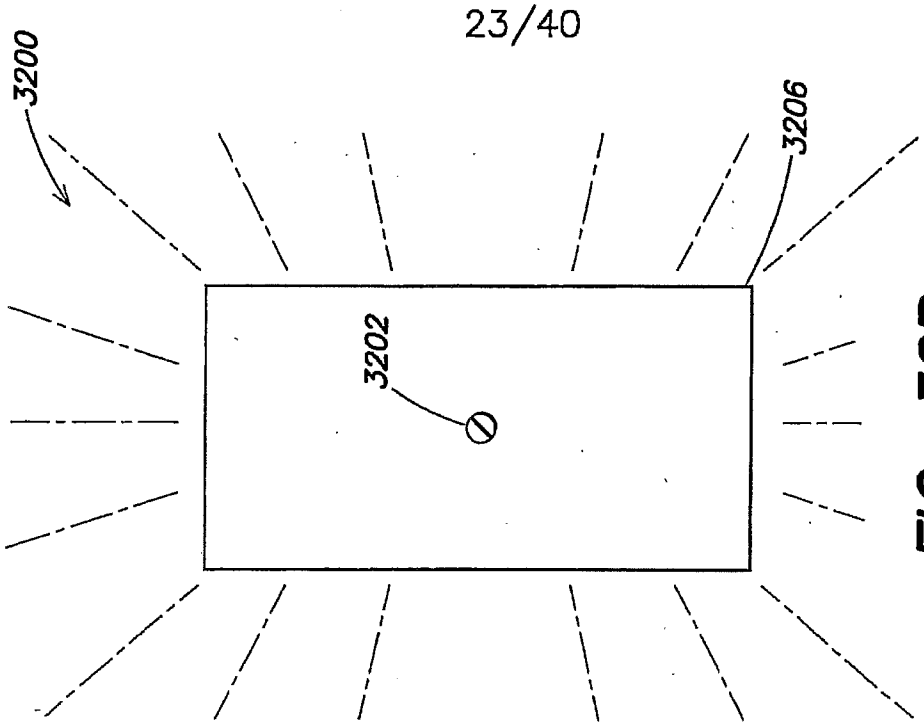


FIG. 32B

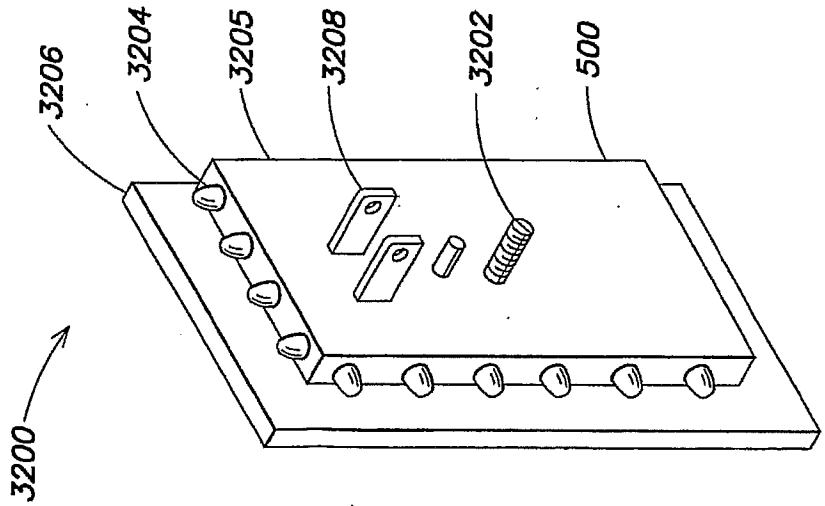


FIG. 32A

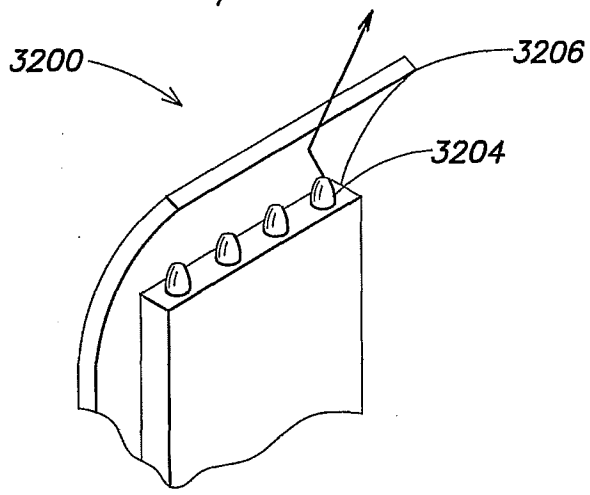


FIG. 33

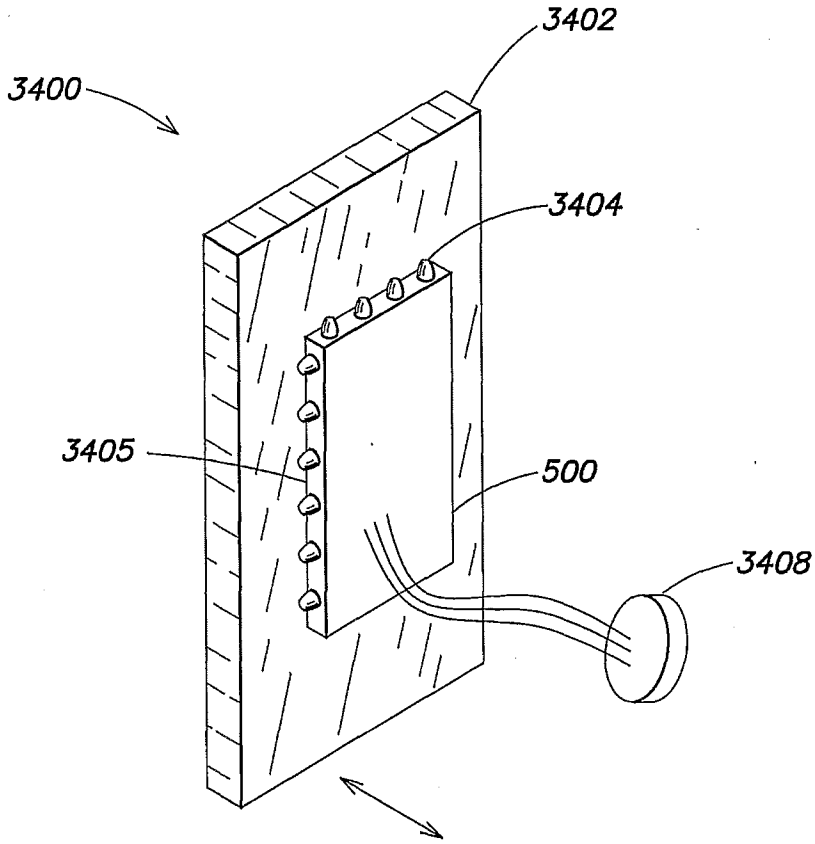


FIG. 34

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1023

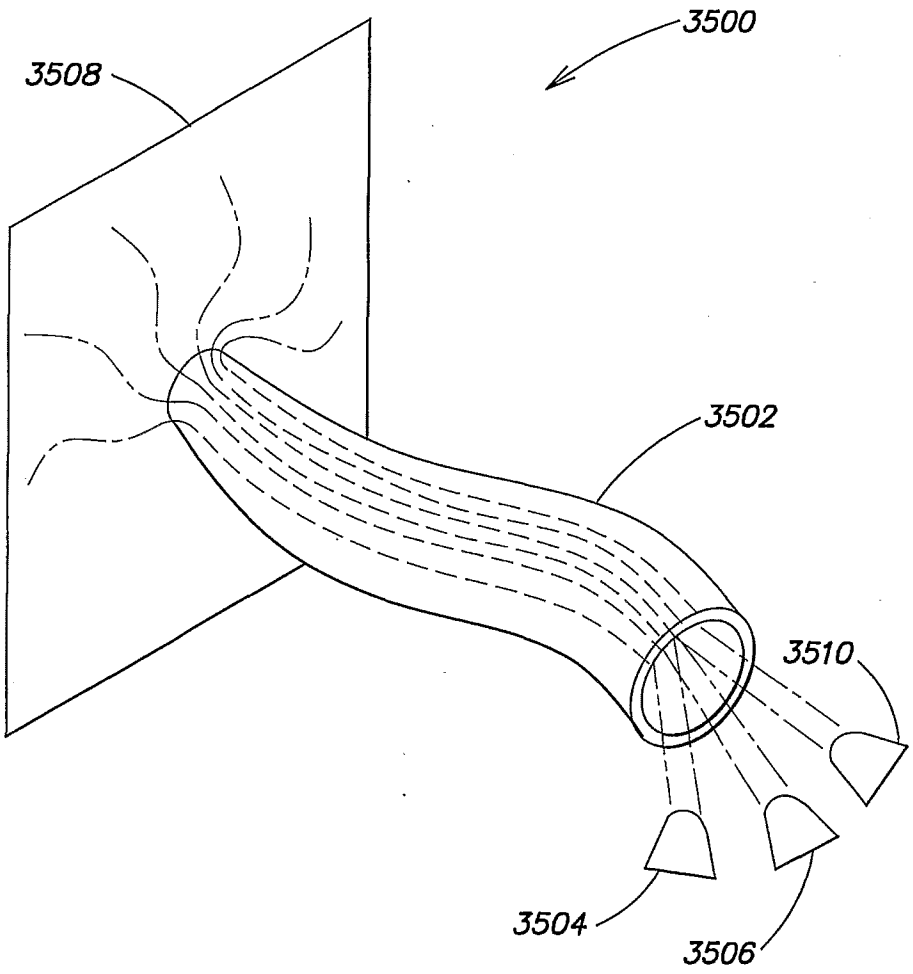


FIG. 35

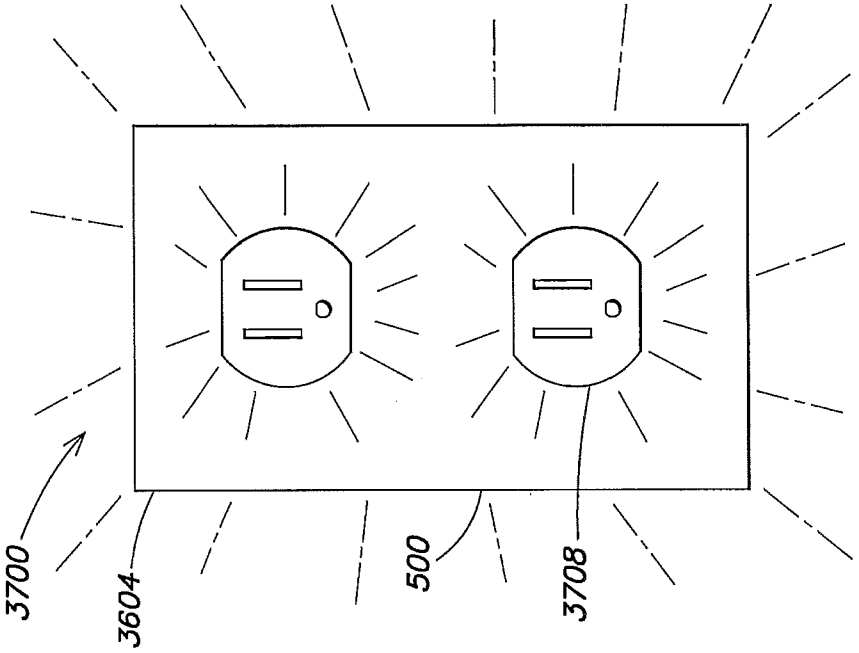


FIG. 37

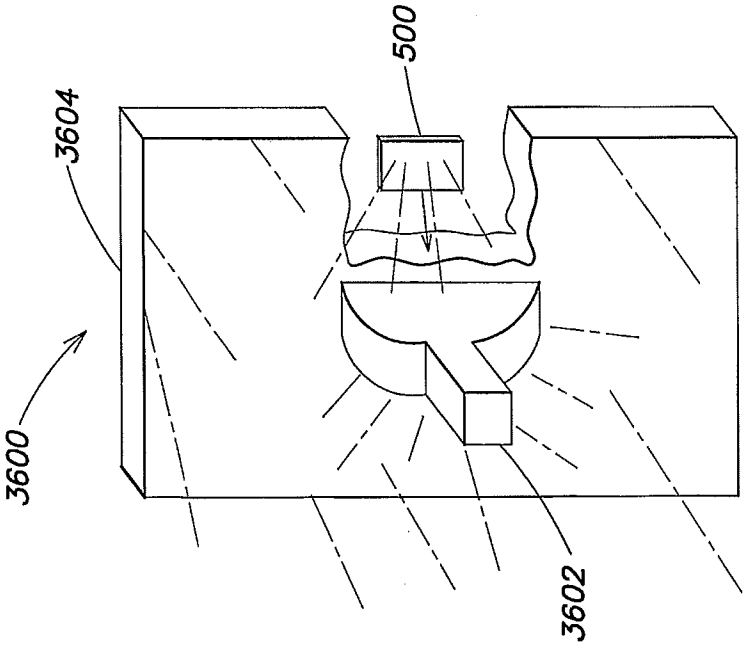


FIG. 36

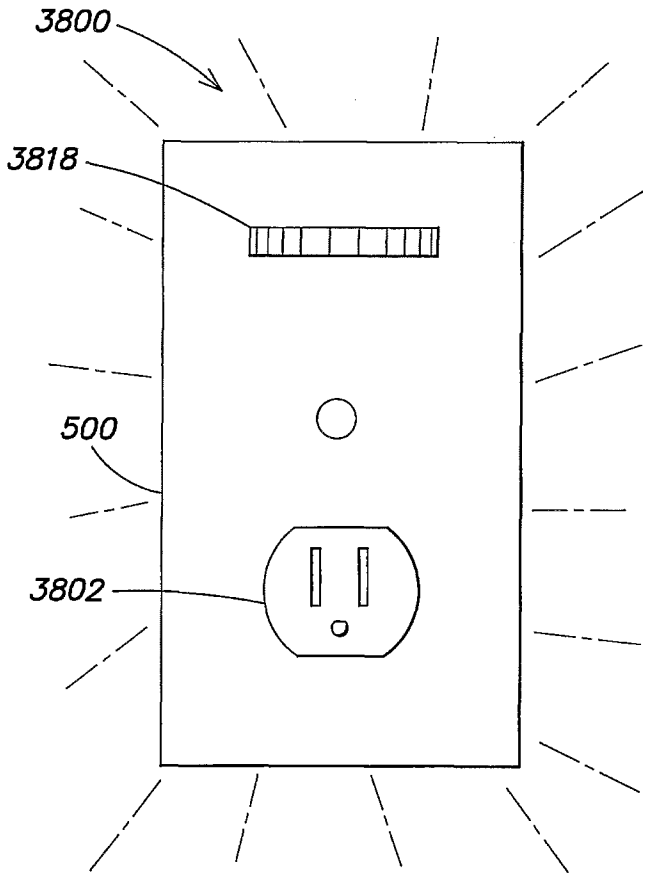


FIG. 38

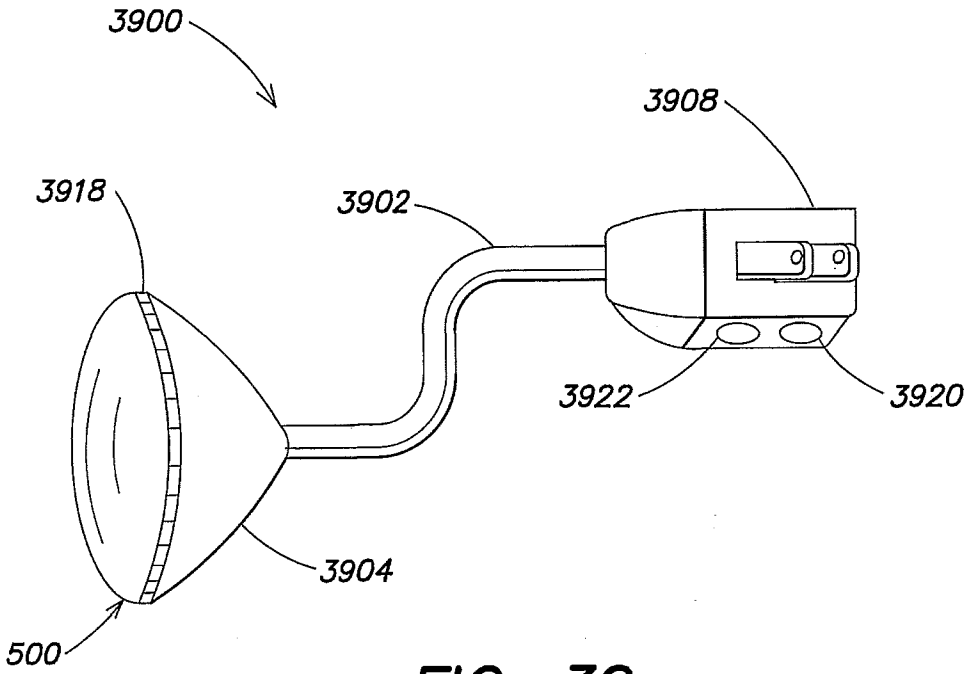

3900
3908
3918
3902
3922
3920
3904
500

FIG. 39

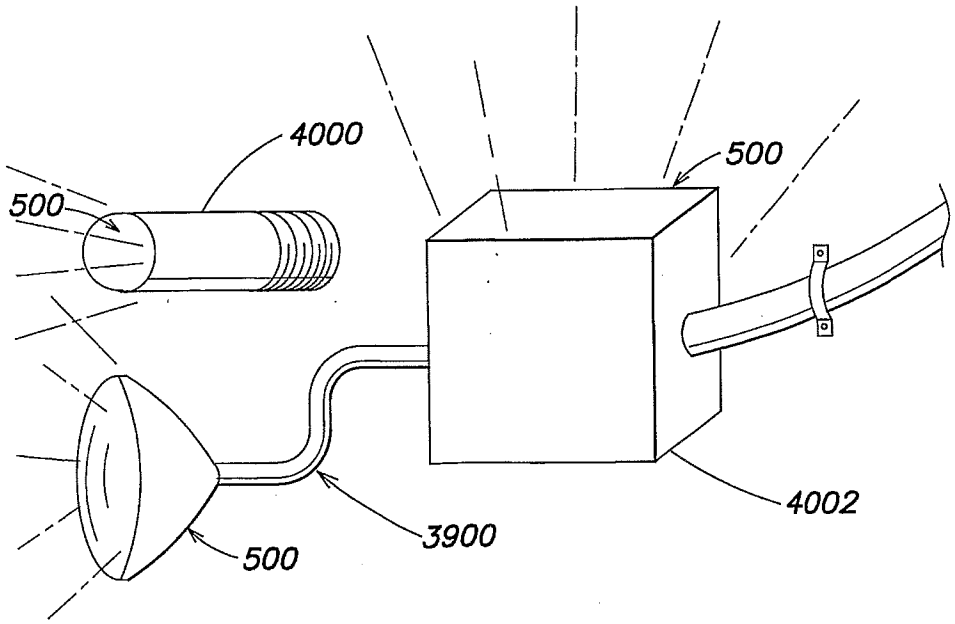

4000
500
500
4002
3900
500

FIG. 40

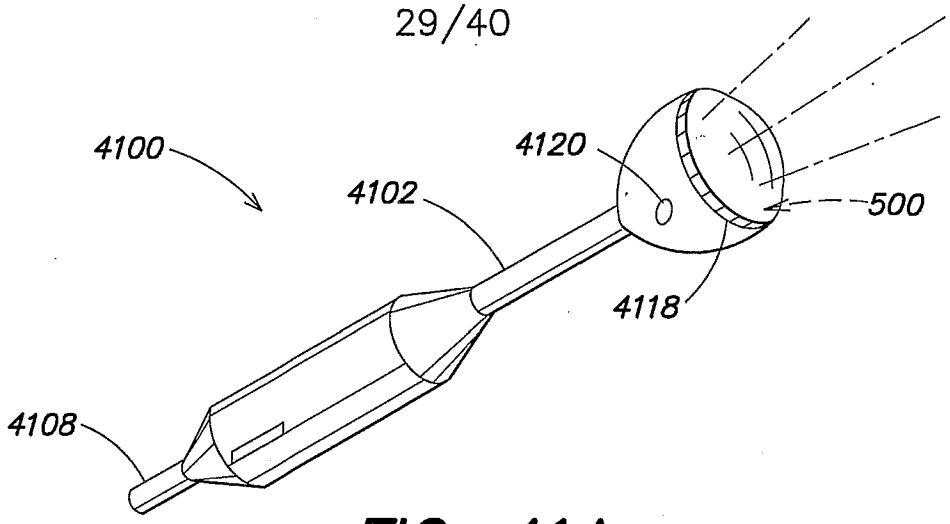


FIG. 41A

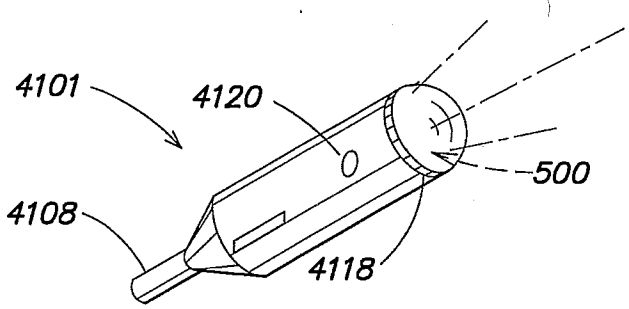


FIG. 41B

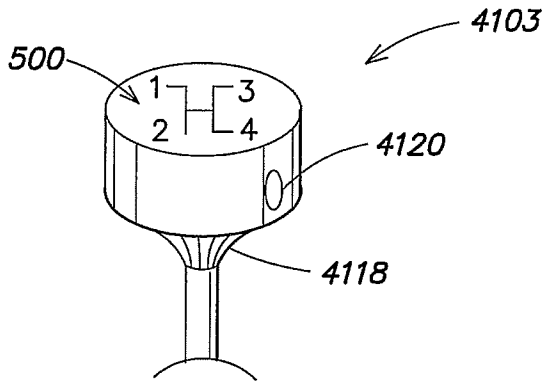


FIG. 41C

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1028

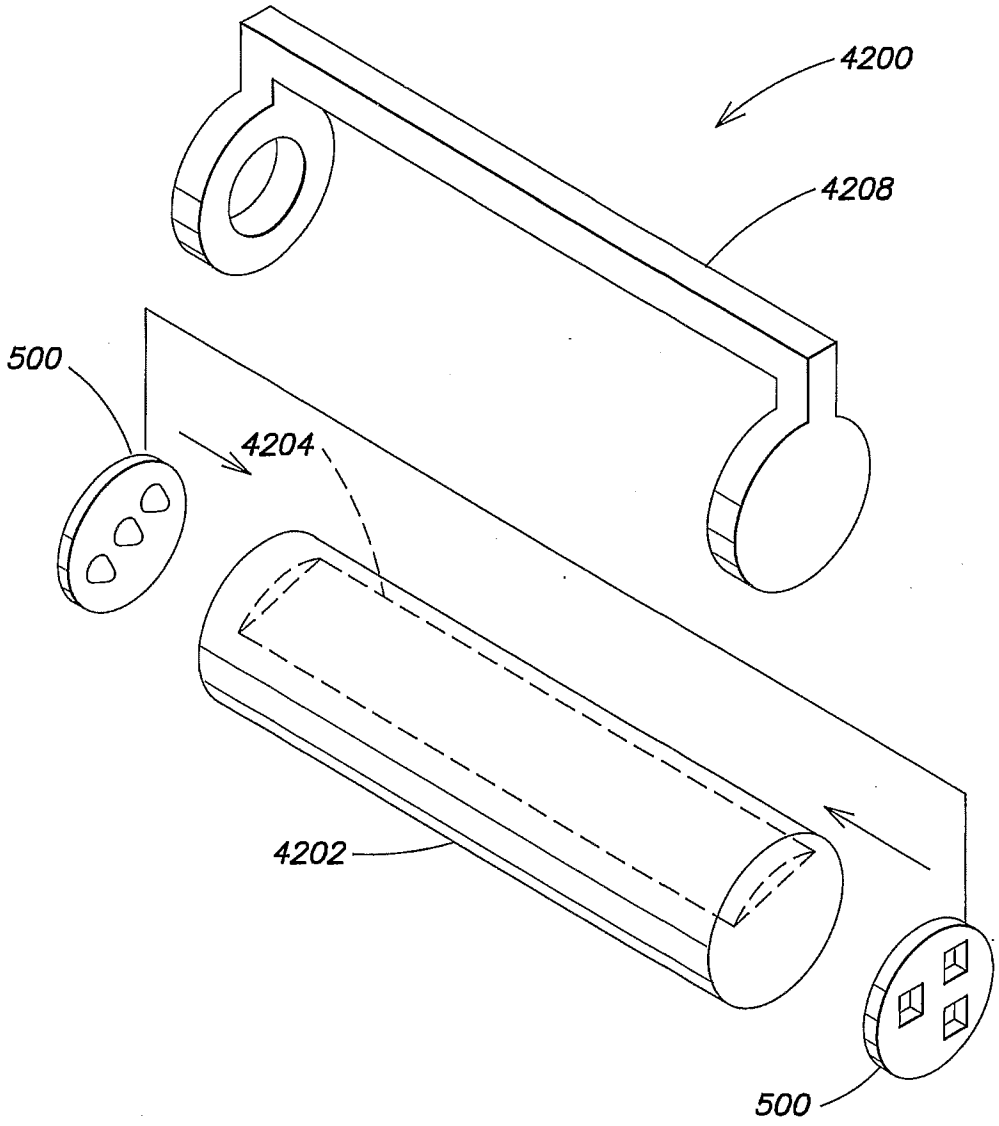


FIG. 42

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1029

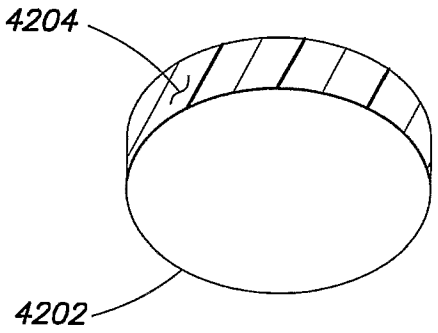


FIG. 43A

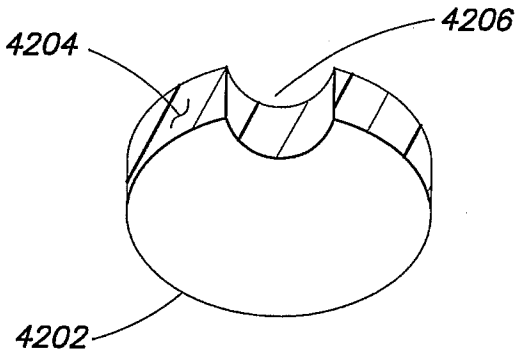


FIG. 43B

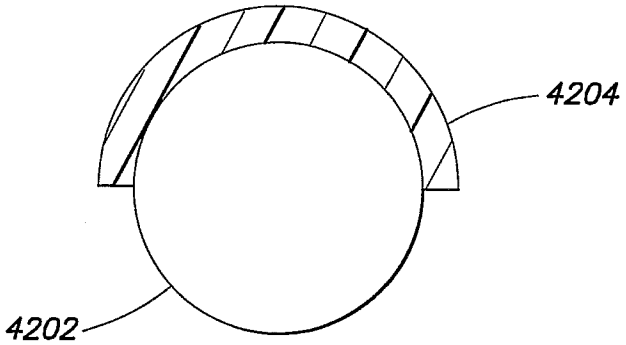


FIG. 43C

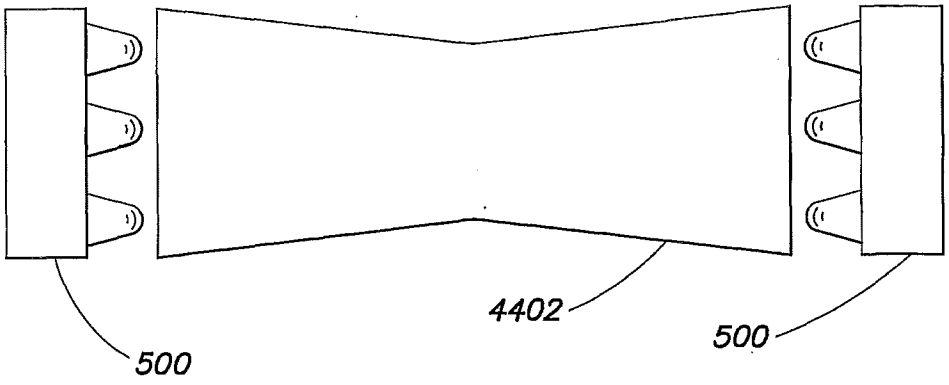


FIG. 44

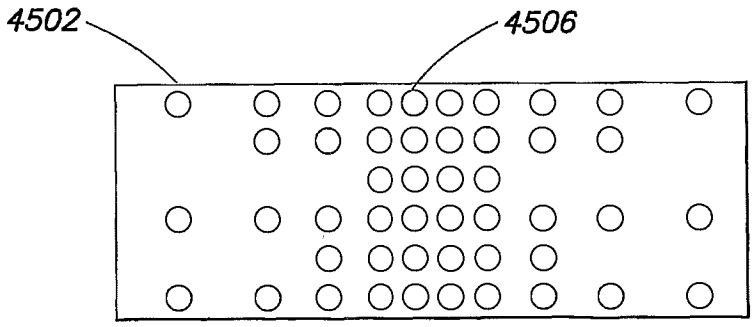


FIG. 45

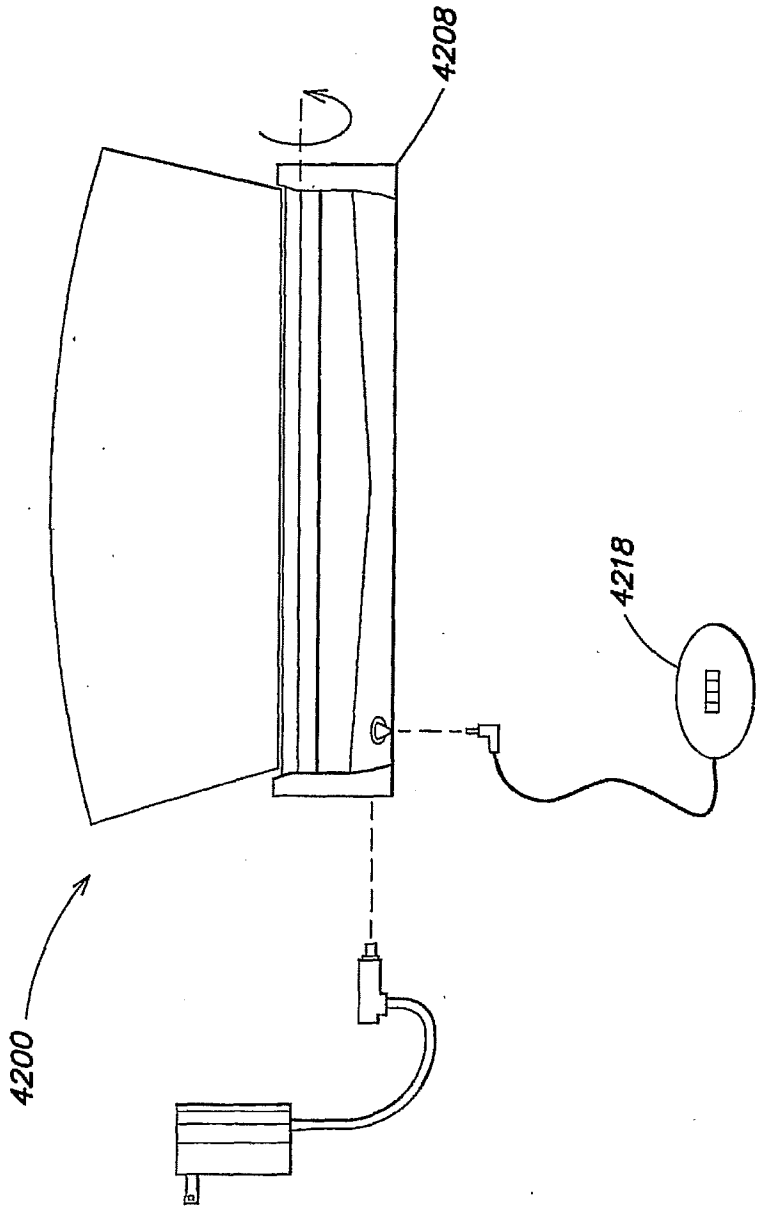


FIG. 46

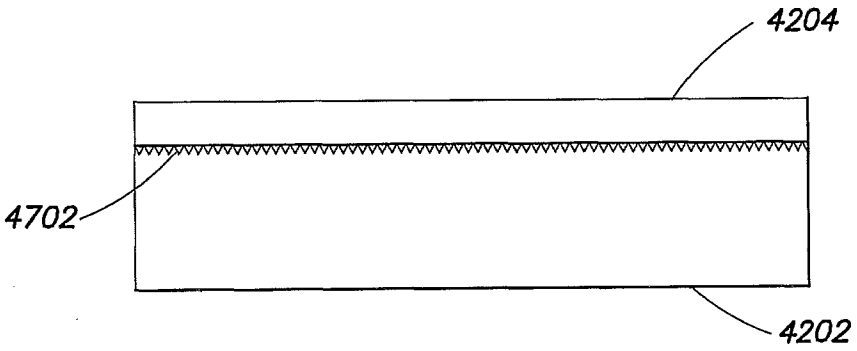


FIG. 47

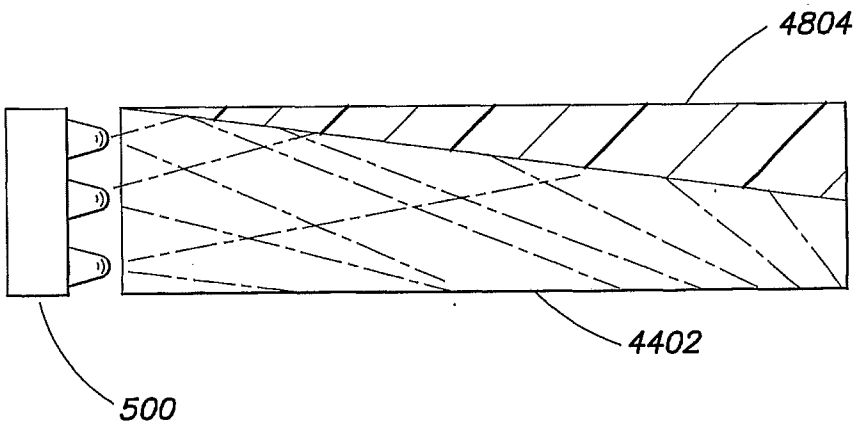


FIG. 48

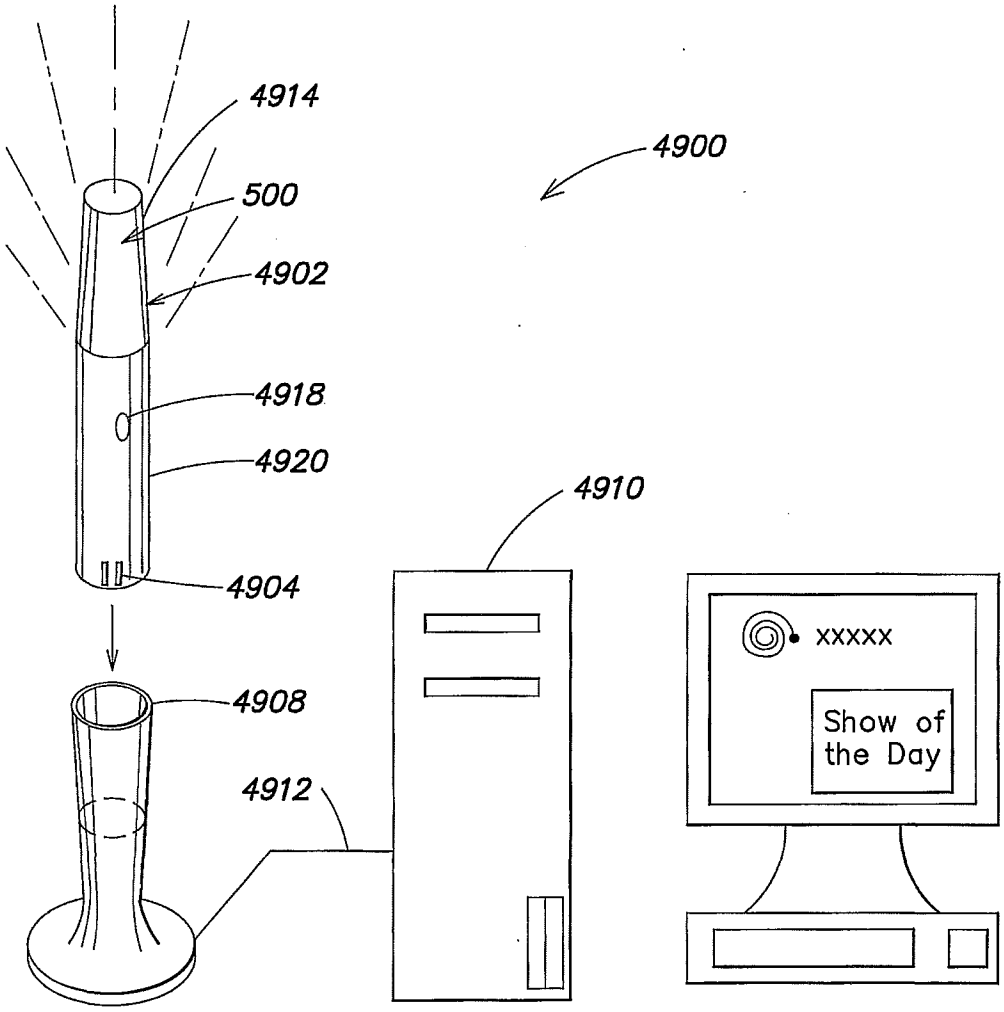

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FIG. 49

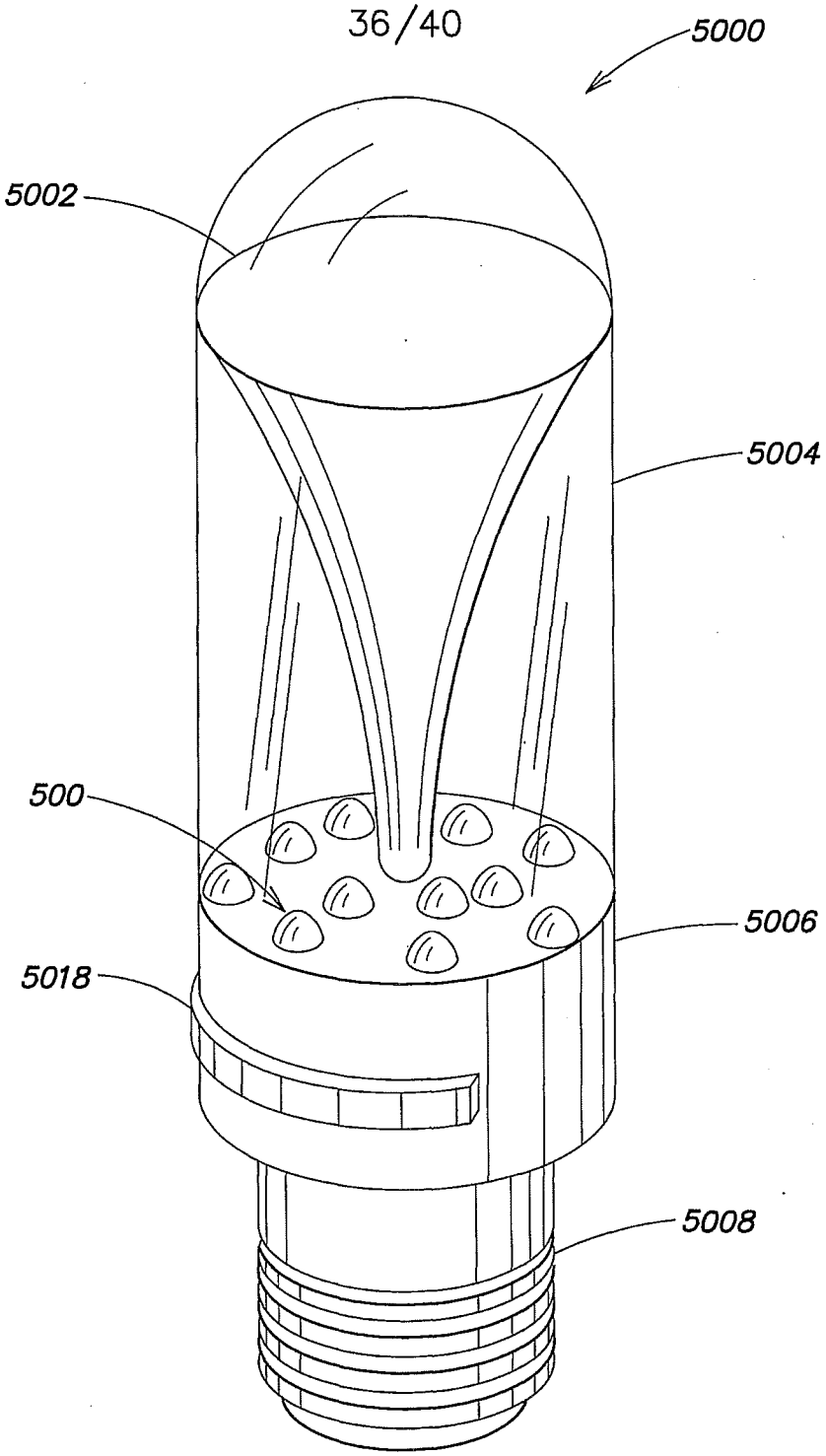


FIG. 50

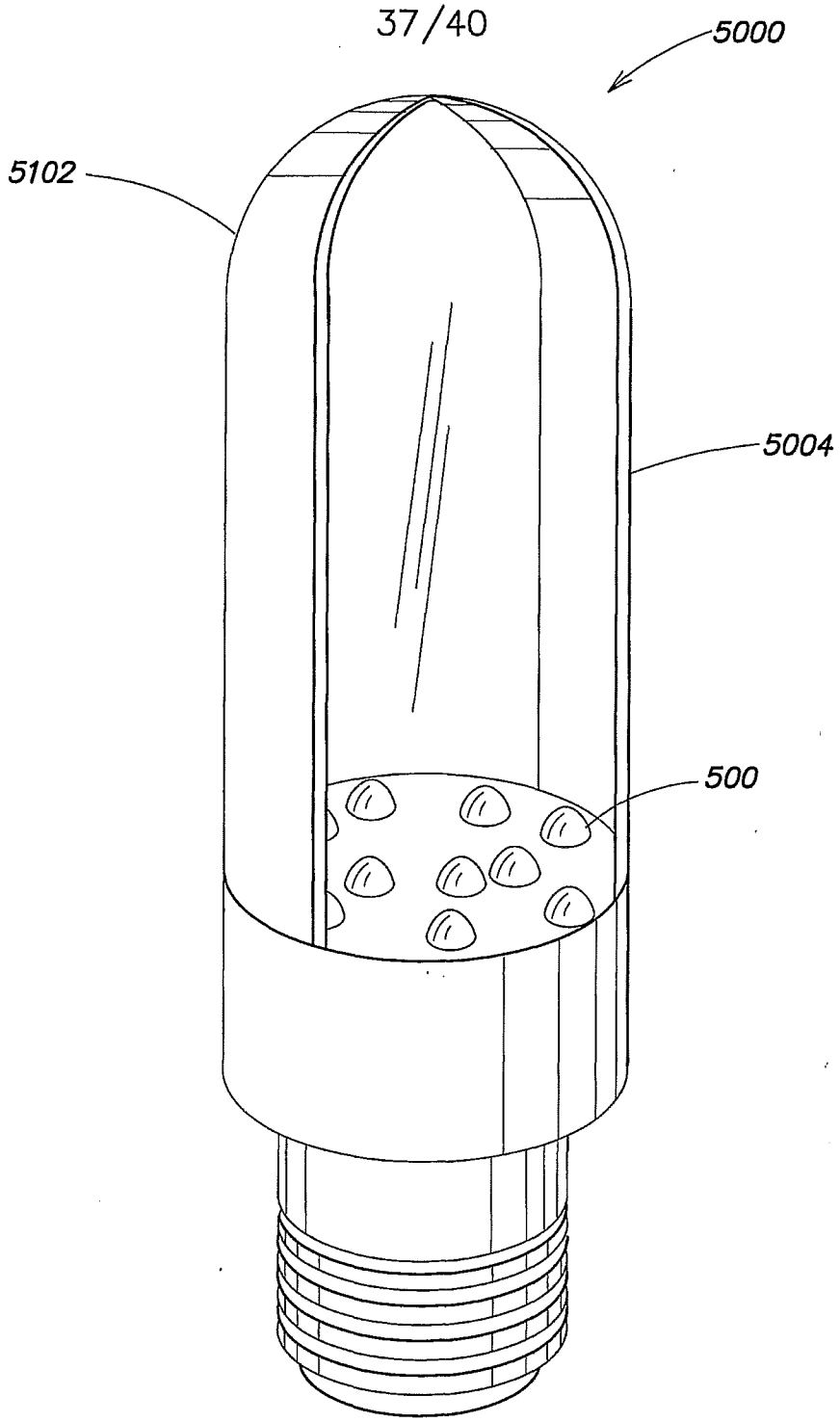


FIG. 51

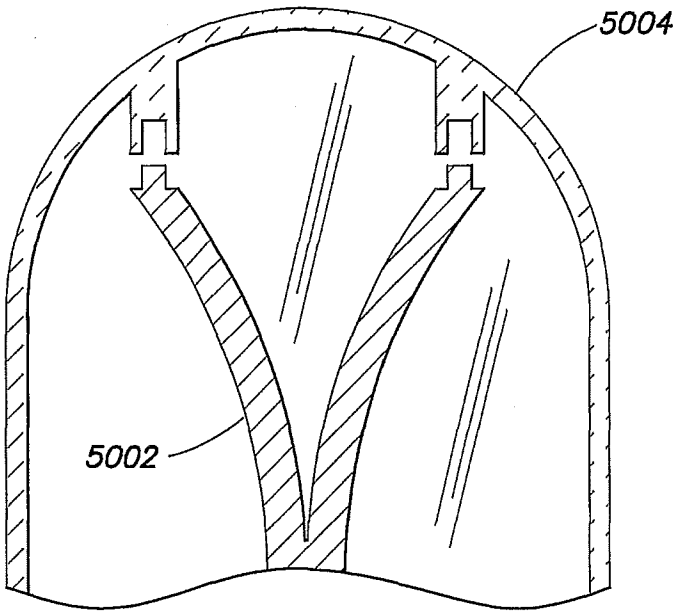


FIG. 52

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1037

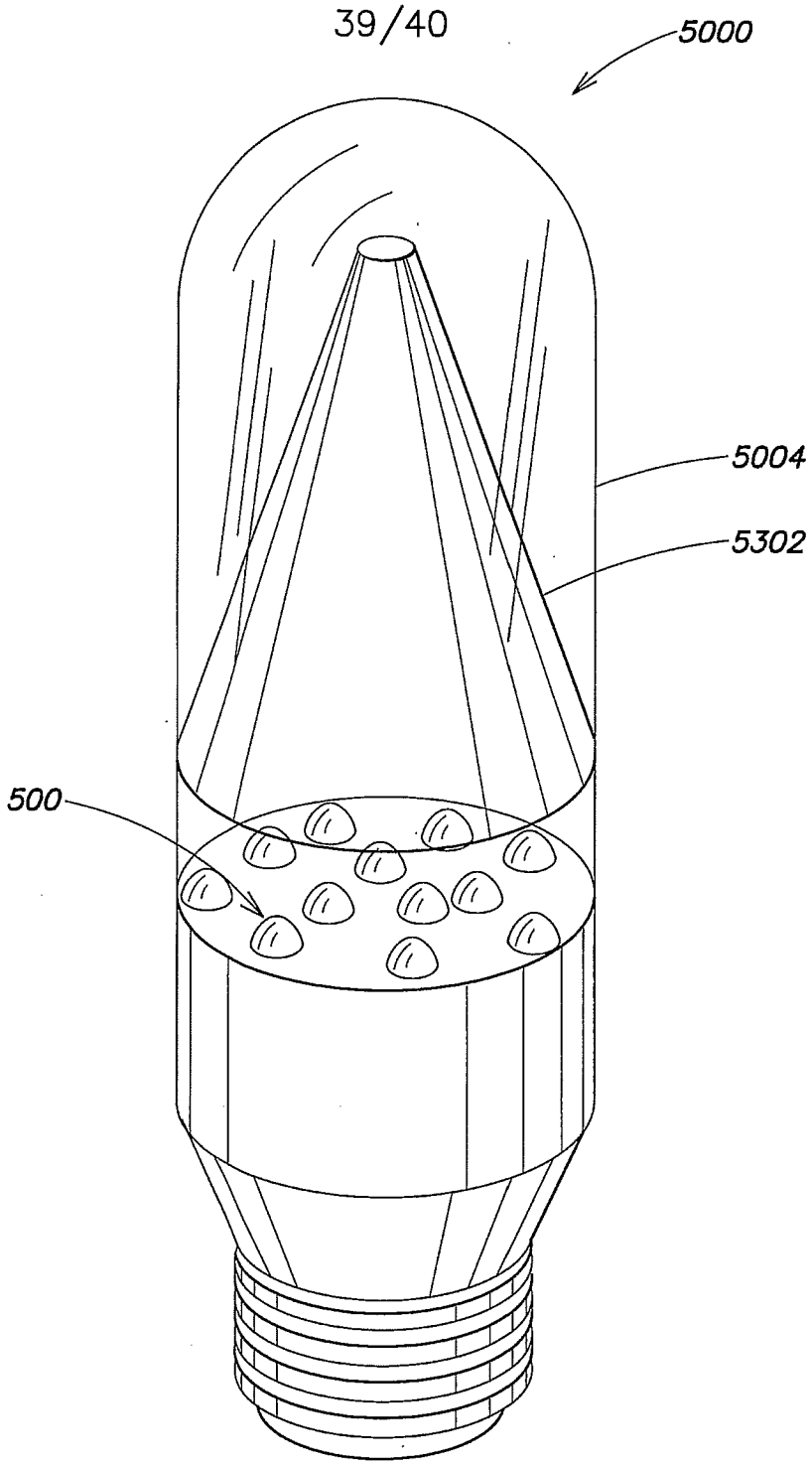


FIG. 53

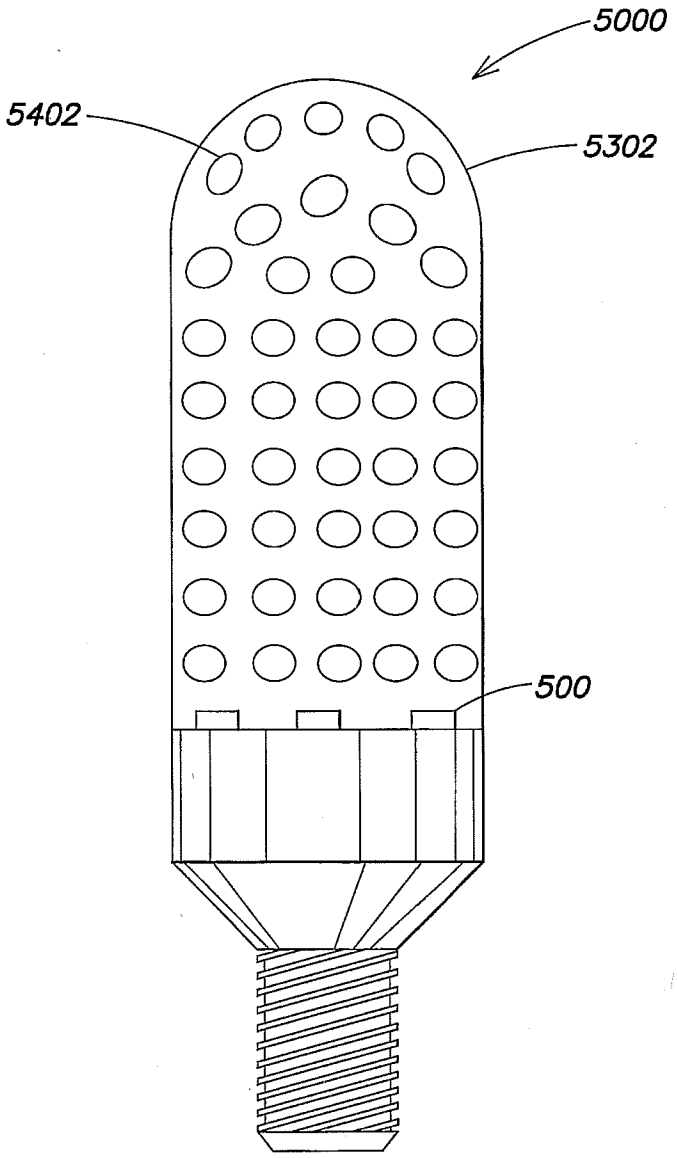


FIG. 54

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/29453

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05B33/08 A61G7/00 F24D13/02 H04N5/74

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05B A61G F24D H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, WPI Data, IBM-TDB, INSPEC, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) & JP 11 290395 A (PARAMOUNT BED CO LTD), 26 October 1999 (1999-10-26)	1
A	abstract	2-15
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 12, 3 January 2001 (2001-01-03) & JP 2000 240962 A (EIDAI CO LTD), 8 September 2000 (2000-09-08) abstract	1-15
A	US 4 809 078 A (YABE NOBOL ET AL) 28 February 1989 (1989-02-28) Whole document	1-15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 December 2002	16/12/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Pierron, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 02/29453

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 11290395 A	26-10-1999	JP 2879819 B2	05-04-1999
JP 2000240962 A	08-09-2000	NONE	
US 4809078 A	28-02-1989	GB 2147765 A ,B	15-05-1985

Form PCT/ISA/210 (patent family annex) (July 1992)

Electronic Acknowledgement Receipt

EFS ID:	44103567
Application Number:	17181802
International Application Number:	
Confirmation Number:	5141
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Customer Number:	24573
Filer:	Dennis A. Majewski/US Patent Mail
Filer Authorized By:	Dennis A. Majewski
Attorney Docket Number:	3725194.00146 14US07
Receipt Date:	22-OCT-2021
Filing Date:	22-FEB-2021
Time Stamp:	16:49:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	Lynk-Labs-Amended-Prlim-Infringement-Contentions-Aug-2021.pdf	872866 22f35f154d90a6a8293c07a0856b2306fd52b43d	no	9

Warnings:

Information:					
2	Non Patent Literature	Lynk-Labs-Answer-to-first-Amend-Complaint.pdf	1431145 c505caeb21b89c0222916bf17563780b2a3590a6	no	67
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Information:					
3	Non Patent Literature	Lynk-Labs-Infringement-contentions-claim-charts-for-US11019697-July-21-2021.pdf	2412262 286a4cc29e824ad3aa2828707117aaee00e66029	no	52
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4	Non Patent Literature	Lynk-Labs-Prelim-Infringement-Contentions-July-21-2021.pdf	872710 f3ab59113672c5938725d958b284e62aeafd0bc2	no	9
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5	Non Patent Literature	Lynk-Labs-v-Sansung-Complaint.pdf	1414245 a0a8887d8d550ed4a44dc42d9519621e56e194ac	no	12
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6	Non Patent Literature	NDIL-1-21-cv-02665-docket-accessed-2021-09-06.pdf	758525 5ea344d61a5bd9e1408611ba1d9b15df7f02719d	no	9
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7	Non Patent Literature	Samsungs-Motion-to-Dismiss-Transfer-or-Stay.pdf	977459 1410697cde6dca10a8ffebc407c28a60a7464e61	no	27
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8	Non Patent Literature	Samsung-v-Lynk-Labs-First-Amended-Complaint.pdf	939474 de60c0907a1c71ce1ecb010dcc21a95d1c1d2f29	no	33
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Information:					
10	Non Patent Literature	EX1003BakerCVEmbdeded.PDF	784403 c9e11d019058cd87ba874eb36999d42150e9e1e2	no	36
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11	Non Patent Literature	EX1018BluetoothIEEE2002standardEmbeddedPart1.pdf	10475444 462200506f60b1ed4f3e1fd5f2f5095ee8819901	no	302
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12	Non Patent Literature	EX1018BluetoothIEEE2002standardEmbeddedPart2.pdf	10478117 b53e57dc9814c19fd5d7a553faa91f55da8281fb	no	370
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13	Non Patent Literature	EX1018BluetoothIEEE2002standardEmbeddedPart3.pdf	9155228 9f773a0583c5fcc8214b55582e0710a38e90514b	no	496
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Information:					
14	Non Patent Literature	EX1030WO2011082168PCTUS2010062235EMBEDDED.PDF	746611 dc16f686b5f307c605b8f20f795612788ceb7106	no	38
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15	Non Patent Literature	EX1073OrderGoverningProceedingsPatentCasesEmbedded.PDF	196882 82a8274e5f9bc6293b06f0da3fe00ed861740d37	no	12
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16	Non Patent Literature	EX1088LynkLabsInfringementcontentionsclaimchartsUS11019697Aug312021EMBEDDED.PDF	1192343 ea68f493d863454c8ed3d9f41837716b997e5e0e	no	50
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17	Non Patent Literature	EX1089EstimatedPatentScheduleNDILLEmbedded.PDF	39317 791ef00b7473786961b92cdade95d4d916fa85fb	no	2
Warnings:					
Information:					
18	Non Patent Literature	Ex1002DeclarationofRJacobBakerPhDPEUS10652979.PDF	2485384 5382a200e01a5a4a23235a1ab6433717615 03593	no	174
Warnings:					
Information:					
19	Non Patent Literature	Ex1003BakerCV-979-Patent.PDF	804321 2fde1748cd9e7c318073a25d6b97745a66b90f6d	no	36
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Information:					
20	Non Patent Literature	Ex1018McGrawDictionary.PDF	922083 b96f31fb58dfeca6c3b793b97916f4202e4463a7	no	10
Warnings:					
Information:					
21	Foreign Reference	Ex1051PiepgrasWO2003026358.PDF	1941106 8f6e20d1de599c2b50f3bf8d65b2f35825a8ade8	no	100
Warnings:					
Information:					
22	Non Patent Literature	Ex1072LynkSupplInitialInfringementContentions551979AppxK3979claimchart.PDF	304843 9b735167d0b37592879625ef91cc54603c04a5bc	no	14
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Information:					

23	Non Patent Literature	Ex1074WDTX621cv005261LynkLabsvSamsungComplaint-979-Patent.PDF	282065 a8488314be3830c28ca77533599a486be925e4e5	no	12
Warnings:					
Information:					
24	Non Patent Literature	Ex1075WDTX621cv0052611FirstAmendedComplaint-979-Patent.PDF	407432 8714c177ab58018dac3c4c2221981f74ab5cffcb	no	18
Warnings:					
Information:					
25	Non Patent Literature	Ex1076NDIL121cv0266564SecondAmendedComplaint-979-Patent.PDF	583583 bd13837fa9ee44de0c5ed43eda7b97e91ac42292	no	44
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Information:					
26	Non Patent Literature	Ex1077NDIL121cv02665Docket20210927-979-Patent-A.PDF	262956 95b161a9bcef8abb5da65a29565ab370868668d3	no	12
Warnings:					
Information:					
27	Non Patent Literature	Ex1078WDTX621cv00526Docket20210927-979-Patent-A.PDF	163614 e484b3bc08877019b86972e603f2ef8b9221ae8a	no	8
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Information:					
28	Non Patent Literature	Ex1079NDIL121cv05126Docket20210929-979-Patent-A.PDF	178032 61caa34eae010c73ab59aa420a02202e00d8505f	no	8
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Information:					
29	Non Patent Literature	Ex1081WDTX621cv00097Docket20210927-HD-SUPP-Patent-A.PDF	177976 ee562a4220b5116338a12d276e0bfa9135af5030	no	10
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30	Non Patent Literature	298NoticeFiling.PDF	61945 5b1ebeb2e4107270d5204476d79bfa9b66077a0c	no	6
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31	Non Patent Literature	551PetitionInter.PDF	1364987 fb9b3b46ce53f1aec799938ace04b18defd5f739	no	90
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35	Non Patent Literature	298-Mandatory-Notice.pdf	132424 8917c0da4090ba418209d38101ae035062a671d3	no	5
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36	Non Patent Literature	298-Petition-Inter.pdf	1800232 c66e6c8779672b1244b0f113d9422f47d6da3b4a	no	93
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37	Non Patent Literature	298-POA.pdf	113825 ac44fca29ec311d7ee63451976ee9c3881aeed75	no	3
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Information:					
38	Non Patent Literature	466-Notice-Filing.pdf	208164 b2c62b4310e1ae561c23dd05f74e5a26869ebc15	no	5
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39	Non Patent Literature	466-Petition-Inter.pdf	1475702 817a1e16ac37da53c6d58d7ceaf454e5f10d1877	no	88
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40	Non Patent Literature	466-Mandatory-Notice.pdf	132417 333556be17c08a5b26e8be65e49188154ae933a0	no	5
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41	Non Patent Literature	466-POA.pdf	113840 b4929fbed11d0369ad88cb19bf68289fb7f8f8bf	no	3
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Information:					
42	Non Patent Literature	674-Mandatory-Notice.pdf	133735 7f0f8c452a0eb1e7b541bc43521aba3c2fff0179	no	5
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43	Non Patent Literature	674-Notice-Filing.pdf	214141 fd012d16eb93a608074d1f33acbdc30bbbf55257	no	6
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Information:					

44	Non Patent Literature	674-Petition-Inter.pdf	3040588 86196d49421520878b62f2d75830860b30ef3f85	no	90
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45	Non Patent Literature	674-POA.pdf	113820 7511f8c36b4e6aa147053db764ce36555f726484	no	3
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46	Non Patent Literature	697-Mandatory-Notice.pdf	133329 d1c47cfabbc020f161e042d59d31eb01f9a68a62	no	5
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47	Non Patent Literature	697-Notice-Accept-Correct-Pet-A.pdf	102160 155e432a46226d560e79bb908f007038458fcbb8	no	2
Warnings:					
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48	Non Patent Literature	697-Notice-Filing-A.pdf	196616 879b5fb00d37d058cf3589da45545aad0e5b51d0	no	6
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49	Non Patent Literature	697-Petition-Inter.pdf	2570537 4262219f04c627eb9827aa1578a3dac6a932b11a	no	95
Warnings:					
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50	Non Patent Literature	697-Pet-Response-Paper-3.pdf	87403 05dcb5cb400e816e3dca63957bd589387a824d6c	no	3
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51	Non Patent Literature	697-POA.pdf	113797 21a0ec8667f49889dda48782f1d44615fdfd3e75	no	3
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New International Application Filed with the USPTO as a Receiving Office

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 November 2011 (17.11.2011)

PCT

(10) International Publication Number
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(51) International Patent Classification:
G05F 1/00 (2006.01)

(21) International Application Number:
PCT/US201 1/036359

(22) International Filing Date:
12 May 201 1 (12.05.201 1)

(25) Filing Language: English

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(30) Priority Data:
61/333,963 12 May 2010 (12.05.2010) US
PCT/US2010/001597 28 May 2010 (28.05.2010) US
PCT/US2010/062235
28 December 2010 (28.12.2010) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier applications:
US PCT/US2010/062235 (CIP)
Filed on 28 December 2010 (28. 12.2010)
US PCT/US2010/001597 (CIP)
Filed on 28 May 2010 (28.05.2010)

(71) Applicant *(for all designated States except US):* **LYNK LABS, INC.** [US/US]; 2511 Technology Drive, Suite 108, Elgin, IL 60123-9323 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only):* **MISKIN, Michael** [US/US]; 2 Pinecone Lane, Sleepy Hollow, IL 601 18 (US).

(74) Agent: **LAKE, Michael, D.;** FACTOR & LAKE, LTD., 1327 W. Washington Blvd., Suite 5G/H, Chicago, IL 60607 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

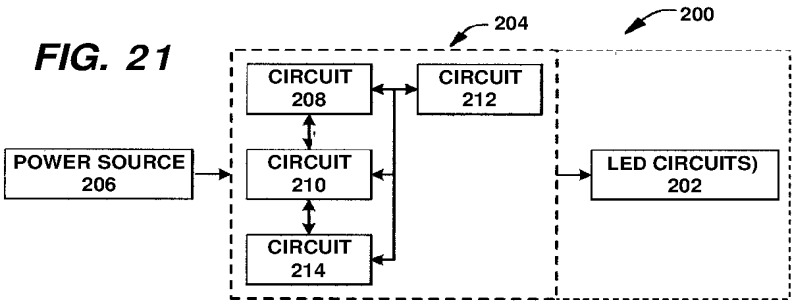
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: LED LIGHTING SYSTEM

FIG. 21



(57) Abstract: An LED lighting system having at least one LED circuit and at least two circuits or drivers capable of receiving an AC voltage at a first frequency and having an output capable of driving the at least one LED circuit, wherein the output of each circuit or driver capable of driving the at least one LED circuit is provided to the at least one LED circuit through a circuit or sensor capable of permitting only a single output from the at least two circuits or drivers be provided to the at least one LED circuit.

WO 2011/143510 © Al

LED LIGHTING SYSTEM

RELATED APPLICATIONS

[Para 1] The application is a continuation-in-part of International Application No. PCT/US20 10/062235 filed December 28, 2010 which claims priority to U.S. Provisional Application No. 61/284,927 filed December 28, 2009 and U.S. Provisional Application No. 61/335,069 filed December 31, 2009 and is a continuation-in-part of U.S. Patent Application No. 12/287,267, filed October 6, 2008, which claims priority to U.S. Provisional Application No. 60/997,771, filed October 6, 2007; U.S. Patent Application No. 12/364,890 filed February 3, 2009 which is a continuation of U.S. Application No. 11/066,414 (now U.S. Patent No. 7,489,086) filed February 25, 2005 which claims priority to U.S. Provisional Application No. 60/547,653 filed February 25, 2004 and U.S. Provisional Application No. 60/559,867 filed April 6, 2004; International Application No. PCT/US201 0/001 597 filed May 28, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/217,215, filed May 28, 2009; International Application No. PCT/US20 10/00 1269 filed April 30, 2010 which is a continuation-in-part of U.S. Application **No.** 12/287,267, and claims priority to U.S. Provisional Application No. 61/215,144, filed May 1, 2009; this application also claims priority to U.S. Provisional Application No. 61/333,963 filed May 12, 2010; the contents of each of these applications are expressly incorporated herein by reference.

TECHNICAL FIELD

[Para 2] The present invention relates to an LED lighting system having multiple circuits or drivers capable of providing an output to at least one LED circuit.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1053

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[Para 3] **None.**

BACKGROUND **OF THE INVENTION**

[Para 4] Description of the Related Art

[Para 5] LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED. Some LEDs have resistors built into the LED package providing a higher voltage LED typically driven with 5V DC or 12V DC.

[Para 6] Some standard AC voltages in the world include 12VAC, 24VAC, 100VAC, 110VAC, 120VAC, 220VAC, 230VAC, 240VAC and 277VAC. Therefore, it would be advantageous to have a single chip LED or multi-chip single LED packages and/or devices that could be easily configured to operate at multiple voltage levels and/or multiple brightness levels by simply selecting a voltage and/or current level when packaging the multi-voltage and/or multi-current single chip LEDs or by selecting a specific voltage and/or current level when integrating the LED package onto a printed circuit board or within a finished lighting product. It would also be advantageous to have multi-current LED chips and/or packages for LED lamp applications in order to provide a means of increasing brightness in LED lamps by switching in additional circuits just as additional filaments are switched in for standard incandescent lamps.

[Para 7] US 7,525,248 discloses a *chip-scale* LED lamp including discrete LEDs capable of being built upon electrically insulative, electrically conductive, or electrically semi

conductive substrates. Further, the construction of the LED lamp enables the lamp to be configured for high voltage AC or DC power operation. The LED based solid-state light emitting device or lamp is built upon an electrically insulating layer that has been formed onto a support surface of a substrate. Specifically, the insulating layer may be epitaxially grown onto the substrate, followed by an LED buildup of an n-type semiconductor layer, an optically active layer, and a p-type semiconductor layer, in succession. Isolated mesa structure of individual, discrete LEDs are formed by etching specific portions of the LED buildup down to the insulating layer, thereby forming trenches between adjacent LEDs. Thereafter, the individual LEDs are electrically coupled together through conductive elements or traces being deposited for connecting the n-type layer of one LED and the p-type layer of an adjacent LED, continuing across all of the LEDs to form the solid-state light emitting device. The device may therefore be formed as an integrated AC/DC light emitter with a positive and negative lead for supplied electrical power. For instance, the LED lamp may be configured for powering by high voltage DC power (e.g., 12V, 24V, etc.) or high voltage AC power (e.g., 110/120V, 220/240V, etc.).

[Para 8] US 7,213,942 discloses a single-*cAip* LED device through the use of integrated circuit technology, which can be used for standard high AC voltage (110 volts for North America, and 220 volts for Europe, Asia, etc.) operation. The ***single-chip*** *A C LED* device integrates many smaller LEDs, which are connected in series. The integration is done during the LED fabrication process and the final product is a single-c/iip device that can be plugged directly into house or building power outlets or directly screwed into incandescent lamp sockets that are powered by standard AC voltages. The series connected smaller LEDs are patterned by photolithography, etching (such as plasma dry etching), and metallization on a single *chip*. The electrical insulation between small LEDs within a *single-chip* is achieved by etching light emitting materials into the insulating substrate so that no light emitting

material is present between small LEDs. The voltage crossing each one of the small LEDs is about the same as that in a conventional DC operating LED fabricated from the same type of material (e.g., about 3.5 volts for blue LEDs).

[Para 9] Accordingly, single chip LEDs have been limited and have not been integrated circuits beyond being fixed series, fixed parallel or series parallel circuit configurations until the development of AC LEDs. The AC LEDs have still however been single circuit or parallel circuit fixed single voltage designs.

[Para 10] LED packages have historically not been integrated circuits beyond being fixed series, fixed parallel or fixed series parallel LED circuit configurations.

[Para 11] The art is deficient in that it does not provide a multi-voltage and/or multi-current circuit monolithically integrated on a single substrate which would be advantageous.

[Para 12] It would further be advantageous to have a multi-voltage and/or multi-brightness circuit that can provide options in voltage level, brightness level and/or AC or DC powering input power preference.

[Para 13] It would further be advantageous to provide multiple voltage level and/or multiple brightness level light emitting LED circuits, chips, packages and lamps "multi-voltage and/or multi-brightness LED devices" that can easily be electrically configured for at least two forward voltage drive levels with direct AC voltage coupling, bridge rectified AC voltage coupling or constant voltage DC power source coupling. For example, it would be advantageous to provide a device that can be driven with more than one AC or DC forward voltage "multi-voltage" at 6V or greater based on a selectable desired operating voltage level that is achieved by electrically connecting the LED circuits in a series or parallel circuit configuration and/or more than one level of brightness "multi-brightness" based on a switching means that connects and/or disconnects at least one additional LED circuit to and/or from a first LED circuit. It would be advantageous if the desired operating voltage

level and/or the desired brightness level electrical connection was achieved and/or completed at the LED packaging level when the multi-voltage and/or multi-brightness circuits and/or single chips are integrated into the LED package, or the LED package may have external electrical contacts that match the integrated multi-voltage and/or multi-brightness circuits and/or single chips within, allowing the drive voltage level and/or the brightness level select-ability to be passed on through to the exterior of the LED package and allowing the voltage level or brightness level to be selected at the LED package user, or the PCB assembly facility, or the end product manufacturer.

[Para 14] It would further be advantageous to provide at least two integrated circuits having a forward voltage of at least 12VAC or 12VDC or greater on a single chip or within a single LED package that provide a means of selecting a forward voltage when packaging a multi-voltage and/or multi-brightness circuit using discrete die (one LED chip at a time) and wire bonding them into a circuit at the packaging level or when packaging one or more multi-voltage and/or multi-brightness level single chips within a LED package.

[Para IS] It would further be advantageous to provide multi-voltage and/or multi-brightness level devices that can provide electrical connection options for either AC or DC voltage operation at preset forward voltage levels of 6V or greater.

[Para 16] It would further be advantageous to provide multi-brightness LED devices that can be switched to different levels of brightness by simply switching additional circuits on or off in addition to a first operating circuit within a single chip and or LED package. This would allow LED lamps to switch to higher brightness levels just like 2-way or 3-way incandescent lamps do today.

[Para 17] The benefits of providing multi-voltage circuits of 6V or greater on a single chip is that an LED packager can use this single chip as a platform to offer more than one LED packaged product with a single chip that addresses multiple voltage levels for various

end customer design requirements. This would also increase production on a single product for the chip maker and improves inventory control. This also improves buying power and inventory control for the LED packager when using one chip.

[Para 18] It would further be advantageous to have a LED lighting assembly which includes LED circuitry for AC or DC drive and a high frequency AC voltage transformer or inverter that could be used to convert low frequency voltages, like for example mains voltage or some other low voltage at 50/60 Hz, to a high frequency without a change in the voltage provided. For example, it would be advantageous to have a LED lighting power supply and/or driver capable of receiving 120 VAC at 60 Hz and be able to provide a high frequency AC output directly to an AC driven LED circuit(s), or alternatively to a DC driven LED circuit(s) through an AC-to-DC rectifier at a voltage equal to or different from the original input voltage to the power supply and/or driver.

[Para 19] It would be further advantageous to combine multiple-voltage LED chips, packages, circuits, lamps, etc., high frequency AC voltage power supplies and/or transformers to drive LEDs by either directly connecting a high frequency transformer or inverter to an AC driven LED circuit(s), or by operably connecting an AC-to-DC rectifier between the high frequency transformer or inveter and a DC driven LED circuit. With proper design considerations LEDs may be driven more efficiently with direct AC or rectified AC than with constant voltage or constant current DC drive schemes. High frequency AC transformers or inverters can be made smaller and more cost effective than constant current or constant voltage DC drivers or power supplies currently being used to power LEDs. The higher the frequency, the smaller the transformer can be made. With proper design consideration and based on the wattage and the frequency of the AC voltage output of the power supply, a high frequency AC voltage transformer can be made small enough to be mounted directly onto a LED lighting PCB assembly.

[**Para** 20] It would be further advantageous to provide an LED lighting system capable of operating after a circuit or driver through which power is supplied to LEDs fails.

[**Para** 21] The present invention provides for these advantages and solves the deficiencies in the art.

SUMMARY OF THE INVENTION

[**Para** 22] According to one aspect of the invention at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage AC LED device for direct AC power operation. Each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation.

[**Para** 23] According to another aspect of the invention, each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit.

[**Para** 24] According to another aspect of the invention, each multi-voltage AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. By way of example, the second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration,

the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 25] According to another aspect of the invention, at least two single voltage series LED circuits, each of which have at least two serially connected LEDs, are formed on a single chip or on a substrate providing a multi-voltage AC or DC operable LED device.

[Para 26] According to another aspect of the invention, each single voltage series LED circuit is designed to be driven with a predetermined forward voltage of at least 6V AC or DC and preferably each single voltage series LED circuit has a matching forward voltage of 6V, 12V, 24V, 120V, or other AC or DC voltage levels. By way of example, each multi-voltage AC or DC LED device would be able to be driven with at least two different AC or DC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage series LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level series LED circuits in series. The second forward voltage drive level of the serially connected series LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected series LED circuits. The at least two parallel connected series LED circuits would be twice the current of the at least two serially connected series LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage series LED device.

[Para 27] According to another aspect of the invention, at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness AC LED device for direct AC power operation.

[Para 28] According to another aspect of the invention, each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation. Each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage

of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit. The at least two AC LED circuits within each multi-voltage and/or multi current AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. The second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 29] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of LEDs is formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 30] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VAC, 24VAC, 120VAC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 31] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of standard diodes, LEDs or some combination thereof is provided separate of the LED circuit or formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 32] According to another aspect of the invention a multi-voltage and/or multi-

current AC LED circuit is integrated within a single chip LED. Each multi-voltage and/or multi-current single chip AC LED comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation. Each single voltage AC LED circuit may have may have at least one voltage input electrical contact at each opposing end of the circuit or the at least two single voltage AC LED circuits may be electrically connected together in series on the single chip and have at least one voltage input electrical contact at each opposing end of the two series connected single voltage AC LED circuits and one voltage input electrical contact at the center junction of the at least two single voltage AC LED circuits connected in series. The at least two single voltage AC LED circuits are integrated within a single chip to form a multi-voltage and/or multi-current single chip AC LED.

[Para 33] According to another aspect of the invention, at least one multi-voltage and/or multi-brightness LED devices may be integrated within a LED lamp. The at least two individual LED circuits within the multi-voltage and/or multi-brightness LED device(s) may be wired in a series or parallel circuit configuration by the LED packager during the LED packaging process thus providing for at least two forward voltage drive options, for example 12VAC and 24VAC or 120VAC and 240VAC that can be selected by the LED packager.

[Para 34] According to another aspect of the invention a multi-voltage and/or multi-current AC LED package is provided, comprising at least one multi-voltage and/or multi-current single chip AC LED integrated within a LED package. The multi-voltage and/or multi-current AC LED package provides matching electrical connectivity pads on the exterior of the LED package to the electrical connectivity pads of the at least one multi-voltage and/or multi-current single chip AC LED integrated within the LED package thus allowing the LED package user to wire the multi-voltage and/or multi-current AC LED package into a series or parallel circuit configuration during the PCB assembly process or final product integration

process and further providing a AC LED package with at least two forward voltage drive options.

[Para 35] According to another aspect of the invention multiple individual discrete LED chips are used to form at least one multi-voltage and/or multi-current AC LED circuit within a LED package thus providing a multi-voltage and/or multi current AC LED package. Each multi-voltage and/or multi-current AC LED circuit within the package comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation The LED package provides electrical connectivity pads on the exterior of the LED package that match the electrical connectivity pads of the at least two single voltage AC LED circuits integrated within the multi-voltage and/or multi-current AC LED package thus allowing the LED package to be wired into a series or parallel circuit configuration during the PCB assembly process and further providing a LED package with at least two forward voltage drive options.

[Para 36] According to another aspect of the invention a multi-voltage and/or multi-current single chip AC LED and/or multi-voltage and/or multi current AC LED package is integrated within an LED lamp. The LED lamp having a structure that comprises a heat sink, a lens cover and a standard lamp electrical base. The multi-voltage and/or multi-current single chip AC LED and/or package is configured to provide a means of switching on at least one additional single voltage AC LED circuit within multi-voltage and/or multi-current AC LED circuit to provide increased brightness from the LED lamp.

[Para 37] According to anther broad aspect of the invention at least one multi-current AC LED single chip is integrated within a LED package.

[Para 38] According to another aspect of the invention, at least one single chip multi-current bridge circuit having standard diodes, LEDs, or some combination thereof is integrated within a LED lamp having a standard lamp base. The single chip multi-current

bridge circuit may be electrically connected together in parallel configuration but left open to accommodate switching on a switch to the more than one on the single chip and have at least one accessible electrical contact at each opposing end of the two series connected circuits and one accessible electrical contact at the center junction of the at least two individual serially connected LED circuits. The at least two individual circuits are integrated within a single chip.

[Para 39] According to another aspect of the invention when the at least two circuits are left unconnected on the single chip and provide electrical pads for connectivity during the packaging process, the LED packager may wire them into series or parallel connection based on the desired voltage level specification of the end LED package product offering.

[Para 40] According to another aspect of the invention, a high frequency transformer or inverter may provide power to at least one multi-voltage and/or multi-brightness LED device or chip. The high frequency transformer or inverter may be either packaged with the LED device or chip and may provide direct AC voltage to the LED device or chip, or as a separate driver or power supply for the LED device or chip capable of being electrically connected to the LED device or chip. The high frequency transformer or inverter is designed to receive a voltage at a low frequency, like for example a voltage at 50/60 Hz like a mains voltage, and output a voltage at a high frequency. The high frequency transformer or inverter may also be configured to step-up or step-down the voltage provided to the transformer or inverter from a source voltage.

[Para 41] According to another aspect of the invention, a high-frequency transformer or inverter may provide power to a DC driven-LED circuit, chip, or device or an LED circuit, chip or device containing one or more series strings of LEDs through a rectifier having standard diodes, LEDs, or some combination thereof may be electrically connected between the high-frequency transformer or inverter and. The rectifier may be provided independently

from the high-frequency transformer or inverter and the LED circuit, chip, or device and electrically connected at its input to the high-frequency transformer or inverter and at its output to the LED circuit, chip or device. Alternatively, the rectifier may be packaged with the high-frequency transformer or inverter forming a power supply or driver for the LED circuit, chip, or device. The rectifier may likewise be packaged directly with, or as part of, an LED circuit, chip, or device. As should be appreciated by those having skill in the art, packaging the rectifier directly with the LED circuit, chip, or device allows for an LED package containing a DC-driven LED circuit, chip, or device, or one or more series strings of LEDs, to be directly plugged into any power supply or driver providing an AC voltage output and operate. As a further alternative, a high-frequency inverter, rectifier, and LED circuit, chip, or device may be packaged into a single lighting device capable of being directly incorporated into a lighting element, or may be incorporated directly into a lamp or other OEM product utilizing LED light.

[Para 42] According to another aspect of the invention, a two-way or three-way switch may be provided directly between a high-frequency inverter providing power to a LED circuits, chip, or device and the LED circuits, chip or device, or in the alternative between a LED circuits, chip, or device and a rectifier having standard diodes, LEDs, or some combination thereof electrically connected to a high-frequency transformer or inverter.

[Para 43] According to another aspect of the invention, an LED lighting system having multiple circuits or drivers capable of receiving an AC voltage input at a first frequency, like for example a mains input, and providing an output capable of driving at least one LED circuit is provided. The LED lighting system includes a sensor capable of sensing the output of each circuit or driver capable of driving the LED circuit, and permitting only a single output to be provided. The sensor may be further capable of switching between circuits or drivers capable of driving the LED circuit if any circuit or driver currently being utilized

fails.

[Para 44] Other aspects and features of the invention will become apparent to those having ordinary skill in the art upon review of the following Description, Claims, and associated Drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 45] FIG. 1 shows a schematic view of a preferred embodiment of the invention;

[Para 46] FIG. 2 shows a schematic view of a preferred embodiment of the invention;

[Para 47] FIG. 3 shows a schematic view of a preferred embodiment of the invention;

[Para 48] FIG. 4 shows a schematic view of a preferred embodiment of the invention;

[Para 49] FIG. 5 shows a schematic view of a preferred embodiment of the invention;

[Para 50] FIG. 6a shows a schematic view of a preferred embodiment of the invention;

[Para 51] FIG. 6b shows a schematic view of a preferred embodiment of the invention;

[Para 52] FIG. 7a shows a schematic view of a preferred embodiment of the invention;

[Para 53] FIG. 7b shows a schematic view of a preferred embodiment of the invention;

[Para 54] FIG. 8 shows a schematic view of a preferred embodiment of the invention;

[Para 55] FIG. 9 shows a schematic view of a preferred embodiment of the invention;

[Para 56] FIG. 10 shows a schematic view of a preferred embodiment of the invention;

[Para 57] FIG. 11 shows a schematic view of a preferred embodiment of the invention;

[Para 58] FIG. 12 shows a schematic view of a preferred embodiment of the invention;

[Para 59] FIG. 13 shows a schematic view of a preferred embodiment of the invention;

[Para 60] FIG. 14 shows a schematic view of a preferred embodiment of the invention;

[Para 61] FIG. 15 shows a schematic view of a preferred embodiment of the invention;

[Para 62] FIG. 16 shows a block diagram of a preferred embodiment of the invention;

[Para 63] FIG. 17 shows a block diagram of a preferred embodiment of the invention;

[Para 64] **FIG.** 18 shows a block diagram of a preferred embodiment of the invention;

[Para 65] **FIG.** 19 shows a block diagram of a preferred embodiment of the invention; and,

[Para 66] **FIG.** 20 shows a block diagram of a preferred embodiment of the invention.

[Para 67] **FIG.** 21 shows a block diagram of an embodiment of an LED system as contemplated by the invention.

[Para 68] **FIG.** 22 shows a block diagram of an embodiment of an LED system as contemplated by the invention.

[Para 69] **FIG.** 23 shows a schematic diagram of a circuit or driver as contemplated by the invention.

[Para 70] **FIG.** 24 shows a schematic diagram of an LED circuit as contemplated by the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[Para 71] While the present invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

[**Para** 72] **FIG.** 1 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 10. The multi-voltage and/or multi-brightness LED lighting device 10 comprises at least two AC LED circuits 12 configured in an imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 16a and 16c are electrically

connected together and 16b and 16d are electrically connected together and one side of the AC voltage input is applied to 16a and 16c and the other side of the AC voltage input is applied to 16b and 16d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 16a and 16c are electrically connected and the AC voltage inputs are applied to electrical contacts 16b and 16d, a second operating forward voltage is required to drive the single chip 18. The single chip 18 may also be configured to operate at more than one brightness level "multi-brightness" by electrically connecting for example 16a and 16b and applying one side of the line of an AC voltage source to 16a ad 16b and individually applying the other side of the line from the AC voltage source a second voltage to 26b and 26c.

[Para 73] FIG. 2 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 20 similar to the multi-voltage and/or multi-brightness LED lighting device 10 described above in FIG. 1. The at least two AC LED circuits 12 are integrated onto a substrate 22. The at least two AC LED circuits 12 configured in a imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d on the exterior of the substrate 22 and can be used to electrically configure and/or control the operating voltage and/or brightness level of the multi-voltage and/or multi-brightness LED lighting device.

[Para **74]** FIG. 3 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 30 similar to the multi-voltage and/or multi-brightness LED lighting device 10 and 20 described in FIGs. 1 and 2. The multi-voltage and/or multi-brightness LED lighting device 30 comprises at least two AC LED circuits 32 having at least two LEDs 34 connected in series and anti-parallel configuration. The at least two AC LED circuits 32 have electrical contacts 36a, 36b, 36c, and 36d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 36a and 36c are electrically connected together and 36b and 36d are electrically connected together and one

side of the AC voltage input is applied to 36a and 36c and the other side of the AC voltage input is applied to 36b and 36d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 36a and 36c are electrically connected and the AC voltage inputs are applied to electrical contacts 36b and 36d, a second operating forward voltage is required to drive the multi-voltage and/or multi-brightness lighting device 30. The multi-voltage and/or multi-brightness lighting device 30 may be a monolithically integrated single chip 38, a monolithically integrated single chip integrated within a LED package 38 or a number of individual discrete die integrated onto a substrate 38 to form a multi-voltage and/or multi-brightness lighting device 30.

[Para **75]** FIG. 4 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in parallel configuration to an AC voltage source and operating at a first forward voltage. A resistor 40 may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device 30.

[Para 76] FIG. 5 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in series configuration to an AC voltage source and operating at a second forward voltage that is approximately two times greater than the first forward voltage of the parallel circuit as described in FIG. 4. A resistor may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device.

[Para 77] FIGs. 6a and 7a disclose schematic diagrams of a multi-voltage and/or multi-brightness LED lighting devices 50. The multi-voltage and/or multi-brightness LED lighting devices 50 comprises at least two AC LED circuits 52, each of which have at least two LEDs 54 in series and anti-parallel relation. The at least two AC LED circuits 52 have at least three electrical contacts 56a, 56b and 56c, and in the case of FIG. 7a a fourth electrical contact 56d.

The at least two AC LED circuits 52 are electrically connected together in parallel at one end 56a and left unconnected at the opposing ends of the electrical contacts 56b and 56c, and in the case of FIG. 7a, 56d. One side of an AC voltage source line is electrically connected to 56a and the other side of an AC voltage source line is individually electrically connected to 56b, 56c, and 56d with either a fixed connection or a switched connection thereby providing a first brightness when AC voltage is applied to 56a and 56b and a second brightness when an AC voltage is applied to 56a, 56b and 56c, and a third brightness when an AC voltage is applied to 56a, 56b, 56c, and 56d. It is contemplated that the multi-voltage and/or multi-brightness LED lighting devices 50 are a single chip, an LED package, an LED assembly or an LED lamp.

[Para 78] FIGs. 6b and 7b disclose a schematic diagram similar to the multi-voltage and/or multi-brightness LED device 50 shown in FIGs. 6a and 7a integrated within a lamp 58 and connected to a switch 60 to control the brightness level of the multi-voltage and/or multi-brightness LED lighting device 50.

[Para 79] FIG. 8 discloses a schematic diagram of a multi-brightness LED lighting device 62 having at least two bridge rectifiers 68 in series with LED circuits 69. Each of the at least two bridge rectifiers 68 in series with LED circuits 69 comprise four LEDs 70 configured in a bridge circuit 68. LED circuits 69 have at least two LEDs 71 connected in series and electrical contacts 72a, 72b and 72c. When one side of an AC voltage is applied to 72a and the other side of an AC voltage line is applied to 72b and 72c individually, the brightness level of the multi-brightness LED lighting device 62 can be increased and/or decreased in a fixed manner or a switching process.

[Para 80] FIG. 9 discloses a schematic diagram the multi-brightness LED lighting device 62 as shown above in FIG. 8 with a switch 74 electrically connected between the multi-brightness LED lighting device 62 and the AC voltage source 78.

[Para 81] FIG. 9 discloses a schematic diagram of at least two single voltage LED circuits integrated with a single chip or within a substrate and forming a multi-voltage and/or multi-brightness LED device.

[Para 82] FIG. 10 discloses a schematic diagram of a single chip LED bridge circuit 80 having four LEDs 81 configured into a bridge circuit and monolithically integrated on a substrate 82. The full wave LED bridge circuit has electrical contacts 86 to provide for AC voltage input connectivity and DC voltage output connectivity.

[Para 83] FIG. 11 discloses a schematic diagram of another embodiment of a single chip multi-voltage and/or multi-brightness LED lighting device 90. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of which have at least two LEDs 94 connected in series. The at least two series LED circuits 92 have electrical contacts 96 at opposing ends to provide a means of electrical connectivity. The at least two series LED circuits are monolithically integrated into a single chip 98. The electrical contacts 96 are used to wire the at least two series LEDs circuit 92 into a series circuit, a parallel circuit or an AC LED circuit all within a single chip.

[Para 84] FIG. 12 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED lighting device 90 as shown above in FIG. 11. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of which have at least two LEDs 94 connected in series. The at least two series LED circuits can be monolithically integrated within a single chip or discrete individual die can be integrated within a substrate to form an LED package 100. The LED package 100 has electrical contacts 102 that are used to wire the at least two series LEDs circuit into a series circuit, a parallel circuit or in anti-parallel to form an AC LED circuit all within a single LED package.

[Para 85] As seen in FIGs. 13-15, a single rectifier 110 may be provided for two or more

LED circuits 92, each containing at least two LEDs 94 connected in series. The single rectifier 110 comprises standard diodes 112 connected to an AC voltage source 116, or in the alternative may be connected to a driver or power supply which ultimately provides an AC voltage, like for example a high frequency AC driver 118. The single rectifier 110 is electrically connected to the LED circuits 92. Specifically, the rectifier 110 connects to a common junction of an anode of at least one LED 94 in each LED circuit 92, and to the cathode of at least one LED 94 in each LED circuit 92. As shown in FIG. 15, the rectifier may instead be connected to a switch, allowing for either one or both of LED circuits 92 to be operative at any given time.

[Para 86] It is contemplated by the invention that diodes 112 in FIGs. 13-15 are interchangeable with LEDs 70 in rectifiers 68 in FIGs. 8 and 9 and vice versa. As should be appreciated by those having skill in the art, any combination of LEDs 70 and diodes 112 can be used in rectifiers 68 and 110, so long as rectifiers 68 and 110 provide DC power from an AC source.

[Para 87] As shown in FIGs. 13 and 14, and further shown in FIGs. 16-20, any lighting devices, chips, or AC LED or DC LED circuits contemplated by the present invention may be powered through a high-frequency AC driver 118. As shown in FIG. 13, any AC source 116 may be connected to the high-frequency driver or inverter or transformer 118, however, as shown in Figs. 16-20 it is contemplated that low frequency voltage 124, like for example a mains voltage, is provided to the high-frequency driver or transformer or inverter 118.

[Para 88] FIGs. 16 and 17 show two embodiments of an AC LED lighting system 140 wherein a high-frequency AC driver, inverter, or transformer 118 for provides a high-frequency voltage to an AC LED circuit, lighting device, or chip 126. AC LED circuit, lighting device, or chip 126 may be any of the devices, circuits, or chips shown and described in FIGs. 1-7, like for example LED lighting devices 10, 20, 30 and/or AC LED circuits 12,

32, or any combination thereof. When multiple AC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such AC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship.

[Para 89] As shown in FIG. 16, the high-frequency AC driver, inverter or transformer 118 may be packaged separately from an (or multiple) AC LED circuit, device, or chip 126. In such embodiments a power source 128 provides voltage to the high-frequency AC driver, inverter or transformer 118 which steps up the frequency of the voltage to a higher frequency and provides the higher-frequency voltage to the AC LED circuit(s), device(s), or chip(s) 126. High-frequency AC driver, inverter, or transformer 118 may further include necessary circuitry, for example a transformer, for stepping-up or stepping-down the AC voltage provided by the power source 128.

[Para 90] As shown in FIG. 17, high-frequency AC driver 118 may be packaged with AC LED circuit(s), device(s), or chip(s) 126 in a unitary AC LED light bulb, lighting element 130. It is contemplated by the invention that a switch may be configured between the high-frequency driver 118 and the AC LED circuit(s), device(s), or chip(s) 126 for selectively operating one or more AC LED circuit, lighting device, or chip. For example, as shown in FIGS. 6A, 6B, 7A, and 7B a 2-way or 3-way switch may be attached at the input side of the AC LED circuit(s), lighting device(s), or chip(s). Such a switch may be located between the high-frequency AC driver, inverter, or transformer 118, and the AC LED circuit(s), lighting device(s), or chip(s).

[Para 91] FIGs. 14 and 18-20 show a DC LED lighting system 142 having a DC LED circuit(s), device(s), or chip(s) 92, 132 being powered by a high-frequency AC driver, inverter, or transformer 118 through a rectifier 110. In operation, the combination of AC sources 116, 128, high-frequency AC driver, inverter or transformer 118, and DC LED

circuit, device, or chip 92, 132 operate in substantially the same manner as that described with respect to FIGs. 16 and 17. However, in each system shown in FIGs. 14 and 18-20, rectifier 110 rectifies the high-frequency AC voltage output of the high-frequency AC driver before a voltage is provided to the DC LED circuit(s), device(s), or chip(s) 92, 132. DC LED circuit(s), device(s), or chip(s) 132 are not limited in form to just circuit 92, and instead may take the form of any of the lighting devices, circuits, or chips shown and described, for example, in FIGs. 8-12. When multiple DC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such DC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship. Additionally, as shown in FIG. 15, a switch, like for example a 2-way switch or a 3-way switch, may also be attached at the input side of DC LED circuit(s), device(s), or chip(s).

[Para 92] As shown in FIGs. 18-20, like in an AC embodiment, AC driver 118, rectifier 110, and DC LED circuit(s), device(s), or chip(s) 132 may be packaged in any number of ways. As shown in FIG. 18, each element may be packaged separately and electrically connected together in series. Alternatively, as shown in FIG. 19, a DC LED driver 134 may be formed by combining the high-frequency AC driver 118 with rectifier 110. As shown in FIG. 20, an additional alternative contemplated by the invention is forming a DC LED lighting element 136, which may be embodied as a light bulb, lighting system, lamp, etc., wherein the DC LED lighting element 136 includes each of a high-frequency AC driver 118, a rectifier 110, and a DC LED circuit(s), lighting device(s), or chip(s) 132. It should be appreciated by those having skill in the art that a lighting element containing only rectifier 110 and a DC LED circuit(s), lighting device(s), or chip(s) 132 may also be designed. Such lighting elements have the advantage of being able to be plugged into any AC source, whether it is a high-frequency AC driver, inverter, or transformer, or a simple mains voltage,

and provide a light output in the same manner as the imbalanced circuit shown in, for example FIGs. 1-7.

[Para 93] FIGs. 2 1 and 22 show embodiments of a lighting system which may be used to incorporate any of the AC LED or DC LED drivers, lighting devices, circuits, chips or the like discussed herein.

[Para 94] FIG. 2 1 shows lighting system 200 having at least one LED circuit 202 connected as a load to driver 204. LED circuit 202 has at least two LEDs connected in series and may be configured in any manner shown and discussed in any of figures, like for example, FIGs. 1-9, 11, and 12, or as shown and discussed later in FIG. 24. As should be appreciated by those having ordinary skill in the art, it is contemplated that lighting system 200 may include two or more LED circuits 202 connected in series, parallel, or series parallel wherein each LED circuit 202 has at least two LEDs connected in series.

[Para 95] Driver 204 in lighting system 200 has an input, like for example a plug, power cord, or other adapter capable of connecting to a power source, for receiving a first AC voltage and frequency from power source 206, which may be any AC power source including a mains power source, and includes at least first circuit 208 and second circuit 2 10 which are each capable of receiving the first AC voltage and first frequency. Circuits 208, 210 each have an output capable of being connected the at least one LED circuit 202 for driving the at least two LEDs connected therein. As seen in FIG. 21, driver 204 may additionally include circuit 214 which is substantially similar to circuits 208, 210. As should be appreciated by those having ordinary skill in the art, any number of circuits may be included in driver 204 so long as each additional circuit is capable of receiving the first AC voltage and first frequency, and having an output capable of being connected the at least one LED circuit 202 for driving the at least two LEDs connected therein.

[Para 96] Driver 204 further includes a sensor in the form of circuit 212 which is

configured to sense and permit the output of only one of first circuit 208 or second circuit 210 to be provided to the at least one LED circuit 202. For example, circuit 212 may be configured to sense the output from both first circuit 208 and second circuit 210 and allow only the output of first circuit 208 to be provided to at least one LED circuit 202 while the output of circuit 210 is blocked or not provided to at least one LED circuit 202. If circuit 212 no longer senses an output from circuit 208, because for example circuit 208 has failed, circuit 212 may disconnect or block the output of circuit 208 from at least one LED circuit 202, and connect the output of circuit 210 to at least one LED circuit 202 so that circuit 210 drives at least one LED circuit 202. As should be appreciated by those having ordinary skill in the art, in embodiments including circuit 214 or any additional circuits capable of receiving the first AC voltage and first frequency and having an output capable driving at least one LED circuit 202, circuit 212 may be configured to allow only a single output through and connect a new circuit output each time the circuit providing an output to at least one LED circuit 202 fails.

[Para 97] In order to achieve this function, circuit 212 may include any sensor and/or switch combination known to those of ordinary skill in the art capable of detecting or sensing the output of circuits 208 and 210, and blocking the outputs so only a single output is provided to at least one LED circuit 202 at all times so long as one of circuit 208 and 210 are operational. Examples of circuits which may be used as circuit 212 include a relay circuit, a micro-controller IC, or a voltage level sensing circuit connected between the output of circuits 208 and 210 and at least one LED circuit 202.

[Para 98] In alternative embodiments, circuit 212 may include a logic gate and multiple circuits, each of the multiple circuits including an RMS converter and a window voltage comparator controlling an analog switch. Each RMS converter would receive the output of circuit 208 or circuit 210 and convert the output voltages to an RMS voltage. The RMS

voltage may then be provided to a respective window voltage comparator, and be compared to high and low reference voltages stored in the each window voltage comparator. If the measured RMS voltage is within the high or low reference range, the comparator may then close an analog switch, allowing the output of circuit 208 or 210 to proceed to the logic gate. The logic gate may then be configured to allow only one received output from circuit 208 or 210 to pass through and be provided to at least one LED circuit 202. If the allowed output from either of circuit 208 or 210 fails and is not provided, the logic gate may then allow the non-allowed output from 208 or 210 to be provided to at least one LED circuit 202. Utilizing a logic gate receiving multiple inputs and an RMS converter and window voltage comparator has the added benefit of blocking the output from either of circuit 208 or 210 if the output is too high or too low, insuring maximum efficiency when driving at least one LED circuit 202.

[Para 99] Regardless of what is used for circuit 212, it should be appreciated by those having ordinary skill in the art that a two-way or three-way switch like that shown and described in FIGS. 6A and 6B or 7A and 7B may be provided on the back end of circuit 212 wherein the two-way or three-way switch may connect additional LED circuits formed as part of at least one LED circuit 202. Utilizing a switch may allow for additional LED circuits to be turned on and off, adjusting the brightness of system 200.

[Para 100] As should be appreciated by those having ordinary skill in the art, any two-way or three-way switch may also be utilized to join the output of circuits 208 and 210, as well as any additional similar circuits included in driver 204, to provide additional power to at least one LED circuit 202. For example, the switch may be used to combine the outputs of circuits 208 and 210 into a single output before reaching circuit 212, or alternatively may alter the logic of a logic gate used in circuit 212, allowing the output of both circuits 208 and 210 to be provided to at least one LED circuit 202.

[Para **101]** FIG. 22 shows an alternative embodiment to FIG. 21 wherein lighting system

300 contains at least one LED circuit 302,which is substantially similar to LED circuit 202, drivers 304 and 306 and sensor 308. In operation, drivers 304 and 306 function in a similar manner as circuits 208 and 210 and sensor 308 may function in substantially the same manner as circuit 212. In the embodiment shown in FIG. 22, however, drivers 304 and 306 may be packaged separately from sensor 308. Packaging each driver 304 and 306 separately may also allow for either driver to be easily replaced within system 300 if either driver 304 or 306 fails.

[Para 102] Drivers 304 and 306 each have a first input for receiving a first AC voltage and frequency and each contain an output capable of being connected to the at least one LED circuit 302 through sensor 308. In embodiments where multiple drivers are used, lighting system 300 may include a single input for power from power source 310, like for example a plug, power cord, or other adapter capable of connecting to and transmitting an AC voltage.

[Para 103] As with the embodiment described in FIG. 21, in embodiments where multiple drivers are used, sensor 308 may be configured to receive the output of the drivers 304 and 306, sense the voltages, and allow only a single output to be provided to at least one LED circuit 302. Sensor 308 may include a relay circuit, a micro-controller IC, or a voltage level sensing circuit connected between the output of circuits 208 and 210 and at least one LED circuit 202.

[Para 104] In alternative embodiments, sensor 308 may include a logic gate and multiple circuits, each of the multiple circuits including an RMS converter and a window voltage comparator controlling an analog switch. Each RMS converter would receive the output of driver 304 or driver 306 and convert the output voltages to an RMS voltage. The RMS voltage may then be provided to a respective window voltage comparator, and be compared to high and low reference voltages stored in the each window voltage comparator. If the measured RMS voltage is within the high or low range, the comparator may then close an

analog switch, allowing the output of driver 304 or 306 to proceed to the logic gate. The logic gate may then be configured to allow only one received output from drivers 304 or 306 to pass through and be provided to at least one LED circuit 302. If the allowed output from either of driver 304 or 306 fails and is not provided, the logic gate may then allow the non-allowed output from drivers 304 or 306 to be provided to at least one LED circuit 302. Utilizing a logic gate receiving multiple inputs and an RMS converter and window voltage comparator has the added benefit of blocking the output from either of drivers 304 and 306 if the output is too high or too low, insuring maximum efficiency when driving at least one LED circuit 302.

[Para 105] While circuits 208, 2 10 and drivers 304, 306 may be any of the drivers or circuits discussed herein capable of driving LED circuits, FIG. 23 shows one embodiment of circuits 208, 210 and a configuration for drivers 304, 306 as contemplated by the invention. As should be appreciated by those having ordinary skill in the art, each of the circuit shown in FIG. 23 may be packaged separately forming drivers 304, 306, or packaged together in a single driver forming driver 204. As such, it should be understood when referring to FIG. 23, the terms circuits 208, 210 may be used interchangeably with the terms driver 304, 306.

[Para 106] As seen in FIG. 23, circuits 208, 210 each contain AC input 400, connected in series with fuse 402, resistor 404, and bridge rectifier 406 which provides DC output 408 from circuits 208, 210 to a sensor or circuit and at least one LED circuit. Circuits 208, 210 may also include a voltage suppressor 4 10 connected in series with fuse 402 and resistor 404, while being connected in parallel with rectifier 406. Voltage suppressor 410 may be a transient voltage suppressor used to protect rectifier 406 and any sensor or circuit or LED circuits connected to the output of the circuit 208 or 210. Circuits 208, 210 and drivers 304, 306 may further include a transformer for stepping the provided AC voltage up or down and/or to adjust the provided AC frequency up or down.

[**Para** 107] Driver 204 may further include further include at least two capacitors connected to a fourth circuit wherein the fourth circuit only allows one of the at least two capacitors to connect to the first or second circuit or any additional circuits included in driver 204 which are providing an output to LED circuit 202. The fourth circuit may be configured to disconnect the one of the at least two capacitors connected to the first or second circuit if the one capacitor fails and then connect at least one other capacitor from the at least two capacitors to circuits 208, 210. The fourth circuit may be configured to connect any one of the at least two capacitors anywhere within the first or second circuit, and preferably in parallel with bridge rectifier 406.

[**Para** 108] In embodiments like that shown in FIG. 22 wherein multiple drivers are provided for lighting system 300, each driver 304, 306 may contain at least two capacitors and an internal sensor wherein the internal sensor only one of the at least two capacitors to form a portion of the driver, *i.e.* form a portion of the circuit shown in FIG. 23.

[**Para** 109] A resistor may be connected in series with the at least two LEDs forming at least one LED circuit 202, 302 in order to suppress the current provided by driver 204 or drivers 304, 306 to further protect the at least two LEDs. FIG. 24 shows an embodiment of at least one LED circuit 202, 302 for use in conjunction with circuits 208, 210 and drivers 304, 306 shown in FIG. 23, wherein at least two LEDs 500 are connected in series with resistor 502. As seen in FIG. 24, LED circuit 202, 302 may further include a capacitor 504 connected in series with LEDs 502 and in parallel with resistor 502 for smoothing the received output from driver 204 or drivers 304, 306. LED circuit 202, 302 finally may also include a fuse 506 to further protect LED circuit 202, 302 from any surge currents.

[**Para** 110] In embodiments where mains power is directly rectified and provided to LED circuit 202, 302 through circuit 212 or sensor 308, LEDs 500 may be high voltage LEDs having a forward voltage of at least 36V. However, it should be appreciated that LEDs

having any forward voltage may be utilized, so long as the total forward voltage across each LED is satisfied by the provided output from driver 204 or drivers 304, 306.

[Para 111] It is to be understood that additional embodiments of the invention described herein may be contemplated by one of ordinary skill in the art, and the scope of the present invention is not limited to the embodiments disclosed. While specific embodiment s of the present invention have been illustrated described, numerous modifications come to mind without significantly departing from the spirit of the invention, and the scope of protection is only limited by the scope of the accompanying claims.

CLAIMS

What is claimed is:

1. An LED lighting system comprising:

at least one LED circuit comprising at least two LEDs connected in series;

a driver having an input for receiving a first AC voltage and frequency from an AC power source, the driver having

a first circuit capable of receiving the first AC voltage and first frequency and having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs;

a second circuit capable of receiving the first AC voltage and first frequency and having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs; and,

a third circuit which senses and permits the output of only one of the first or second circuits to be provided to the at least one LED circuit.

2. The LED lighting system of claim 1 wherein the third circuit is configured to sense and provide the output of the first circuit to the at least one LED circuit.

3. The LED lighting system of claims 1 or 2 wherein the third circuit is configured to sense and provide to the output of the second circuit to the at least one LED circuit if no output is sensed from the first circuit.

4. The LED lighting system of any of claims 1-3 wherein the AC voltage source is mains power.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1083

5. The LED lighting system of any of claims 1-4 further comprising at least two LED circuits each having at least two LEDs connected in series.

6. The LED lighting system of any of claims 1-5 wherein each of the first and second circuit includes a resistor, a fuse and a bridge rectifier connected in series with the received AC voltage and current such that the output of the second and third circuits is a DC voltage and current.

7. The LED lighting system of claim 6 wherein the first and second circuit further include a voltage suppressor connected in parallel with the bridge rectifier, the voltage suppressor being connected in series with the resistor and the fuse.

8. The LED lighting system of claim 7 wherein the voltage suppressor is a transient voltage suppressor.

9. The LED lighting system of any of claims 1-8 wherein the at least one LED circuit includes a resistor connected in series with the two or more LED circuits.

10. The LED lighting system of claim 9 wherein the at least one LED circuit includes a capacitor connected in parallel with the resistor.

11. The LED lighting system of any of claims 1-10 further comprising at least one additional circuit capable of receiving the first AC voltage and first frequency and having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs.

12. The LED lighting system of claim 11 wherein the third circuit is configured to switch to the at least one additional circuit if no output is sensed from the first circuit or the second circuit.

13. The system of any of claims 1-12 wherein the first and second circuits include a transformer connected to the AC power source for stepping the input AC voltage up or down.

14. The system of any of claims 1-13 wherein the first and second circuits include a transformer connected to the AC power source for stepping the frequency of the input AC voltage up or down.

15. The LED lighting system of any of claims 1-14 wherein the forward voltage of each of the at least two LEDs is at least 36V.

16. The LED lighting system of any of claims 1-15 wherein the driver further includes at least two capacitors connected to a fourth circuit wherein the fourth circuit only allows one of the at least two capacitors to connect to the first or second circuit.

17. The LED lighting system of claim 16 wherein the fourth circuit is configured to disconnect the one of the at least two capacitors connected to the first or second circuit if the one capacitor fails.

18. The LED lighting system of claim 17 wherein the fourth circuit connects a different capacitor from the at least two capacitors to the first or second circuit if the one of the at least two capacitors fails.

19. An LED lighting system comprising:

at least one LED circuit comprising at least two LEDs connected in series;

a first driver having an input for receiving a first AC voltage and frequency from an AC power source, the first driver having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs;

a second driver having an input for receiving the first AC voltage and frequency from the AC power source, the second driver having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs; and,

a sensor for sensing the output of the first and second drivers, the sensor being configured to provide the output of only the first or second driver to the at least one LED circuit.

20. The LED lighting system of claim 19 wherein the sensor is configured to sense and provide the output of the first driver to the at least one LED circuit.

21. The LED lighting system of claims 19 or 20 wherem the sensor is configured to provide the output of the second driver to the at least one LED circuit if the output of the first driver is not sensed.

22. The LED lighting system of claims 19-21 wherein the AC power source is mains power.

23. The LED lighting system of any of claims 19-22 wherein each of the first and second drivers include a resistor, a fuse, and a bridge rectifier connected in series such that the output of the first and second drivers is a DC voltage and current.

24. The LED lighting system of claim 23 wherein each of the first and second drivers include a voltage suppressor.

25. The LED lighting system of claim 23 wherein the voltage suppressor is a transient voltage suppressor.

26. The LED lighting system of any of claims 19-25 wherein the first and second drivers each include a transformer capable of stepping the first AC voltage up or down.

27. The LED lighting system of any of claims 19-26 wherein the first and second drivers each include a transformer capable of stepping the first AC frequency up or down.

28. The LED lighting system of claims 19-26 further comprising at least two LED circuits comprising at least two LEDs connected in series wherein the at least two LED circuits are connected to each other in parallel and are capable of receiving the output from either of the first or second drivers.

29. The LED lighting system of claim 28 wherein the at least two LED circuits each include a resistor connected in series with the at least two LEDs.

30. The LED lighting system of claims 28 or 29 wherein the at least two LED circuits each include a capacitor connected in series with the at least two LEDs.

31. The LED lighting system of claim 30 wherein the capacitor is connected in parallel to the resistor.

32. The LED lighting system of any of claims 19-31 further comprising at least one additional driver having an input for receiving a first AC voltage and frequency from

an AC power source, the third driver having an output capable of being connected to the at least one LED circuit to drive the at least two LEDs.

33. The LED lighting system of claim 32 further wherein the sensor is capable of providing the output of the at least one additional driver to the at least one LED circuit if an output is not sensed from either of the first or second driver.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1088

FIG. 2

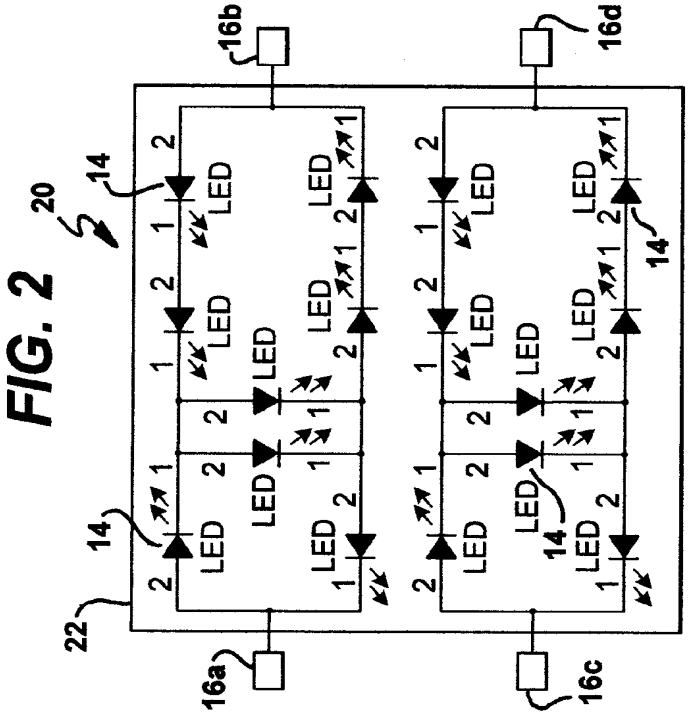
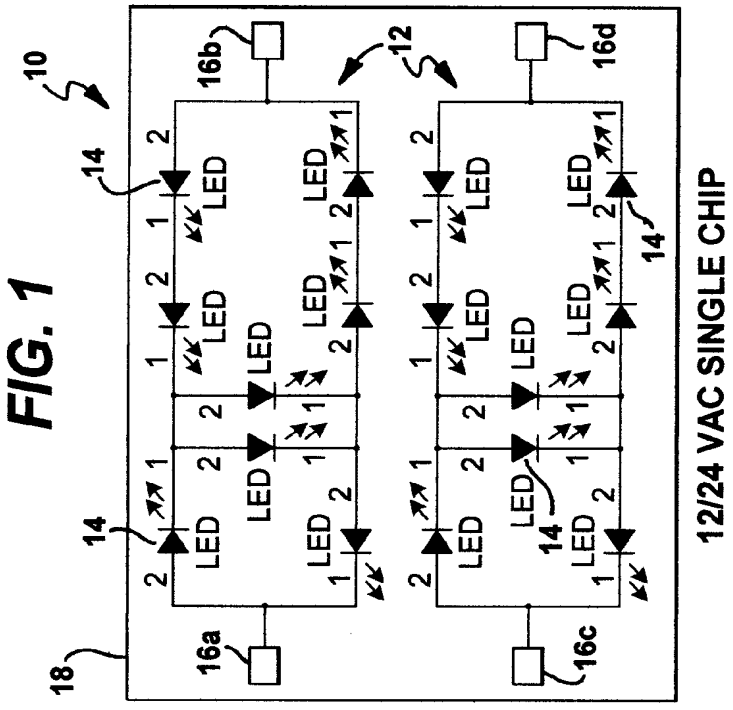

16b
16d
20
14
LED
22
16a
16c

FIG. 1


10
12
16b
16d
14
LED
18
16a
16c
12/24 VAC SINGLE CHIP

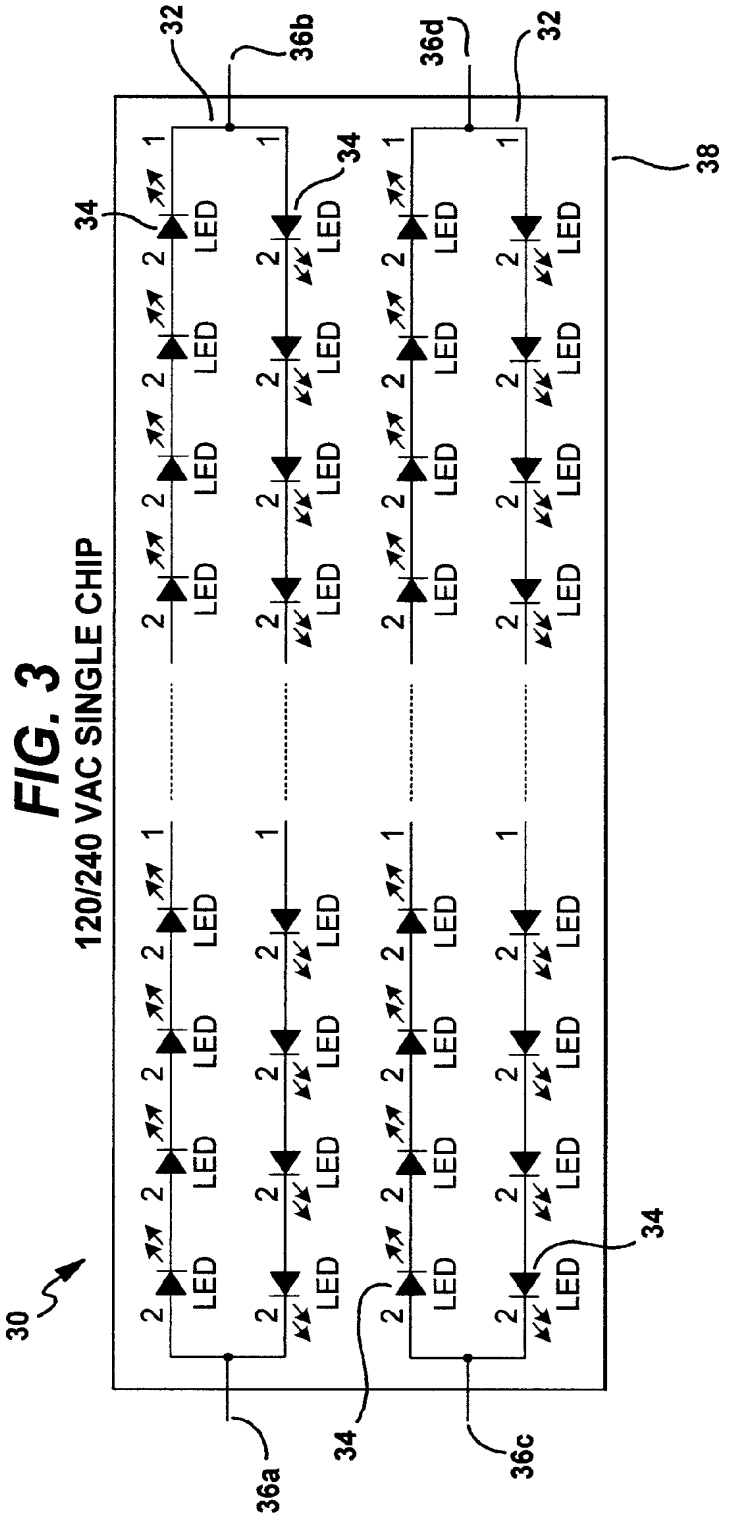
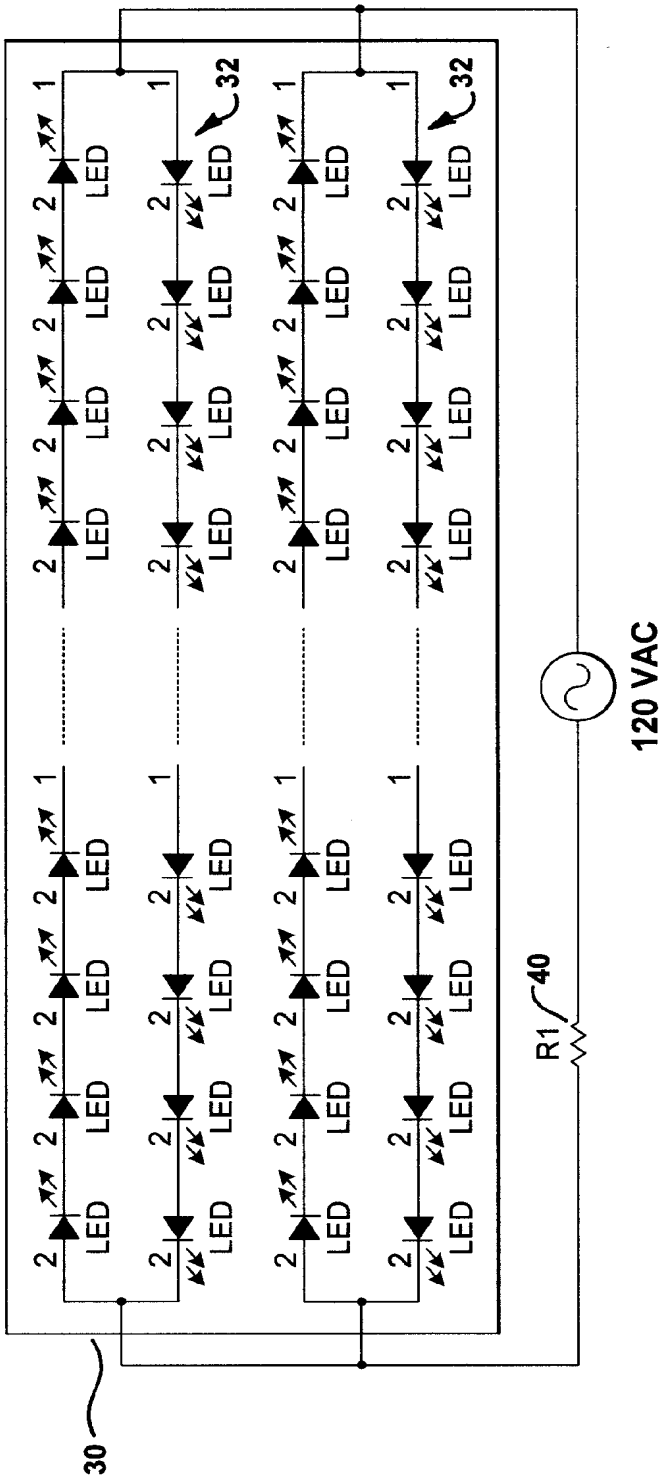

120/240 VAC SINGLE CHIP
30
32
36b
36d
32
38
34
34
34
36a
34
36c
LED
1
2

FIG. 3

FIG. 4



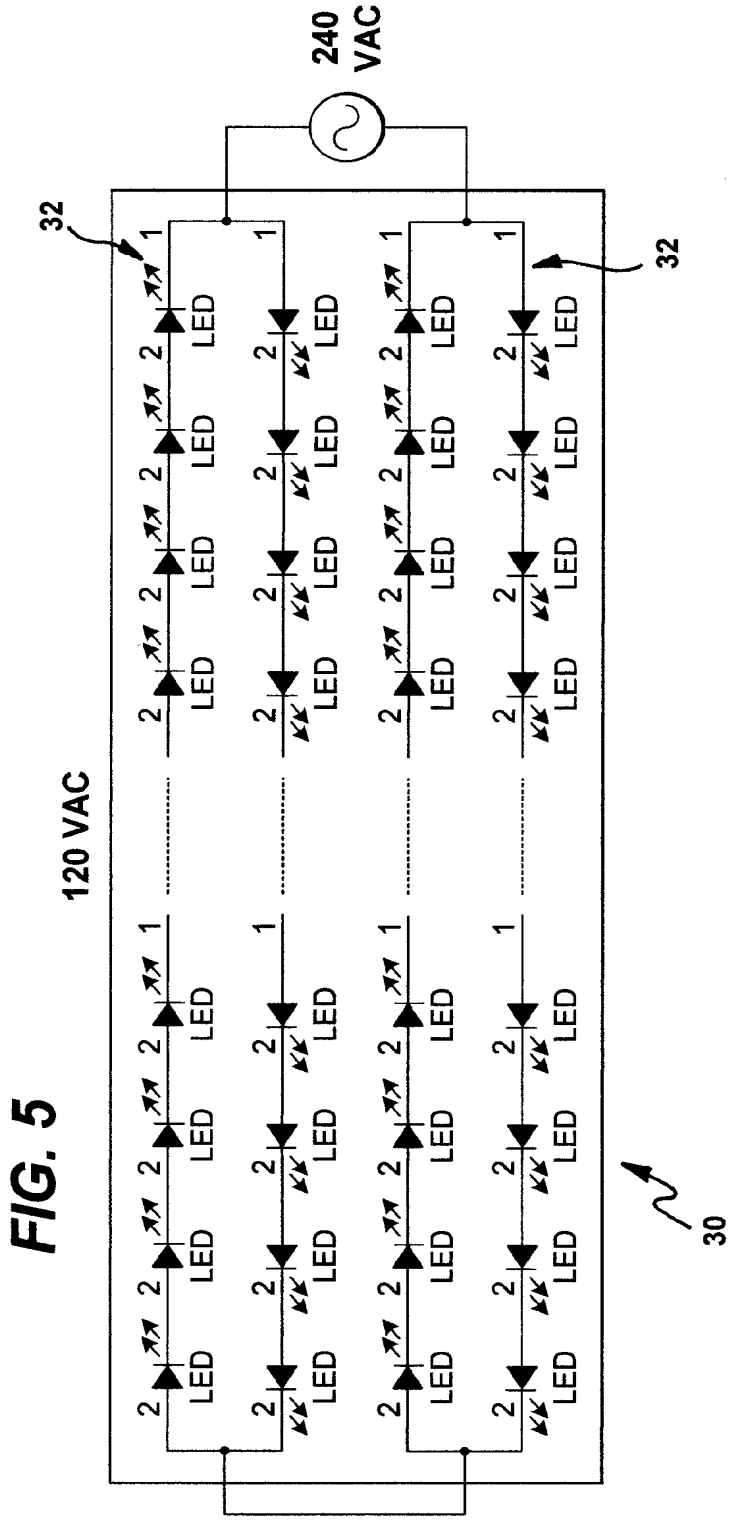


FIG. 5

FIG. 6B
2-WAY SINGLE CHIP
AC LED FOR 2-WAY LAMP

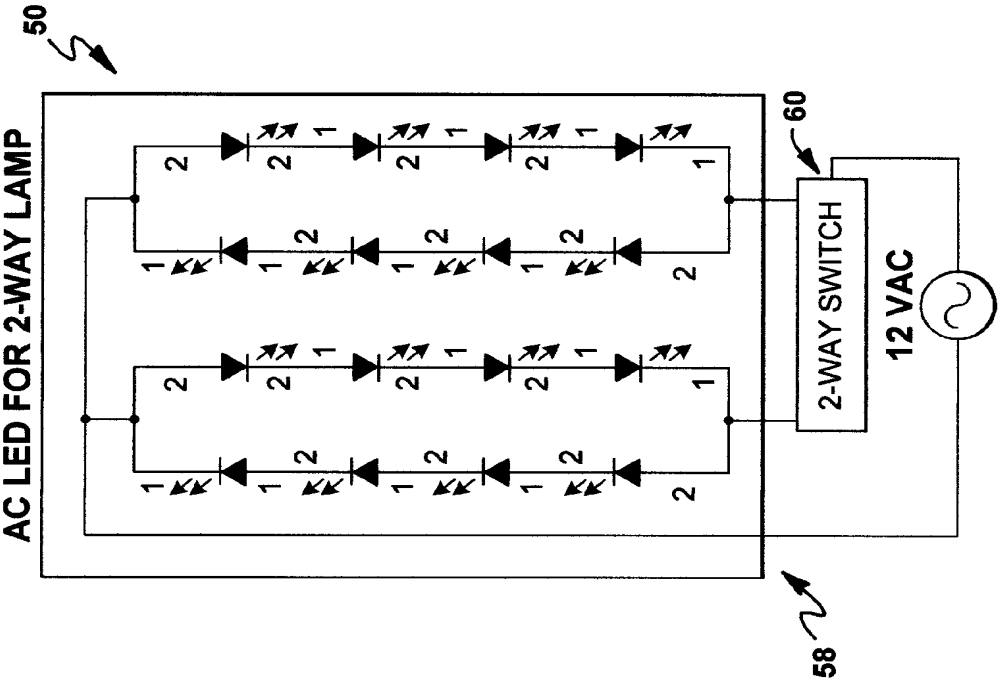


FIG. 6A
2-WAY SINGLE CHIP 12V
AC LED FOR 2-WAY LAMP

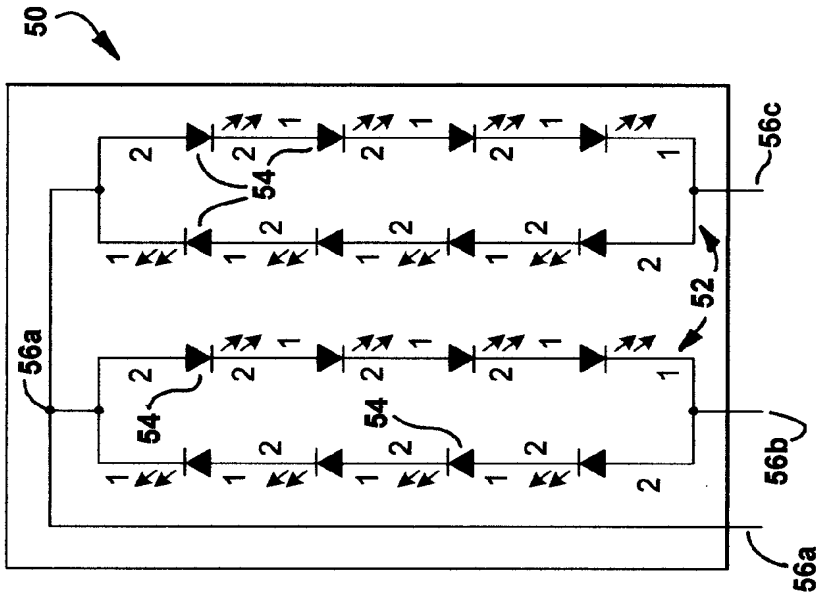


FIG. 7A

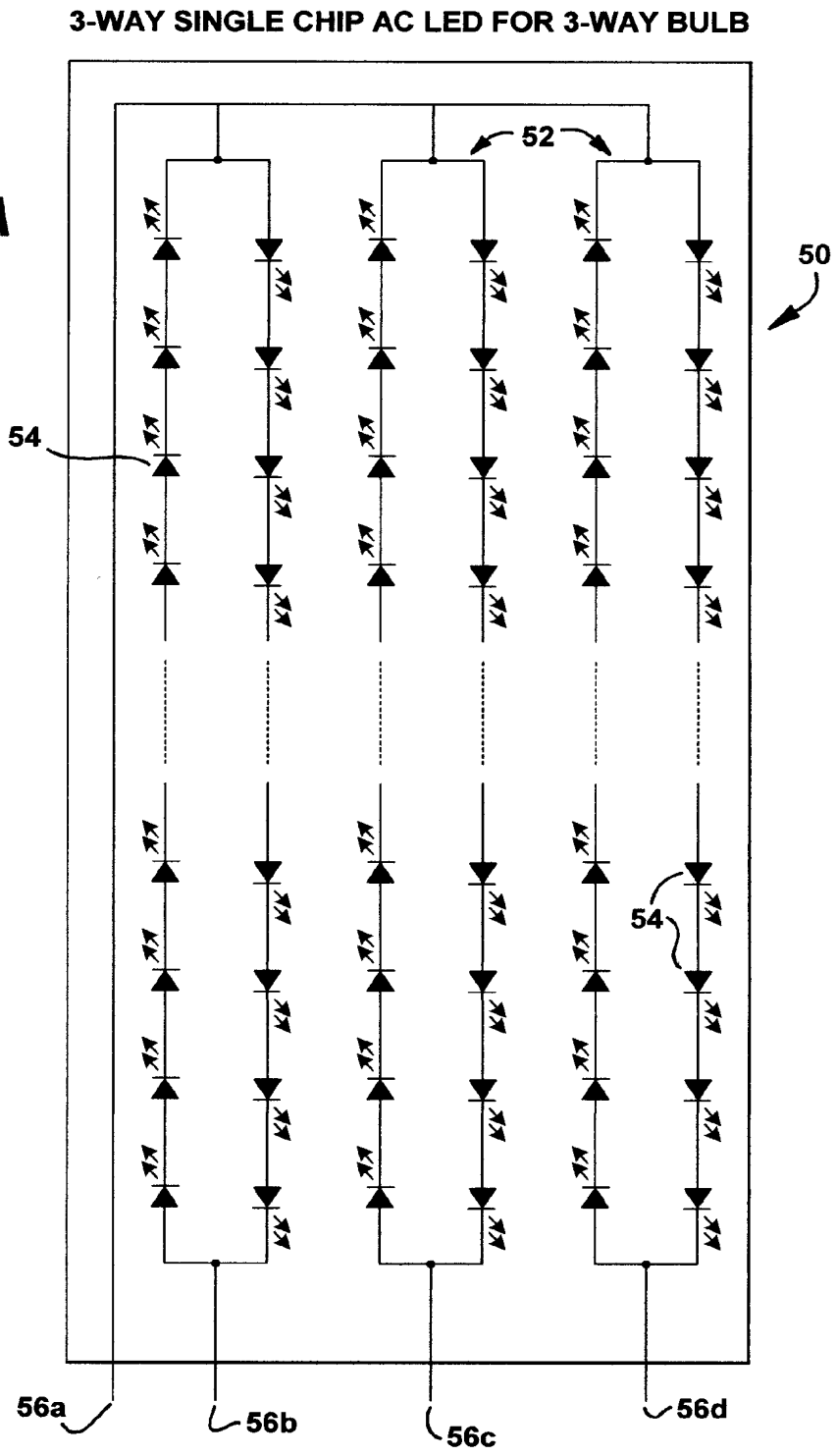

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
52
50
54
54
56a
56b
56c
56d

FIG. 7B

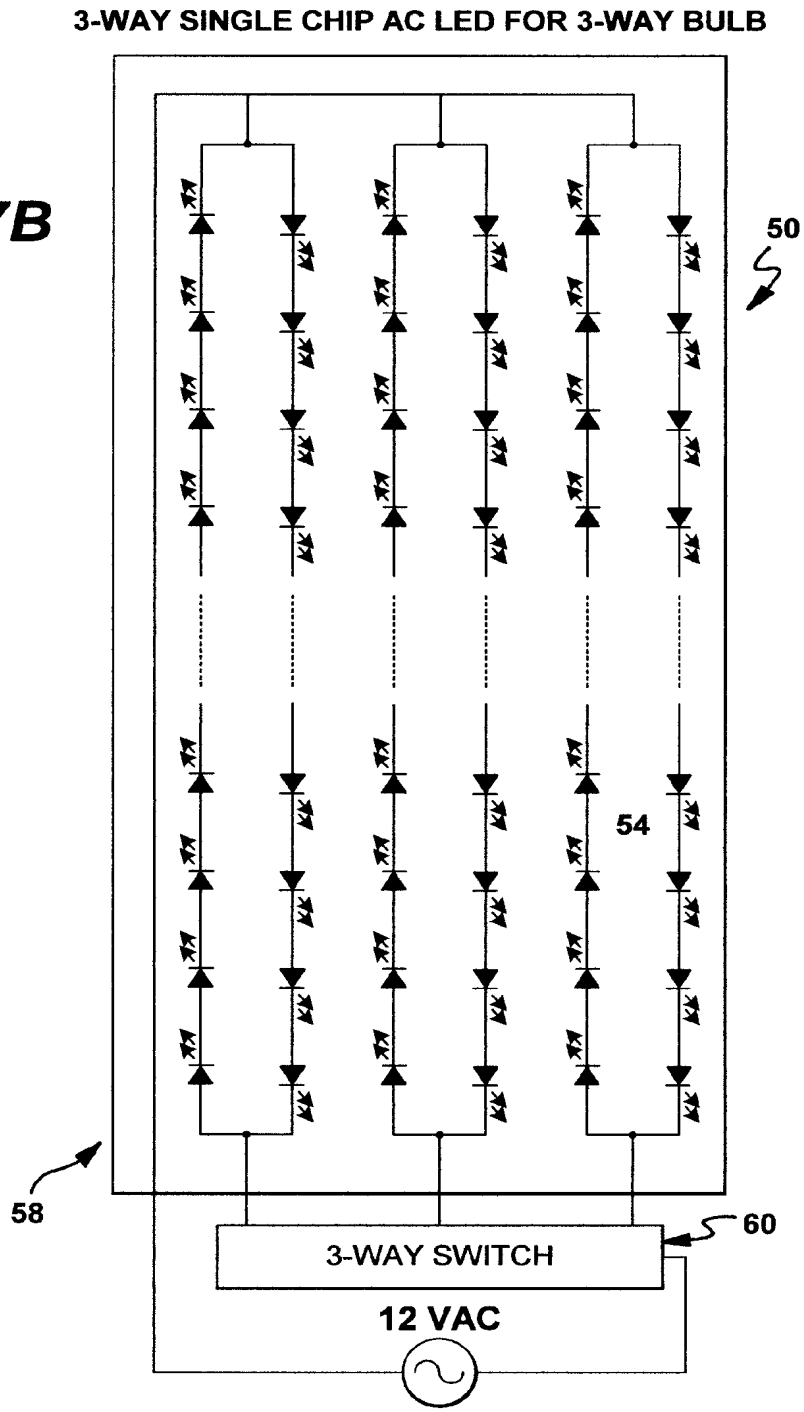

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
50
54
58
60
3-WAY SWITCH
12 VAC

FIG. 8

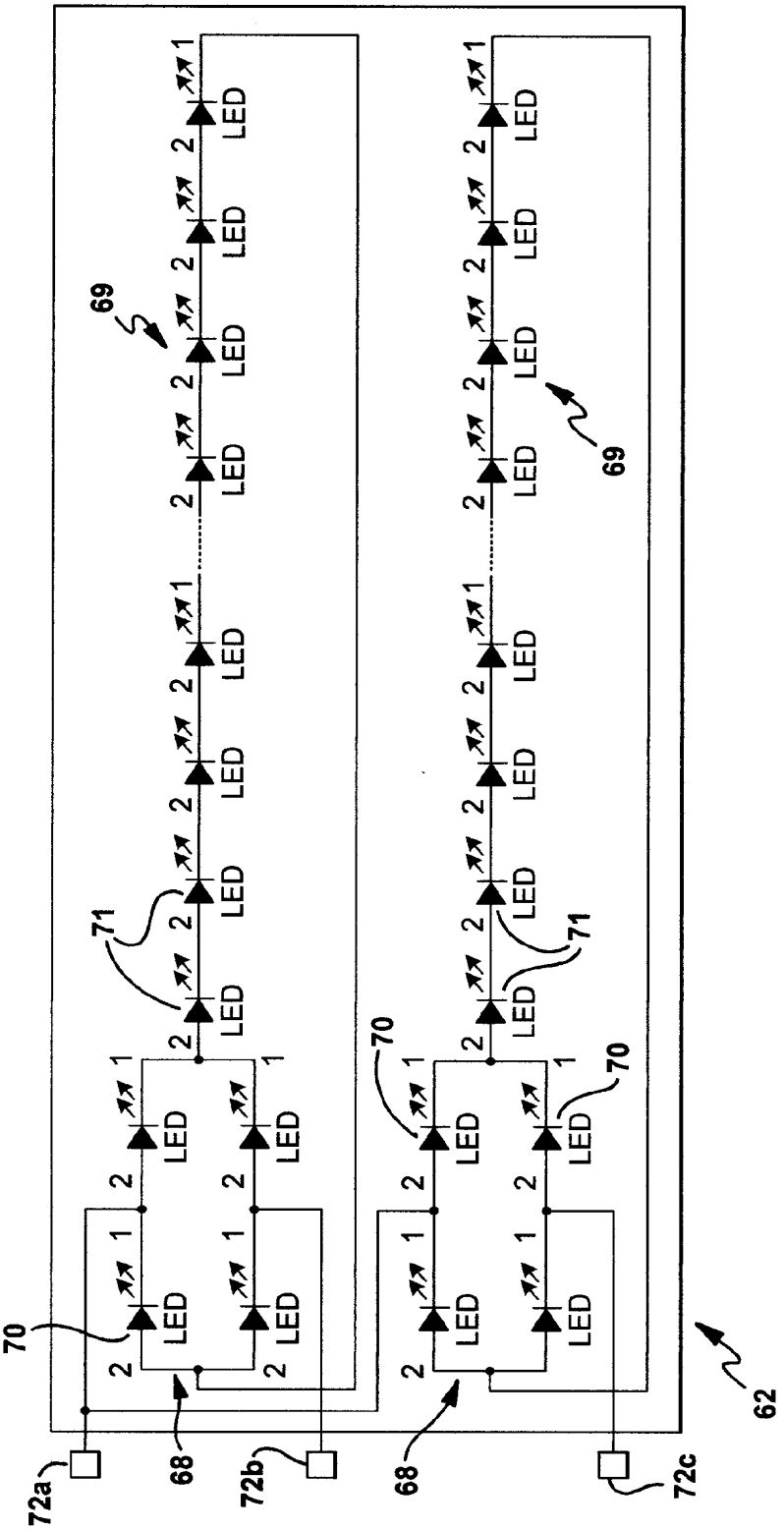
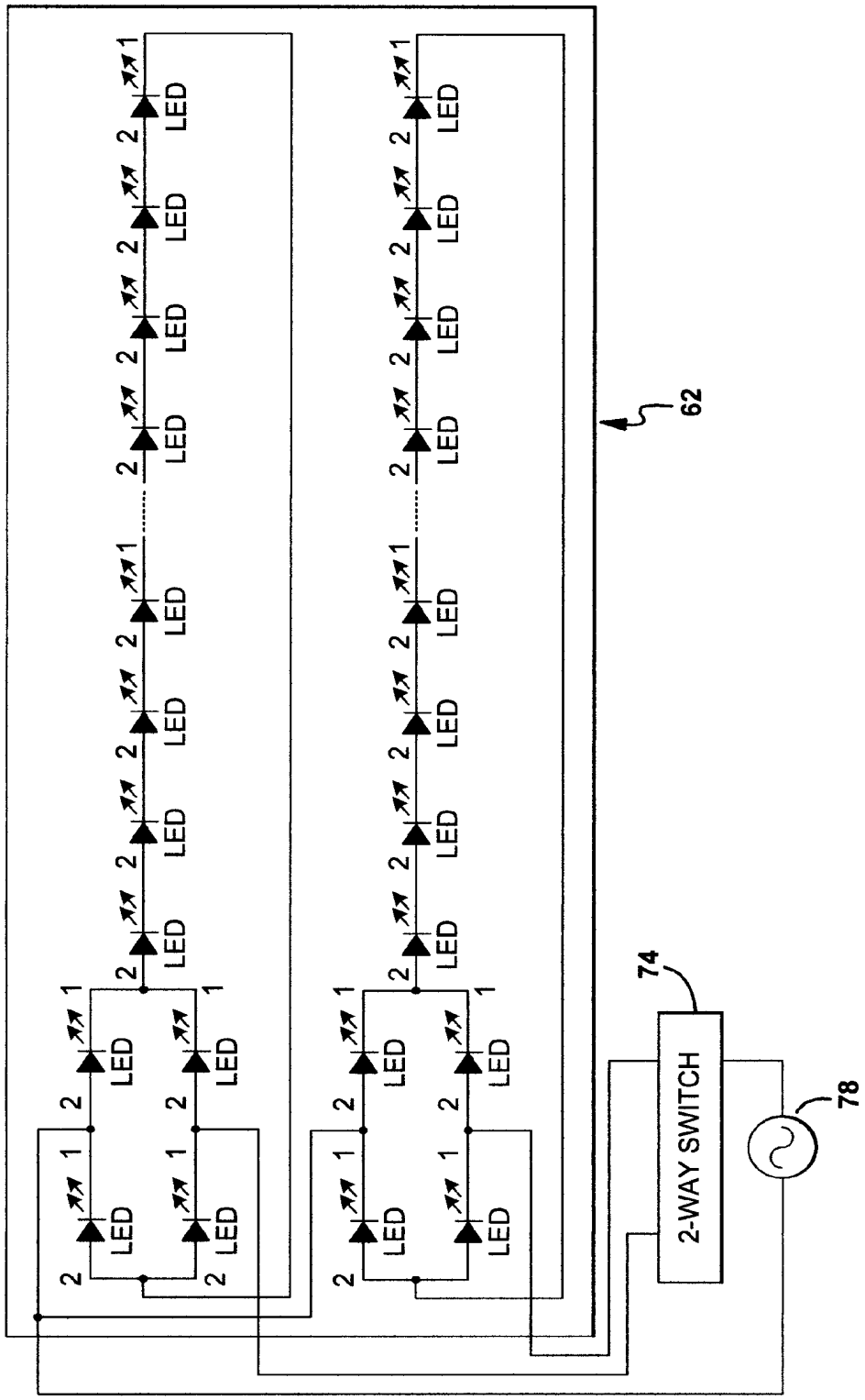


FIG. 9



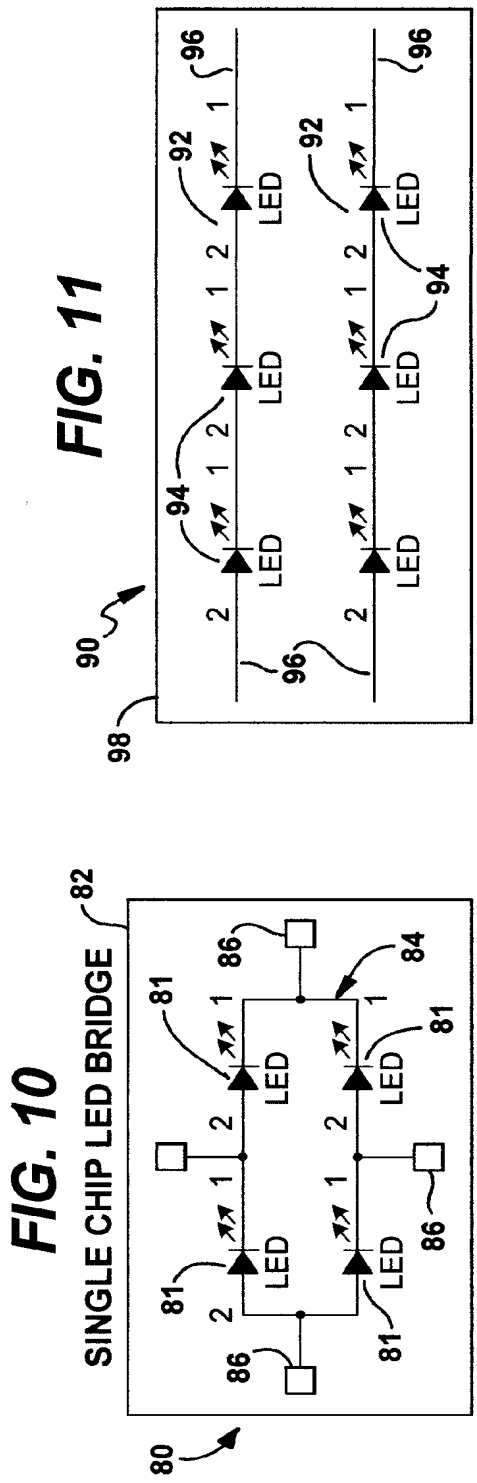


FIG. 10

FIG. 11

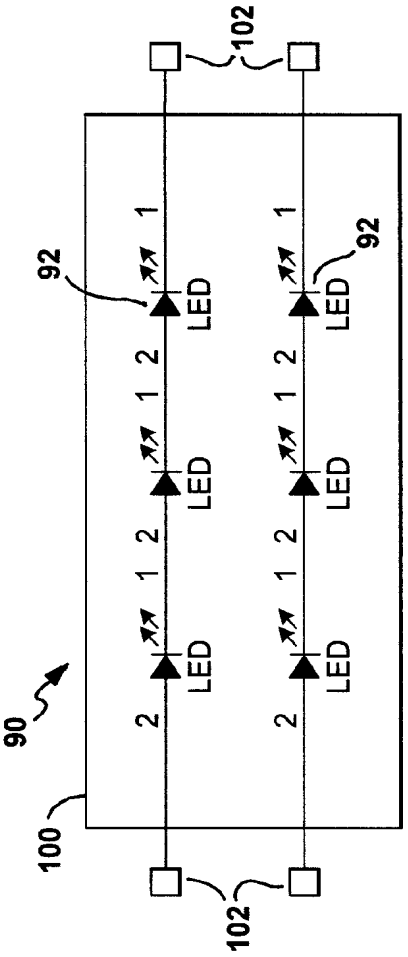


FIG. 12

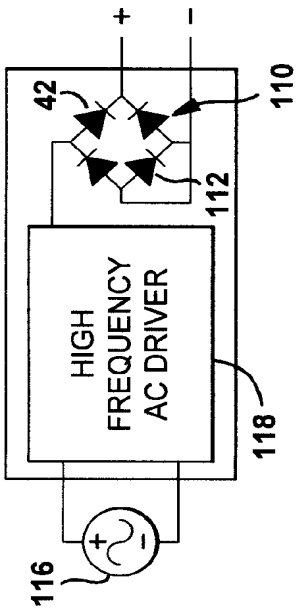


FIG. 13

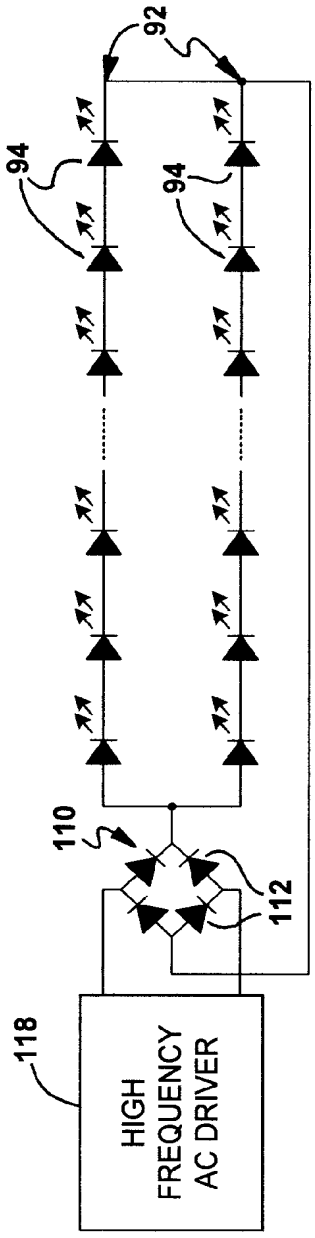


FIG. 14

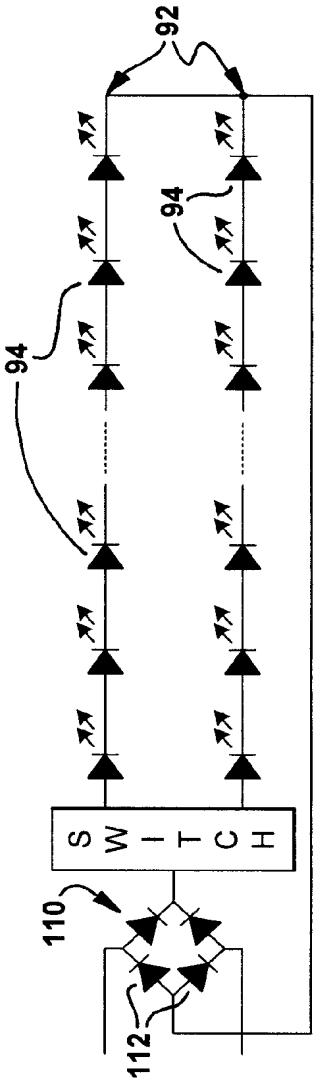


FIG. 15

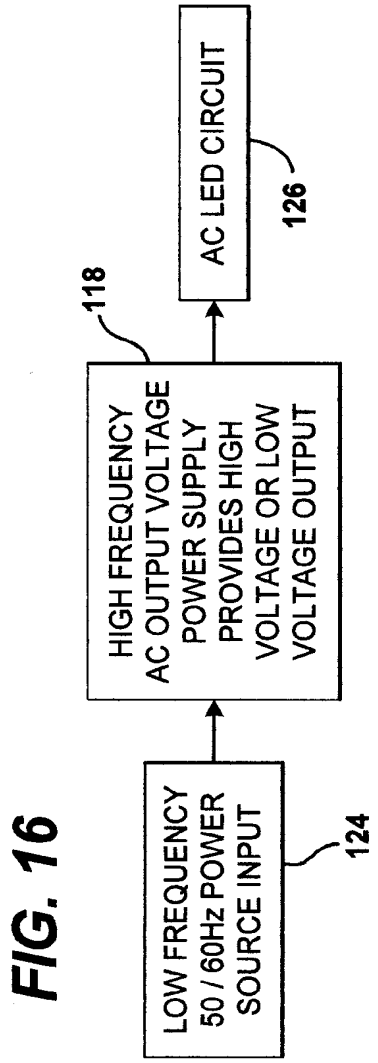

LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
PROVIDES HIGH
VOLTAGE OR LOW
VOLTAGE OUTPUT
118
AC LED CIRCUIT
126

FIG. 16

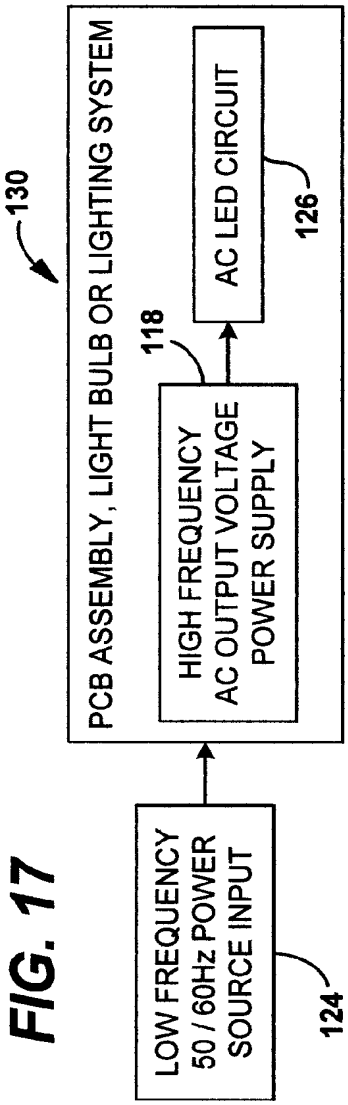

130
PCB ASSEMBLY, LIGHT BULB OR LIGHTING SYSTEM
LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
118
AC LED CIRCUIT
126

FIG. 17

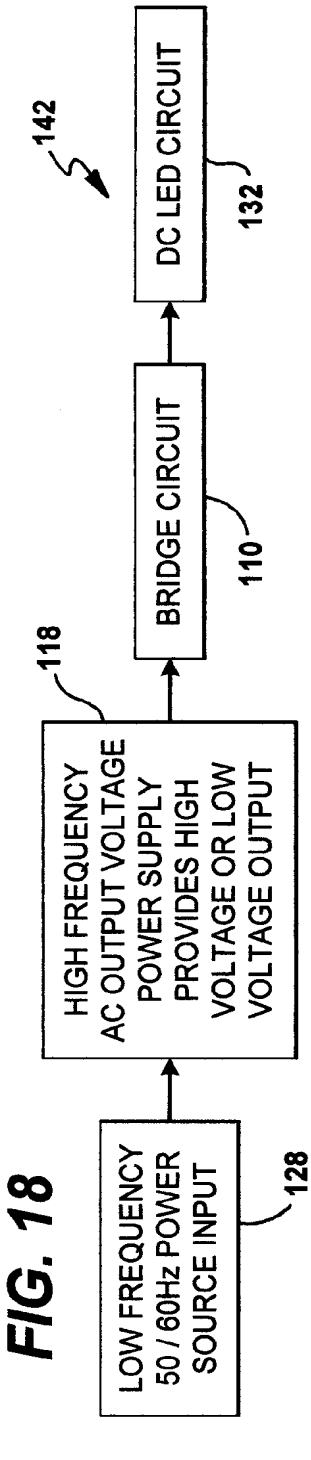


FIG. 18

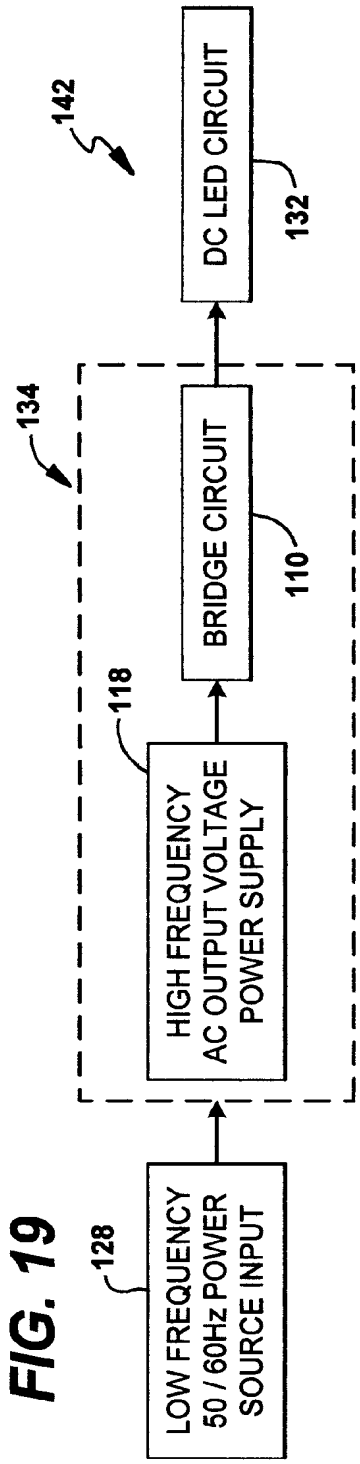


FIG. 19

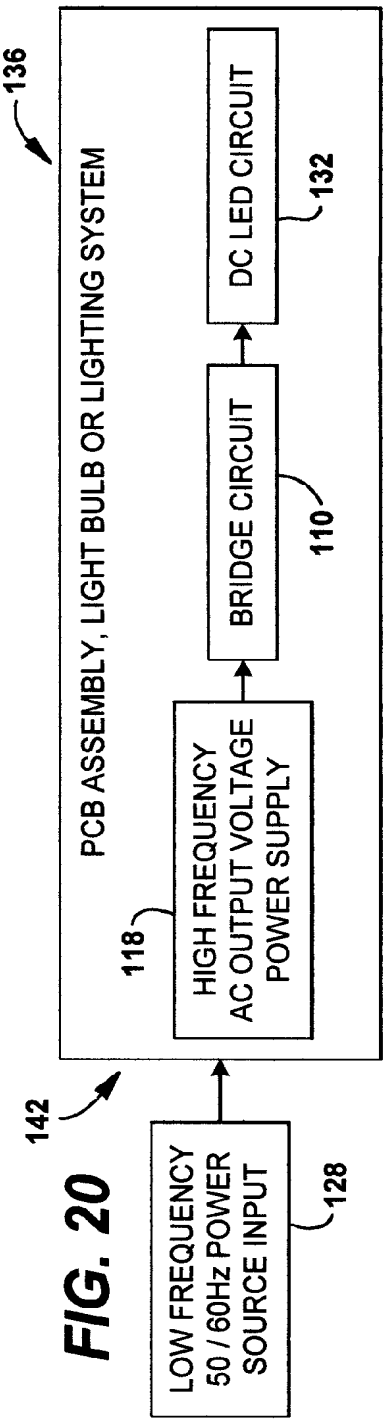


FIG. 20

FIG. 21

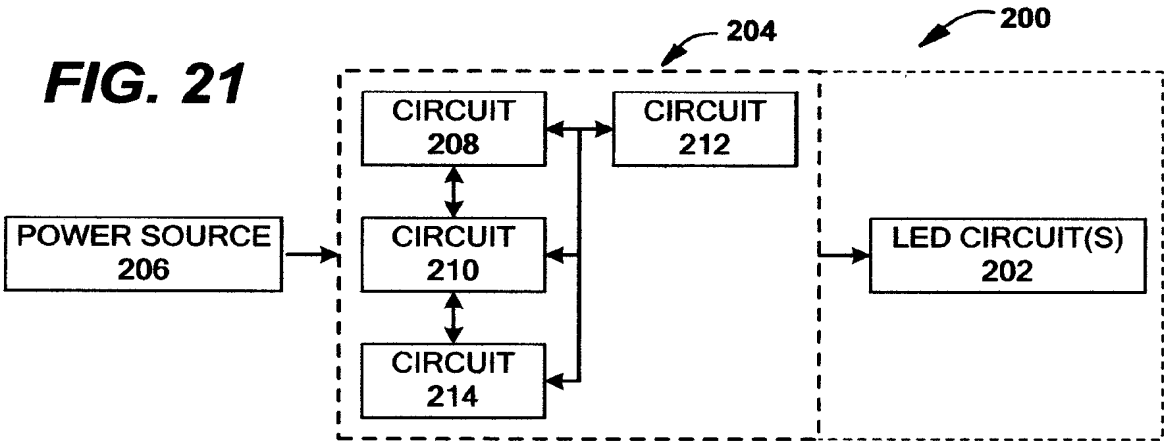


FIG. 22

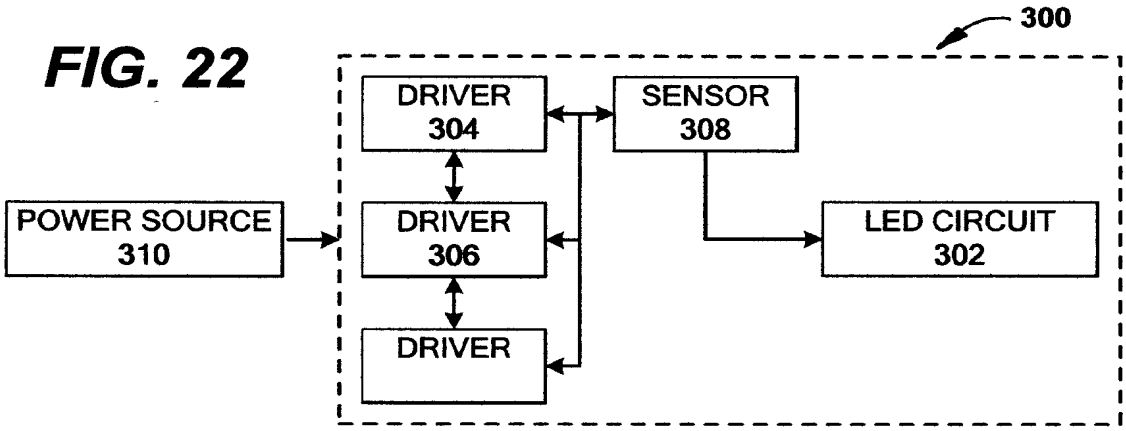


FIG. 23

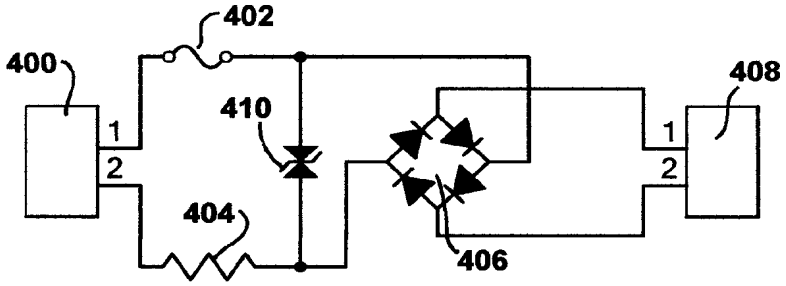
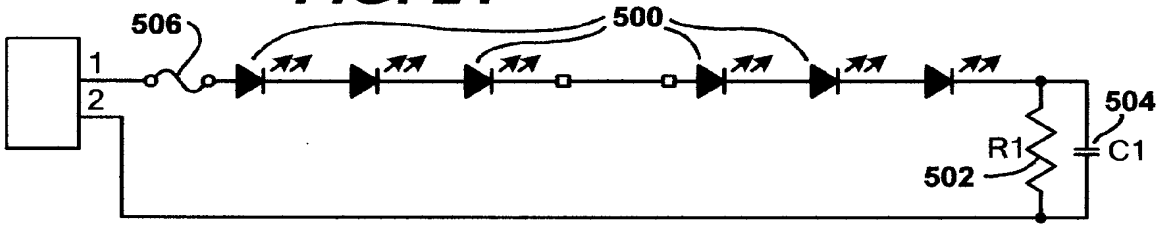


FIG. 24



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/36359

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G05F 1/00 (2011.01)
USPC - 315/294
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 315/294

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 315/185R,192,210,250,291,294,297 (text search)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (PGPB, USPT, EPAB, JPAB), Google,
Search terms used: led, light, emitting, diode, altemat, current, ac, frequenc, dc, direct, rectif, analog, digital, convert, back, up, backup, source, fail, power, input, supply, series, spare, driv, sens, detect, monitor, output, voltage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/0021185 A1 (Ng) 22 January 2009 (22.01.2009), para [0029]-[0035]	1-2, 19-20
Y		3, 21
Y	WO 2008/124701 (Vandersluis et al.) 16 October 2008 (16.10.2008), para [0004], [0015]	3, 21
A	US 2010/0039794 A1 (Ghanem et al.) 18 February 2010 (18.02.2010), entire document	1-3, 19-21
A	US 6,107,744 A (Bavaro) et al. 22 August 2000 (22.08.2000), entire document	1-3, 19-21

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2011 (10.08.2011)	17 AUG 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. **571-273-3201**	Authorized officer: Lee W. Young **PCT Helpdesk: 571-272-4300** **PCT OSP: 571-272-7774**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/36359

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-18, 22-33
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the-invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1104

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(19) World Intellectual Property Organization
International Bureau

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PCT

(10) International Publication Number
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H05B 37/00 (2006.01)

(21) International Application Number:
PCT/US2010/062235

(22) International Filing Date:
28 December 2010 (28.12.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

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61/335,069	31 December 2009 (31.12.2009)	US
PCT/US2010/001269	30 April 2010 (30.04.2010)	US
PCT/US2010/001597	28 May 2010 (28.05.2010)	US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier applications:

US	PCT/US2010/001597 (CIP)
Filed on	28 May 2010 (28.05.2010)
US	PCT/US2010/001269 (CIP)
Filed on	30 April 2010 (30.04.2010)
US	12/287,267 (CIP)
Filed on	6 October 2008 (06.10.2008)
US	12/364,890 (CIP)
Filed on	3 February 2009 (03.02.2009)

(71) Applicant *(for all designated States except US)*: **LYNK LABS, INC.** [US/US]; 2511 Technology Drive, Suite 108, Elgin, IL 60123-9323 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MISKIN, Michael** [US/US]; 2 Pinecone Lane, Sleepy Hollow, IL 60118 (US). **KOTTRISCH, Robert, L.** [GB/GB]; 10 The Hollies, Shefford, Bedfordshire SG175BX (GB).

(74) Agent: **LAKE, Micheal, D.**; Factor & Lake, LTD., 1327 W. Washington Blvd., Suite 5G/H, Chicago, IL 60607 (US).

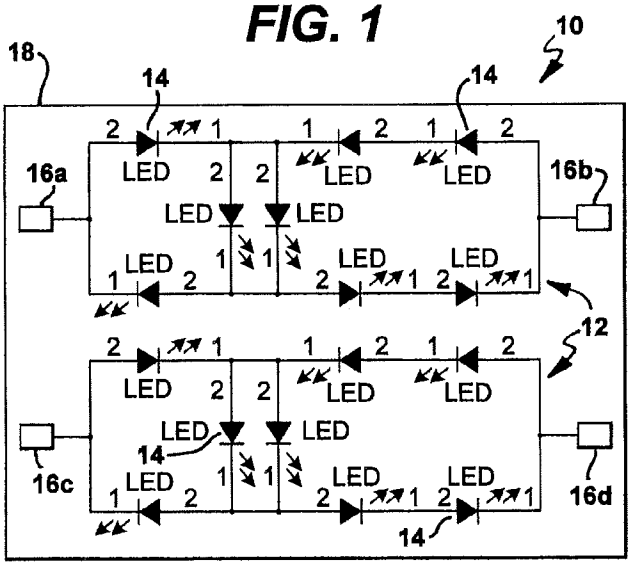
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD,

[Continued on next page]

(54) Title: HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

(57) Abstract: A system and method transforming AC voltage to a high-frequency AC voltage and providing the high-frequency AC voltage to an AC LED circuit or rectifying the high-frequency circuit to a DC voltage and providing the DC voltage to a DC LED circuit.

FIG. 1



12/24 VAC SINGLE CHIP

WO 2011/082168 A1

SAMSUNG EXHIBIT 1049
PGR2023-00016 - Home Depot
Ex. 1003 - Page 1105

SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

RELATED APPLICATIONS

[Para 1] The application is a continuation-in-part of U.S. Patent Application No. 12/287,267, filed October 6, 2008, which claims priority to U.S. Provisional Application No. 60/997,771, filed October 6, 2007; this application is also a continuation-in-part of U.S. Patent Application No. 12/364,890 filed February 3, 2009 which is a continuation of U.S. Application No. 11/066,414 (now U.S. Patent No. 7,489,086) filed February 25, 2005 which claims priority to U.S. Provisional Application No. 60/547,653 filed February 25, 2004 and U.S. Provisional Application No. 60/559,867 filed April 6, 2004; this application is also a continuation in part of International Application No. PCT/US2010/001597 filed May 28, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/217,215, filed May 28, 2009; this application is also a continuation-in-part of International Application No. PCT/US2010/001269 filed April 30, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/215,144, filed May 1, 2009; this application also claims priority to U.S. Provisional Application No. 61/284,927 filed December 28, 2009 and U.S. Provisional Application No. 61/335,069 filed December 31, 2009; the contents of each of these applications are expressly incorporated herein by reference.

TECHNICAL FIELD

[Para 2] The present invention generally relates to light emitting diodes ("LEDs") for AC operation. The present invention specifically relates to multiple voltage level, multiple brightness level, and voltage selectable LED devices, packages and lamps, high frequency driven LED circuits and high frequency drivers and drive methods for LEDs.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[Para 3] None.

BACKGROUND OF THE INVENTION

[Para 4] Field of the Invention

[Para 5] The present invention generally relates to light emitting diodes ("LEDs") for high frequency and selectable voltage, multi-voltage level and/or multi-brightness level operation. The present invention specifically relates to high frequency operation, voltage selectable, multiple voltage level and multiple brightness level light emitting diode circuits, single chips, packages and lamps "devices" for direct AC voltage power source operation or bridge rectified AC voltage power source operation..

[Para 6] Description of the Related Art

[Para 7] LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED. Some LEDs have resistors built into the LED package providing a higher voltage LED typically driven with 5V DC or 12V DC.

[Para 8] Some standard AC voltages in the world include 12VAC, 24VAC, 100VAC, 110VAC, 120VAC, 220VAC, 230VAC, 240VAC and 277VAC. Therefore, it would be advantageous to have a single chip LED or multi-chip single LED packages and/or devices that could be easily configured to operate at multiple voltage levels and/or multiple brightness levels by simply selecting a voltage and/or current level when packaging the multi-voltage and/or multi-current single chip LEDs or by selecting a specific voltage and/or current level when integrating the LED package onto a printed circuit board or within a finished lighting product. It would also be advantageous to have multi-current LED chips and/or packages for LED lamp applications in order to provide a means of increasing brightness in LED lamps by switching in additional circuits just as additional filaments are switched in for standard incandescent lamps.

[Para 9] US 7,525,248 discloses a ***chip***-scale LED lamp including discrete LEDs capable of being built upon electrically insulative, electrically conductive, or electrically semi conductive substrates. Further, the construction of the LED lamp enables the lamp to be configured for high voltage AC or DC power operation. The LED based solid-state light

emitting device or lamp is built upon an electrically insulating layer that has been formed onto a support surface of a substrate. Specifically, the insulating layer may be epitaxially grown onto the substrate, followed by an LED buildup of an n-type semiconductor layer, an optically active layer, and a p-type semiconductor layer, in succession. Isolated mesa structure of individual, discrete LEDs are formed by etching specific portions of the LED buildup down to the insulating layer, thereby forming trenches between adjacent LEDs. Thereafter, the individual LEDs are electrically coupled together through conductive elements or traces being deposited for connecting the n-type layer of one LED and the p-type layer of an adjacent LED, continuing across all of the LEDs to form the solid-state light emitting device. The device may therefore be formed as an integrated AC/DC light emitter with a positive and negative lead for supplied electrical power. For instance, the LED lamp may be configured for powering by high voltage DC power (e.g., 12V, 24V, etc.) or high voltage AC power (e.g., 110/120V, 220/240V, etc.).

[Para 10] US 7,213,942 discloses a single-***chip*** LED device through the use of integrated circuit technology, which can be used for standard high AC voltage (110 volts for North America, and 220 volts for Europe, Asia, etc.) operation. The single-***chip AC LED*** device integrates many smaller LEDs, which are connected in series. The integration is done during the LED fabrication process and the final product is a single-***chip*** device that can be plugged directly into house or building power outlets or directly screwed into incandescent lamp sockets that are powered by standard AC voltages. The series connected smaller LEDs are patterned by photolithography, etching (such as plasma dry etching), and metallization on a single ***chip***. The electrical insulation between small LEDs within a single-***chip*** is achieved by etching light emitting materials into the insulating substrate so that no light emitting material is present between small LEDs. The voltage crossing each one of the small LEDs is about the same as that in a conventional DC operating LED fabricated from the same type of material (e.g., about 3.5 volts for blue LEDs).

[Para 11] Accordingly, single chip LEDs have been limited and have not been integrated circuits beyond being fixed series, fixed parallel or series parallel circuit configurations until the development of AC LEDs. The AC LEDs have still however been single circuit or parallel circuit fixed single voltage designs.

[Para 12] LED packages have historically not been integrated circuits beyond being fixed series, fixed parallel or fixed series parallel LED circuit configurations.

[Para 13] The art is deficient in that it does not provide a multi-voltage and/or multi-current circuit monolithically integrated on a single substrate which would be advantageous.

[Para 14] It would further be advantageous to have a multi-voltage and/or multi-brightness circuit that can provide options in voltage level, brightness level and/or AC or DC powering input power preference.

[Para 15] It would further be advantageous to provide multiple voltage level and/or multiple brightness level light emitting LED circuits, chips, packages and lamps "multi-voltage and/or multi-brightness LED devices" that can easily be electrically configured for at least two forward voltage drive levels with direct AC voltage coupling, bridge rectified AC voltage coupling or constant voltage DC power source coupling. This invention comprises circuits and devices that can be driven with more than one AC or DC forward voltage "multi-voltage" at 6V or greater based on a selectable desired operating voltage level that is achieved by electrically connecting the LED circuits in a series or parallel circuit configuration and/or more than one level of brightness "multi-brightness" based on a switching means that connects and/or disconnects at least one additional LED circuit to and/or from a first LED circuit. The desired operating voltage level and/or the desired brightness level electrical connection may be achieved and/or completed at the LED packaging level when the multi-voltage and/or multi-brightness circuits and/or single chips are integrated into the LED package, or the LED package may have external electrical contacts that match the integrated multi-voltage and/or multi-brightness circuits and/or single chips within, thus allowing the drive voltage level and/or the brightness level select-ability to be passed on through to the exterior of the LED package and allowing the voltage level or brightness level to be selected at the LED package user, or the PCB assembly facility, or the end product manufacturer.

[Para 16] It would further be advantageous to provide at least two integrated circuits having a forward voltage of at least 12VAC or 12VDC or greater on a single chip or within a single LED package that provide a means of selecting a forward voltage when packaging a multi-voltage and/or multi-brightness circuit using discrete die (one LED chip at a time) and wire bonding them into a circuit at the packaging level or when packaging one or more multi-voltage and/or multi-brightness level single chips within a LED package.

[Para 17] It would further be advantageous to provide multi-voltage and/or multi-brightness level devices that can provide electrical connection options for either AC or DC voltage operation at preset forward voltage levels of 6V or greater.

[Para 18] It would further be advantageous to provide multi-brightness LED devices that can be switched to different levels of brightness by simply switching additional circuits on or off in addition to a first operating circuit within a single chip and or LED package. This

would allow LED lamps to switch to higher brightness levels just like 2-way or 3-way incandescent lamps do today.

[Para 19] The benefits of providing multi-voltage circuits of 6V or greater on a single chip is that an LED packager can use this single chip as a platform to offer more than one LED packaged product with a single chip that addresses multiple voltage levels for various end customer design requirements. This also increase production on a single product for the chip maker and improves inventory control. This also improves buying power and inventory control for the LED packager when using one chip.

[Para 20] It would further be advantageous to have a LED lighting assembly which includes LED circuitry for AC or DC drive and a high frequency AC voltage transformer or inverter that could be used to convert low frequency voltages, like for example mains voltage or some other low voltage at 50/60 Hz, to a high frequency without a change in the voltage provided. For example, it would be advantageous to have a LED lighting power supply and/or driver capable of receiving 120 VAC at 60 Hz and be able to provide a high frequency AC output directly to an AC driven LED circuit(s), or alternatively to a DC driven LED circuit(s) through an AC-to-DC rectifier at a voltage equal to or different from the original input voltage to the power supply and/or driver.

[Para 21] It would be further advantageous to combine multiple-voltage LED chips, packages, circuits, lamps, etc., high frequency AC voltage power supplies and/or transformers to drive LEDs by either directly connecting a high frequency transformer or inverter to an AC driven LED circuit(s), or by operably connecting an AC-to-DC rectifier between the high frequency transformer or inveter and a DC driven LED circuit. With proper design considerations LEDs may be driven more efficiently with direct AC or rectified AC than with constant voltage or constant current DC drive schemes. High frequency AC transformers or inverters can be made smaller and more cost effective than constant current or constant voltage DC drivers or power supplies currently being used to power LEDs. The higher the frequency, the smaller the transformer can be made. With proper design consideration and based on the wattage and the frequency of the AC voltage output of the power supply, a high frequency AC voltage transformer can be made small enough to be mounted directly onto a LED lighting PCB assembly.

[Para 22] The present invention provides for these advantages and solves the deficiencies in the art.

SUMMARY OF THE INVENTION

[Para 23] According to one aspect of the invention at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage AC LED device for direct AC power operation. Each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation.

[Para 24] According to another aspect of the invention, each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit.

[Para 25] According to another aspect of the invention, each multi-voltage AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. By way of example, the second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 26] According to another aspect of the invention, at least two single voltage series LED circuits, each of which have at least two serially connected LEDs, are formed on a single chip or on a substrate providing a multi-voltage AC or DC operable LED device.

[Para 27] According to another aspect of the invention, each single voltage series LED circuit is designed to be driven with a predetermined forward voltage of at least 6V AC or DC and preferably each single voltage series LED circuit has a matching forward voltage of 6V, 12V, 24V, 120V, or other AC or DC voltage levels. By way of example, each multi-voltage AC or DC LED device would be able to be driven with at least two different AC or DC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage series LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level series LED circuits in series. The second forward voltage drive level of the serially connected series LED circuits would be

approximately twice the level of the first forward voltage drive level of the parallel connected series LED circuits. The at least two parallel connected series LED circuits would be twice the current of the at least two serially connected series LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage series LED device.

[Para 28] According to another aspect of the invention, at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness AC LED device for direct AC power operation.

[Para 29] According to another aspect of the invention, each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation. Each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit. The at least two AC LED circuits within each multi-voltage and/or multi current AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. The second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 30] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of LEDs is formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in

parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 31] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VAC, 24VAC, 120VAC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 32] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of standard diodes, LEDs or some combination thereof is provided separate of the LED circuit or formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 33] According to another aspect of the invention a multi-voltage and/or multi-current AC LED circuit is integrated within a single chip LED. Each multi-voltage and/or multi-current single chip AC LED comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation. Each single voltage AC LED circuit may have may have at least one voltage input electrical contact at each opposing end of the circuit or the at least two single voltage AC LED circuits may be electrically connected together in series on the single chip and have at least one voltage input electrical contact at each

opposing end of the two series connected single voltage AC LED circuits and one voltage input electrical contact at the center junction of the at least two single voltage AC LED circuits connected in series. The at least two single voltage AC LED circuits are integrated within a single chip to form a multi-voltage and/or multi-current single chip AC LED.

[Para 34] According to another aspect of the invention, at least one multi-voltage and/or multi-brightness LED devices may be integrated within a LED lamp. The at least two individual LED circuits within the multi-voltage and/or multi-brightness LED device(s) may be wired in a series or parallel circuit configuration by the LED packager during the LED packaging process thus providing for at least two forward voltage drive options, for example 12VAC and 24VAC or 120VAC and 240VAC that can be selected by the LED packager.

[Para 35] According to another aspect of the invention a multi-voltage and/or multi-current AC LED package is provided, comprising at least one multi-voltage and/or multi-current single chip AC LED integrated within a LED package. The multi-voltage and/or multi-current AC LED package provides matching electrical connectivity pads on the exterior of the LED package to the electrical connectivity pads of the at least one multi-voltage and/or multi-current single chip AC LED integrated within the LED package thus allowing the LED package user to wire the multi-voltage and/or multi-current AC LED package into a series or parallel circuit configuration during the PCB assembly process or final product integration process and further providing a AC LED package with at least two forward voltage drive options.

[Para 36] According to another aspect of the invention multiple individual discrete LED chips are used to form at least one multi-voltage and/or multi-current AC LED circuit within a LED package thus providing a multi-voltage and/or multi current AC LED package. Each multi-voltage and/or multi-current AC LED circuit within the package comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation The LED package provides electrical connectivity pads on the exterior of the LED package that match the electrical connectivity pads of the at least two single voltage AC LED circuits integrated within the multi-voltage and/or multi-current AC LED package thus allowing the LED package to be wired into a series or parallel circuit configuration during the PCB assembly process and further providing a LED package with at least two forward voltage drive options.

[Para 37] According to another aspect of the invention a multi-voltage and/or multi-current single chip AC LED and/or multi-voltage and/or multi current AC LED package is integrated within an LED lamp. The LED lamp having a structure that comprises a heat sink,

a lens cover and a standard lamp electrical base. The multi-voltage and/or multi-current single chip AC LED and/or package is configured to provide a means of switching on at least one additional single voltage AC LED circuit within multi-voltage and/or multi-current AC LED circuit to provide increased brightness from the LED lamp.

[Para 38] According to anther broad aspect of the invention at least one multi-current AC LED single chip is integrated within a LED package.

[Para 39] According to another aspect of the invention, at least one single chip multi-current bridge circuit having standard diodes, LEDs, or some combination thereof is integrated within a LED lamp having a standard lamp base. The single chip multi-current bridge circuit may be electrically connected together in parallel configuration but left open to accommodate switching on a switch to the more than one on the single chip and have at least one accessible electrical contact at each opposing end of the two series connected circuits and one accessible electrical contact at the center junction of the at least two individual serially connected LED circuits. The at least two individual circuits are integrated within a single chip.

[Para 40] According to another aspect of the invention when the at least two circuits are left unconnected on the single chip and provide electrical pads for connectivity during the packaging process, the LED packager may wire them into series or parallel connection based on the desired voltage level specification of the end LED package product offering.

[Para 41] According to another aspect of the invention, a high frequency transformer or inverter may provide power to at least one multi-voltage and/or multi-brightness LED device or chip. The high frequency transformer or inverter may be either packaged with the LED device or chip and may provide direct AC voltage to the LED device or chip, or as a separate driver or power supply for the LED device or chip capable of being electrically connected to the LED device or chip. The high frequency transformer or inverter is designed to receive a voltage at a low frequency, like for example a voltage at 50/60 Hz like a mains voltage, and output a voltage at a high frequency. The high frequency transformer or inverter may also be configured to step-up or step-down the voltage provided to the transformer or inverter from a source voltage.

[Para 42] According to another aspect of the invention, a high-frequency transformer or inverter may provide power to a DC driven-LED circuit, chip, or device or an LED circuit, chip or device containing one or more series strings of LEDs through a rectifier having standard diodes, LEDs, or some combination thereof may be electrically connected between the high-frequency transformer or inverter and. The rectifier may be provided independently

from the high-frequency transformer or inverter and the LED circuit, chip, or device and electrically connected at its input to the high-frequency transformer or inverter and at its output to the LED circuit, chip or device. Alternatively, the rectifier may be packaged with the high-frequency transformer or inverter forming a power supply or driver for the LED circuit, chip, or device. The rectifier may likewise be packaged directly with, or as part of, an LED circuit, chip, or device. As should be appreciated by those having skill in the art, packaging the rectifier directly with the LED circuit, chip, or device allows for an LED package containing a DC-driven LED circuit, chip, or device, or one or more series strings of LEDs, to be directly plugged into any power supply or driver providing an AC voltage output and operate. As a further alternative, a high-frequency inverter, rectifier, and LED circuit, chip, or device may be packaged into a single lighting device capable of being directly incorporated into a lighting element, or may be incorporated directly into a lamp or other OEM product utilizing LED light.

[Para 43] According to another aspect of the invention, a two-way or three-way switch may be provided directly between a high-frequency inverter providing power to a LED circuits, chip, or device and the LED circuits, chip or device, or in the alternative between a LED circuits, chip, or device and a rectifier having standard diodes, LEDs, or some combination thereof electrically connected to a high-frequency transformer or inverter.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 44] FIG. 1 shows a schematic view of a preferred embodiment of the invention;

[Para 45] FIG. 2 shows a schematic view of a preferred embodiment of the invention;

[Para 46] FIG. 3 shows a schematic view of a preferred embodiment of the invention;

[Para 47] FIG. 4 shows a schematic view of a preferred embodiment of the invention;

[Para 48] FIG. 5 shows a schematic view of a preferred embodiment of the invention;

[Para 49] FIG. 6a shows a schematic view of a preferred embodiment of the invention;

[Para 50] FIG. 6b shows a schematic view of a preferred embodiment of the invention;

[Para 51] FIG. 7a shows a schematic view of a preferred embodiment of the invention;

[Para 52] FIG. 7b shows a schematic view of a preferred embodiment of the invention;

[Para 53] FIG. 8 shows a schematic view of a preferred embodiment of the invention;

[Para 54] FIG. 9 shows a schematic view of a preferred embodiment of the invention;

[Para 55] FIG. 10 shows a schematic view of a preferred embodiment of the invention;

[Para 56] FIG. 11 shows a schematic view of a preferred embodiment of the invention;

[Para 57] FIG. 12 shows a schematic view of a preferred embodiment of the invention;

[Para 58] FIG. 13 shows a schematic view of a preferred embodiment of the invention;

[Para 59] FIG. 14 shows a schematic view of a preferred embodiment of the invention;

[Para 60] FIG. 15 shows a schematic view of a preferred embodiment of the invention;

[Para 61] FIG. 16 shows a block diagram of a preferred embodiment of the invention;

[Para 62] FIG. 17 shows a block diagram of a preferred embodiment of the invention;

[Para 63] FIG. 18 shows a block diagram of a preferred embodiment of the invention;

[Para 64] FIG. 19 shows a block diagram of a preferred embodiment of the invention; and,

[Para 65] FIG. 20 shows a block diagram of a preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[Para 66] FIG. 1 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 10. The multi-voltage and/or multi-brightness LED lighting device 10 comprises at least two AC LED circuits 12 configured in an imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 16a and 16c are electrically connected together and 16b and 16d are electrically connected together and one side of the AC voltage input is applied to 16a and 16c and the other side of the AC voltage input is applied to 16b and 16d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 16a and 16c are electrically connected and the AC voltage inputs are applied to electrical contacts 16b and 16d, a second operating forward voltage is required to drive the single chip 18. The single chip 18 may also be configured to operate at more than one brightness level "multi-brightness" by electrically connecting for example 16a and 16b and applying one side of the line of an AC voltage source to 16a ad 16b and individually applying the other side of the line from the AC voltage source a second voltage to 26b and 26c.

[Para 67] FIG. 2 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 20 similar to the multi-voltage and/or multi-brightness LED lighting device 10 described above in FIG. 1 . The at least two AC LED circuits 12 are integrated onto a substrate 22. The at least two AC LED circuits 12 configured in a imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d on the exterior of the substrate 22 and can be used to electrically configure and/or control the operating voltage and/or brightness level of the multi-voltage and/or multi-brightness LED lighting device.

[Para 68] FIG. 3 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 30 similar to the multi-voltage and/or multi-brightness LED lighting device 10 and 20 described in FIGs. 1 and 2. The multi-voltage and/or multi-brightness LED lighting device 30 comprises at least two AC LED circuits 32 having at least two LEDs 34 connected in series and anti-parallel configuration. The at least two AC LED circuits 32 have electrical contacts 36a, 36b, 36c, and 36d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 36a and 36c are electrically connected together and 36b and 36d are electrically connected together and one side of the AC voltage input is applied to 36a and 36c and the other side of the AC voltage input is applied to 36b and 36d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 36a and 36c are electrically connected and the AC voltage inputs are applied to electrical contacts 36b and 36d, a second operating forward voltage is required to drive the multi-voltage and/or multi-brightness lighting device 30. The multi-voltage and/or multi-brightness lighting device 30 may be a monolithically integrated single chip 38, a monolithically integrated single chip integrated within a LED package 38 or a number of individual discrete die integrated onto a substrate 38 to form a multi-voltage and/or multi-brightness lighting device 30.

[Para 69] FIG. 4 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in parallel configuration to an AC voltage source and operating at a first forward voltage. A resistor 40 may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device 30.

[Para 70] FIG. 5 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in series configuration to an AC voltage source and operating at a second forward voltage that is approximately two times greater than the first forward voltage of the parallel circuit as described in FIG. 4. A resistor may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device.

[Para 71] FIGs. 6a and 7a disclose schematic diagrams of a multi-voltage and/or multi-brightness LED lighting devices 50. The multi-voltage and/or multi-brightness LED lighting devices 50 comprises at least two AC LED circuits 52, each of which have at least two LEDs 54 in series and anti-parallel relation. The at least two AC LED circuits 52 have at least three electrical contacts 56a, 56b and 56c, and in the case of FIG. 7a a fourth electrical contact 56d. The at least two AC LED circuits 52 are electrically connected together in parallel at one end

56a and left unconnected at the opposing ends of the electrical contacts 56b and 56c, and in the case of FIG. 7a, 56d. One side of an AC voltage source line is electrically connected to 56a and the other side of an AC voltage source line is individually electrically connected to 56b, 56c, and 56d with either a fixed connection or a switched connection thereby providing a first brightness when AC voltage is applied to 56a and 56b and a second brightness when an AC voltage is applied to 56a, 56b and 56c, and a third brightness when an AC voltage is applied to 56a, 56b, 56c, and 56d. It is contemplated that the multi-voltage and/or multi-brightness LED lighting devices 50 are a single chip, an LED package, an LED assembly or an LED lamp.

[Para 72] FIGs. 6b and 7b disclose a schematic diagram similar to the multi-voltage and/or multi-brightness LED device 50 shown in FIGs. 6a and 7a integrated within a lamp 58 and connected to a switch 60 to control the brightness level of the multi-voltage and/or multi-brightness LED lighting device 50.

[Para 73] FIG. 8 discloses a schematic diagram of a multi-brightness LED lighting device 62 having at least two bridge rectifiers 68 in series with LED circuits 69. Each of the at least two bridge rectifiers 68 in series with LED circuits 69 comprise four LEDs 70 configured in a bridge circuit 68. LED circuits 69 have at least two LEDs 71 connected in series and electrical contacts 72a, 72b and 72c. When one side of an AC voltage is applied to 72a and the other side of an AC voltage line is applied to 72b and 72c individually, the brightness level of the multi-brightness LED lighting device 62 can be increased and/or decreased in a fixed manner or a switching process.

[Para 74] FIG. 9 discloses a schematic diagram the multi-brightness LED lighting device 62 as shown above in FIG. 8 with a switch 74 electrically connected between the multi-brightness LED lighting device 62 and the AC voltage source 78.

[Para 75] FIG. 9 discloses a schematic diagram of at least two single voltage LED circuits integrated with a single chip or within a substrate and forming a multi-voltage and/or multi-brightness LED device.

[Para 76] FIG. 10 discloses a schematic diagram of a single chip LED bridge circuit 80 having four LEDs 81 configured into a bridge circuit and monolithically integrated on a substrate 82. The full wave LED bridge circuit has electrical contacts 86 to provide for AC voltage input connectivity and DC voltage output connectivity.

[Para 77] FIG. 11 discloses a schematic diagram of another embodiment of a single chip multi-voltage and/or multi-brightness LED lighting device 90. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of

which have at least two LEDs 94 connected in series. The at least two series LED circuits 92 have electrical contacts 96 at opposing ends to provide a means of electrical connectivity. The at least two series LED circuits are monolithically integrated into a single chip 98. The electrical contacts 96 are used to wire the at least two series LEDs circuit 92 into a series circuit, a parallel circuit or an AC LED circuit all within a single chip.

[Para 78] FIG. 12 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED lighting device 90 as shown above in FIG. 11. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of which have at least two LEDs 94 connected in series. The at least two series LED circuits can be monolithically integrated within a single chip or discrete individual die can be integrated within a substrate to form an LED package 100. The LED package 100 has electrical contacts 102 that are used to wire the at least two series LEDs circuit into a series circuit, a parallel circuit or in anti-parallel to form an AC LED circuit all within a single LED package.

[Para 79] As seen in FIGs. 13-15, a single rectifier 110 may be provided for two or more LED circuits 92, each containing at least two LEDs 94 connected in series. The single rectifier 110 comprises standard diodes 112 connected to an AC voltage source 116, or in the alternative may be connected to a driver or power supply which ultimately provides an AC voltage, like for example a high frequency AC driver 118. The single rectifier 110 is electrically connected to the LED circuits 92. Specifically, the rectifier 110 connects to a common junction of an anode of at least one LED 94 in each LED circuit 92, and to the cathode of at least one LED 94 in each LED circuit 92. As shown in FIG. 15, the rectifier may instead be connected to a switch, allowing for either one or both of LED circuits 92 to be operative at any given time.

[Para 80] It is contemplated by the invention that diodes 112 in FIGs. 13-15 are interchangeable with LEDs 70 in rectifiers 68 in FIGs. 8 and 9 and vice versa. As should be appreciated by those having skill in the art, any combination of LEDs 70 and diodes 112 can be used in rectifiers 68 and 110, so long as rectifiers 68 and 110 provide DC power from an AC source.

[Para 81] As shown in FIGs. 13 and 14, and further shown in FIGs. 16-20, any lighting devices, chips, or AC LED or DC LED circuits contemplated by the present invention may be powered through a high-frequency AC driver, inverter or transformer 118. As shown in FIG. 13, any AC source 116 may be connected to the high-frequency driver or inverter or transformer 118, however, as shown in Figs. 16-20 it is contemplated that low frequency

voltage 124, like for example a mains voltage, is provided to the high-frequency driver or transformer or inverter 118.

[Para 82] FIGs. 16 and 17 show two embodiments of an AC LED lighting system 140 wherein a high-frequency AC driver, inverter, or transformer 118 for provides a high-frequency voltage to an AC LED circuit, lighting device, or chip 126. AC LED circuit, lighting device, or chip 126 may be any of the devices, circuits, or chips shown and described in FIGs. 1-7, like for example LED lighting devices 10, 20, 30 and/or AC LED circuits 12, 32, or any combination thereof. When multiple AC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such AC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship.

[Para 83] As shown in FIG. 16, the high-frequency AC driver, inverter or transformer 118 may be packaged separately from an (or multiple) AC LED circuit, device, or chip 126. In such embodiments a power source 128 provides voltage to the high-frequency AC driver, inverter or transformer 118 which steps up the frequency of the voltage to a higher frequency and provides the higher-frequency voltage to the AC LED circuit(s), device(s), or chip(s) 126. High-frequency AC driver, inverter, or transformer 118 may further include necessary circuitry, for example a transformer, for stepping-up or stepping-down the AC voltage provided by the power source 128.

[Para 84] As shown in FIG. 17, high-frequency AC driver, inverter, or transformer 118 may be packaged with AC LED circuit(s), device(s), or chip(s) 126 in a unitary AC LED light bulb, lighting element 130. It is contemplated by the invention that a switch may be configured between the high-frequency driver, inverter, or transformer 118 and the AC LED circuit(s), device(s), or chip(s) 126 for selectively operating one or more AC LED circuit, lighting device, or chip. For example, as shown in FIGS. 6A, 6B, 7A, and 7B a 2-way or 3-way switch may be attached at the input side of the AC LED circuit(s), lighting device(s), or chip(s). Such a switch may be located between the high-frequency AC driver, inverter, or transformer 118, and the AC LED circuit(s), lighting device(s), or chip(s).

[Para 85] FIGs. 14 and 18-20 show a DC LED lighting system 142 having a DC LED circuit(s), device(s), or chip(s) 92, 132 being powered by a high-frequency AC driver, inverter, or transformer 118 through a rectifier 110. In operation, the combination of AC sources 116, 128, high-frequency AC driver, inverter or transformer 118, and DC LED circuit, device, or chip 92, 132 operate in substantially the same manner as that described with respect to FIGs. 16 and 17. However, in each system shown in FIGs. 14 and 18-20,

rectifier 110 rectifies the high-frequency AC voltage output of the high-frequency AC driver, inverter, or transformer before a voltage is provided to the DC LED circuit(s), device(s), or chip(s) 92, 132. DC LED circuit(s), device(s), or chip(s) 132 are not limited in form to just circuit 92, and instead may take the form of any of the lighting devices, circuits, or chips shown and described, for example, in FIGs. 8-12. When multiple DC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such DC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship. Additionally, as shown in FIG. 15, a switch, like for example a 2-way switch or a 3-way switch, may also be attached at the input side of DC LED circuit(s), device(s), or chip(s).

[Para 86] As shown in FIGs. 18-20, like in an AC embodiment, AC driver, inverter, or transformer 118, rectifier 110, and DC LED circuit(s), device(s), or chip(s) 132 may be packaged in any number of ways. As shown in FIG. 18, each element may be packaged separately and electrically connected together in series. Alternatively, as shown in FIG. 19, a DC LED driver 134 may be formed by combining the high-frequency AC driver, inverter, or transformer 118 with rectifier 110. As shown in FIG. 20, an additional alternative contemplated by the invention is forming a DC LED lighting element 136, which may be embodied as a light bulb, lighting system, lamp, etc., wherein the DC LED lighting element 136 includes each of a high-frequency AC driver, inverter, or transformer 118, a rectifier 110, and a DC LED circuit(s), lighting device(s), or chip(s) 132. It should be appreciated by those having skill in the art that a lighting element containing only rectifier 110 and a DC LED circuit(s), lighting device(s), or chip(s) 132 may also be designed. Such lighting elements have the advantage of being able to be plugged into any AC source, whether it is a high-frequency AC driver, inverter, or transformer, or a simple mains voltage, and provide a light output in the same manner as the imbalanced circuit shown in, for example FIGs. 1-7.

CLAIMS

What is claimed is:

1. A lighting system powered by an AC voltage source, the lighting system comprising:
    a. a high-frequency AC driver which outputs a relatively constant voltage at a relatively constant frequency, wherein the relatively constant frequency output is substantially higher than the frequency of an input voltage; and,
    b. at least two LED circuits each of which have at least two LEDs connected in series, electrically connected to the high-frequency AC driver.
2. The lighting system of claim 1 wherein each of the at least two LED circuits include:
    a. at least two LEDs connected in an opposing series relationship such that the anode of each of the at least two LEDs form a first node;
    b. at least two LEDs connected in an opposing series relationship such that the cathode of each of the at least two LEDs form a second node; and,
    c. a cross connecting LED connecting the first node to the second node such that the cathode of the cross connecting LED is connected to the first node, and the anode of the cross connecting LED is connected to the second node.
3. The lighting system of claim 2 wherein each of the at least two LED circuits are capable of being connected to the high-frequency AC driver in either a series relationship or a parallel relationship.
4. The lighting system of claim 3 wherein each of the two LED circuits have substantially identical forward operating voltages.
5. The lighting system of claim 4 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.
6. The lighting system of claim 5 wherein the switch is a two-way switch.
7. The lighting system of claim 5 wherein the switch is a three-way switch.
8. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged separately.
9. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged together forming an AC LED lighting device.

10. The lighting system of claim 1 further comprising a bridge rectifier electrically connected between the high-frequency AC driver and the at least two LED circuits.

11. The lighting system of claim 10 wherein the at least two LED circuits include at least two LEDs connected in series.

12. The lighting system of claim 10 wherein the bridge rectifier is formed using diodes.

13. The lighting system of claim 10 wherein the bridge rectifier is formed using LEDs.

14. The lighting system of claim 10 wherein the bridge rectifier is formed using a combination of diodes and LEDs.

15. The lighting system of claim 11 wherein each of the at least two LED circuits are capable of being connected in either a series relationship or a parallel relationship.

16. The lighting system of claim 15 wherein each of the at least two LED circuits have a substantially identical forward operating voltage.

17. The lighting system of claim 16 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.

18. The lighting system of claim 17 wherein the switch is a two-way switch.

19. The lighting system of claim 17 wherein the switch is a three-way switch.

20. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and at least two LED circuits are packaged separately.

21. The lighting system of claim 10 wherein the high-frequency AC driver and the bridge rectifier are packaged together forming a DC LED driver.

22. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and the at least two LED circuits are packaged together forming a DC LED lighting device.

23. The lighting system of claim 10 wherein the rectifier and the at least two LED circuits are packaged together.

24. A LED lighting device comprising:

a. at least one LED circuit;

b. the at least one LED circuit having at least two LEDs connected in series;

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1125

c. a bridge rectifier wherein the at least one LED circuit being electrically connected to the bridge rectifier.

25. The LED lighting device of claim 24 further comprising at least one additional LED circuit wherein the at least one additional LED circuit includes two LEDs connected in series.

26. The LED lighting device of claim 25 wherein a second bridge rectifier is electrically connected to the at least one additional LED circuit.

27. The LED lighting device of claim 25 wherein the at least one additional LED circuit is electrically connected to the bridge rectifier.

28. The LED lighting device of claim 27 wherein a switch is electrically connected between:

a. the bridge rectifier and,

b. the at least one LED circuit and the at least one additional LED circuit.

29. The LED lighting device of claim 26 wherein a switch is electrically connected to the inputs of each of the bridge rectifier and the second bridge rectifier.

30. The LED lighting device of claims 28 and 29 wherein the at least one LED circuit and the at least one additional LED circuit have a substantially identical forward voltage.

31. The LED lighting device of claim 30 wherein the at least LED circuit and the at least one additional LED circuit are capable of being connected in either a series relationship or a parallel relationship.

32. The LED lighting device of claims 24-31 further comprising a high-frequency AC driver attached to one or more of the bridge rectifier and the second bridge rectifier.

33. A LED lighting device comprising:

a. at least two LED circuits;

b. each of the at least two LED circuits having at least two LEDs connected in series;

c. a bridge rectifier wherein each of the at least two LED circuits are electrically connected to the bridge rectifier in a parallel relationship.

34. A method of providing light, the method comprising the steps of:

    a. providing an AC voltage at a first frequency;

    b. transforming the AC voltage at a first frequency to a provided voltage at a second frequency;

    c. supplying the provided voltage at the second frequency to at least two LED circuits.

35. The method of claim 34 wherein a high-frequency AC driver transforms the AC voltage at the first frequency to the provided voltage at the second frequency.

36. The method of claim 35 wherein the AC voltage and the provided voltage are substantially identical AC voltages.

37. The method of claim 35 wherein the provided voltage is a second AC voltage less than the AC voltage.

38. The method of claim 35 wherein the provided voltage is a second AC voltage greater than the AC voltage.

39. The method of claim 35 further comprising the step of rectifying the provided voltage at the second frequency prior to supplying the provided voltage to the at least two LED circuits.

40. The method of claim 39 wherein a bridge rectifier rectifies the provided voltage at the second frequency.

41. The method of claims 35-40 further comprising the step of selecting how many of the at least two LED circuits receive the provided AC voltage.

42. The method of claim 41 wherein one of a two-way switch or a three-way switch is used to select how many of the at least two LED circuits are supplied with the provided voltage.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1128

FIG. 2

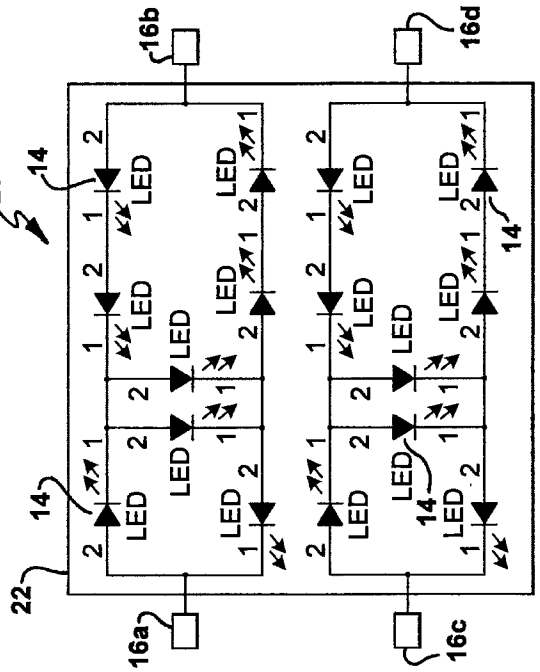
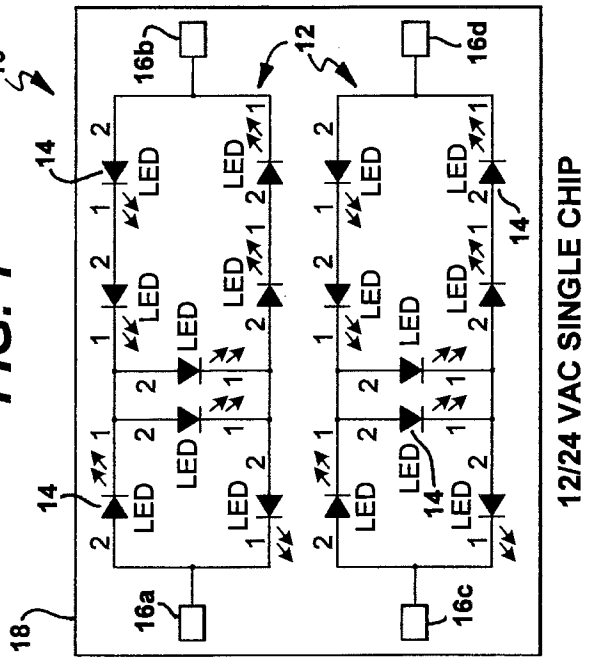


FIG. 1



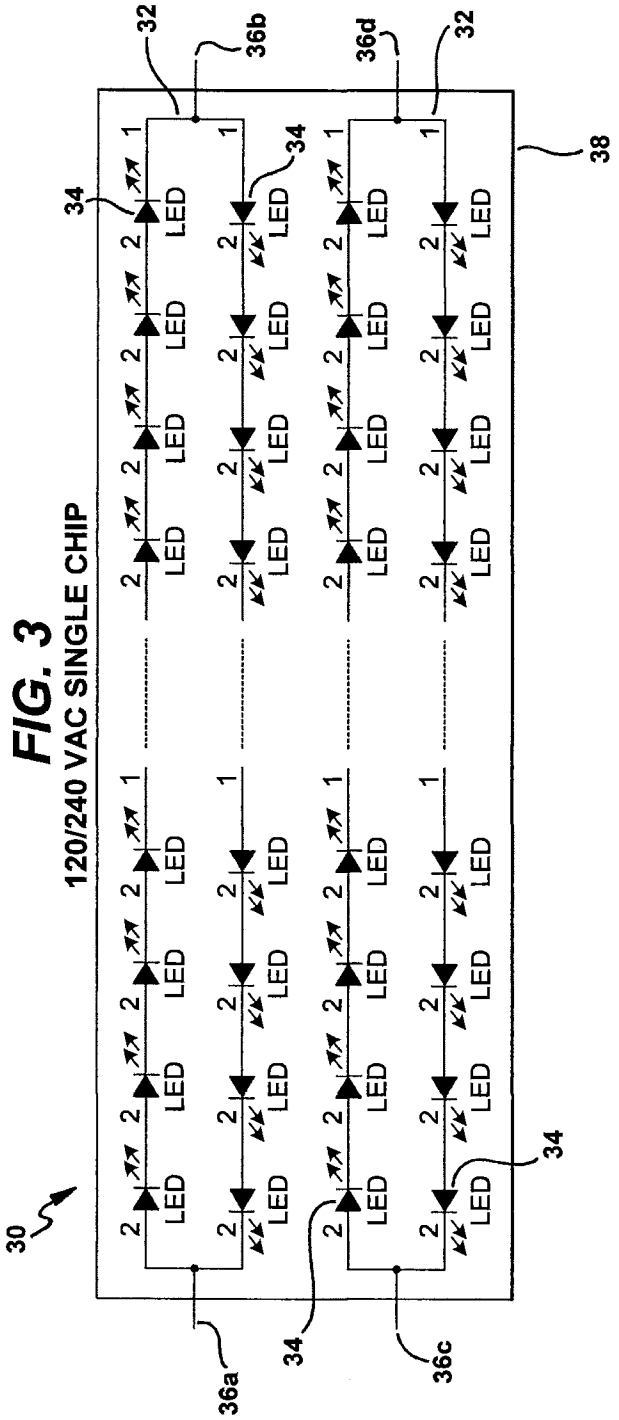
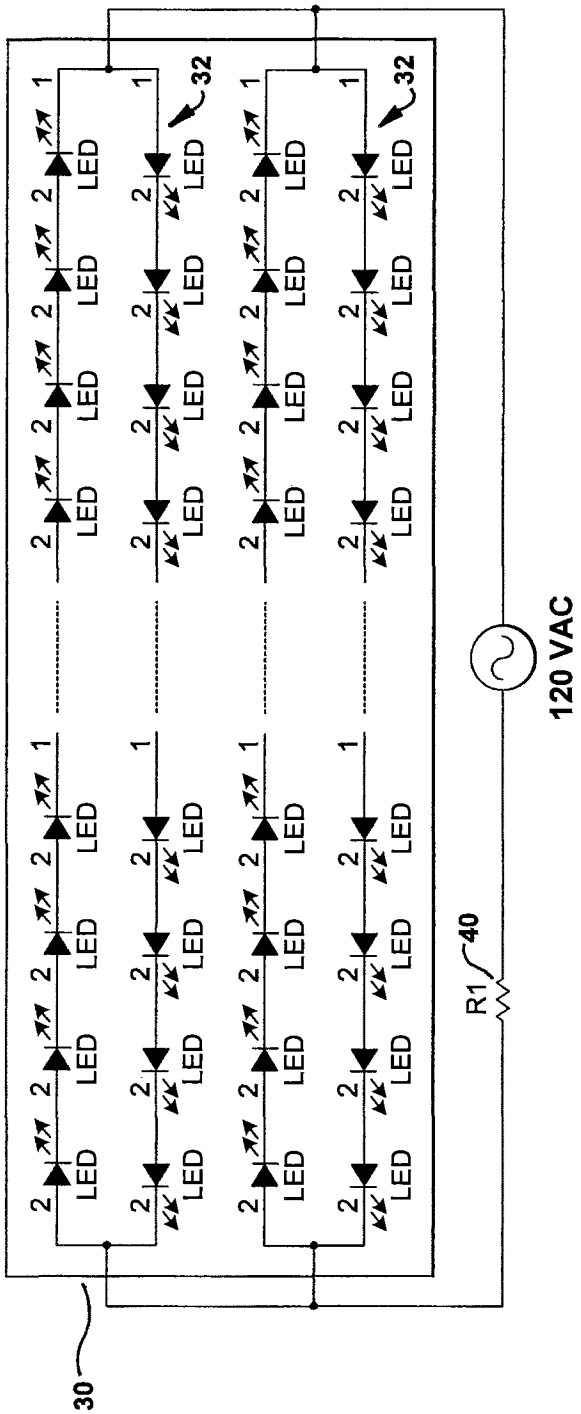

120/240 VAC SINGLE CHIP
30
32
36b
36d
32
38
34
34
34
34
36a
36c
LED
1
2

FIG. 3

FIG. 4



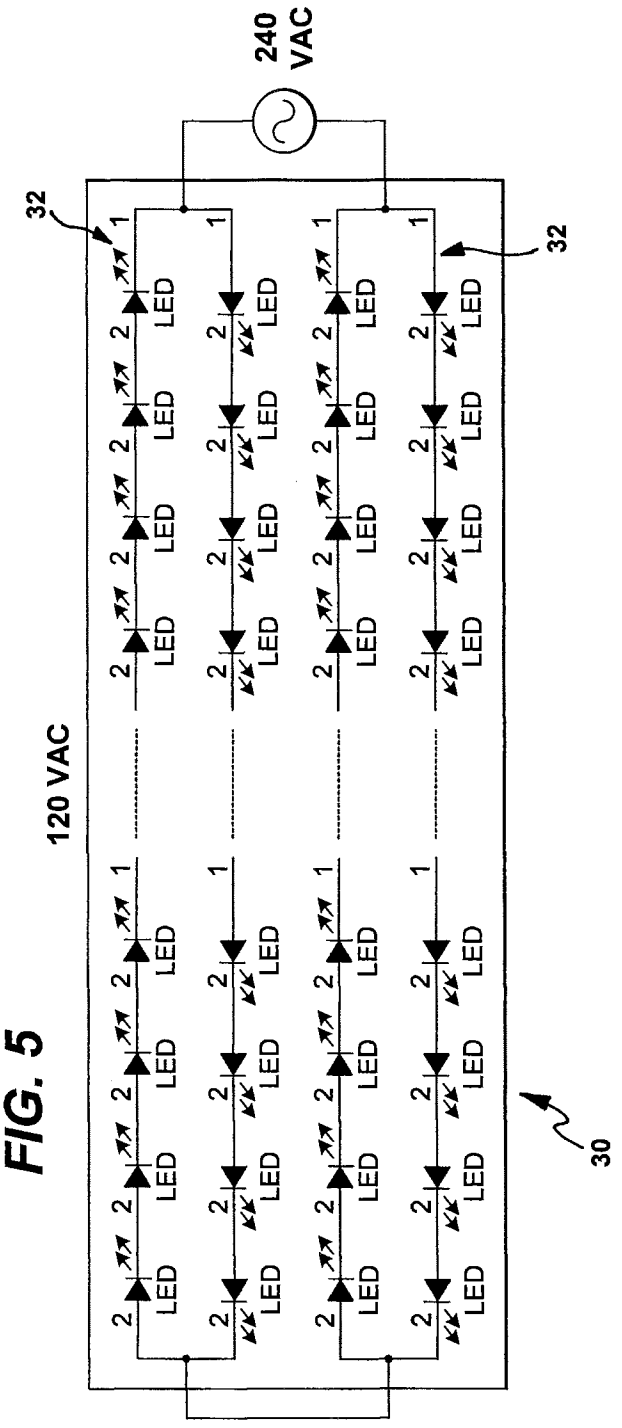


FIG. 5

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1132

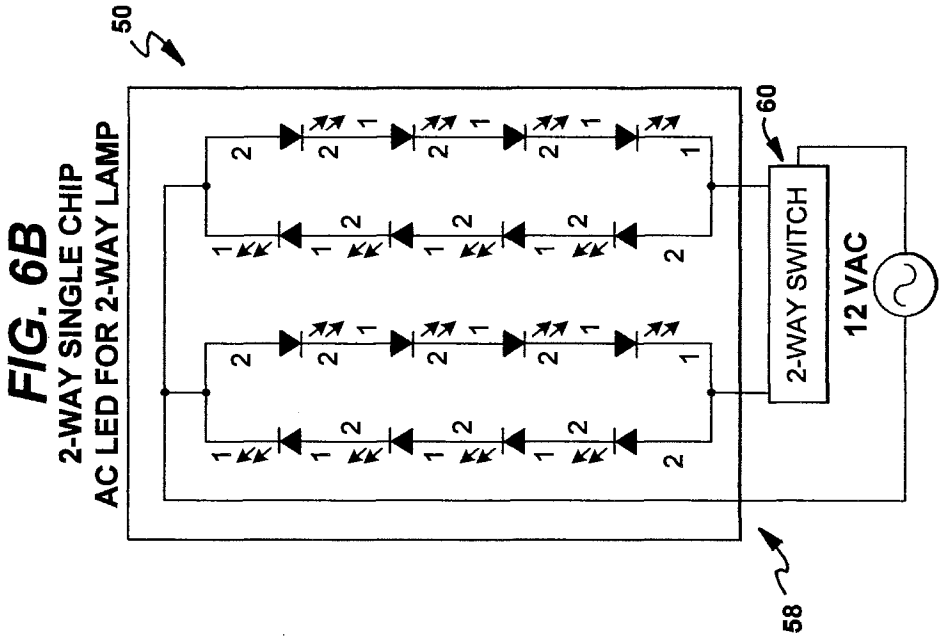


FIG. 6B
2-WAY SINGLE CHIP
AC LED FOR 2-WAY LAMP

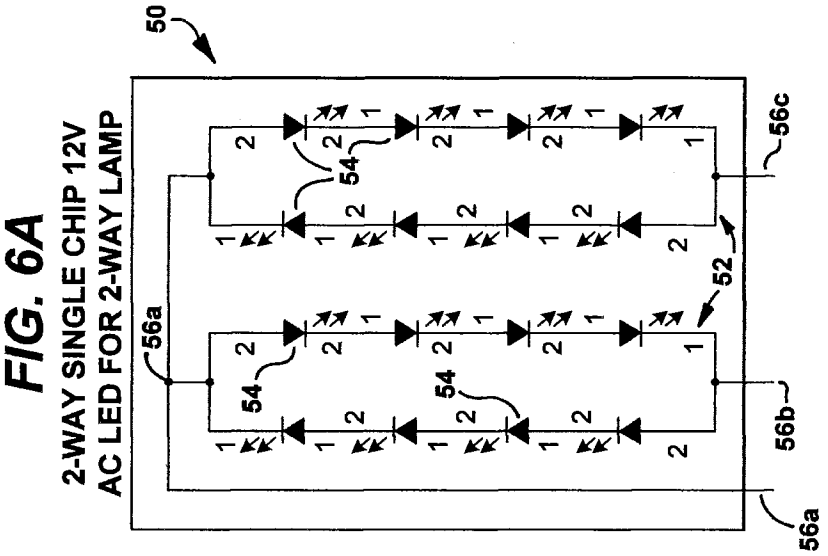


FIG. 6A
2-WAY SINGLE CHIP 12V
AC LED FOR 2-WAY LAMP

FIG. 7A

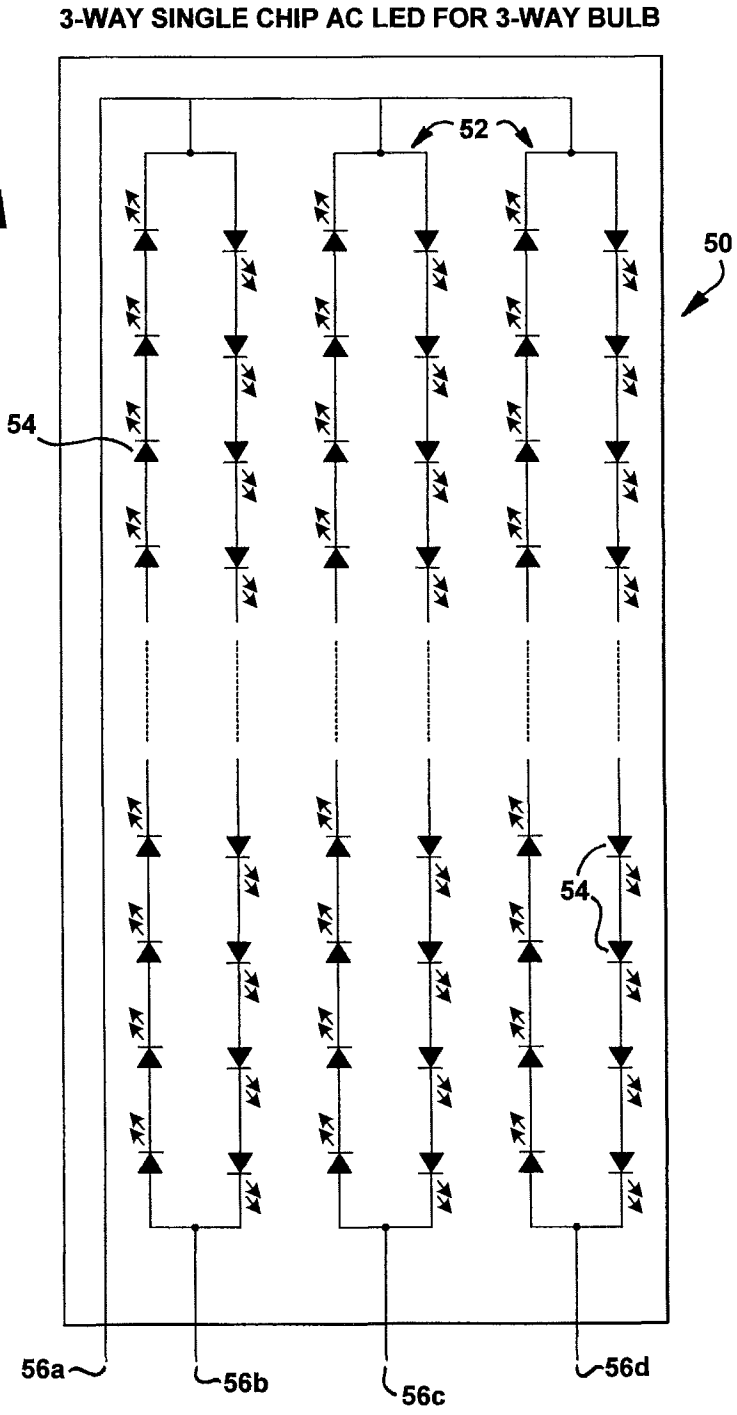

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
52
50
54
54
56a
56b
56c
56d

FIG. 7B

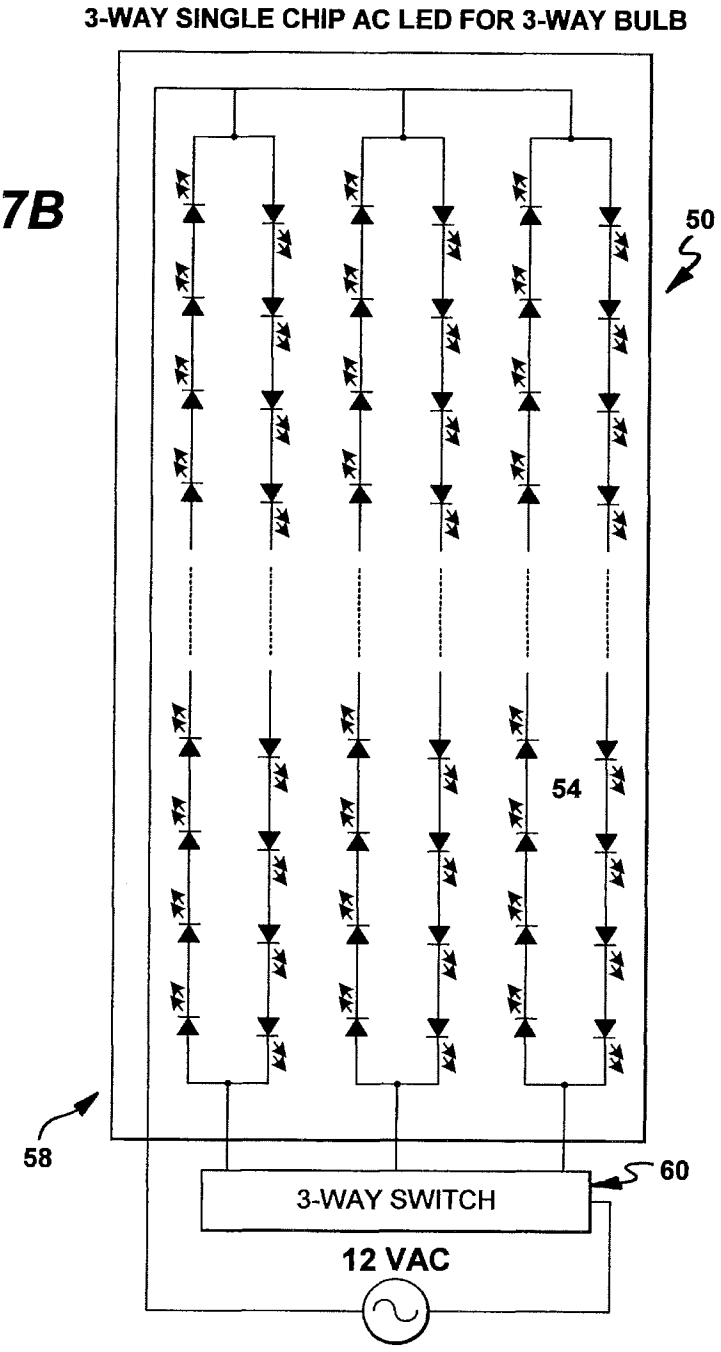
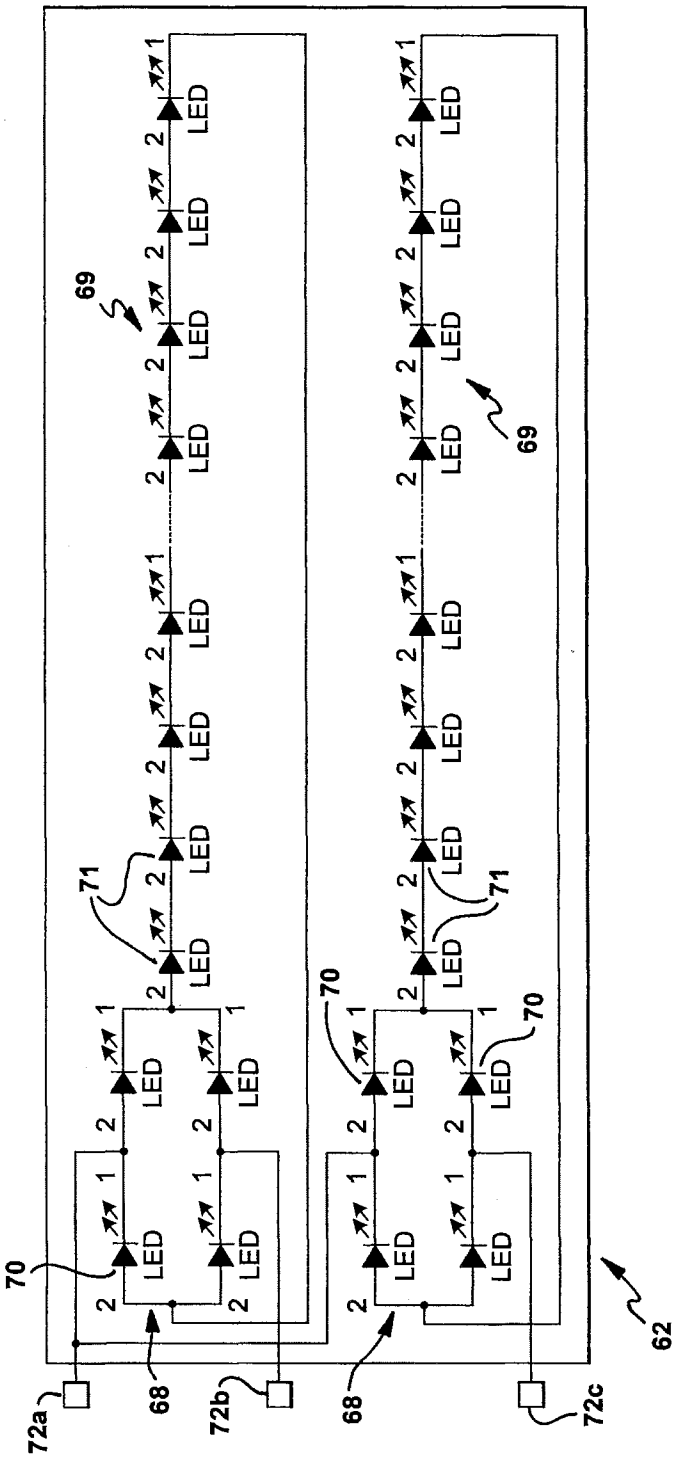
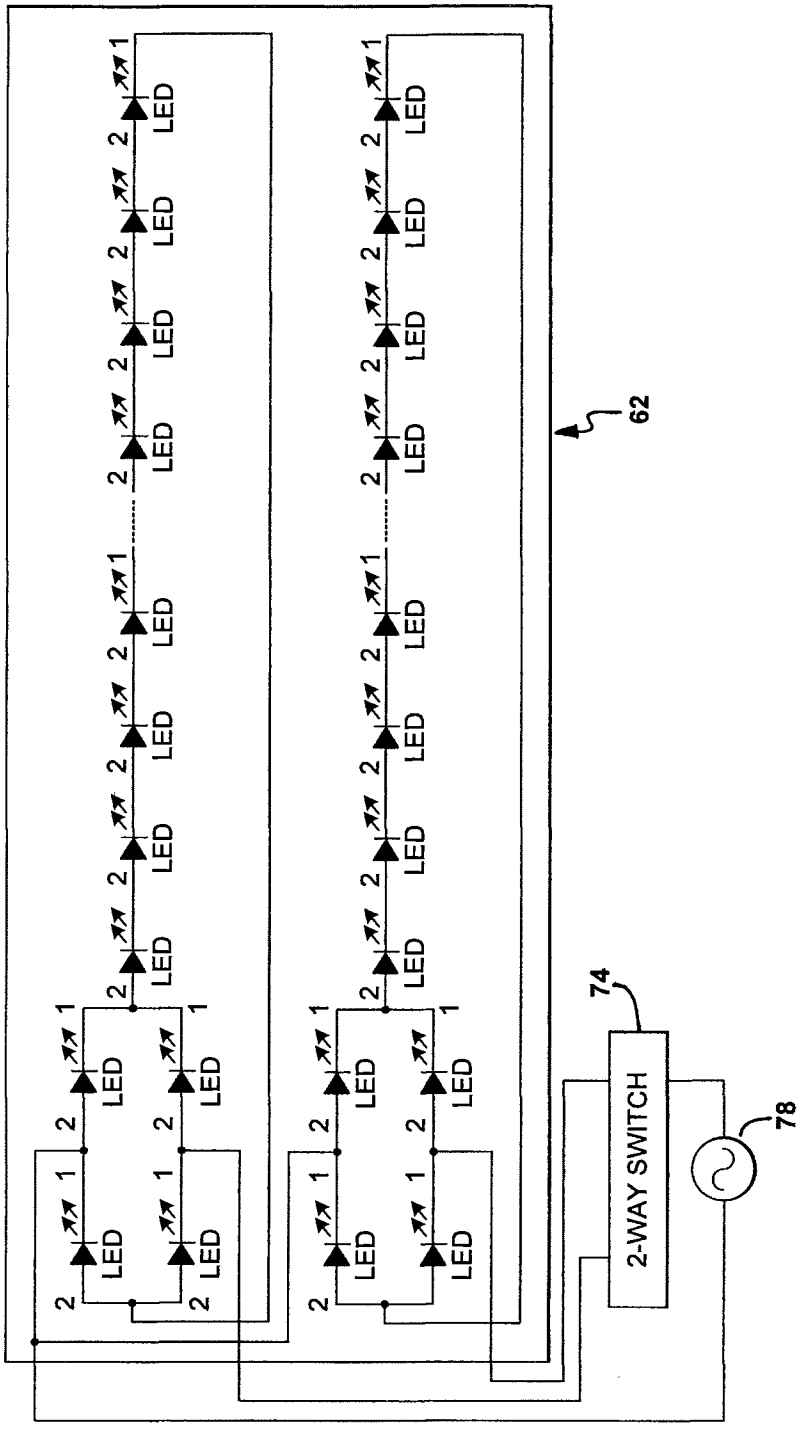

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
50
54
58
60
3-WAY SWITCH
12 VAC

FIG. 8



PGR2023-00016 - Home Depot
Ex. 1003 - Page 1136

FIG. 9



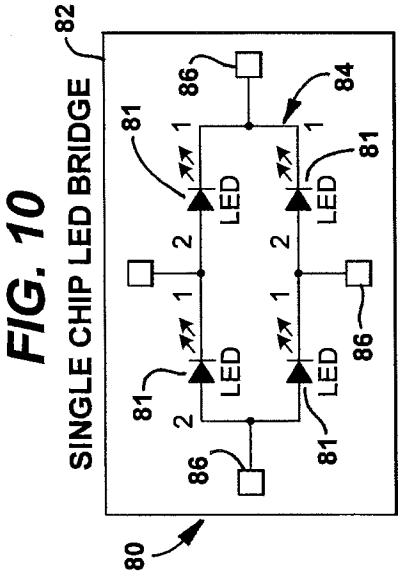


FIG. 10

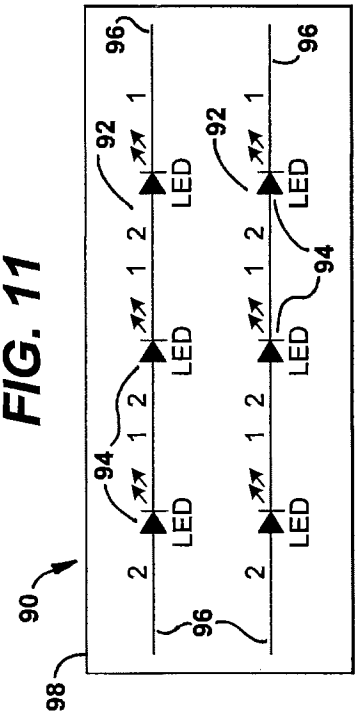


FIG. 11

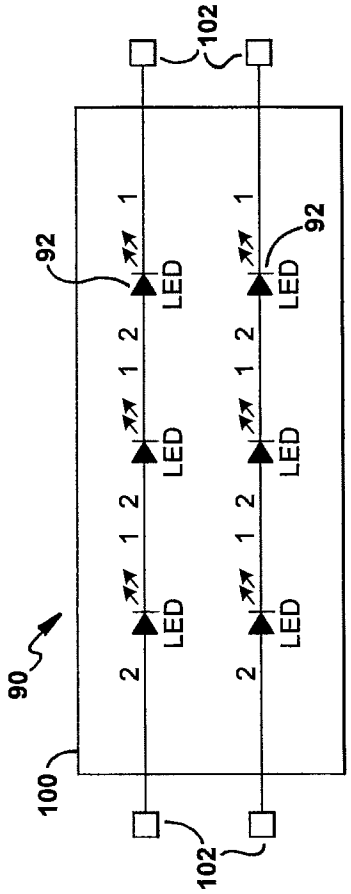


FIG. 12

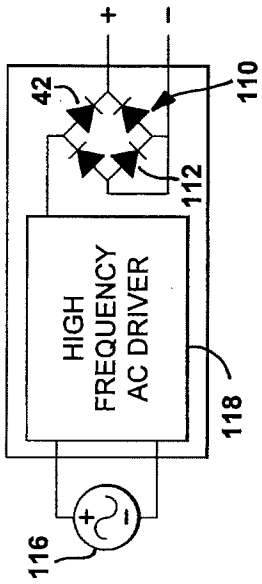


FIG. 13

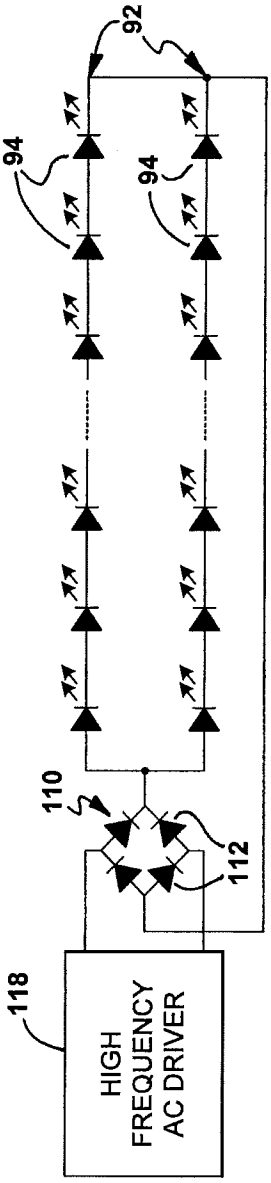


FIG. 14

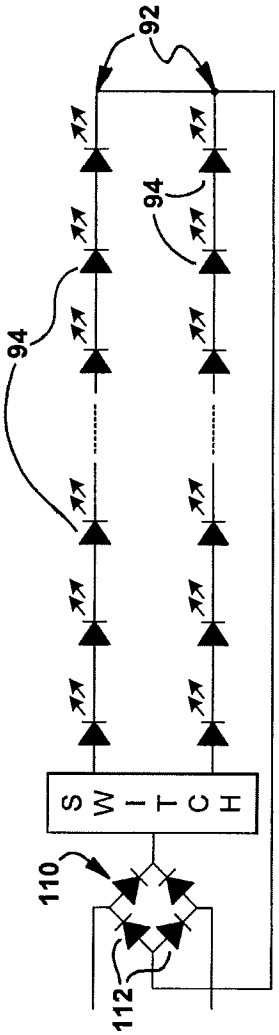


FIG. 15

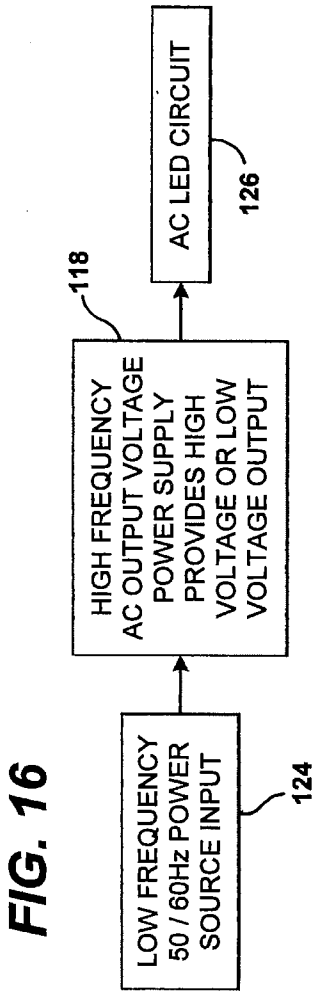

LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
PROVIDES HIGH
VOLTAGE OR LOW
VOLTAGE OUTPUT
118
AC LED CIRCUIT
126

FIG. 16

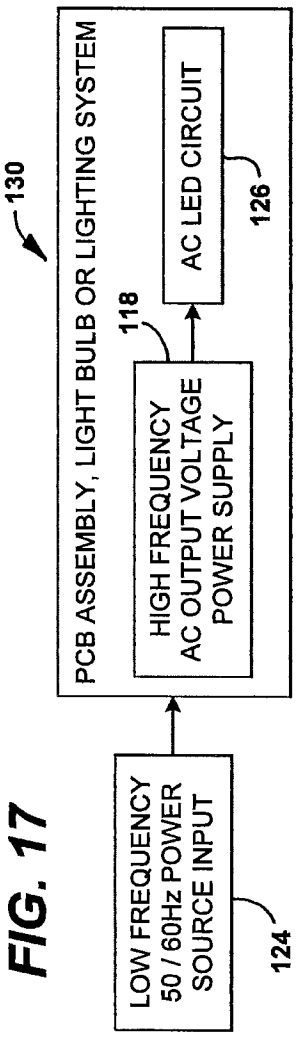

130
PCB ASSEMBLY, LIGHT BULB OR LIGHTING SYSTEM
LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
118
AC LED CIRCUIT
126

FIG. 17

FIG. 18

FIG. 19

FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H05B 37/00 (2011.01)
USPC - 315/185R
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 315/185R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 362/800; 315/185R, 200R, 246, 250, 291 (keyword limited - see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; Google Scholar
Terms: lighting, led, transformer, voltage, frequency, ac, dc, rectifier, driver, bridge, constant, cathode, anode, port, node, switch, series, input.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2009/0295300 A1 (King) 03 December 2009 (03.12.2009), entire document, especially abstract, para [0009], [0015], [0031], [0033], [0035], [0053], [0059], [0060], [0061], [0065], [0069], [0070], [0082], [0086], [0089], [0092], [0101], [0108].	24-31, 33-42 --- 1-23
Y	US 2008/0203936 A1 (Mariyama et al.) 28 August 2008 (28.08.2008), entire document, especially abstract, para [0012], [0015], [0017], [0018], [0019], [0053], [0129], [0133], [0136].	1-23
A	US 2008/0158915 A1 (Williams) 03 July 2008 (03.07.2008), entire document, especially abstract, para [0008], [0009], [0010], [0050].	1-31, 33-42

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2011 (14.02.2011)	08 MAR 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 32
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

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International Bureau

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(75) Inventors/Applicants *(for US only)*: **BEART, Pilgrim, Giles, William** [GB/GB]; 35 Royston Road, Harston, Cambridge CB2 5NH (GB). **WHITEWOOD, David, Paul** [GB/GB]; Castlebarn, Glottenham, Robertsbridge, E. Sussex TN32 5EB (GB). **CHENG, Lily, Ka-Lai** [CA/GB]; Flat 10, Citygate, Woodhead Drive, Cambridge CB4 1YZ (GB). **HAY, James, Westwood** [GB/GB]; 10 Watermead, Bar Hill, Cambridge CB3 8TJ (GB).

(74) Agents: **HITCHING, Peter, Matthew** et al.; Haseltine Lake, Imperial House, 15-19 Kingsway, London WC2B 6UD (GB).

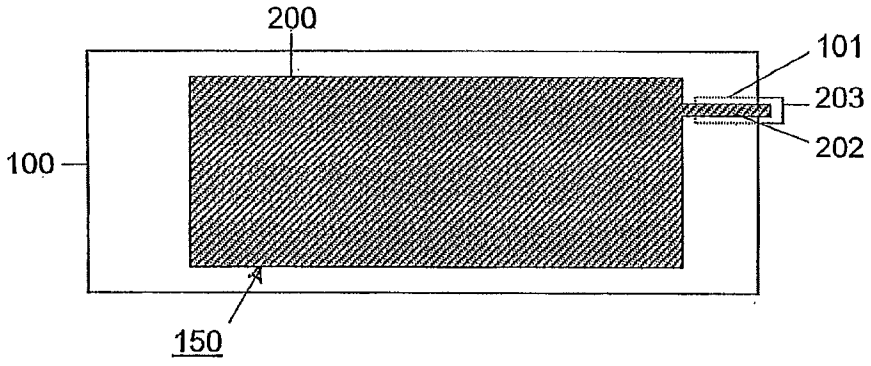
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, EG, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: ADAPTING PORTABLE ELECTRICAL DEVICES TO RECEIVE POWER WIRELESSLY



(57) Abstract: Wireless power receiving apparatus (150) is retrofitted to a portable electrical device (100) to enable the device to receive power wirelessly. The apparatus comprises a power-receiving element (200) adapted to be attached to the device, e.g. by adhesive (201), and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another. One or more power connectors (203) are connected electrically to the power-receiving element and are adapted to be connected, when the apparatus is in use, to one or more corresponding power connectors (101) of the portable electrical device to deliver power received by the element to the device. The power-receiving element may be in the form of a sticker or may be carried by or incorporated in a replacement cover portion for the portable electrical device.

WO 2004/055654 A2

PGR2023-00015 EXHIBIT 1013
SAMSUNG EXHIBIT 1013
Ex. 1003 - Page 1143

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1144

ADAPTING PORTABLE ELECTRICAL DEVICES TO RECEIVE POWER WIRELESSLY

The present invention relates to adapting portable electrical devices to receive power wirelessly.

Many of today's portable devices contain an internal secondary cell or battery which may be recharged by temporarily attaching an external adaptor to the power connector of the device. However this is something of a nuisance for users because it requires manual dexterity, requires both hands, and, especially, because different manufacturers use incompatible connectors, so the right adaptor must be located for each device.

Various means have been proposed for charging devices without the need to attach an external adaptor. These include:

- A surface providing power by presenting an array of contacts which then mate with receiving contacts on the device. Examples include:
  - In academia, the "Networked Surfaces" research conducted by James Scott and Frank Hoffman of the Laboratory for Communications Engineering, Engineering Department, University Of Cambridge, U.K.
  - In business, the wire-free electricity base proposed by MobileWise Inc., U.S.A.
- A surface providing power to devices by induction, without any contacts, for example as disclosed in patent publication no. WO-A-03/96512. In this system, the device incorporates a substantially flat element for receiving power inductively, conditioning it and then providing it to the device's battery and electronics.

These solutions typically require a device design to be modified, typically by the Original Equipment Manufacturer, in order to incorporate the power-receiving

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1145

element during manufacture. However there are a very large number of existing portable devices which are not already enabled. It would therefore be convenient to have a solution whereby the user could enable an existing device by simply retrofitting a power-receiving element to it.

According to a first aspect of the present invention, there is provided wireless power receiving apparatus for use with a portable electrical device to enable the device to receive power wirelessly, the apparatus comprising: a power-receiving element adapted to be attached to the device, and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and one or more power connectors which, when the apparatus is in use, are connected electrically to the power-receiving element and are adapted to be connected to one or more corresponding power connectors of the portable electrical device to deliver power received by the element to the device.

The benefit of the invention is that it enables users to add wireless power transfer capability to their existing portable devices easily.

In use, the user simply attaches the power-receiving element to the portable device and then connects the power connector(s) to the corresponding power connector(s) (power-input) of the portable device, thus enabling the device to receive power without wires from a transmitter of power (e.g. an external charger) for example by way of electromagnetic induction.

The means of attaching the power-receiving element to the device might be an adhesive, or might be some mechanical means such as a clip. The power receiving element could alternatively snap-fit on the device or slide on to it. The element may be removable or permanently attached once applied.

Yet another way of attaching the power-receiving element to the portable electrical device is to have a rigid connection between the power-receiving element and at least one of the power connectors. In this case, connection of that power connector or

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1146

those power connectors to the corresponding power connector(s) on the portable electrical device serves to attach the power-receiving element mechanically to the device without the need for any separate attaching means such as adhesive or a clip.

Another way of attaching the power-receiving element to the portable electrical device is to form the power-receiving element as part of a replacement cover portion of the portable electrical device. Some devices, such as mobile phones, have replaceable cover portions so that the user can change the appearance or "skin" of the device.

Optionally, the power-connector(s) may be attached to the power-receiving element by a flexible connecting member, allowing the power-connector(s) to be inserted and removed from the device's power-input while the power-receiving element remains attached for convenient future use. Preferably, the flexible connecting member also serves to connect the one or more power connectors electrically to the power-receiving element.

In one embodiment the electrical connections (e.g. wires) extending between the power-receiving element and power connectors are detachable from the power-receiving element and/or from the power connectors when the apparatus is not in use. This can enable the electrical connections and the power connectors to be removed to protect them from possible damage whilst still leaving the power-receiving element attached.

By having the electrical connections detachable it is also possible to offer a single design of power-receiving element but several different designs of power connector (or power connector plus electrical connection such as a flying lead) for use with different portable electrical devices.

Optionally, the power-connector may itself incorporate a contact means similar to the power-receiving input of the device, so that even when it is connected to the device,

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1147

the device may still be plugged in to a conventional adaptor in a "pass-through" fashion.

The portable electrical device may have first connector means adapted to connect to corresponding second connector means of external equipment. The first connector means provide the one or more corresponding power connectors of the portable electrical device, possibly together with one or more further connectors for other purposes such as signal or data input/output. In this case, the apparatus preferably further comprises: third connector means adapted to connect to the device's first connector means, the third connector means providing the power connector(s) of the apparatus; fourth connector means adapted to connect to the external equipment's second connector means; and a pass-through connection arrangement interconnecting at least one connector of the third connector means and a corresponding connector of said fourth connector means.

The third and fourth connector means may be on opposite faces of a power connector unit or block so that the unit or block can be sandwiched between the external equipment (e.g. a car hands-free cradle for a mobile phone) and the portable electrical device. It is not necessary for the pass-through connection arrangement to interconnect the power connectors of the third and fourth connector means, although this is preferable to enable power to be supplied from the external equipment when available. The pass-through connection arrangement could serve just to interconnect signal or data connectors of the third and fourth connector means.

If the power received by the power-receiving means must be power-conditioned before being passed to the device, the power-conditioning circuitry may optionally be incorporated into the power-receiving element or the power-connector.

Optionally, all parts of the invention, especially the adhesive, may be substantially waterproof.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1148

Optionally, the power-receiving element may be coloured and textured such that, when adhered to the device, it appears to be a part of the device. Alternatively, or additionally, the power-receiving means may carry text or pictures, for example a logo or advertising.

Optionally, the power-receiving element may include a substantially transparent pocket into which pictures and the like may be slid.

In another embodiment, a part of the power-receiving element which must be placed in proximity with the transmitter is marked or coloured or labelled distinctively. In this way, the user can be informed of how to position or orient the power-receiving element (attached to the portable electrical device) relative to the transmitter so that power is transferred efficiently from the transmitter to the power-receiving element.

Optionally, a power indicator may be provided, optionally in the power-receiving element or the power-connector, to indicate when power is being received and/or being passed to the device. The indicator may produce light (perhaps an LED or electroluminescent panel), sound or vibration.

Optionally, the power-receiving element may be applied inside the device instead of outside, for example to the rear of the battery compartment.

Optionally, the power-connector may connect to internal power contacts within the device, possibly to its batteries and/or battery contacts.

Preferably, the power-receiving element is substantially flat. Alternatively, but preferably in addition, the power-receiving element is flexible. These features make it easy to attach the power-receiving element to the portable electrical device at a suitable internal or external surface portion thereof. When the surface portion is an internal one, having the power-receiving element substantially flat and/or flexible makes it possible to fit the element conveniently even in confined spaces such as battery compartments. When the surface portion is external, these features make it

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1149

possible to attach the power-receiving element without significantly affecting the overall shape and/or ergonomics of the portable electrical device.

According to a second aspect of the present invention, there is provided in combination a portable electrical device and wireless power receiving apparatus embodying the aforesaid first aspect of the present invention.

The following non-exhaustive list illustrates some examples of devices that can be enabled using the present invention. Possibilities are not limited to those described below:

- A mobile communication device, for example a radio, mobile telephone or walkie-talkie;
- A portable computing device, for example a personal digital assistant or palmtop or laptop computer;
- Portable entertainment devices, for example a music player, game console or toy;
- Personal care items, for example a toothbrush, shaver, hair curler, hair rollers;
- A portable imaging device, for example video recorder or camera;
- Containers of contents that may require heating, for example coffee mugs, plates, cooking pots, nail-polish and cosmetic containers;
- Consumer devices, for example torches, clocks and fans;
- A battery-pack for insertion into any of the above;
- A standard-sized battery cell;

In the case of unintelligent secondary devices such as a battery cell, some sophisticated charge-control means may also be necessary to meter inductive power to the cell and to deal with situations where multiple cells in a device have different charge states. Furthermore, it becomes more important for the transmitter of power to be able to indicate a "charged" condition, since the secondary cell or battery may not be easily visible when located inside another electrical device.

According to a third aspect of the present invention there is provided a power-receiving element in the form of a sticker adapted to be attached adhesively to a surface portion of a portable electrical device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

By providing the power-receiving element in the form of a sticker the user can readily retrofit the power-receiving element to the portable electrical device.

For convenience of delivery and attachment, the sticker preferably has a removable backing sheet on its adhesive side which is removed at the time of attaching the element to the device.

The side of the sticker opposite its adhesive side may conform in appearance to surface portions of the portable electrical device that will be adjacent to that opposite side when the sticker is attached to the device. This can enable the sticker-form power-receiving element to be attached unobtrusively or invisibly to the outside of the portable electrical device.

In another embodiment the sticker has, on its side opposite its adhesive side, a substantially transparent pocket for carrying an insert. The insert may carry text or pictures, for example a logo or advertising.

According to a fourth aspect of the present invention, there is provided a replacement cover portion for a portable electrical device, the cover portion carrying or incorporating a power-receiving element adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device. Preferably, the replacement cover portion has substantially the same size and shape as the cover portion which it replaces. Alternatively, the replacement cover portion may be thicker than that which it

replaces, or extend over the side of the portable electrical device which houses the power connector, to allow the connection means to connect to the power connector.

In one embodiment the replacement cover portion has a power connector part carrying one or more power connectors arranged to connect, when the replacement cover portion is in place on the device, to one or more corresponding power connectors of the portable electrical device. Preferably, the power connector part is connected rigidly or semi-rigidly (e.g. resiliently) to the remaining parts of the replacement cover portion so that fitting the replacement cover portion automatically brings the one or more power connectors of the replacement cover portion into electrical connection with the one or more corresponding power connectors of the portable electrical device.

In another embodiment, the replacement cover portion covers a battery compartment of the portable electrical device and has one or more battery connectors adapted to connect to one or more corresponding battery connectors of the device and/or to terminals of one or more batteries installed in the device. For example, the one or more battery connectors of the cover portion may be adapted to be interposed between the battery terminals and the corresponding battery connectors of the device.

In another embodiment, the replacement cover portion covers a battery compartment of the portable electrical device, and the cover portion further carries or incorporates at least one rechargeable battery. When the replacement cover portion is in place on the device the battery is installed operatively in the battery compartment. The power-receiving element is connected operatively to the battery for charging the battery when power is received wirelessly from the transmitter.

The replacement cover portion is, for example, a replacement cover portion for a handset of a mobile communications network.

According to a fifth aspect of the present invention, there is provided a method of adapting a portable electrical device having no wireless power receiving capability to

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1152

have such a capability, the method comprising: attaching a power-receiving element to the device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and connecting one or more power connectors, which are connected electrically to the element, to one or more corresponding power connectors of the device so that power received by the element can be delivered to the device.

According to a still further aspect of the present invention, there is provided an attachable means for receiving power, the means comprising:

i) a substantially flat power-receiving means of sufficiently small dimensions that it can attach to an existing portable device without significantly altering its ergonomics;

ii) a power connector capable of attaching to the power input of an existing portable device; and

iii) a means of attaching part or all of the above to a portable device.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:

Figure 1a shows a schematic side view of a portable electrical device and a first example of wireless power receiving apparatus embodying the present invention;

Figure 1b is a schematic end view corresponding to Figure 1a;

Figure 1c is a plan view corresponding to Figure 1a;

Figures 2a to 2c are respective schematic side, end and plan views of a portable electrical device and a second example of wireless power receiving apparatus embodying the present invention;

Figures 3a and 3b are respective schematic plan and side views of a power-receiving

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1153

element embodying the present invention;

Figure 4 shows a circuit diagram of parts of circuitry included in apparatus according to one embodiment of the present invention;

Figure 5 shows a schematic cross-sectional view of a power connector of apparatus according to one embodiment of the present invention;

Figure 6 shows a schematic perspective view of a power-receiving element in the form of a sticker according to one embodiment of the present invention;

Figure 7 shows a schematic perspective view of a power-receiving element according to another embodiment of the present invention.

Figure 8 shows a schematic perspective view of parts of a handset for use in a mobile communications network, a battery pack therefor and a replacement cover portion for the handset according to one embodiment of the present invention;

Figure 9 shows a schematic perspective view of the handset and battery pack of Figure 8 and a replacement cover portion for the handset according to another embodiment of the present invention; and

Figure 10 shows a schematic perspective view of the handset of Figure 8 and a replacement cover portion for the handset according to yet another embodiment of the present invention.

FIGURE 1 shows parts of apparatus 150 according to a first embodiment of the present invention, and an example portable electrical device (mobile handset) 100 with which the apparatus is used. As originally manufactured the device has no wireless power receiving capability.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1154

As shown in side view in Figure 1a the device 100 has a power-connector 101 which in this case is a socket. The apparatus 150 comprises a substantially flat power-receiving element 200, a layer of adhesive 201, a flexible connecting member (flexible wiring) 202 and a power-connector 203 capable of being plugged-in to the device's power-connector 101.

Figures 1b and 1c show end and plan views of the arrangement of Figure 1a. The rear face (underside) of the mobile device 100 is uppermost in Figure 1a, and it is to this face that the element 200 is attached.

Figures 2a to 2c shows corresponding views to those of Figures 1a to 1c but for apparatus 160 according to the second embodiment of the present invention. In this case the device power connections (first connector means) 111a,b are contact strips instead of a socket. These device power connections 111a,b are adapted to connect to corresponding mating strips (second connector means – not shown) of external equipment (not shown) such as a charger. A power connector unit 213 of the apparatus has corresponding mating strips (third connector means) 215a,b on an inner face 214 thereof which make electrical contact with the device's power connections 111a,b. In addition, further connectors (fourth connector means) 217a,b are provided on an outer face 216 of the power connector unit 213 so that other equipment, for example an in-car hands-free unit or charger, having the second connector means may still be connected. These further connectors 217a,b are connected electrically to the corresponding contacts 215a,b by a pass-through connection arrangement incorporated into the power connector unit 213. The connectors 215a,b and 217a,b may include connectors used for purposes other than power delivery, for example input/output of signals and data.

Figures 3a and 3b show plan and side views respectively of one example of a substantially flat power-receiving element 200 for use in embodiments of the present invention. A magnetic core consists of six strips of amorphous metal 400 each measuring 50x30x0.02mm, stacked. Around these is wound a coil 300, which could be for example of copper wire, tape, or a stamped or pressed metal. In this case, the

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1155

coil passes around the core 30 times, with a centre-tap, providing current to three connections 202 which connect to further circuitry described later with reference to Figure 4. The entire element is readily flexible, which is useful in making it conform to any non-flat part of the device to which it is applied, and also makes it less fragile, since the entire element can be less than 0.2mm thick.

Further information regarding the power-receiving element of the example shown in Figures 3a and 3b, and regarding further examples of suitable power-receiving element is given in our patent publications WO-A-03/096361 and WO-A-03/096512, the entire contents of which are incorporated herein by reference. Various designs of a transmitter of wireless power suitable for use with the power-receiving element are also disclosed in these patent publications.

Figure 4 shows circuitry 450 capable of converting the alternating current delivered by the power receiving element into power suitable for use in a portable electronic device. A parallel-resonating capacitor 501 tunes the coil, which allows increased power transfer. A value of 100's of nF is typical, depending on the exact core materials and coil construction, and therefore inductance. The alternating current is full-wave rectified by diodes 500. Schottky diodes with a forward voltage drop of 0.3V provide best performance. Capacitor 502 provides smoothing of the DC. The voltage at this point is unregulated, which may be sufficient to send to subsequent electronics within the portable device, if it is capable of taking such. Optional voltage regulator 503 limits the voltage for devices which are not capable of taking an unregulated supply. This regulator may be a linear or switch mode type, and may optionally also contain other protection and system management circuitry. Optional indicator 504 indicates that power is being received.

An alternative configuration to that shown in Figures 3a, 3b and 4 would be to use a full bridge rectifier instead of diodes 500, removing the need for the centre-tap, but increasing the total power loss. With this configuration, the tuning capacitor may be parallel-resonant or series-resonant.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1156

Figure 5 shows a detail view of one implementation of a power connector 600. A barrel-shaped protrusion carries two conducting rings 601 and 602 which mate with contacts within the power input socket of the portable device. The circuitry 450 of Figure 4 is contained within the power connector, and the optional power indicator 504 is visible externally. Optionally the connector 600 is removable from an end 603 of the flexible wiring 202, allowing different power connectors to be fitted to suit the particular device, each with the appropriate circuitry (power electronics) 450.

Alternatively, one end of the flexible wiring 202 could be removable from the power-receiving element 200 and the other end attached permanently to the power connector 600. This would allow the power connector 600 and flexible wiring 202 to be sold as one unit, and the power-receiving element to be sold as another unit. Again, this would make it possible to offer different versions of the power connector plus flexible wiring to work with different portable electrical devices, whilst offering only a single design of power-receiving element. The removable connections between the flexible wiring and the power connector and/or power-receiving element can be made by any suitable electrical connection arrangement such as a plug and socket.

A preferred implementation of the present invention is illustrated schematically in Figure 6. In this implementation, the power-receiving element is in the form of a "sticker" 700. The element 700 has a layer of adhesive 702 on one surface 701 thereof. The element is supplied with a removable backing sheet 703 which protects the adhesive 702 prior to attachment of the element to the portable electrical device. The backing sheet 703 is peeled off by a user to expose the layer of adhesive 702 on surface 701. After peeling off the backing sheet 703 the user simply presses the power-receiving element on its adhesive side 702 to the portable electrical device.

Figure 7 shows a schematic perspective view of a power-receiving element in another embodiment of the present invention. In this embodiment the power-receiving element 800 has, on its side 801 which will be visible to a user when the element is attached to the device, a transparent pocket 802. An insert 803, for

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1157

example a slip of paper or card, is carried within the pocket 802. The insert may bear text or pictures, for example a logo or advertising.

Another preferred implementation of apparatus embodying the present invention is in the form of a replacement cover portion of the portable electrical device itself. There are several types of portable electrical device commercially available which have replaceable cover portions. Handsets for use in mobile communications networks made by several major manufacturers are one example. Replacement cover portions for such devices can advantageously carry or incorporate at least the power-receiving element of apparatus embodying the present invention.

Figure 8 shows a schematic perspective view of such a handset 900. The handset 900 has a battery compartment 902 for holding a removable battery pack 904. The removable battery pack 904 is, for example, a rechargeable battery pack. The battery pack 904 has terminals (not shown) which connect to corresponding battery connectors 906 of the handset 900 within the battery compartment 902 when the battery pack 904 is installed in the battery compartment. The handset 900 also has a power connector 908 at a bottom end 910 thereof.

A replacement cover portion 950 according to an embodiment of the present invention is adapted to be fitted to the handset 900. The replacement cover portion in this embodiment is a rear cover portion and covers the battery compartment 902 of the handset 900 as well as other parts thereof. The cover portion 950 has on its inner face or incorporated within it a power-receiving element 952. The element 952 may, for example, be the same as the power-receiving element 200 described hereinbefore. The cover portion 950 is designed to extend at one end 954 beyond the bottom end 910 of the handset 900. At the end 954 the cover portion 950 has a power connector part 956 carrying one or more power connectors 958. The power connector(s) is/are connected in some suitable way (not shown) to the power-receiving element 952, either directly or via power conditioning circuitry such as the circuitry 450 of Figure 4. The power connector(s) 958 is/are adapted to connect to the corresponding power connector(s) of the handset power connector 908. This arrangement is convenient in

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1158

that installation of the cover portion 950 on the handset 900 automatically makes the required electrical connections between the power-receiving element 952 and the power connector 908 of the handset. If necessary, the power connector part 956 of the cover portion 950 may be connected semi-rigidly (e.g. resiliently) instead of rigidly to the remaining parts of the cover portion 950. This can make it easier for the power connector(s) 958 of the cover portion to be connected to the corresponding power connector(s) of the handset 900 when the cover portion is being fitted to the handset.

Figure 9 shows another embodiment in which the power-receiving element is carried by or incorporated in a replacement cover portion. In Figure 9, a replacement cover portion 1000 does not have the extended end 954 or the power connector part 956 of the replacement cover portion 950 of Figure 8. Instead, an internal power connector part 1002 is connected, preferably via power conditioning circuitry such as the circuitry 450 of Figure 4, to the power-receiving element 952. The connection may be made using flexible wiring 1004. The power connector part 1002 is sufficiently thin to enable it to be interposed between the battery terminals of the battery pack 904 and the power connectors 906 formed within the battery compartment 902 of the handset 900. In a similar way to that described previously with reference to Figure 2, the power connector part 1002 has a set of contacts on both its main faces. The two sets of contacts are connected together by a pass-through connection arrangement. This enables the power from the battery pack 904 to be supplied to the power connectors 906 when the power-receiving element is not receiving power wirelessly from a transmitter.

Figure 10 shows yet another embodiment in which a replacement cover portion 1050 carries or incorporates a rechargeable battery pack 1054 in addition to a power-receiving element 952. The electrical connections between the power receiving element 952 and the battery pack 1054 are made by suitable means (not shown) incorporated in or carried by the cover portion 1050. The fitting of the replacement cover portion 1050 to the handset 900 brings the battery terminals of the battery pack 1054 into contact with the power connectors 906 of the handset 900.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1159

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. Wireless power receiving apparatus for use with a portable electrical device to enable the device to receive power wirelessly, the apparatus comprising:

a power-receiving element adapted to be attached to the device, and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and

one or more power connectors which, when the apparatus is in use, are connected electrically to the power-receiving element and are adapted to be connected to one or more corresponding power connectors of the portable electrical device to deliver power received by the element to the device.

2. Apparatus as claimed in claim 1, wherein said power-receiving element is adapted to be attached adhesively to the device when the apparatus is in use.

3. Apparatus as claimed in claim 1, further comprising mechanical attachment means adapted to attach the power-receiving element mechanically to the device when the apparatus is in use.

4. Apparatus as claimed in claim 1, wherein said power-receiving element forms part of a replacement cover portion of the portable electrical device.

5. Apparatus as claimed in claim 1, wherein said power-receiving element and at least one of said power connectors of the apparatus are connected rigidly together, whereby connection of said at least one power connector to its said corresponding power connector of the portable electrical device serves to attach the power-receiving element mechanically to the device.

6. Apparatus as claimed in any one of claims 1 to 4, further comprising a flexible connecting member connecting said one or more power connectors flexibly to said power-receiving element.

7. Apparatus as claimed in claim 6, wherein said flexible connecting member also serves to connect said one or more power connectors electrically to the power-receiving element.

8. Apparatus as claimed in any one of claims 1 to 5, having one or more electrical connections extending between said power-receiving element and said one or more power connectors, said one or more electrical connections being detachable

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1161

from said power-receiving element and/or from said one or more power connectors when the apparatus is not in use.

9. Apparatus as claimed in any preceding claim, wherein said portable electrical device has first connector means adapted to connect to corresponding second connector means of external equipment, said first connector means providing said one or more corresponding power connectors of the portable electrical device, and the apparatus further comprising:

third connector means adapted to connect to said first connector means of the portable electrical device, said third connector means providing said one or more power connectors of the apparatus;

fourth connector means adapted to connect to said second connector means of said external equipment; and

a pass-through connection arrangement interconnecting at least one connector of said third connector means and a corresponding connector of said fourth connector means.

10. Apparatus as claimed in claim 9, wherein said first to fourth connector means also provide connectors for purposes other than power delivery, and said pass-through connection arrangement serves to interconnect corresponding connectors of said third and fourth connector means used for said other purposes.

11. Apparatus as claimed in any preceding claim, further comprising:

power-conditioning circuitry operable to condition the power received by the power-receiving element prior to delivery to the portable electrical device.

12. Apparatus as claimed in any preceding claim, wherein said power-receiving element is small relative to said portable electrical device.

13. Apparatus as claimed in any preceding claim, wherein said power-receiving element is thin relative to said portable electrical device.

14. Apparatus as claimed in any preceding claim, wherein a volume occupied by said power-receiving element is small in comparison with a volume occupied by said portable electrical device.

15. Apparatus as claimed in any preceding claim, wherein said power-receiving element is of sufficiently small dimensions that, when attached to the portable electrical device, it does not substantially alter the ergonomics of the device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1162

16. Apparatus as claimed in any preceding claim, wherein parts of said power-receiving element that are visible to a user of the device when the element is attached to the device have an external appearance which conforms to an external appearance of adjacent parts of the device.

17. Apparatus as claimed in any preceding claim, wherein a part of said power-receiving element which must be placed in proximity with the transmitter is marked or coloured or labelled distinctively.

18. Apparatus as claimed in any preceding claim, wherein said power-receiving element has, at a surface thereof that is visible to a user of the portable electrical device when the element is attached to the device, a substantially transparent pocket for carrying an insert to be visible to the user.

19. Apparatus as claimed in any preceding claim further comprising an indicator which produces a predetermined indication of an operating state of the apparatus.

20. Apparatus as claimed in any preceding claim, wherein said power-receiving element is substantially flat.

21. Apparatus as claimed in any preceding claim, wherein said power-receiving element is flexible.

22. In combination a portable electrical device and wireless power receiving apparatus as claimed in any preceding claim.

23. The combination of claim 22, wherein said power-receiving element is attached to an external surface portion of the device.

24. The combination of claim 22, wherein said power-receiving element is attached to an internal surface portion of the device.

25. The combination of claim 24, wherein said internal surface portion is a surface portion of a battery compartment of the device.

26. The combination of any one of claims 22 to 25, wherein said one or more corresponding power connectors of the portable electrical device are internal power connectors.

27. The combination of any one of claims 22 to 26, wherein said one or more corresponding power connectors of the portable electrical device are battery connectors.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1163

28. A power-receiving element in the form of a sticker adapted to be attached adhesively to a surface portion of a portable electrical device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

29. A power-receiving element as claimed in claim 28, wherein said sticker has a removable backing sheet on its adhesive side which is removed at the time of attaching the element to the device.

30. A power-receiving element as claimed in claim 28 or 29, wherein a side of said sticker opposite its adhesive side conforms in appearance to surface portions of the portable electrical device that will be adjacent to said opposite side when the sticker is attached to the device.

31. A power-receiving element as claimed in any one of claims 28 to 30, wherein said sticker has, on its side opposite its adhesive side, a substantially transparent pocket for carrying an insert.

32. A replacement cover portion for a portable electrical device, the cover portion carrying or incorporating a power-receiving element adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

33. A replacement cover portion as claimed in claim 32, having a power connector part carrying one or more power connectors connected operatively to the power-receiving element and arranged to connect, when the replacement cover portion is in place on the device, to one or more corresponding power connectors of the portable electrical device.

34. A replacement cover portion as claimed in claim 32 or 33, adapted to cover a battery compartment of the portable electrical device, and having one or more battery connectors adapted to connect to one or more corresponding battery connectors of the device and/or to terminals of one or more batteries installed in the device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1164

35. A replacement cover portion as claimed in claim 34, wherein said one or more battery connectors of the cover portion are adapted to be interposed between said battery terminals and said corresponding battery connectors of the device.

36. A replacement cover portion as claimed in claim 32 or 33, adapted to cover a battery compartment of the portable electrical device, and further carrying or incorporating at least one rechargeable battery such that, when the replacement cover portion is in place on a device, the battery is installed operatively in the battery compartment, the power-receiving element being connected operatively to the battery for charging the battery for charging the battery when power is received wirelessly from the transmitter.

37. A replacement cover portion as claimed in any one of claims 32 to 36, being a replacement cover portion for a handset of a mobile communications network.

38. A method of adapting a portable electrical device having no wireless power receiving capability to have such a capability, the method comprising:

attaching a power-receiving element to the device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and

connecting one or more power connectors, which are connected electrically to the element, to one or more corresponding power connectors of the device so that power received by the element can be delivered to the device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1165

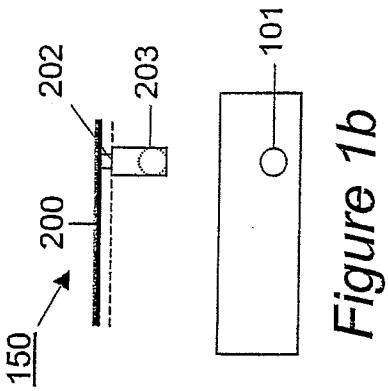


Figure 1b

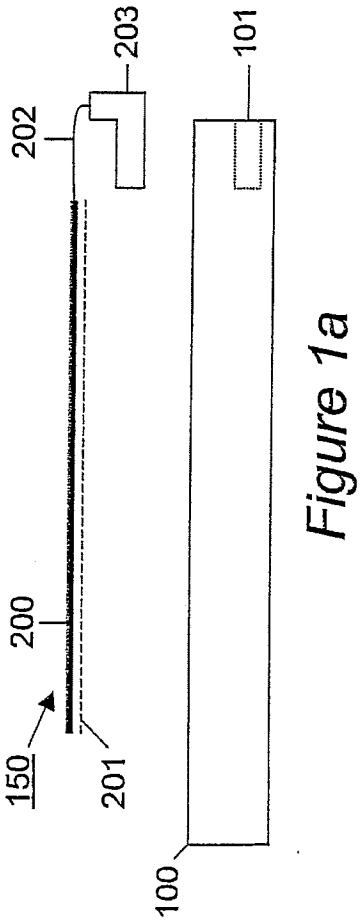


Figure 1a

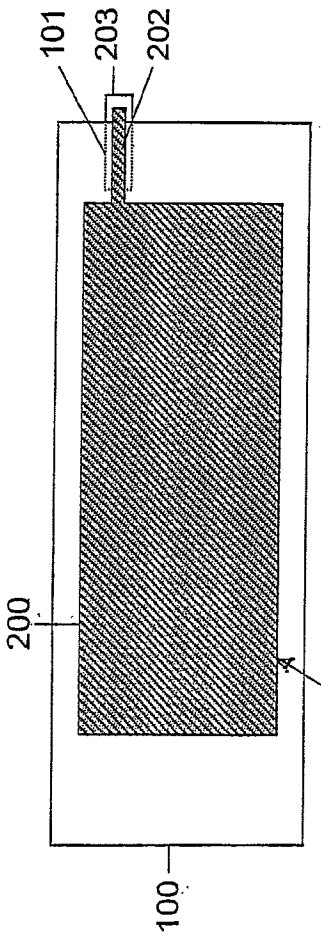


Figure 1c

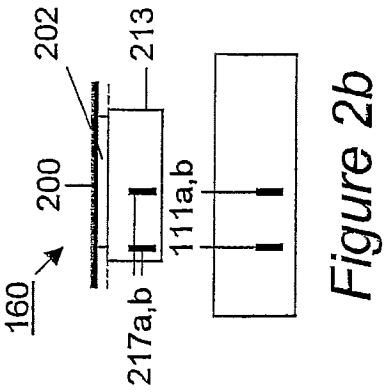


Figure 2b

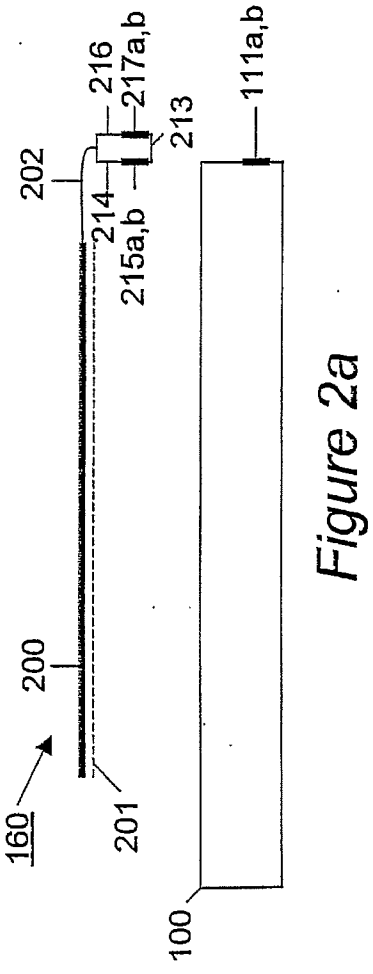


Figure 2a

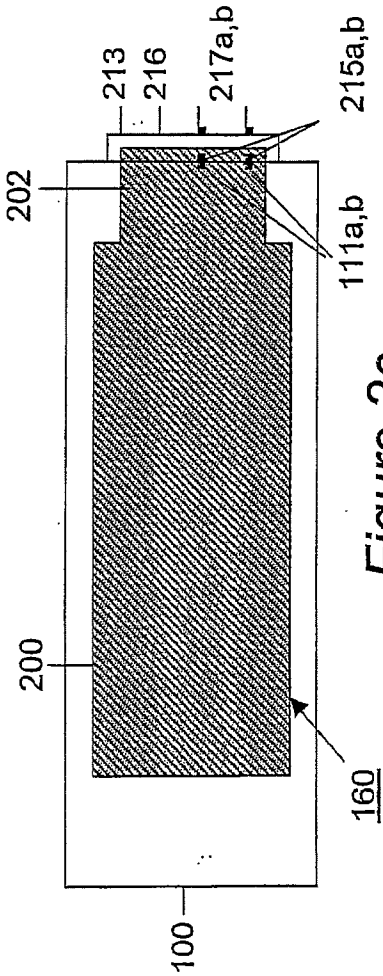


Figure 2c

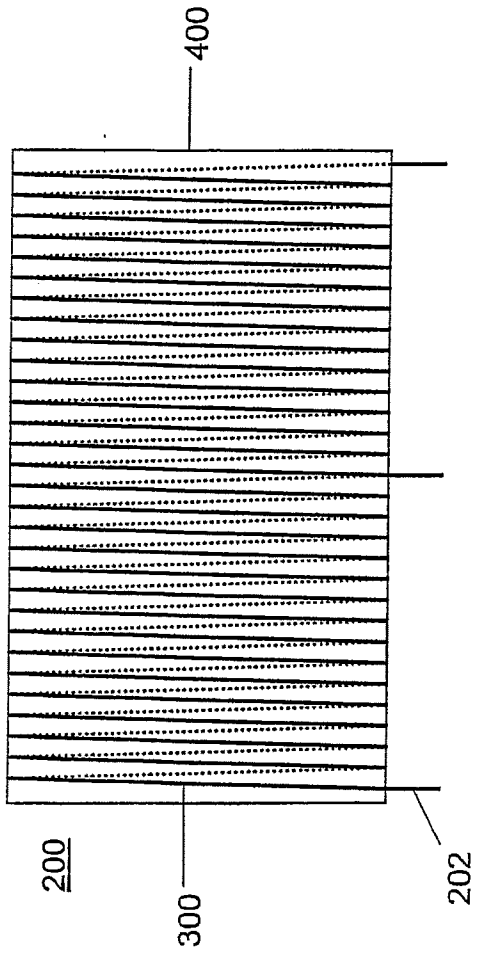


Figure 3a

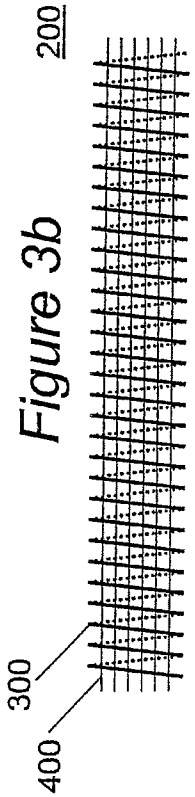
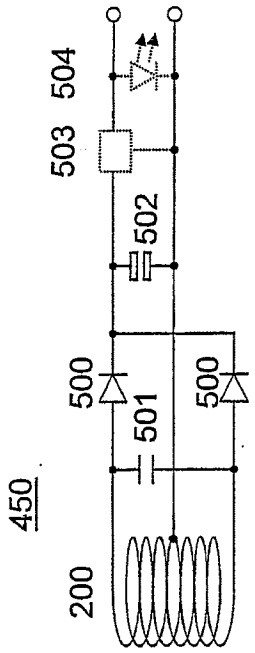


Figure 3b

Figure 4



PGR2023-00016 - Home Depot
Ex. 1003 - Page 1169

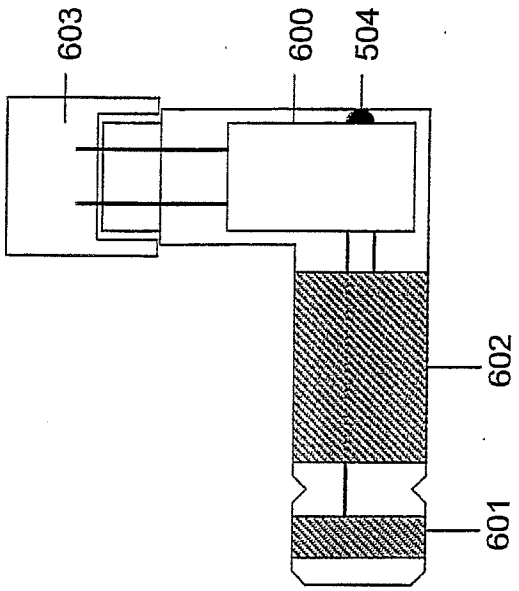


Figure 5

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1170

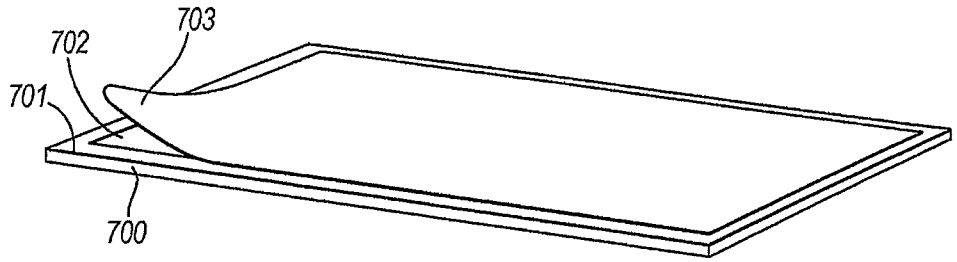


Fig.6

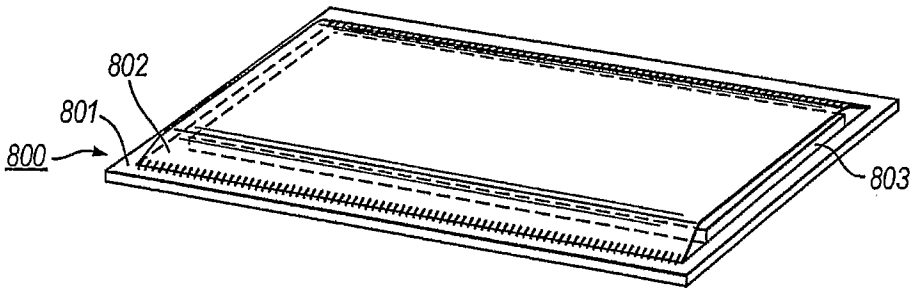


Fig.7

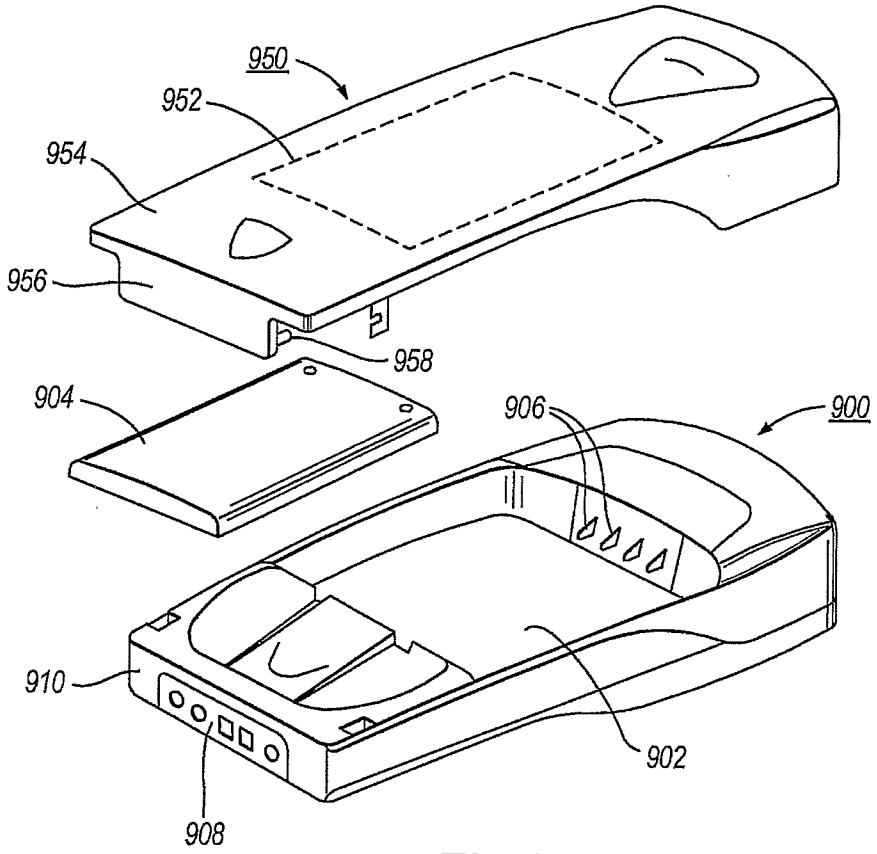


Fig.8

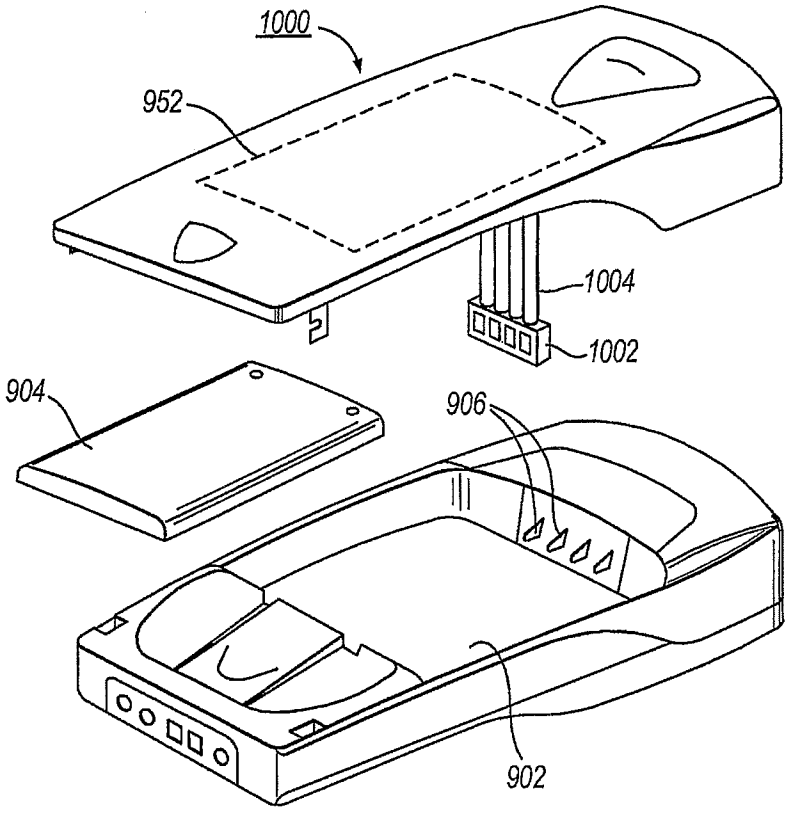


Fig.9

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1173

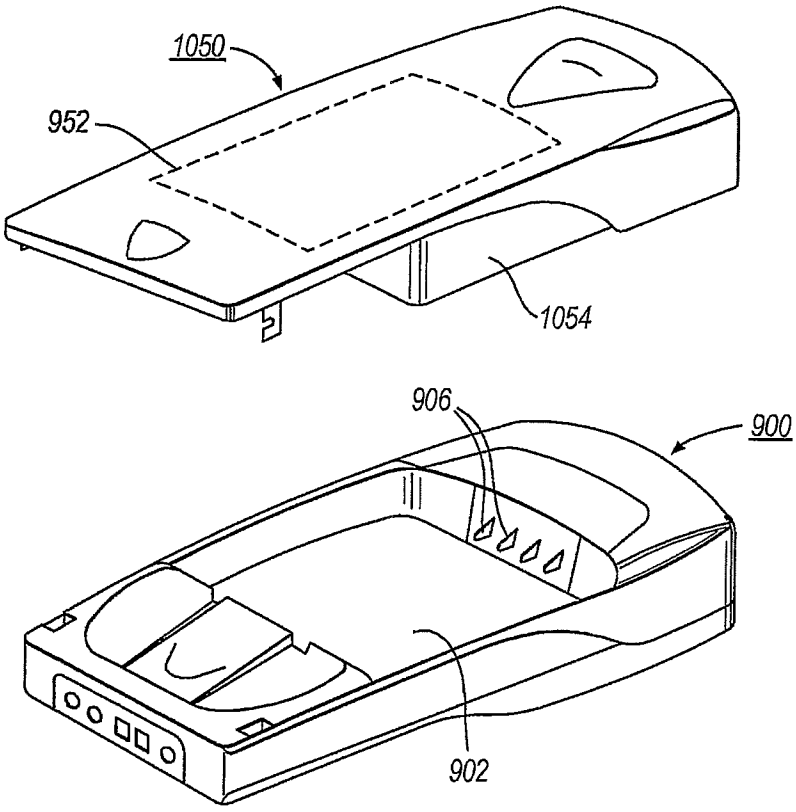


Fig.10

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1174

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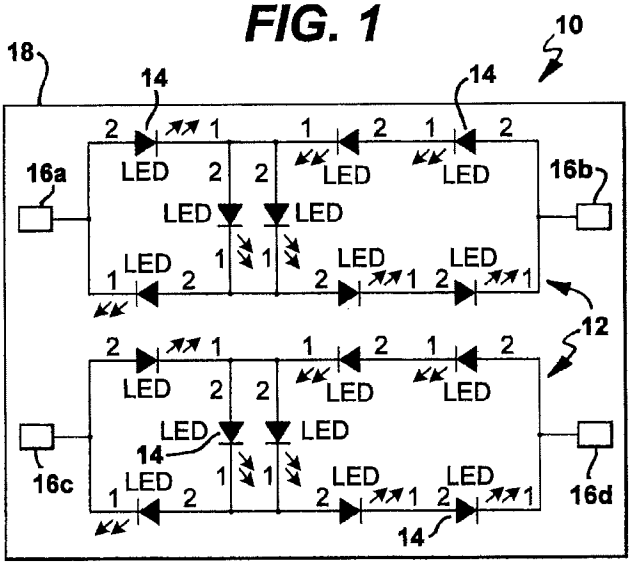
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[Continued on next page]

(54) Title: HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

(57) Abstract: A system and method transforming AC voltage to a high-frequency AC voltage and providing the high-frequency AC voltage to an AC LED circuit or rectifying the high-frequency circuit to a DC voltage and providing the DC voltage to a DC LED circuit.

FIG. 1



12/24 VAC SINGLE CHIP

WO 2011/082168 A1

SAMSUNG EXHIBIT 1030
PGR2023-00016 - Home Depot
Ex. 1003 - Page 1175

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PGR2023-00016 - Home Depot
Ex. 1003 - Page 1176

HIGH FREQUENCY MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES

RELATED APPLICATIONS

[Para 1] The application is a continuation-in-part of U.S. Patent Application No. 12/287,267, filed October 6, 2008, which claims priority to U.S. Provisional Application No. 60/997,771, filed October 6, 2007; this application is also a continuation-in-part of U.S. Patent Application No. 12/364,890 filed February 3, 2009 which is a continuation of U.S. Application No. 11/066,414 (now U.S. Patent No. 7,489,086) filed February 25, 2005 which claims priority to U.S. Provisional Application No. 60/547,653 filed February 25, 2004 and U.S. Provisional Application No. 60/559,867 filed April 6, 2004; this application is also a continuation in part of International Application No. PCT/US2010/001597 filed May 28, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/217,215, filed May 28, 2009; this application is also a continuation-in-part of International Application No. PCT/US2010/001269 filed April 30, 2010 which is a continuation-in-part of U.S. Application No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/215,144, filed May 1, 2009; this application also claims priority to U.S. Provisional Application No. 61/284,927 filed December 28, 2009 and U.S. Provisional Application No. 61/335,069 filed December 31, 2009; the contents of each of these applications are expressly incorporated herein by reference.

TECHNICAL FIELD

[Para 2] The present invention generally relates to light emitting diodes ("LEDs") for AC operation. The present invention specifically relates to multiple voltage level, multiple brightness level, and voltage selectable LED devices, packages and lamps, high frequency driven LED circuits and high frequency drivers and drive methods for LEDs.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[Para 3] None.

BACKGROUND OF THE INVENTION

[Para 4] Field of the Invention

[Para 5] The present invention generally relates to light emitting diodes ("LEDs") for high frequency and selectable voltage, multi-voltage level and/or multi-brightness level operation. The present invention specifically relates to high frequency operation, voltage selectable, multiple voltage level and multiple brightness level light emitting diode circuits, single chips, packages and lamps "devices" for direct AC voltage power source operation or bridge rectified AC voltage power source operation..

[Para 6] Description of the Related Art

[Para 7] LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED. Some LEDs have resistors built into the LED package providing a higher voltage LED typically driven with 5V DC or 12V DC.

[Para 8] Some standard AC voltages in the world include 12VAC, 24VAC, 100VAC, 110VAC, 120VAC, 220VAC, 230VAC, 240VAC and 277VAC. Therefore, it would be advantageous to have a single chip LED or multi-chip single LED packages and/or devices that could be easily configured to operate at multiple voltage levels and/or multiple brightness levels by simply selecting a voltage and/or current level when packaging the multi-voltage and/or multi-current single chip LEDs or by selecting a specific voltage and/or current level when integrating the LED package onto a printed circuit board or within a finished lighting product. It would also be advantageous to have multi-current LED chips and/or packages for LED lamp applications in order to provide a means of increasing brightness in LED lamps by switching in additional circuits just as additional filaments are switched in for standard incandescent lamps.

[Para 9] US 7,525,248 discloses a ***chip***-scale LED lamp including discrete LEDs capable of being built upon electrically insulative, electrically conductive, or electrically semi conductive substrates. Further, the construction of the LED lamp enables the lamp to be configured for high voltage AC or DC power operation. The LED based solid-state light

emitting device or lamp is built upon an electrically insulating layer that has been formed onto a support surface of a substrate. Specifically, the insulating layer may be epitaxially grown onto the substrate, followed by an LED buildup of an n-type semiconductor layer, an optically active layer, and a p-type semiconductor layer, in succession. Isolated mesa structure of individual, discrete LEDs are formed by etching specific portions of the LED buildup down to the insulating layer, thereby forming trenches between adjacent LEDs. Thereafter, the individual LEDs are electrically coupled together through conductive elements or traces being deposited for connecting the n-type layer of one LED and the p-type layer of an adjacent LED, continuing across all of the LEDs to form the solid-state light emitting device. The device may therefore be formed as an integrated AC/DC light emitter with a positive and negative lead for supplied electrical power. For instance, the LED lamp may be configured for powering by high voltage DC power (e.g., 12V, 24V, etc.) or high voltage AC power (e.g., 110/120V, 220/240V, etc.).

[Para 10] US 7,213,942 discloses a single-***chip*** LED device through the use of integrated circuit technology, which can be used for standard high AC voltage (110 volts for North America, and 220 volts for Europe, Asia, etc.) operation. The single-***chip AC LED*** device integrates many smaller LEDs, which are connected in series. The integration is done during the LED fabrication process and the final product is a single-***chip*** device that can be plugged directly into house or building power outlets or directly screwed into incandescent lamp sockets that are powered by standard AC voltages. The series connected smaller LEDs are patterned by photolithography, etching (such as plasma dry etching), and metallization on a single ***chip***. The electrical insulation between small LEDs within a single-***chip*** is achieved by etching light emitting materials into the insulating substrate so that no light emitting material is present between small LEDs. The voltage crossing each one of the small LEDs is about the same as that in a conventional DC operating LED fabricated from the same type of material (e.g., about 3.5 volts for blue LEDs).

[Para 11] Accordingly, single chip LEDs have been limited and have not been integrated circuits beyond being fixed series, fixed parallel or series parallel circuit configurations until the development of AC LEDs. The AC LEDs have still however been single circuit or parallel circuit fixed single voltage designs.

[Para 12] LED packages have historically not been integrated circuits beyond being fixed series, fixed parallel or fixed series parallel LED circuit configurations.

[Para 13] The art is deficient in that it does not provide a multi-voltage and/or multi-current circuit monolithically integrated on a single substrate which would be advantageous.

[Para 14] It would further be advantageous to have a multi-voltage and/or multi-brightness circuit that can provide options in voltage level, brightness level and/or AC or DC powering input power preference.

[Para 15] It would further be advantageous to provide multiple voltage level and/or multiple brightness level light emitting LED circuits, chips, packages and lamps "multi-voltage and/or multi-brightness LED devices" that can easily be electrically configured for at least two forward voltage drive levels with direct AC voltage coupling, bridge rectified AC voltage coupling or constant voltage DC power source coupling. This invention comprises circuits and devices that can be driven with more than one AC or DC forward voltage "multi-voltage" at 6V or greater based on a selectable desired operating voltage level that is achieved by electrically connecting the LED circuits in a series or parallel circuit configuration and/or more than one level of brightness "multi-brightness" based on a switching means that connects and/or disconnects at least one additional LED circuit to and/or from a first LED circuit. The desired operating voltage level and/or the desired brightness level electrical connection may be achieved and/or completed at the LED packaging level when the multi-voltage and/or multi-brightness circuits and/or single chips are integrated into the LED package, or the LED package may have external electrical contacts that match the integrated multi-voltage and/or multi-brightness circuits and/or single chips within, thus allowing the drive voltage level and/or the brightness level select-ability to be passed on through to the exterior of the LED package and allowing the voltage level or brightness level to be selected at the LED package user, or the PCB assembly facility, or the end product manufacturer.

[Para 16] It would further be advantageous to provide at least two integrated circuits having a forward voltage of at least 12VAC or 12VDC or greater on a single chip or within a single LED package that provide a means of selecting a forward voltage when packaging a multi-voltage and/or multi-brightness circuit using discrete die (one LED chip at a time) and wire bonding them into a circuit at the packaging level or when packaging one or more multi-voltage and/or multi-brightness level single chips within a LED package.

[Para 17] It would further be advantageous to provide multi-voltage and/or multi-brightness level devices that can provide electrical connection options for either AC or DC voltage operation at preset forward voltage levels of 6V or greater.

[Para 18] It would further be advantageous to provide multi-brightness LED devices that can be switched to different levels of brightness by simply switching additional circuits on or off in addition to a first operating circuit within a single chip and or LED package. This

would allow LED lamps to switch to higher brightness levels just like 2-way or 3-way incandescent lamps do today.

[Para 19] The benefits of providing multi-voltage circuits of 6V or greater on a single chip is that an LED packager can use this single chip as a platform to offer more than one LED packaged product with a single chip that addresses multiple voltage levels for various end customer design requirements. This also increase production on a single product for the chip maker and improves inventory control. This also improves buying power and inventory control for the LED packager when using one chip.

[Para 20] It would further be advantageous to have a LED lighting assembly which includes LED circuitry for AC or DC drive and a high frequency AC voltage transformer or inverter that could be used to convert low frequency voltages, like for example mains voltage or some other low voltage at 50/60 Hz, to a high frequency without a change in the voltage provided. For example, it would be advantageous to have a LED lighting power supply and/or driver capable of receiving 120 VAC at 60 Hz and be able to provide a high frequency AC output directly to an AC driven LED circuit(s), or alternatively to a DC driven LED circuit(s) through an AC-to-DC rectifier at a voltage equal to or different from the original input voltage to the power supply and/or driver.

[Para 21] It would be further advantageous to combine multiple-voltage LED chips, packages, circuits, lamps, etc., high frequency AC voltage power supplies and/or transformers to drive LEDs by either directly connecting a high frequency transformer or inverter to an AC driven LED circuit(s), or by operably connecting an AC-to-DC rectifier between the high frequency transformer or inveter and a DC driven LED circuit. With proper design considerations LEDs may be driven more efficiently with direct AC or rectified AC than with constant voltage or constant current DC drive schemes. High frequency AC transformers or inverters can be made smaller and more cost effective than constant current or constant voltage DC drivers or power supplies currently being used to power LEDs. The higher the frequency, the smaller the transformer can be made. With proper design consideration and based on the wattage and the frequency of the AC voltage output of the power supply, a high frequency AC voltage transformer can be made small enough to be mounted directly onto a LED lighting PCB assembly.

[Para 22] The present invention provides for these advantages and solves the deficiencies in the art.

SUMMARY OF THE INVENTION

[Para 23] According to one aspect of the invention at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage AC LED device for direct AC power operation. Each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation.

[Para 24] According to another aspect of the invention, each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit.

[Para 25] According to another aspect of the invention, each multi-voltage AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. By way of example, the second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 26] According to another aspect of the invention, at least two single voltage series LED circuits, each of which have at least two serially connected LEDs, are formed on a single chip or on a substrate providing a multi-voltage AC or DC operable LED device.

[Para 27] According to another aspect of the invention, each single voltage series LED circuit is designed to be driven with a predetermined forward voltage of at least 6V AC or DC and preferably each single voltage series LED circuit has a matching forward voltage of 6V, 12V, 24V, 120V, or other AC or DC voltage levels. By way of example, each multi-voltage AC or DC LED device would be able to be driven with at least two different AC or DC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage series LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level series LED circuits in series. The second forward voltage drive level of the serially connected series LED circuits would be

approximately twice the level of the first forward voltage drive level of the parallel connected series LED circuits. The at least two parallel connected series LED circuits would be twice the current of the at least two serially connected series LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage series LED device.

[Para 28] According to another aspect of the invention, at least two single voltage AC LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness AC LED device for direct AC power operation.

[Para 29] According to another aspect of the invention, each single voltage AC LED circuit has at least two LEDs connected to each other in opposing parallel relation. Each single voltage AC LED circuit is designed to be driven with a predetermined forward voltage of at least 6VAC and preferably each single voltage AC LED circuit has a matching forward voltage of 6VAC, 12VAC, 24VAC, 120VAC, or other AC voltage levels for each single voltage AC LED circuit. The at least two AC LED circuits within each multi-voltage and/or multi current AC LED device would be able to be driven with at least two different AC forward voltages resulting in a first forward voltage drive level by electrically connecting the two single voltage AC LED circuits in parallel and a second forward voltage drive level by electrically connecting the at least two single voltage level AC LED circuits in series. The second forward voltage drive level of the serially connected AC LED circuits would be approximately twice the level of the first forward voltage drive level of the parallel connected AC LED circuits. The at least two parallel connected AC LED circuits would be twice the current of the at least two serially connected AC LED circuits. In either circuit configuration, the brightness would be approximately the same with either forward voltage drive selection of the multi-voltage LED device.

[Para 30] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of LEDs is formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in

parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 31] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VAC, 24VAC, 120VAC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 32] According to another aspect of the invention at least two single voltage LED circuits are formed on a single chip or on a substrate, and at least one bridge circuit made of standard diodes, LEDs or some combination thereof is provided separate of the LED circuit or formed on the same single chip or substrate providing a multi-voltage and/or multi-brightness LED device for direct DC power operation. Each single voltage LED circuit has at least two LEDs connected to each other in series. Each single voltage LED circuit is designed to be driven with a predetermined forward voltage and preferably matching forward voltages for each circuit such as 12VDC, 24VDC, 120VDC, or other DC voltage levels for each single voltage LED circuit. Each multi-voltage and/or multi-brightness LED device would be able to be driven with at least two different DC forward voltages resulting in a first forward voltage drive level when the two single voltage LED circuits are connected in parallel and a second forward voltage drive level that is twice the level of the first forward voltage drive level when the at least two LED circuits are connected in series.

[Para 33] According to another aspect of the invention a multi-voltage and/or multi-current AC LED circuit is integrated within a single chip LED. Each multi-voltage and/or multi-current single chip AC LED comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation. Each single voltage AC LED circuit may have may have at least one voltage input electrical contact at each opposing end of the circuit or the at least two single voltage AC LED circuits may be electrically connected together in series on the single chip and have at least one voltage input electrical contact at each

opposing end of the two series connected single voltage AC LED circuits and one voltage input electrical contact at the center junction of the at least two single voltage AC LED circuits connected in series. The at least two single voltage AC LED circuits are integrated within a single chip to form a multi-voltage and/or multi-current single chip AC LED.

[Para 34] According to another aspect of the invention, at least one multi-voltage and/or multi-brightness LED devices may be integrated within a LED lamp. The at least two individual LED circuits within the multi-voltage and/or multi-brightness LED device(s) may be wired in a series or parallel circuit configuration by the LED packager during the LED packaging process thus providing for at least two forward voltage drive options, for example 12VAC and 24VAC or 120VAC and 240VAC that can be selected by the LED packager.

[Para 35] According to another aspect of the invention a multi-voltage and/or multi-current AC LED package is provided, comprising at least one multi-voltage and/or multi-current single chip AC LED integrated within a LED package. The multi-voltage and/or multi-current AC LED package provides matching electrical connectivity pads on the exterior of the LED package to the electrical connectivity pads of the at least one multi-voltage and/or multi-current single chip AC LED integrated within the LED package thus allowing the LED package user to wire the multi-voltage and/or multi-current AC LED package into a series or parallel circuit configuration during the PCB assembly process or final product integration process and further providing a AC LED package with at least two forward voltage drive options.

[Para 36] According to another aspect of the invention multiple individual discrete LED chips are used to form at least one multi-voltage and/or multi-current AC LED circuit within a LED package thus providing a multi-voltage and/or multi current AC LED package. Each multi-voltage and/or multi-current AC LED circuit within the package comprises at least two single voltage AC LED circuits. Each single voltage AC LED circuit has at least two LEDs in anti-parallel configuration to accommodate direct AC voltage operation The LED package provides electrical connectivity pads on the exterior of the LED package that match the electrical connectivity pads of the at least two single voltage AC LED circuits integrated within the multi-voltage and/or multi-current AC LED package thus allowing the LED package to be wired into a series or parallel circuit configuration during the PCB assembly process and further providing a LED package with at least two forward voltage drive options.

[Para 37] According to another aspect of the invention a multi-voltage and/or multi-current single chip AC LED and/or multi-voltage and/or multi current AC LED package is integrated within an LED lamp. The LED lamp having a structure that comprises a heat sink,

a lens cover and a standard lamp electrical base. The multi-voltage and/or multi-current single chip AC LED and/or package is configured to provide a means of switching on at least one additional single voltage AC LED circuit within multi-voltage and/or multi-current AC LED circuit to provide increased brightness from the LED lamp.

[Para 38] According to anther broad aspect of the invention at least one multi-current AC LED single chip is integrated within a LED package.

[Para 39] According to another aspect of the invention, at least one single chip multi-current bridge circuit having standard diodes, LEDs, or some combination thereof is integrated within a LED lamp having a standard lamp base. The single chip multi-current bridge circuit may be electrically connected together in parallel configuration but left open to accommodate switching on a switch to the more than one on the single chip and have at least one accessible electrical contact at each opposing end of the two series connected circuits and one accessible electrical contact at the center junction of the at least two individual serially connected LED circuits. The at least two individual circuits are integrated within a single chip.

[Para 40] According to another aspect of the invention when the at least two circuits are left unconnected on the single chip and provide electrical pads for connectivity during the packaging process, the LED packager may wire them into series or parallel connection based on the desired voltage level specification of the end LED package product offering.

[Para 41] According to another aspect of the invention, a high frequency transformer or inverter may provide power to at least one multi-voltage and/or multi-brightness LED device or chip. The high frequency transformer or inverter may be either packaged with the LED device or chip and may provide direct AC voltage to the LED device or chip, or as a separate driver or power supply for the LED device or chip capable of being electrically connected to the LED device or chip. The high frequency transformer or inverter is designed to receive a voltage at a low frequency, like for example a voltage at 50/60 Hz like a mains voltage, and output a voltage at a high frequency. The high frequency transformer or inverter may also be configured to step-up or step-down the voltage provided to the transformer or inverter from a source voltage.

[Para 42] According to another aspect of the invention, a high-frequency transformer or inverter may provide power to a DC driven-LED circuit, chip, or device or an LED circuit, chip or device containing one or more series strings of LEDs through a rectifier having standard diodes, LEDs, or some combination thereof may be electrically connected between the high-frequency transformer or inverter and. The rectifier may be provided independently

from the high-frequency transformer or inverter and the LED circuit, chip, or device and electrically connected at its input to the high-frequency transformer or inverter and at its output to the LED circuit, chip or device. Alternatively, the rectifier may be packaged with the high-frequency transformer or inverter forming a power supply or driver for the LED circuit, chip, or device. The rectifier may likewise be packaged directly with, or as part of, an LED circuit, chip, or device. As should be appreciated by those having skill in the art, packaging the rectifier directly with the LED circuit, chip, or device allows for an LED package containing a DC-driven LED circuit, chip, or device, or one or more series strings of LEDs, to be directly plugged into any power supply or driver providing an AC voltage output and operate. As a further alternative, a high-frequency inverter, rectifier, and LED circuit, chip, or device may be packaged into a single lighting device capable of being directly incorporated into a lighting element, or may be incorporated directly into a lamp or other OEM product utilizing LED light.

[Para 43] According to another aspect of the invention, a two-way or three-way switch may be provided directly between a high-frequency inverter providing power to a LED circuits, chip, or device and the LED circuits, chip or device, or in the alternative between a LED circuits, chip, or device and a rectifier having standard diodes, LEDs, or some combination thereof electrically connected to a high-frequency transformer or inverter.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 44] FIG. 1 shows a schematic view of a preferred embodiment of the invention;

[Para 45] FIG. 2 shows a schematic view of a preferred embodiment of the invention;

[Para 46] FIG. 3 shows a schematic view of a preferred embodiment of the invention;

[Para 47] FIG. 4 shows a schematic view of a preferred embodiment of the invention;

[Para 48] FIG. 5 shows a schematic view of a preferred embodiment of the invention;

[Para 49] FIG. 6a shows a schematic view of a preferred embodiment of the invention;

[Para 50] FIG. 6b shows a schematic view of a preferred embodiment of the invention;

[Para 51] FIG. 7a shows a schematic view of a preferred embodiment of the invention;

[Para 52] FIG. 7b shows a schematic view of a preferred embodiment of the invention;

[Para 53] FIG. 8 shows a schematic view of a preferred embodiment of the invention;

[Para 54] FIG. 9 shows a schematic view of a preferred embodiment of the invention;

[Para 55] FIG. 10 shows a schematic view of a preferred embodiment of the invention;

[Para 56] FIG. 11 shows a schematic view of a preferred embodiment of the invention;

[Para 57] FIG. 12 shows a schematic view of a preferred embodiment of the invention;

[Para 58] FIG. 13 shows a schematic view of a preferred embodiment of the invention;

[Para 59] FIG. 14 shows a schematic view of a preferred embodiment of the invention;

[Para 60] FIG. 15 shows a schematic view of a preferred embodiment of the invention;

[Para 61] FIG. 16 shows a block diagram of a preferred embodiment of the invention;

[Para 62] FIG. 17 shows a block diagram of a preferred embodiment of the invention;

[Para 63] FIG. 18 shows a block diagram of a preferred embodiment of the invention;

[Para 64] FIG. 19 shows a block diagram of a preferred embodiment of the invention; and,

[Para 65] FIG. 20 shows a block diagram of a preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[Para 66] FIG. 1 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 10. The multi-voltage and/or multi-brightness LED lighting device 10 comprises at least two AC LED circuits 12 configured in an imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 16a and 16c are electrically connected together and 16b and 16d are electrically connected together and one side of the AC voltage input is applied to 16a and 16c and the other side of the AC voltage input is applied to 16b and 16d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 16a and 16c are electrically connected and the AC voltage inputs are applied to electrical contacts 16b and 16d, a second operating forward voltage is required to drive the single chip 18. The single chip 18 may also be configured to operate at more than one brightness level "multi-brightness" by electrically connecting for example 16a and 16b and applying one side of the line of an AC voltage source to 16a ad 16b and individually applying the other side of the line from the AC voltage source a second voltage to 26b and 26c.

[Para 67] FIG. 2 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 20 similar to the multi-voltage and/or multi-brightness LED lighting device 10 described above in FIG. 1 . The at least two AC LED circuits 12 are integrated onto a substrate 22. The at least two AC LED circuits 12 configured in a imbalanced bridge circuit, each of which have at least two LEDs 14. The at least two AC LED circuits have electrical contacts 16a, 16b, 16c, and 16d on the exterior of the substrate 22 and can be used to electrically configure and/or control the operating voltage and/or brightness level of the multi-voltage and/or multi-brightness LED lighting device.

[Para 68] FIG. 3 discloses a schematic diagram of a multi-voltage and/or multi-brightness LED lighting device 30 similar to the multi-voltage and/or multi-brightness LED lighting device 10 and 20 described in FIGs. 1 and 2. The multi-voltage and/or multi-brightness LED lighting device 30 comprises at least two AC LED circuits 32 having at least two LEDs 34 connected in series and anti-parallel configuration. The at least two AC LED circuits 32 have electrical contacts 36a, 36b, 36c, and 36d at opposing ends to provide various connectivity options for an AC voltage source input. For example, if 36a and 36c are electrically connected together and 36b and 36d are electrically connected together and one side of the AC voltage input is applied to 36a and 36c and the other side of the AC voltage input is applied to 36b and 36d, the circuit becomes a parallel circuit with a first operating forward voltage. If only 36a and 36c are electrically connected and the AC voltage inputs are applied to electrical contacts 36b and 36d, a second operating forward voltage is required to drive the multi-voltage and/or multi-brightness lighting device 30. The multi-voltage and/or multi-brightness lighting device 30 may be a monolithically integrated single chip 38, a monolithically integrated single chip integrated within a LED package 38 or a number of individual discrete die integrated onto a substrate 38 to form a multi-voltage and/or multi-brightness lighting device 30.

[Para 69] FIG. 4 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in parallel configuration to an AC voltage source and operating at a first forward voltage. A resistor 40 may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device 30.

[Para 70] FIG. 5 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED device 30 as described in FIG. 3 having the at least two AC LED circuits 32 connected in series configuration to an AC voltage source and operating at a second forward voltage that is approximately two times greater than the first forward voltage of the parallel circuit as described in FIG. 4. A resistor may be used to limit current to the multi-voltage and/or multi-brightness LED lighting device.

[Para 71] FIGs. 6a and 7a disclose schematic diagrams of a multi-voltage and/or multi-brightness LED lighting devices 50. The multi-voltage and/or multi-brightness LED lighting devices 50 comprises at least two AC LED circuits 52, each of which have at least two LEDs 54 in series and anti-parallel relation. The at least two AC LED circuits 52 have at least three electrical contacts 56a, 56b and 56c, and in the case of FIG. 7a a fourth electrical contact 56d. The at least two AC LED circuits 52 are electrically connected together in parallel at one end

56a and left unconnected at the opposing ends of the electrical contacts 56b and 56c, and in the case of FIG. 7a, 56d. One side of an AC voltage source line is electrically connected to 56a and the other side of an AC voltage source line is individually electrically connected to 56b, 56c, and 56d with either a fixed connection or a switched connection thereby providing a first brightness when AC voltage is applied to 56a and 56b and a second brightness when an AC voltage is applied to 56a, 56b and 56c, and a third brightness when an AC voltage is applied to 56a, 56b, 56c, and 56d. It is contemplated that the multi-voltage and/or multi-brightness LED lighting devices 50 are a single chip, an LED package, an LED assembly or an LED lamp.

[Para 72] FIGs. 6b and 7b disclose a schematic diagram similar to the multi-voltage and/or multi-brightness LED device 50 shown in FIGs. 6a and 7a integrated within a lamp 58 and connected to a switch 60 to control the brightness level of the multi-voltage and/or multi-brightness LED lighting device 50.

[Para 73] FIG. 8 discloses a schematic diagram of a multi-brightness LED lighting device 62 having at least two bridge rectifiers 68 in series with LED circuits 69. Each of the at least two bridge rectifiers 68 in series with LED circuits 69 comprise four LEDs 70 configured in a bridge circuit 68. LED circuits 69 have at least two LEDs 71 connected in series and electrical contacts 72a, 72b and 72c. When one side of an AC voltage is applied to 72a and the other side of an AC voltage line is applied to 72b and 72c individually, the brightness level of the multi-brightness LED lighting device 62 can be increased and/or decreased in a fixed manner or a switching process.

[Para 74] FIG. 9 discloses a schematic diagram the multi-brightness LED lighting device 62 as shown above in FIG. 8 with a switch 74 electrically connected between the multi-brightness LED lighting device 62 and the AC voltage source 78.

[Para 75] FIG. 9 discloses a schematic diagram of at least two single voltage LED circuits integrated with a single chip or within a substrate and forming a multi-voltage and/or multi-brightness LED device.

[Para 76] FIG. 10 discloses a schematic diagram of a single chip LED bridge circuit 80 having four LEDs 81 configured into a bridge circuit and monolithically integrated on a substrate 82. The full wave LED bridge circuit has electrical contacts 86 to provide for AC voltage input connectivity and DC voltage output connectivity.

[Para 77] FIG. 11 discloses a schematic diagram of another embodiment of a single chip multi-voltage and/or multi-brightness LED lighting device 90. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of

which have at least two LEDs 94 connected in series. The at least two series LED circuits 92 have electrical contacts 96 at opposing ends to provide a means of electrical connectivity. The at least two series LED circuits are monolithically integrated into a single chip 98. The electrical contacts 96 are used to wire the at least two series LEDs circuit 92 into a series circuit, a parallel circuit or an AC LED circuit all within a single chip.

[Para 78] FIG. 12 discloses a schematic diagram of the same multi-voltage and/or multi-brightness LED lighting device 90 as shown above in FIG. 11. The multi-voltage and/or multi-brightness LED lighting device 90 has at least two series LED circuits 92 each of which have at least two LEDs 94 connected in series. The at least two series LED circuits can be monolithically integrated within a single chip or discrete individual die can be integrated within a substrate to form an LED package 100. The LED package 100 has electrical contacts 102 that are used to wire the at least two series LEDs circuit into a series circuit, a parallel circuit or in anti-parallel to form an AC LED circuit all within a single LED package.

[Para 79] As seen in FIGs. 13-15, a single rectifier 110 may be provided for two or more LED circuits 92, each containing at least two LEDs 94 connected in series. The single rectifier 110 comprises standard diodes 112 connected to an AC voltage source 116, or in the alternative may be connected to a driver or power supply which ultimately provides an AC voltage, like for example a high frequency AC driver 118. The single rectifier 110 is electrically connected to the LED circuits 92. Specifically, the rectifier 110 connects to a common junction of an anode of at least one LED 94 in each LED circuit 92, and to the cathode of at least one LED 94 in each LED circuit 92. As shown in FIG. 15, the rectifier may instead be connected to a switch, allowing for either one or both of LED circuits 92 to be operative at any given time.

[Para 80] It is contemplated by the invention that diodes 112 in FIGs. 13-15 are interchangeable with LEDs 70 in rectifiers 68 in FIGs. 8 and 9 and vice versa. As should be appreciated by those having skill in the art, any combination of LEDs 70 and diodes 112 can be used in rectifiers 68 and 110, so long as rectifiers 68 and 110 provide DC power from an AC source.

[Para 81] As shown in FIGs. 13 and 14, and further shown in FIGs. 16-20, any lighting devices, chips, or AC LED or DC LED circuits contemplated by the present invention may be powered through a high-frequency AC driver, inverter or transformer 118. As shown in FIG. 13, any AC source 116 may be connected to the high-frequency driver or inverter or transformer 118, however, as shown in Figs. 16-20 it is contemplated that low frequency

voltage 124, like for example a mains voltage, is provided to the high-frequency driver or transformer or inverter 118.

[Para 82] FIGs. 16 and 17 show two embodiments of an AC LED lighting system 140 wherein a high-frequency AC driver, inverter, or transformer 118 for provides a high-frequency voltage to an AC LED circuit, lighting device, or chip 126. AC LED circuit, lighting device, or chip 126 may be any of the devices, circuits, or chips shown and described in FIGs. 1-7, like for example LED lighting devices 10, 20, 30 and/or AC LED circuits 12, 32, or any combination thereof. When multiple AC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such AC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship.

[Para 83] As shown in FIG. 16, the high-frequency AC driver, inverter or transformer 118 may be packaged separately from an (or multiple) AC LED circuit, device, or chip 126. In such embodiments a power source 128 provides voltage to the high-frequency AC driver, inverter or transformer 118 which steps up the frequency of the voltage to a higher frequency and provides the higher-frequency voltage to the AC LED circuit(s), device(s), or chip(s) 126. High-frequency AC driver, inverter, or transformer 118 may further include necessary circuitry, for example a transformer, for stepping-up or stepping-down the AC voltage provided by the power source 128.

[Para 84] As shown in FIG. 17, high-frequency AC driver, inverter, or transformer 118 may be packaged with AC LED circuit(s), device(s), or chip(s) 126 in a unitary AC LED light bulb, lighting element 130. It is contemplated by the invention that a switch may be configured between the high-frequency driver, inverter, or transformer 118 and the AC LED circuit(s), device(s), or chip(s) 126 for selectively operating one or more AC LED circuit, lighting device, or chip. For example, as shown in FIGS. 6A, 6B, 7A, and 7B a 2-way or 3-way switch may be attached at the input side of the AC LED circuit(s), lighting device(s), or chip(s). Such a switch may be located between the high-frequency AC driver, inverter, or transformer 118, and the AC LED circuit(s), lighting device(s), or chip(s).

[Para 85] FIGs. 14 and 18-20 show a DC LED lighting system 142 having a DC LED circuit(s), device(s), or chip(s) 92, 132 being powered by a high-frequency AC driver, inverter, or transformer 118 through a rectifier 110. In operation, the combination of AC sources 116, 128, high-frequency AC driver, inverter or transformer 118, and DC LED circuit, device, or chip 92, 132 operate in substantially the same manner as that described with respect to FIGs. 16 and 17. However, in each system shown in FIGs. 14 and 18-20,

rectifier 110 rectifies the high-frequency AC voltage output of the high-frequency AC driver, inverter, or transformer before a voltage is provided to the DC LED circuit(s), device(s), or chip(s) 92, 132. DC LED circuit(s), device(s), or chip(s) 132 are not limited in form to just circuit 92, and instead may take the form of any of the lighting devices, circuits, or chips shown and described, for example, in FIGs. 8-12. When multiple DC LED circuits, lighting devices, or chips are connected to the high-frequency driver in combination, such DC LED circuit(s), lighting device(s), or chip(s) may be connected together in either a series relationship, a parallel relationship, or a series-parallel relationship. Additionally, as shown in FIG. 15, a switch, like for example a 2-way switch or a 3-way switch, may also be attached at the input side of DC LED circuit(s), device(s), or chip(s).

[Para 86] As shown in FIGs. 18-20, like in an AC embodiment, AC driver, inverter, or transformer 118, rectifier 110, and DC LED circuit(s), device(s), or chip(s) 132 may be packaged in any number of ways. As shown in FIG. 18, each element may be packaged separately and electrically connected together in series. Alternatively, as shown in FIG. 19, a DC LED driver 134 may be formed by combining the high-frequency AC driver, inverter, or transformer 118 with rectifier 110. As shown in FIG. 20, an additional alternative contemplated by the invention is forming a DC LED lighting element 136, which may be embodied as a light bulb, lighting system, lamp, etc., wherein the DC LED lighting element 136 includes each of a high-frequency AC driver, inverter, or transformer 118, a rectifier 110, and a DC LED circuit(s), lighting device(s), or chip(s) 132. It should be appreciated by those having skill in the art that a lighting element containing only rectifier 110 and a DC LED circuit(s), lighting device(s), or chip(s) 132 may also be designed. Such lighting elements have the advantage of being able to be plugged into any AC source, whether it is a high-frequency AC driver, inverter, or transformer, or a simple mains voltage, and provide a light output in the same manner as the imbalanced circuit shown in, for example FIGs. 1-7.

CLAIMS

What is claimed is:

1. A lighting system powered by an AC voltage source, the lighting system comprising:
    a. a high-frequency AC driver which outputs a relatively constant voltage at a relatively constant frequency, wherein the relatively constant frequency output is substantially higher than the frequency of an input voltage; and,
    b. at least two LED circuits each of which have at least two LEDs connected in series, electrically connected to the high-frequency AC driver.
2. The lighting system of claim 1 wherein each of the at least two LED circuits include:
    a. at least two LEDs connected in an opposing series relationship such that the anode of each of the at least two LEDs form a first node;
    b. at least two LEDs connected in an opposing series relationship such that the cathode of each of the at least two LEDs form a second node; and,
    c. a cross connecting LED connecting the first node to the second node such that the cathode of the cross connecting LED is connected to the first node, and the anode of the cross connecting LED is connected to the second node.
3. The lighting system of claim 2 wherein each of the at least two LED circuits are capable of being connected to the high-frequency AC driver in either a series relationship or a parallel relationship.
4. The lighting system of claim 3 wherein each of the two LED circuits have substantially identical forward operating voltages.
5. The lighting system of claim 4 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.
6. The lighting system of claim 5 wherein the switch is a two-way switch.
7. The lighting system of claim 5 wherein the switch is a three-way switch.
8. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged separately.
9. The lighting system of claim 1 wherein the high-frequency AC driver and at least two LED circuits are packaged together forming an AC LED lighting device.

10. The lighting system of claim 1 further comprising a bridge rectifier electrically connected between the high-frequency AC driver and the at least two LED circuits.

11. The lighting system of claim 10 wherein the at least two LED circuits include at least two LEDs connected in series.

12. The lighting system of claim 10 wherein the bridge rectifier is formed using diodes.

13. The lighting system of claim 10 wherein the bridge rectifier is formed using LEDs.

14. The lighting system of claim 10 wherein the bridge rectifier is formed using a combination of diodes and LEDs.

15. The lighting system of claim 11 wherein each of the at least two LED circuits are capable of being connected in either a series relationship or a parallel relationship.

16. The lighting system of claim 15 wherein each of the at least two LED circuits have a substantially identical forward operating voltage.

17. The lighting system of claim 16 further comprising a switch configured between the high-frequency AC driver and the at least two LED circuits.

18. The lighting system of claim 17 wherein the switch is a two-way switch.

19. The lighting system of claim 17 wherein the switch is a three-way switch.

20. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and at least two LED circuits are packaged separately.

21. The lighting system of claim 10 wherein the high-frequency AC driver and the bridge rectifier are packaged together forming a DC LED driver.

22. The lighting system of claim 10 wherein the high-frequency AC driver, the bridge rectifier, and the at least two LED circuits are packaged together forming a DC LED lighting device.

23. The lighting system of claim 10 wherein the rectifier and the at least two LED circuits are packaged together.

24. A LED lighting device comprising:

a. at least one LED circuit;

b. the at least one LED circuit having at least two LEDs connected in series;

c. a bridge rectifier wherein the at least one LED circuit being electrically connected to the bridge rectifier.

25. The LED lighting device of claim 24 further comprising at least one additional LED circuit wherein the at least one additional LED circuit includes two LEDs connected in series.

26. The LED lighting device of claim 25 wherein a second bridge rectifier is electrically connected to the at least one additional LED circuit.

27. The LED lighting device of claim 25 wherein the at least one additional LED circuit is electrically connected to the bridge rectifier.

28. The LED lighting device of claim 27 wherein a switch is electrically connected between:

a. the bridge rectifier and,

b. the at least one LED circuit and the at least one additional LED circuit.

29. The LED lighting device of claim 26 wherein a switch is electrically connected to the inputs of each of the bridge rectifier and the second bridge rectifier.

30. The LED lighting device of claims 28 and 29 wherein the at least one LED circuit and the at least one additional LED circuit have a substantially identical forward voltage.

31. The LED lighting device of claim 30 wherein the at least LED circuit and the at least one additional LED circuit are capable of being connected in either a series relationship or a parallel relationship.

32. The LED lighting device of claims 24-31 further comprising a high-frequency AC driver attached to one or more of the bridge rectifier and the second bridge rectifier.

33. A LED lighting device comprising:

a. at least two LED circuits;

b. each of the at least two LED circuits having at least two LEDs connected in series;

c. a bridge rectifier wherein each of the at least two LED circuits are electrically connected to the bridge rectifier in a parallel relationship.

34. A method of providing light, the method comprising the steps of:

    a. providing an AC voltage at a first frequency;

    b. transforming the AC voltage at a first frequency to a provided voltage at a second frequency;

    c. supplying the provided voltage at the second frequency to at least two LED circuits.

35. The method of claim 34 wherein a high-frequency AC driver transforms the AC voltage at the first frequency to the provided voltage at the second frequency.

36. The method of claim 35 wherein the AC voltage and the provided voltage are substantially identical AC voltages.

37. The method of claim 35 wherein the provided voltage is a second AC voltage less than the AC voltage.

38. The method of claim 35 wherein the provided voltage is a second AC voltage greater than the AC voltage.

39. The method of claim 35 further comprising the step of rectifying the provided voltage at the second frequency prior to supplying the provided voltage to the at least two LED circuits.

40. The method of claim 39 wherein a bridge rectifier rectifies the provided voltage at the second frequency.

41. The method of claims 35-40 further comprising the step of selecting how many of the at least two LED circuits receive the provided AC voltage.

42. The method of claim 41 wherein one of a two-way switch or a three-way switch is used to select how many of the at least two LED circuits are supplied with the provided voltage.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1198

FIG. 2

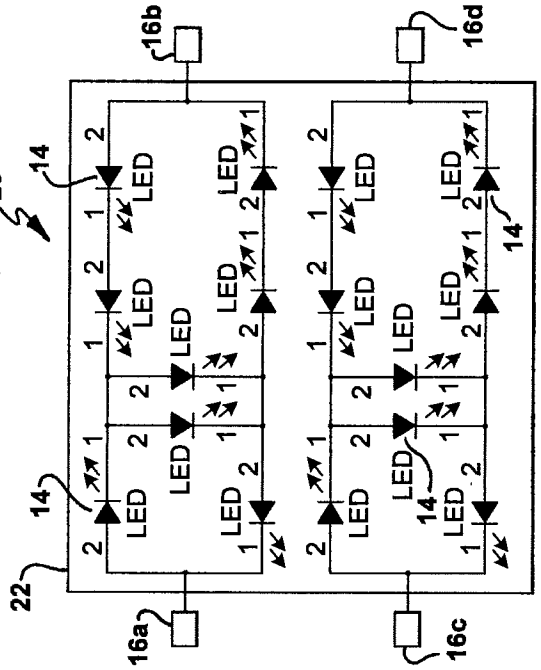
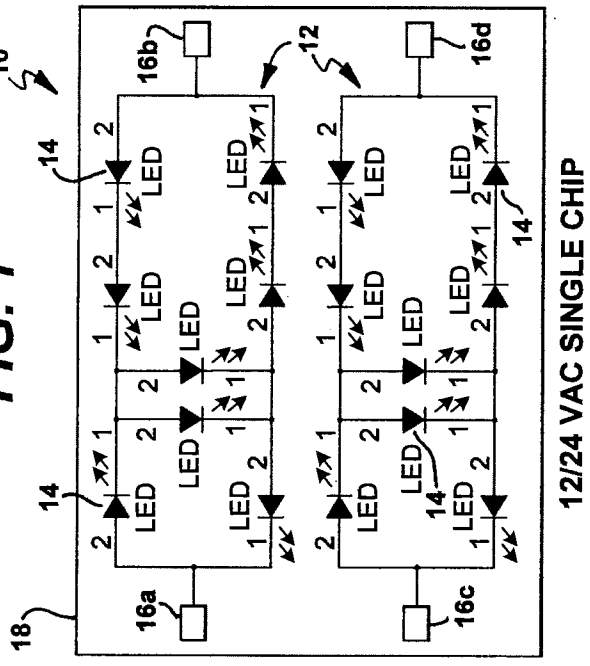


FIG. 1



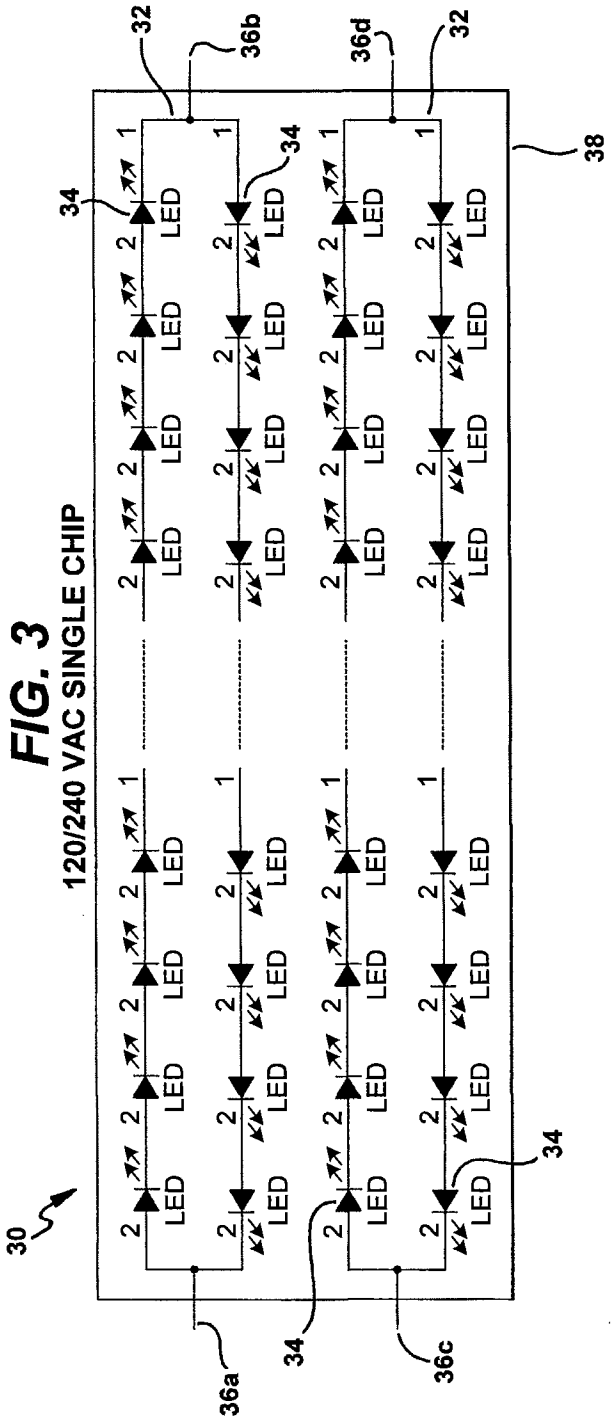
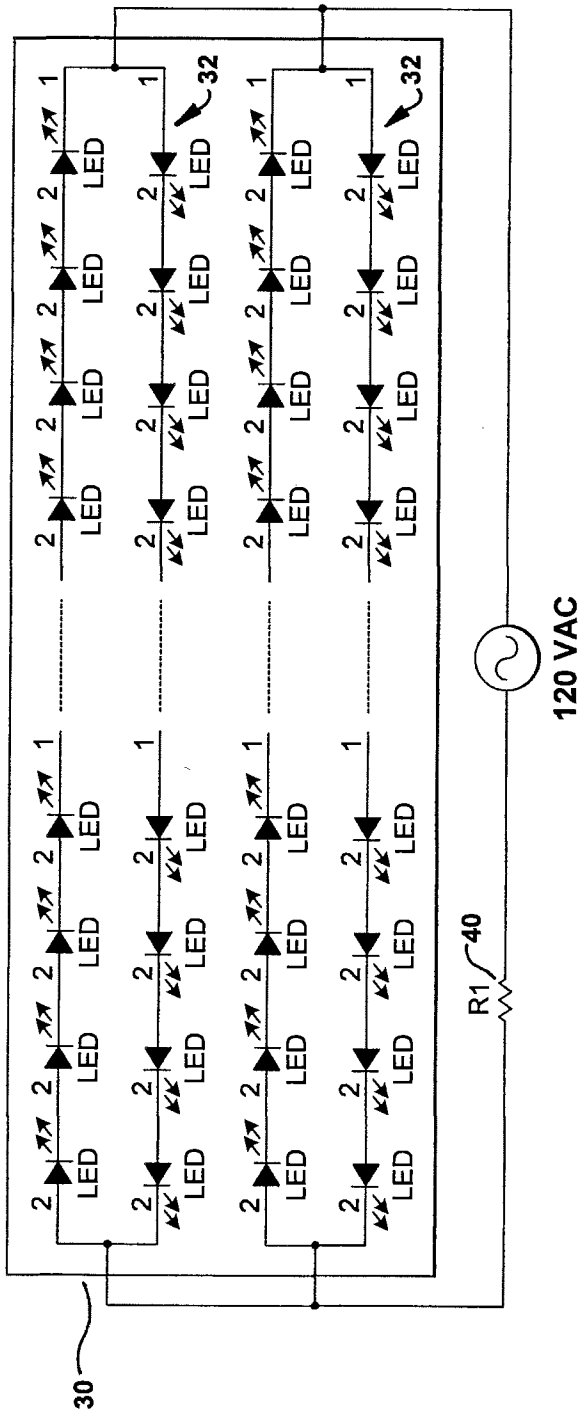

120/240 VAC SINGLE CHIP
30
32
36b
36d
32
38
34
34
34
36a
34
36c
LED
1
2

FIG. 3

FIG. 4



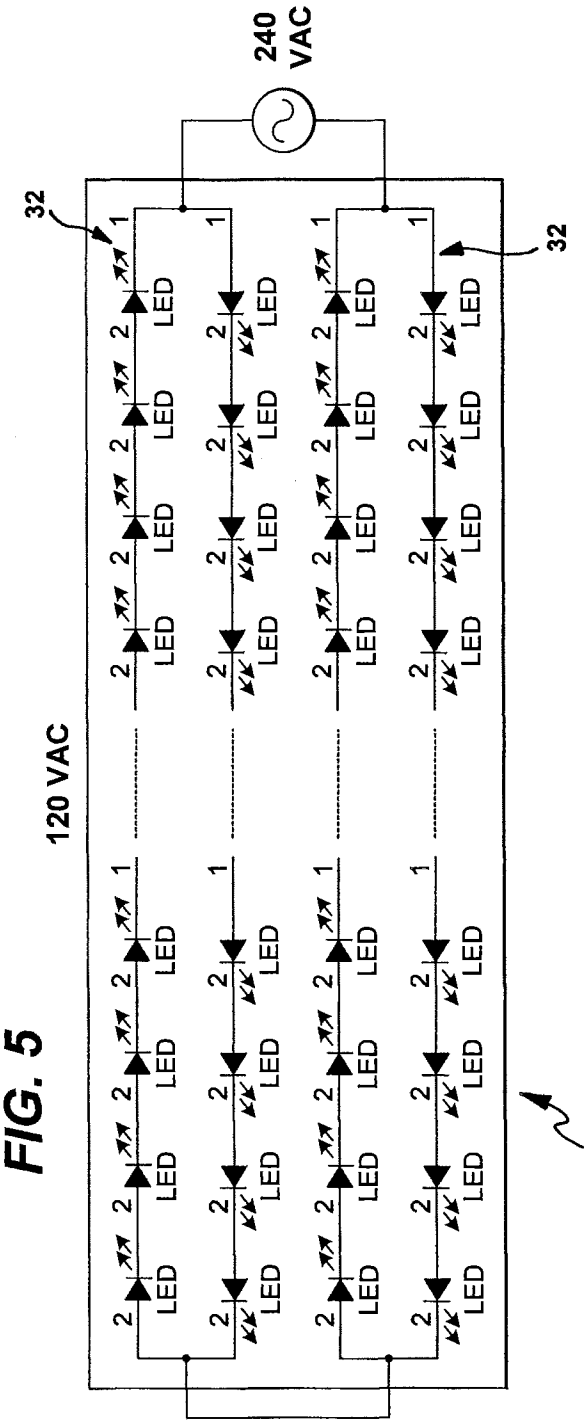


FIG. 5

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1202

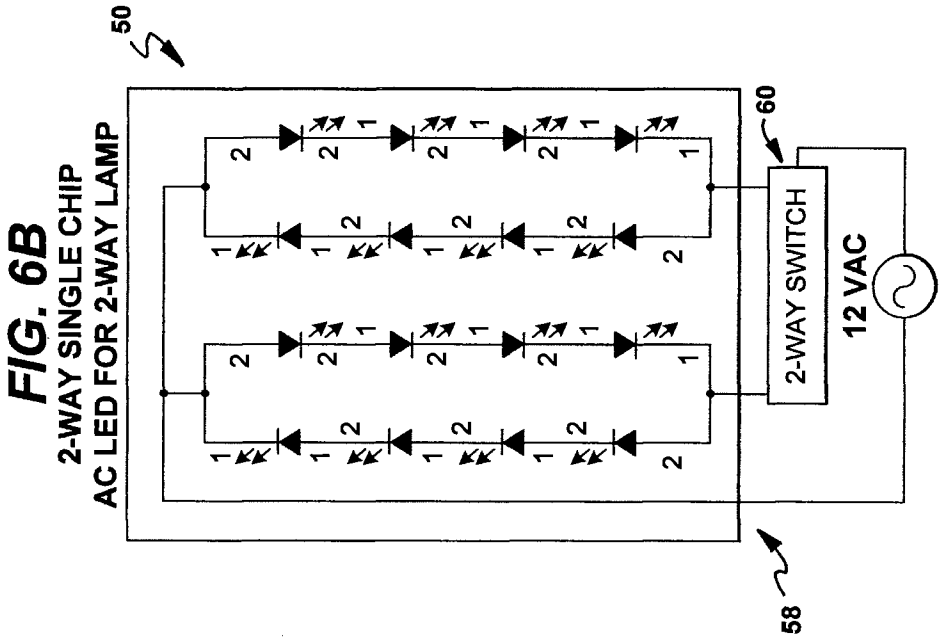


FIG. 6B
2-WAY SINGLE CHIP
AC LED FOR 2-WAY LAMP

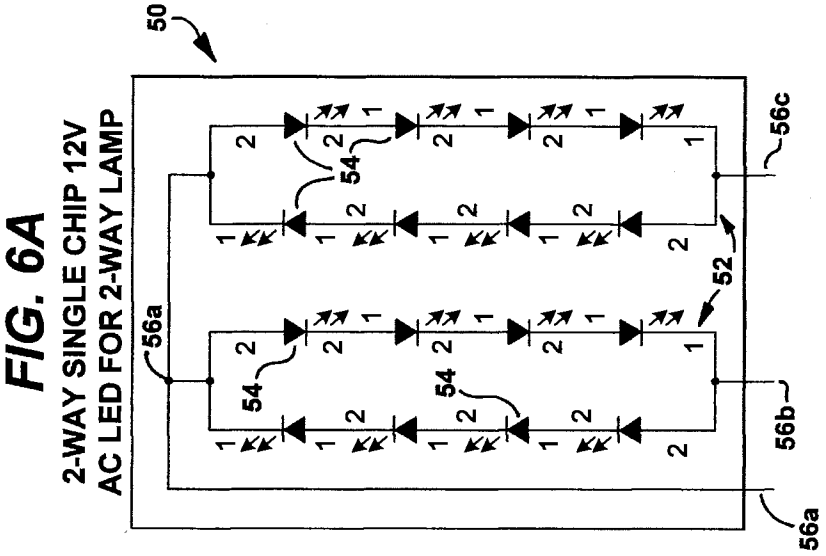


FIG. 6A
2-WAY SINGLE CHIP 12V
AC LED FOR 2-WAY LAMP

FIG. 7A

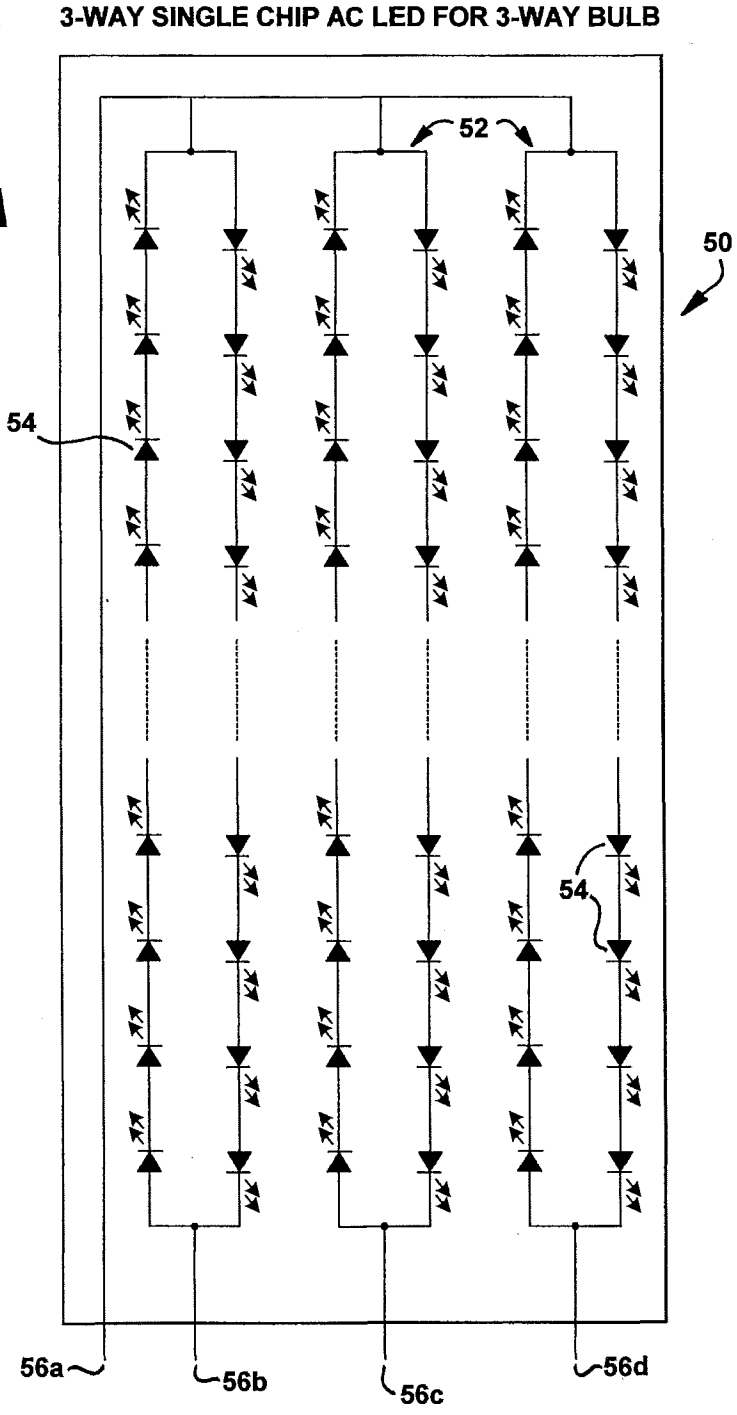

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
52
50
54
54
56a
56b
56c
56d

FIG. 7B

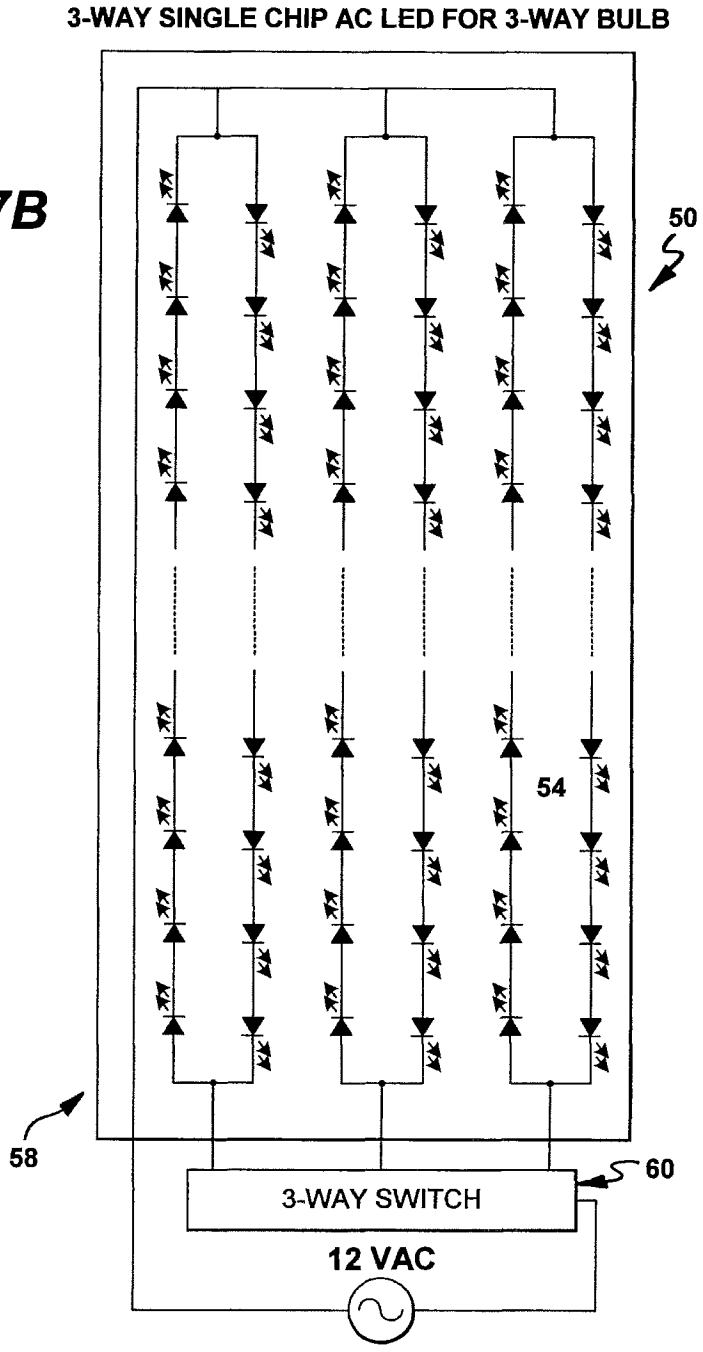
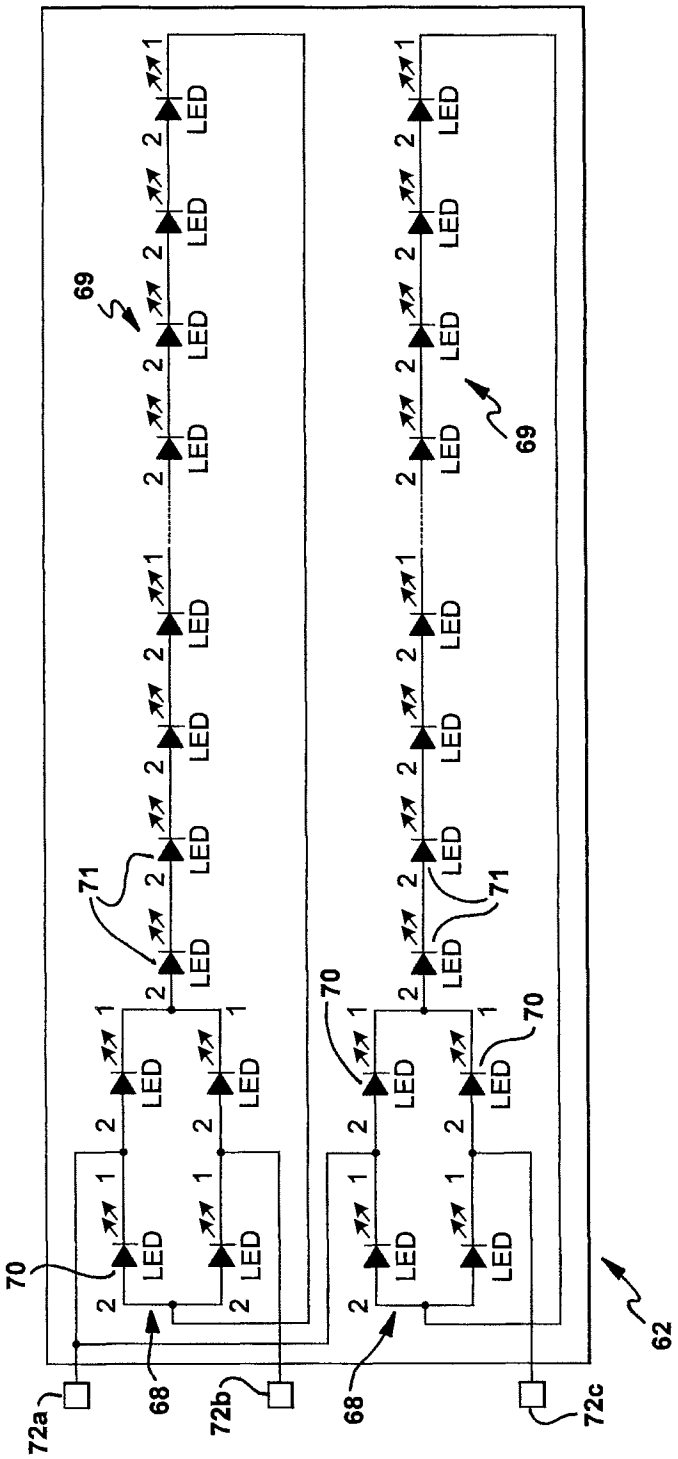
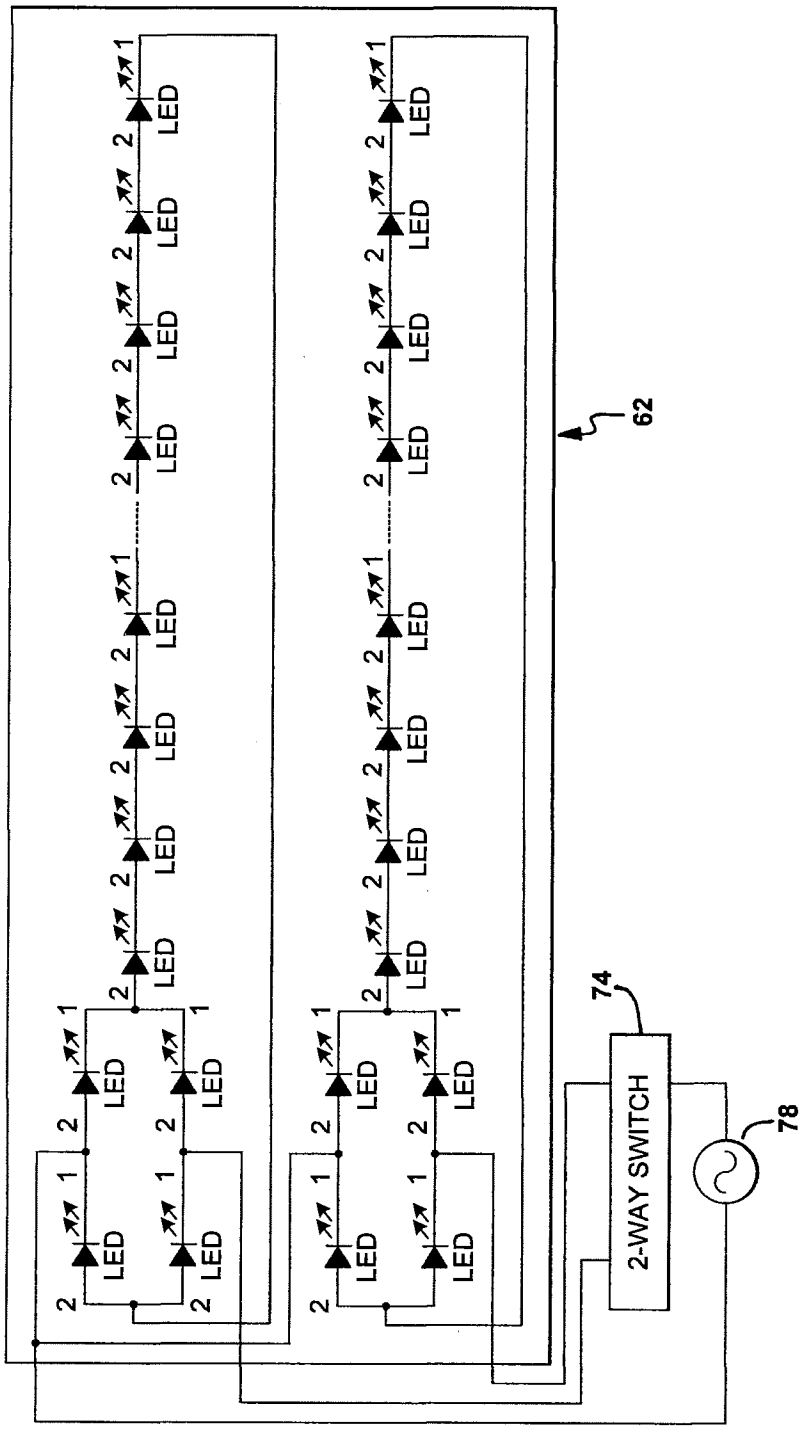

3-WAY SINGLE CHIP AC LED FOR 3-WAY BULB
50
54
58
60
3-WAY SWITCH
12 VAC

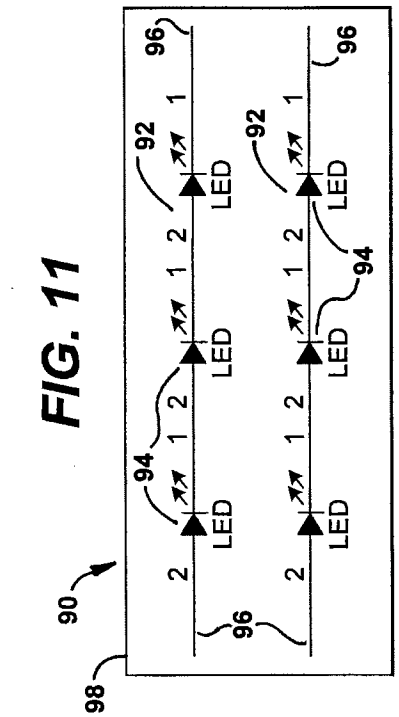
FIG. 8

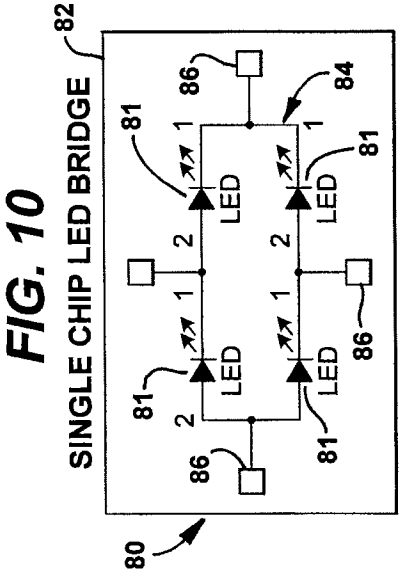


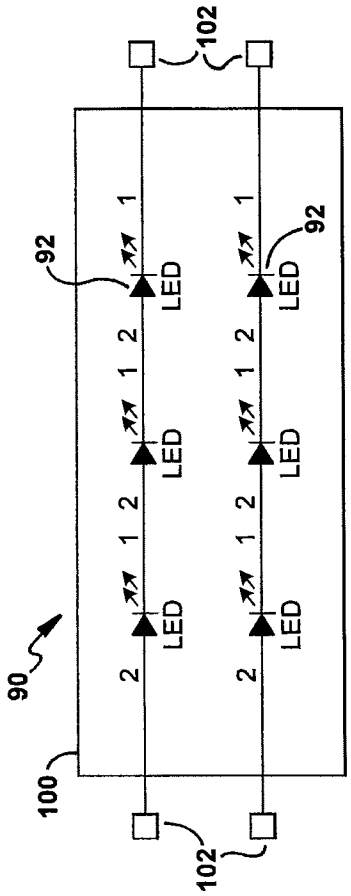
PGR2023-00016 - Home Depot
Ex. 1003 - Page 1206

FIG. 9




FIG. 11
90
98
96
92
94
LED
1
2


FIG. 10
SINGLE CHIP LED BRIDGE
80
82
81
84
86
LED
1
2


FIG. 12
90
92
100
102
LED
1
2

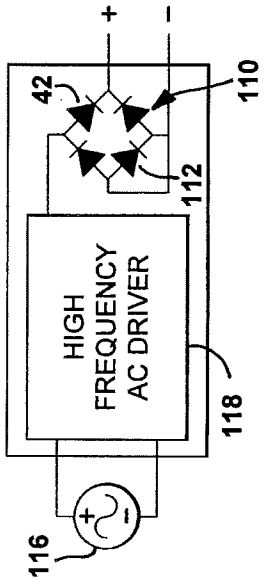


FIG. 13

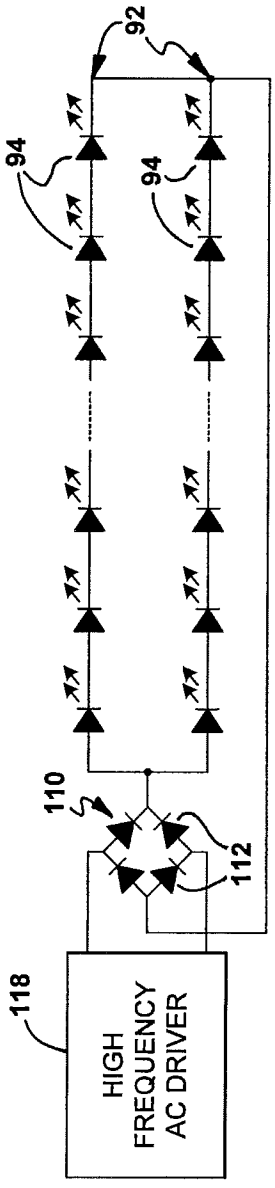


FIG. 14

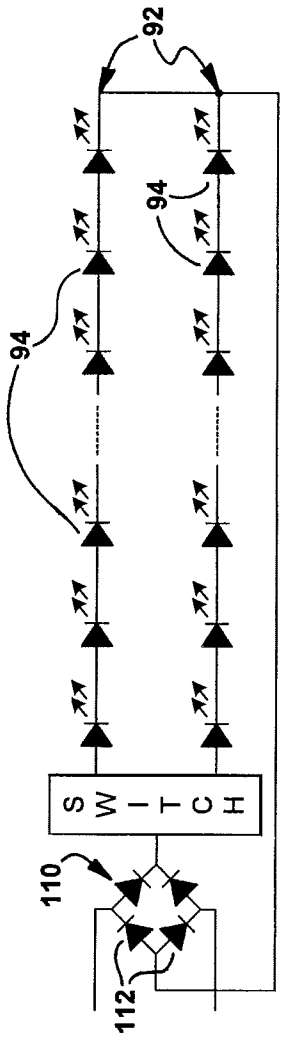


FIG. 15

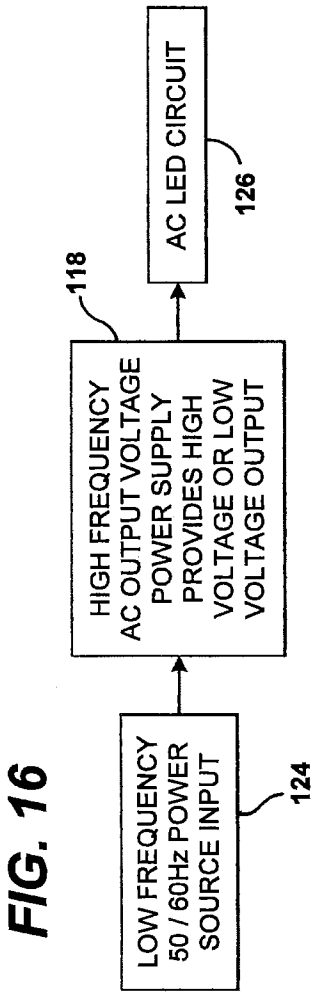

LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
PROVIDES HIGH
VOLTAGE OR LOW
VOLTAGE OUTPUT
118
AC LED CIRCUIT
126

FIG. 16

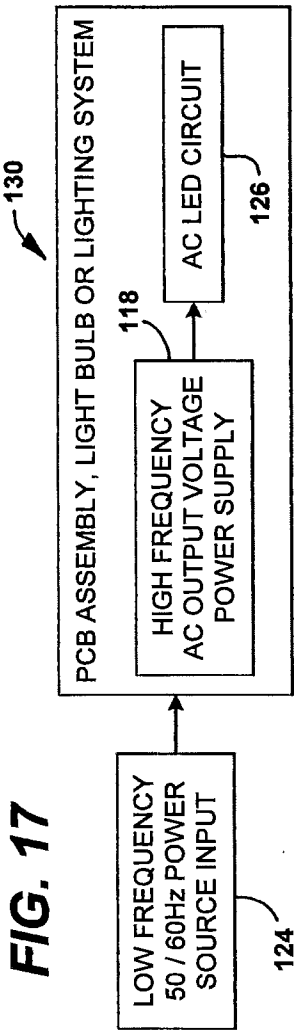

130
PCB ASSEMBLY, LIGHT BULB OR LIGHTING SYSTEM
LOW FREQUENCY
50 / 60Hz POWER
SOURCE INPUT
124
HIGH FREQUENCY
AC OUTPUT VOLTAGE
POWER SUPPLY
118
AC LED CIRCUIT
126

FIG. 17

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1210

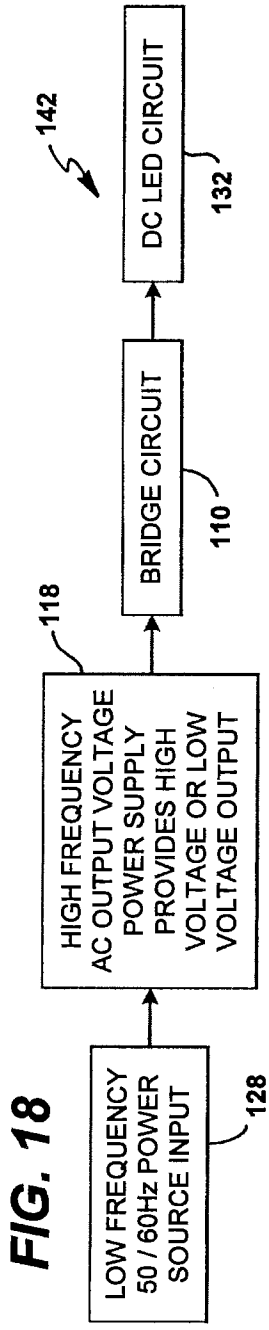


FIG. 18

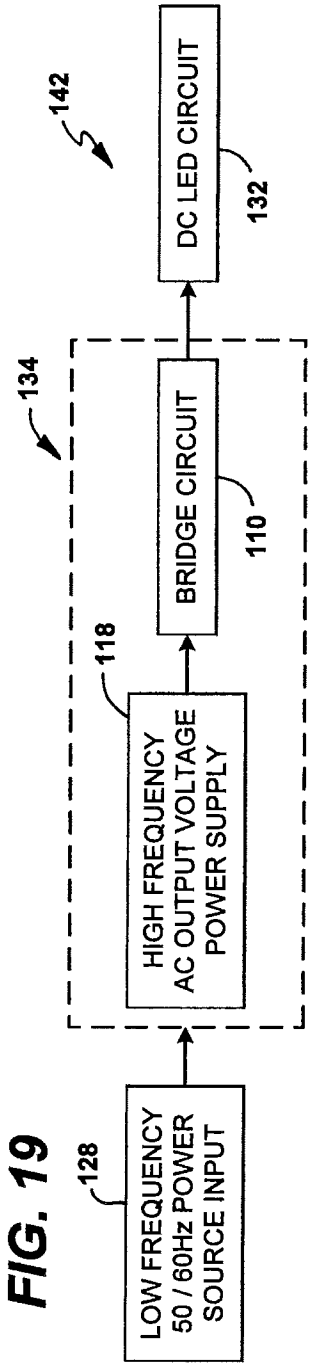


FIG. 19

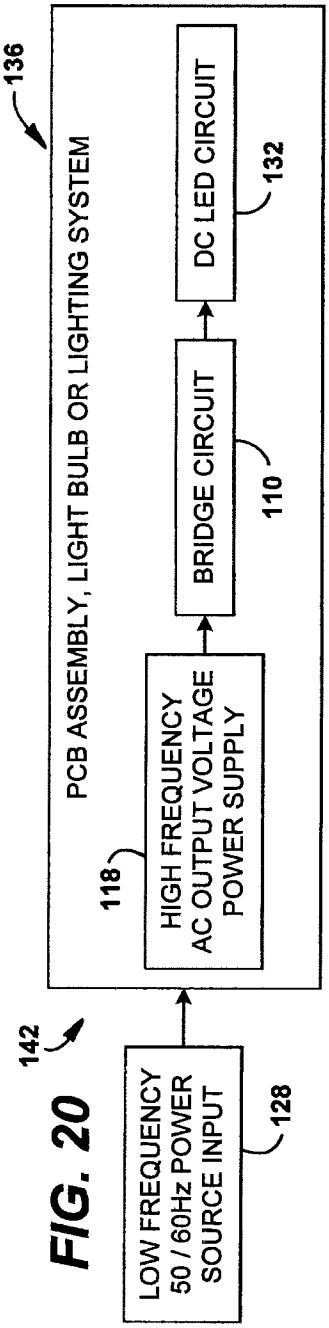


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H05B 37/00 (2011.01)
USPC - 315/185R
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 315/185R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 362/800; 315/185R, 200R, 246, 250, 291 (keyword limited - see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; Google Scholar
Terms: lighting, led, transformer, voltage, frequency, ac, dc, rectifier, driver, bridge, constant, cathode, anode, port, node, switch, series, input.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2009/0295300 A1 (King) 03 December 2009 (03.12.2009), entire document, especially abstract, para [0009], [0015], [0031], [0033], [0035], [0053], [0059], [0060], [0061], [0065], [0069], [0070], [0082], [0086], [0089], [0092], [0101], [0108].	24-31, 33-42 --- 1-23
Y	US 2008/0203936 A1 (Mariyama et al.) 28 August 2008 (28.08.2008), entire document, especially abstract, para [0012], [0015], [0017], [0018], [0019], [0053], [0129], [0133], [0136].	1-23
A	US 2008/0158915 A1 (Williams) 03 July 2008 (03.07.2008), entire document, especially abstract, para [0008], [0009], [0010], [0050].	1-31, 33-42

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2011 (14.02.2011)	08 MAR 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/62235

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 32
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

(12) UK Patent Application (19) GB (11) 2 202 414 (13) A

(43) Application published 21 Sep 1988

(21) Application No 8705583

(22) Date of filing 10 Mar 1987

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Oxley Developments Company Limited

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(51) INT CL⁴
H04B 5/00 H05B 33/08

(52) Domestic classification (Edition J):
H4L CX
H2H LL3
U1S 1926 2124 H2H H4L

(56) Documents cited
GB 1319412 GB 0778072 EP A2 0179536
EP A2 0145430 WO A1 84/04212

(58) Field of search
H4L
H2H
Selected US specifications from IPC sub-classes
H04B H05B

(54) Transmission of power and/or data

(57) A system in which power or data is transmitted across a panel/bulkhead (14) by means of a low frequency magnetic coupling between a pair of transmission and receiving coils (12,16) disposed on the two sides of the panel/bulkhead (14), respectively. The system can include a panel mounting lamp unit (22) comprising the receiving coil (16) in series with a diode (18) and an LED (20), the latter components being mounted together in or on a common housing which is adapted to be fitted to the panel/bulkhead (14) at a position opposite to the transmission coil (12). Data from a computer (28, Fig 5) may be coupled to a transmitter (38) via a modulator (32) for reception by a receiver (42).

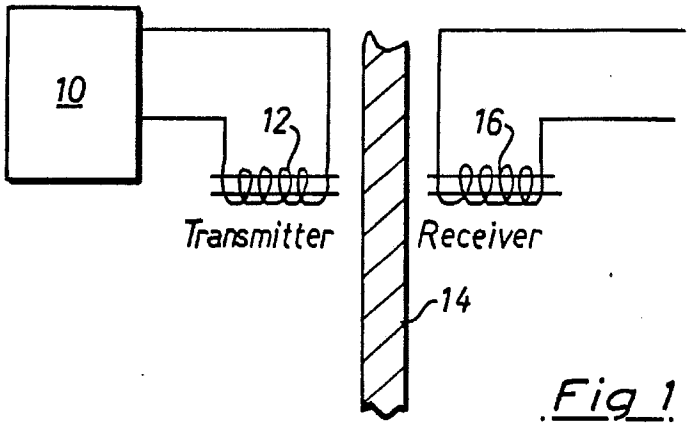


Fig 1

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.
The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

GB 2 202 414 A

PGR2015-00116 - Exhibit 1010
SAMSUNG
Ex. 1003 - Page 1213

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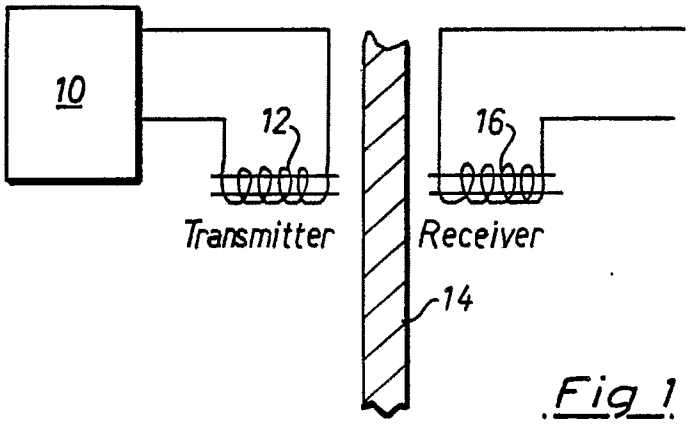


Fig 1

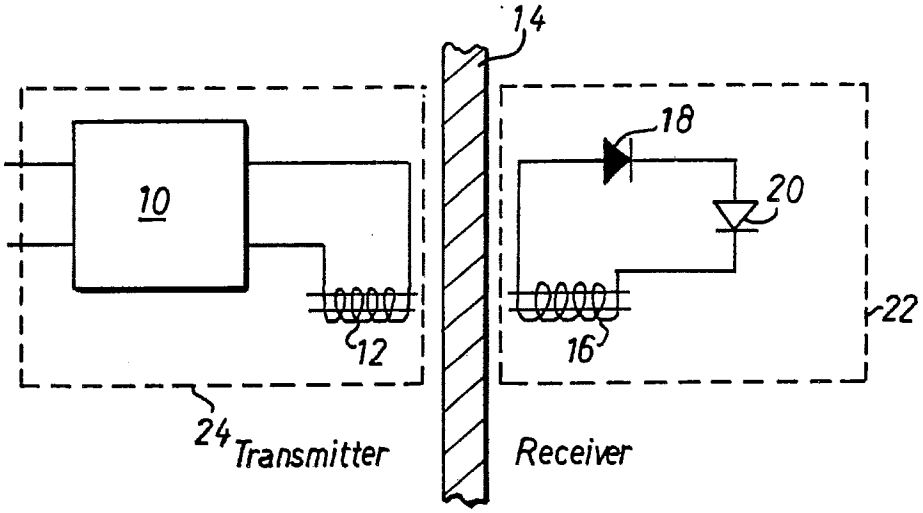
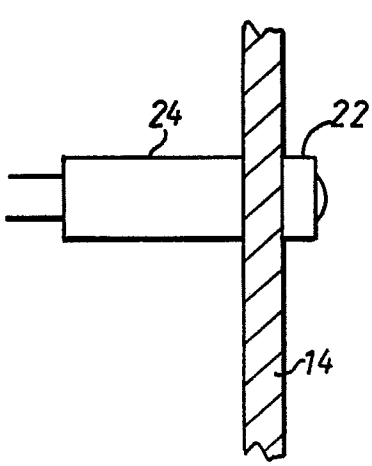
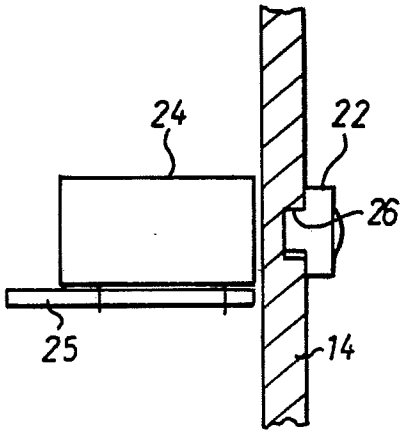


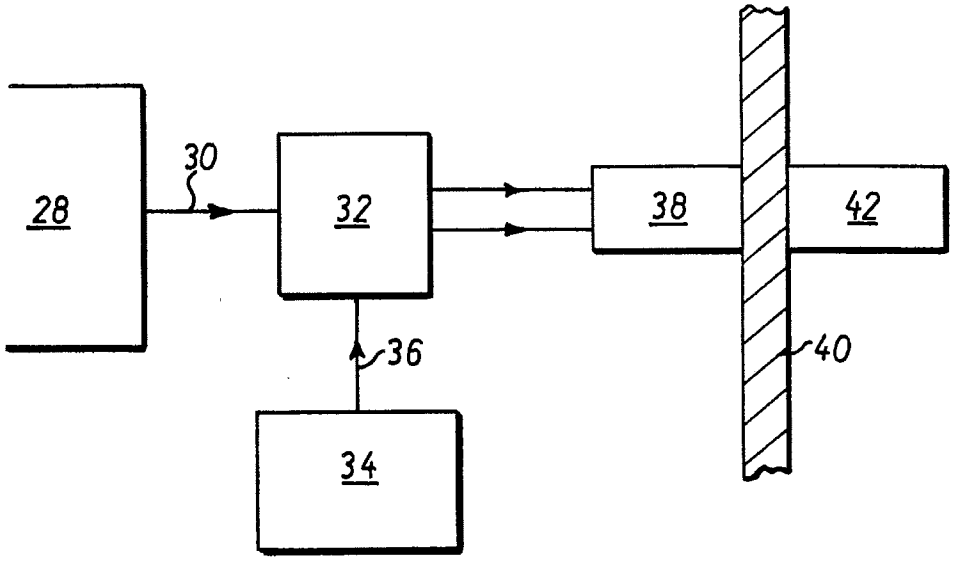
Fig 2

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1214

2/2







Transmission of power and/or data

The present invention is concerned with a means of transmitting power and/or data through a solid member, such as an instrument panel or bulkhead.

There exist many engineering situations where it would be very advantageous if power and/or data could be transmitted locally between two adjacent positions which are separated by a solid wall, such as a metal plate forming an instrument panel or bulkhead. It is, of course, known in principle to transmit power and data using radio waves. However, where a number of transmissions are to be made in closely adjacent positions, radio transmissions have the disadvantage that interference between separate transmission is virtually impossible to avoid with very costly and complex filtering circuitry.

It is one object of the present invention to provide a system which avoids the above-discussed disadvantage of radio waves and which enables large numbers of individual transmitter/receiver pairs to be positioned in relatively close proximity to each other without mutual interference between adjacent channels.

It is another object of the present invention to provide a panel mountable indicator lamp which can be energised from within a housing structure without requiring any wiring connection through the housing wall.

In accordance with the present invention in its broadest aspect, there is provided a system in which power or data is transmitted across a panel/bulkhead by means of a low frequency magnetic coupling between a pair of transmission and receiving coils disposed on the two sides of the panel/bulkhead, respectively.

Preferably, the coils are iron-cored so as to produce a concentrated magnetic field. A typical operating frequency is of the order of 200 Hz.

In one type of embodiment, the receiving coil is mounted in series with a rectifier and an LED lamp to form a lamp unit. Preferably, the latter components are encapsulated to form said lamp unit.

Such a lamp unit can be mounted on a panel/bulkhead by any convenient means, e.g. by adhesive or by the use of a blind, screw-threaded hole in the panel/bulkhead.

In accordance with a second aspect of this invention, there is provided a panel mounting lamp unit comprising a magnetic pick-up coil in series with a diode and an LED, the latter components being mounted together in or on a common housing which is adapted to be fitted to a panel/bulkhead at a position opposite to a magnetic transmission coil disposed on the other side of the panel/bulkhead and capable of emitting a low-frequency magnetic field.

By arranging for the lamp unit to be fitted to the panel/bulkhead without penetrating right through

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1217

it, the lamp unit can be powered and controlled from the transmission coil side of the panel/bulkhead without requiring any mechanical through-connection.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a basic arrangement in accordance with the present invention;

Fig. 2 is a circuit diagram of a second arrangement in accordance with the present invention for transmitting power through a panel;

Figs. 3 and 4 show diagrammatically two possible forms of panel-mounted indicator lamps incorporating the present invention; and

Fig. 5 is a block circuit diagram of an arrangement in accordance with the present invention for the transmission of both power and data through a panel or bulkhead.

Referring first to Fig. 1, there is shown an osullator 10 energising a transmitter coil 12 to create an alternating electromagnetic flux. This flux penetrates through a panel/bulkhead 14 and induces an E.M.F. in a receiver coil 16.

The transmitter current may be modulated in order to convey information to a demodulator in the receiver. Alternatively, a basic sinusoidal transmitter could convey power to the receiver, which may be rectified (see below).

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1218

Such systems can operate with a wide variety of panel/bulkhead materials. For example, aluminium and its alloys, plastics and stainless steel are all suitable. Ferrous materials will also function, although with limitations on maximum panel thickness.

Panel mounted components, such as indicator lamps, of conventional design require a through mounting hole which must then be sealed to prevent the ingress of dust, liquids, gasses etc. In some instances the seal must be hermetic, which may be difficult to maintain in the event of bulb changing, rewiring etc.

In the arrangement of Fig. 2, the receiver includes a diode 18 in series with an indicator LED 20 and the receiver coil 16. The elements 16, 18 and 20 can be encapsulated to form a unitary component 22 which requires no through mounting hole. Panel sealing integrity is therefore maintained even if any of the elements of the component 22 or the component 22 itself, have to be changed. A zero leakage characteristic for the housing is therefore inherent in this system. The transmitter components can be similarly encapsulated in a transmitter unit 24.

The receiver unit 22 can be mounted by any convenient means, two examples being shown in Figures 3 and 4. In the example of Fig. 3, the transmitter and lamp/receiver units 24, 22 are mounted on the panel/bulkhead 14 by means of a suitable adhesive. In the example of Fig. 4, the lamp/receiver unit 22 is mounted

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1219

in a blind threaded hole 26 and the transmitter unit 24 is mounted on a printed circuit board 25. Typical panel thicknesses may be in the range of 3mm to 6mm but the invention is not limited to this range.

Using the aforegoing system, it will be appreciated that the following advantages can be obtained :-

1. Lamps may be replaced (either for repair or colour change) without breaking the panel seal. This can be of particular use in applications where the equipment is exposed to hazardous materials, e.g. in the chemical industry.

2. A lamp/receiver unit 22 can be used to interrogate an instrument's output state and then removed for security reasons.

3. Panel drilling is unnecessary and allows a manufacturer to change panel designs by moving the mounting position of lamps.

In further applications, data can be superimposed on a carrier and transmitted through a panel. This possiblity is illustrated in Fig. 5 where a data system 28, such as a computer, supplies a control signal on a line 30 to a modulator 32 in which a carrier signal (e.g. 200 Hz), provided by an oscillator 34 on a line 36, can be modified to form a modulated signal to a transmitter 38. Data superimposed on the carrier can thereby be transmitted through the panel 40. Carrier can then be demodulated to power and control a receiver

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1220

unit. Two-way transmission is possible with such a system.

It is preferred to use iron-cored transmission and pick-up coils 12, 16 in the present system so as to produce a concentrated magnetic field. Due to the concentrated and localised nature of the field, indicator lamps can be densely packed without interference problems arising since cross-talk between lamps sharing the same panel will not provide sufficient coil voltage to overcome the LED forward voltage of other receiver devices.

Preferably, the transmitted electromagnetic signal is of sinusoidal form but any other suitable waveshape may be used within the ambit of the invention.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1221

CLAIMS

1. A system in which power or data is transmitted across a panel/bulkhead by means of a low frequency magnetic coupling between a pair of transmission and receiving coils disposed on the two sides of the panel/bulkhead, respectively.

2. A system as claimed in claim 1, wherein the coils are iron-cored so as to produce a concentrated magnetic field.

3. A system as claimed in claim 1 or 2, wherein the receiving coil is mounted in series with a rectifier and an LED lamp to form a lamp unit.

4. A system as claimed in claim 3, wherein the receiving coil, the rectifier and the LED are encapsulated to form said lamp unit.

5. A system as claimed in claim 3 or 4, wherein the lamp unit is adapted to be mounted on the panel/bulkhead by an adhesive or by the use of a blind, screw-threaded recess in the panel/bulkhead.

6. A system as claimed in any of claims 1 to 5, wherein, in order to transmit data through the panel/bulkhead, the low frequency electromagnetic field transmitted by the transmission coil is modulated by a data signal, the corresponding signal generated in the receiving coil being correspondingly demodulated to recover the data.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1222

7. A system as claimed in any of claims 1 to 5, wherein the transmission coil produces an alternating or electromagnetic field having a frequency of the order of 200Hz.

8. A panel mounting lamp unit comprising a magnetic pick-up coil in series with a diode and an LED, the latter components being mounted together in or on a common housing which is adapted to be fitted to a panel/bulkhead at a position opposite to a magnetic transmission coil disposed on the other side of the panel/bulkhead and capable of emitting a low-frequency magnetic field.

9. A panel mounting lamp unit as claimed in claim 6, wherein the pick-up coil, the diode and the LED are encapsulated to form said lamp unit.

10. A panel mounting lamp unit as claimed in claim 6 or 7, wherein the lamp unit is adapted to be mounted on the panel/bulkhead by an adhesive or by the use of a blind, screw-threaded recess in the panel/bulkhead.

11. A system for transmitting power or data across a panel/bulkhead, substantially as hereinbefore described with reference to the accompanying drawings.

12. A panel mounting lamp unit substantially as hereinbefore described with reference to and as illustrated in Fig. 2, 3 or 4 of the accompanying drawings.

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Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Multiplex techniques ltd, St Mary Cray, Kent. Con. 1/87.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1223

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-111104
(P2004-111104A)
(43)公開日　平成16年4月8日(2004.4.8)

(51)Int.Cl.[7]	F I		テーマコード（参考）
H05B 37/02	H05B 37/02	L	3K073
F21S 2/00	H05B 37/02	H	5F041
F21S 8/04	H01L 33/00	J	
H01L 33/00	F21S 5/00	A	
// F21Y 101:02	F21S 1/02	G	

審査請求 未請求　請求項の数 27　OL　（全 24 頁）　最終頁に続く

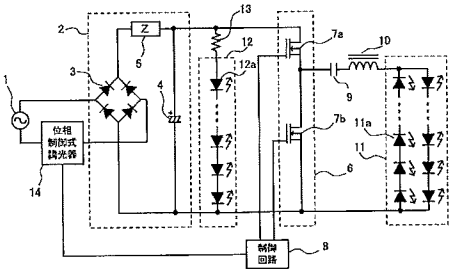
(21)出願番号　特願2002-269034(P2002-269034)
(22)出願日　平成14年9月13日(2002.9.13)

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東京都千代田区丸の内二丁目２番３号　三菱電機株式会社内

最終頁に続く

(54)【発明の名称】ＬＥＤ点灯装置及び照明器具

(57)【要約】
【課題】一般照明に適し、必要に基づいて白色や有色等の任意の発光色に　化させて照明の演出ができるＬＥＤ点灯装置及び照明器具を得る。
【解決手段】商用電源１を直流に　換する直流電源回路２と、直流を高周波に　換するインバータ回路６と、商用電源１と直流電源回路２との間に　入された位相制御式調光器１４の出力に基づいてインバータ回路６の　動周波　を制御する制御回路８と、インバータ回路６の出力電流を制限するインダクタ１０と、このインダクタ１０に直列接　された直流カットコンデンサ９と、インダクタ１０と直流カットコンデンサ９の直列回路に接　され、白色ＬＥＤ１１ａが互いに逆並列接　された白色ＬＥＤアレイ１１と、アノード側を高電位側にして直流電源回路２に接　され、有色ＬＥＤ１２ａが直列接　された有色ＬＥＤアレイ１２と、を備える。
【選　】　1



RGR2023-00016 - Home Depot
SAMSUNG EXHIBIT 1010
Ex. 1003 - Page 1225

【特許請求の範　】
【請求項１】
第１の発光手段と、
前記第１の発光手段と異なる発光色の第２の発光手段と、
前記第１、第２の発光手段を制御する制御手段と、を備え、
前記制御手段は、全光時に前記第１の発光手段を主点灯手段として点灯し、調光時に前記第２の発光手段を主点灯手段として点灯し、前記第１または第２の発光手段の発光色のいずれか一方を白色とし、前記全光時の明るさ及び発光色と、前記調光時の明るさ及び発光色とを連　的に　化させることを特　とするＬＥＤ点灯装置。
【請求項２】
第１の白色の発光手段と、
第１の発光手段と異なる発光色の第２の発光手段と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて前記第１、第２の発光手段の出力を調整する制御手段と、を備え、
前記制御手段は、全光時は前記第１の発光手段の出力を前記第２の発光手段の出力より大きくし、調光度に基づいて第１及び第２の発光手段の出力を　調減少させるとともに、調光時は前記第１の発光手段の出力を前記第２の発光手段の出力より小さくしたことを特とするＬＥＤ点灯装置。
【請求項３】
第１の白色の発光手段と、
前記第１の発光手段と異なる発光色の第２の発光手段と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて前記第１、第２の発光手段の出力を調整する制御手段と、を備え、
前記制御手段は、全光時は前記第１の発光手段の出力を前記第２の発光手段の出力より大きくし、調光度に基づいて第１の発光手段の出力を　調減少させるとともに、前記第２の発光手段の出力を、所定の調光度以下で　調減少させることを特　とするＬＥＤ点灯装置。
【請求項４】
第１の白色の発光手段と、
前記第１の発光手段と異なる発光色の第２の発光手段と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて前記第１、第２の発光手段の出力を調整する制御手段と、を備え、
前記制御手段は、前記第１の発光手段の出力と前記第２の発光手段の合計出力を調光度に基づいて　調減少させるときに、調光度に基づいて前記第１の発光手段の出力を　調減少させ、前記第２の発光手段の出力を　調　加させることを特　とするＬＥＤ点灯装置。
【請求項５】
第１及び第２の発光手段が少なくとも一つ以上のＬＥＤからなることを特　とする請求項１～４のいずれかに記載のＬＥＤ点灯装置。
【請求項６】
商用電源を直流に　換する直流電源回路と、
直流を高周波に　換するインバータ回路と、
前記商用電源と前記直流電源回路との間に　入された位相制御式調光器の出力に基づいて前記インバータ回路の　動周波　を制御する制御回路と、
前記インバータ回路の出力電流を制限する第１のインダクタと、
この第１のインダクタに直列接　された直流カットコンデンサと、
前記第１のインダクタと前記直流カットコンデンサの直列回路に接　され、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイと、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1226

アノード側を高電位側にして前記直流電源回路に接　され、有色ＬＥＤが直列接　された有色ＬＥＤアレイと、
を備えたことを特　とするＬＥＤ点灯装置。
【請求項７】
商用電源を直流に　換する直流電源回路と、
直流を高周波に　換するインバータ回路と、
前記商用電源と前記直流電源回路との間に　入された位相制御式調光器の出力に基づいて前記インバータ回路の　動周波　を制御する制御回路と、
前記インバータ回路の出力電流を制限する第１のインダクタと、
この第１のインダクタに直列接　された直流カットコンデンサと、
前記第１のインダクタと前記直流カットコンデンサの直列回路に接　され、
前記インバータ回路の出力を全波整流する全波整流器を介して接　され、白色ＬＥＤが直列接　された白色ＬＥＤアレイと、
アノード側を高電位側にして前記直流電源回路に接　され、有色ＬＥＤが直列接　された有色ＬＥＤアレイと、
を備えたことを特　とするＬＥＤ点灯装置。
【請求項８】
直流電源回路と、
直流を高周波に　換するインバータ回路と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて前記インバータ回路の　動周波　を制御する制御回路と、
前記インバータ回路の出力電流を制限する第１のインダクタと、
前記第１のインダクタに直列接　された直流カットコンデンサと、
前記第１のインダクタと前記直流カットコンデンサの直列回路に接　されたＬＥＤユニットと、を備え、
前記ＬＥＤユニットは、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイと第２のインダクタとの直列回路と、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイと第１のコンデンサとの直列回路とが、互いに並列接　されたことを特　とするＬＥＤ点灯装置。
【請求項９】
ＬＥＤユニットの各ＬＥＤに　して、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したことを特　とする請求項８記載のＬＥＤ点灯装置。
【請求項１０】
ＬＥＤユニットにおいて、一　の互いに逆並列接　されたＬＥＤが複　直列接　され、それぞれの　に　して、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したことを特　とする請求項８記載のＬＥＤ点灯装置。
【請求項１１】
直流電源回路と、
アノード側を高電位側にして前記直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及びスイッチング素子との直列回路と、
アノード側を高電位側にして前記直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び抵抗との直列回路と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて直流電源回路の出力及び前記スイッチング素子のｏｎ－ｄｕｔｙを制御する制御回路と、を備え、
前記制御回路は、調光度が深くなるにつれて直流電源回路の出力を　調減少させ、かつ、前記スイッチング素子のｏｎ－ｄｕｔｙを　調減少させることを特　とするＬＥＤ点灯装置。
【請求項１２】

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1227

直流電源回路と、
アノード側を高電位側にして前記直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及び第１のスイッチング素子との直列回路と、
アノード側を高電位側にして前記直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び第２のスイッチング素子との直列回路と、
調光度を定める調光信号を出力する調光手段と、
この調光手段からの調光信号に基づいて前記直流電源回路の出力と前記第、第２のスイッチング素子とを制御する制御回路と、を備え、
前記制御回路は、調光度が深くなるにつれて直流電源回路の出力を　調減少させ、かつ、第１のスイッチング素子のｏｎ－ｄｕｔｙに　する第２のスイッチング素子のｏｎ－ｄｕｔｙを相　的に　調　加させることを特　とするＬＥＤ点灯装置。

【請求項１３】
白色ＬＥＤからなる白色ＬＥＤアレイ及び有色ＬＥＤからなる有色ＬＥＤアレイを点灯する点灯手段と、
前記白色ＬＥＤアレイ及び前記有色ＬＥＤアレイの合計の出力を一定に保つ制御回路と、
前記白色ＬＥＤ及び有色ＬＥＤの出力比を段階的または連　的に切換える切換手段と、を備え、
前記制御回路は前記切換手段からの信号に基づいて前記出力比を　化させることを特　とするＬＥＤ点灯装置。

【請求項１４】
直流電源回路と、
アノード側を高電位側にして前記直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及び第１のスイッチング素子との直列回路と、
アノード側を高電位側にして前記直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び第２のスイッチング素子との直列回路と、
前記第１、第２のスイッチング素子のｏｎ－ｄｕｔｙの合計を一定にする制御回路と、
前記白色ＬＥＤ及び有色ＬＥＤの出力比を段階的または連　的に切換える切換手段と、を備え、
前記制御回路は前記切換手段からの信号に基づいて前記第１、第２のスイッチング素子のｏｎ－ｄｕｔｙの比を　化させることを特　とするＬＥＤ点灯装置。

【請求項１５】
第２の発光手段、有色ＬＥＤまたは有色ＬＥＤアレイの発光色が、電球色、黄色またはオレンジ色であることを特　とする請求項１～１４のいずれかに記載のＬＥＤ点灯装置。

【請求項１６】
請求項１～１５のいずれかに記載のＬＥＤ点灯装置を、口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、第１の発光手段または白色ＬＥＤ及び第２の発光手段または有色ＬＥＤを互い違いに均等に配設したことを特　とする電球形の照明器具。

【請求項１７】
請求項１～１５のいずれかに記載のＬＥＤ点灯装置を、口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、第１の発光手段または白色ＬＥＤが床面方向を照射し、第２の発光手段または有色ＬＥＤが壁面または天井方向を照射するように配設したことを特　とする照明器具。

【請求項１８】
調光する調光手段または切換手段をスイッチとして筐体に設けたことを特　とする請求項１６または１７記載の電球形の照明器具。

【請求項１９】
直管　光灯用器具に装着可能な端子付きの口金を両端に有する筐体と、
前記両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、
前記ＬＥＤユニットは、ＬＥＤが互いに逆並列接　されたＬＥＤアレイからなることを特

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1228

とする直管形の照明器具。
【請求項２０】
直管　光灯用器具に装着可能な端子付き口金を両端に有する筐体と、
前記両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、
前記ＬＥＤユニットは、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイとインダクタとの直列回路と、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイとコンデンサとの直列回路とが、互いに並列接　されたことを特　とする直管形の照明器具。
【請求項２１】
直管　光灯用器具本体に装着可能な端子付き口金を両端に有する筐体と、
前記両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、
前記ＬＥＤユニットは、一方の前記口金上の第１の端子と他方の前記口金上の第１の端子間に、インダクタ及び白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイとが直列接　され、他方の前記口金上の前記第１の端子と第２の端子とが短絡され、一方の前記口金上の前記第１の端子と第２の端子間に、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイが接　されたことを特　とする直管形の照明器具。
【請求項２２】
口金の少なくとも一方が、１８０度回転可能であることを特　とする請求項２１記載の直管形の照明器具。
【請求項２３】
有色ＬＥＤまたは有色ＬＥＤの発光色が、電球色、黄色またはオレンジ色であることを特　とする請求項２０～２２のいずれかに記載の照明器具。
【請求項２４】
直流電源回路と、
直流を高周波に　換するインバータ回路と、
前記インバータ回路を　動する制御回路と、
前記インバータ回路の出力電流を制限する第１のインダクタと、
第１のインダクタに直列接　された直流カットコンデンサと、
第１のインダクタと前記直流カットコンデンサの直列回路に直列接　されるＬＥＤユニットと、を備え、
前記ＬＥＤユニットにおいて、ＬＥＤアレイが互いに逆並列接　され、ＬＥＤアレイを構成する各ＬＥＤに　して、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したことを特　とするＬＥＤ点灯装置。
【請求項２５】
直流電源回路と、
直流を高周波に　換するインバータ回路と、
前記インバータ回路を　動する制御回路と、
前記インバータ回路の出力電流を制限する第１のインダクタと、
第１のインダクタに直列接　された直流カットコンデンサと、
第１のインダクタと前記直流カットコンデンサの直列回路に直列接　されるＬＥＤユニットと、を備え、
前記ＬＥＤユニットにおいて、一　の互いに逆並列接　されたＬＥＤが複　直列接　され、それぞれの　に　して、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したことを特　とするＬＥＤ点灯装置。
【請求項２６】
前記ＬＥＤユニットの両端の電　を　出する電　　出回路を備え、
　出された電　が所定　を超えた場合に前記インバータ回路を停止することを特　とする請求項２４または２５記載のＬＥＤ点灯装置。
【請求項２７】
直流電源回路と、
直流を高周波に　換するインバータ回路と、

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1229

前記インバータ回路を　動する制御回路と、
インバータ回路の出力点に接　された直流カットコンデンサとＬＥＤユニットとの直列回路と、を備え、
前記ＬＥＤユニットにおいて、複　のＬＥＤが逆直列接　され、各ＬＥＤにインダクタが並列接　されたことを特　とするＬＥＤ点灯装置。
【発明の詳細な　明】
【０００１】
【発明の属する技術分野】
この発明は、ＬＥＤ点灯装置及び照明装置に関するものである。
【０００２】
【　　の技術】
相　的に演色性が良好でかつ短寿命の第１の光源と、相　的に演色性が　く長寿命の第２の光源とを備え、第１の光源の寿命を長くする寿命延長手段（センサー装置）を設け、相　的に演色性が良好でかつ短寿命の第１の光源の寿命を寿命延長手段により長くでき、第１の光源と第２の光源の寿命の差をなくすことができるので、第１の光源と第２の光源を　に混合させる場合に比べてランプ交換回　を半分に減らせるようにしている（例えば、特許文献１参照）。
【０００３】
【特許文献１】
特開２００１－８５１６９公報（第６－７頁、　２）
【０００４】
【発明が解決しようとする課題】
　　の照明装置では、第１の光源に白色ＬＥＤ、第２の光源に黄色ＬＥＤを使用し、白色ＬＥＤで調光し、黄色ＬＥＤで一定点灯し、白色ＬＥＤのみを寿命末期に交換するようにすることができるが、黄色ＬＥＤを調光することができず、白色ＬＥＤと黄色ＬＥＤの両方を調光して照明の演出効果を得ることはできないという問題があった。
【０００５】
また、一般的なＬＥＤ点灯装置は、商用電源を直流化し、制御抵抗により電流を制限して複　のＬＥＤに直流電流を通電し点灯する構成であり、制御抵抗の損失が大きいく、一般照明のようにある程度の出力を要する場合は、制御抵抗の発熱が大きくなる問題があった。
また、一般的なＬＥＤ点灯装置を　　した照明器具は、白熱形電球や直管　光灯のように一般照明として使用するには、まだ、適しないという問題があった。
【０００６】
この発明は、上記の課題を解決するためになされたもので、簡　な構成で、一般照明に適し、また、必要に基づいて白色や有色等の任意の発光色に　化させて照明の演出ができ、しかも、発熱が少ない小型のＬＥＤ点灯装置及び照明器具を得ることを目的とする。
【０００７】
【課題を解決するための手段】
この発明に係るＬＥＤ点灯装置は、第１の発光手段と、前記第１の発光手段と異なる発光色の第２の発光手段と、前記第１、第２の発光手段を制御する制御手段と、を備え、前記制御手段は、全光時に前記第１の発光手段を主点灯手段として点灯し、調光時に前記第２の発光手段を主点灯手段として点灯し、前記第１または第２の発光手段の発光色のいずれか一方を白色とし、前記全光時の明るさ及び発光色と、前記調光時の明るさ及び発光色とを連　的に　化させるものである。
【０００８】
【発明の実施の形態】
実施の形態１・
　１はこの発明の実施形態１を示すＬＥＤ点灯装置の回路　、　２は位相制御式調光器の出力波形　、　３は位相角と各ＬＥＤアレイに流れる電流の関係を示す　、　４はＬＥＤ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1230

点灯装置を　した電球形照明器具の構成　、　５は電流　化をさせた場合の、調光度と発光色との関係を示す　である。

【０００９】

１において、１は商用電源、２は直流電源であり、ダイオードブリッジ３、平滑コンデンサ４及びインピーダンス素子５からなっている。６はインバータ回路であり、スイッチング素子７ａ及び７ｂからなり、ここではスイッチング素子７ａ及び７ｂにＭＯＳＦＥＴを使用している。８は、インバータ回路６を　動する制御回路、９は直流カットコンデンサ、１０はインダクタ、１１は、第１の発光手段である白色ＬＥＤ１１ａの直列回路が逆並列に接　された白色ＬＥＤアレイ、１２は、白色ＬＥＤとは異なる例えば有色の第２の発光手段である電球色ＬＥＤ１２ａの直列回路からなる。電球色ＬＥＤアレイ、１３は制御抵抗である。１４は、商用電源１と直流電源回路２との間に　入され、商用電源１から供給される電力を位相制御して調光させる位相制御式調光器であり、通常は、白熱電球の調光用に一般に用いられるものである。

【００１０】

次に動作について　１～　５により　明する。

商用電源１からの交流電源は、ダイオードブリッジ３によって全波整流され、平滑コンデンサ４によって平滑化され、直流電　源となる。インピーダンス素子５は突入電流抑制用のものであり、インダクタまたは抵抗等が用いられる。

インバータ回路６　で、ＭＯＳＦＥＴ７ａ、７ｂは制御回路８の　動信号によって交互にＯＮ／ＯＦＦし、直流電源回路２の直流出力を高周波に　換する。

インバータ回路６からの高周波電流はインダクタ１０によって制限され、白色ＬＥＤアレイ１１に投入される。　って、白色ＬＥＤアレイ１１において、それぞれの白色ＬＥＤ１１ａは半波整流された高周波電流で点灯されることになる。また、直流電源回路２からの直流出力は、制御抵抗１３によって電流を制限され、電球色ＬＥＤアレイ１２に印加され、電球色ＬＥＤアレイ１２が点灯される。

【００１１】

２は、位相制御式調光器１４によって切られる商用電源１の波形を示すものである。は一例として位相角９０度付近のものを示したが、通常０～１８０度まで制御される。制御回路８は、この位相角に　じた位相制御式調光器１４のい出力により出力周波　を　調　加する制御を行う。出力周波　が上昇した場合、インダクタ１０のインピーダンスが大きくなり、白色ＬＥＤアレイ１１に通電される電流が減少する。　って、位相制御式調光器１４の位相角が　えると白色ＬＥＤアレイ１１は調光され、明るさは暗くなっていくことになる。

また、位相制御式調光器１４の位相角が９０度を超えると、平滑コンデンサ４の電　が下がり、電球色ＬＥＤアレイ１２へ通電される電流が減少することにより、調光され、明るさは暗くなっていくことになる。

【００１２】

３は、上記の、位相角と各ＬＥＤアレイに流れる電流を示すものであり、白色ＬＥＤアレイ１１に流れる実効電流をｉｗ１、電球色ＬＥＤアレイ１２に流れる平均電流をｉｙ１とする。上記のように、ｉｗ１は位相各に　して　調減少し、ｉｙ２は位相角９０～１８０度において　調減少する。なお、　３は調光度と電流の関係も示しており、調光する（暗くする）場合、ｉｗ１は位相各に　して　調減少し、ｉｙ２は位相角９０～１８０度において　調減少する。

【００１３】

次に、　１に示したＬＥＤ点灯装置を電球形照明器具に　　した場合の例を　４により　明する。　において、１５ａはプラスチックなどからなる筐体、１５ｂは、すりガラス、プラスチックなどからなる筐体、１６は口金であり、筐体１５ａ　部にはＬＥＤ点灯装置が　されている。

白色ＬＥＤ１１ａと、電球色ＬＥＤ１２ａとを互い違いに均等に配置することにより、グローブ１５ｂを介して得られる発光色は、白色ＬＥＤ１１と電球色ＬＥＤ１２をそれぞれ

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1231

の明るさを平均化したものとなる。

【００１４】

このような構成において、　３のような電流　化をさせた場合の、調光度と発光色との関係は　５に示すように、調光度が明るい白色、調光する（暗くする）と電球色となる。

【００１５】

以上のように、第１の発光手段と、第１の発光手段と異なる発光色の第２の発光手段と、第１、第２の発光手段を制御する制御手段と、を備え、制御手段は、全光時に第１の発光手段を主点灯手段として点灯し、調光時に第２の発光手段を主点灯手段として点灯し、第１または第２の発光手段の発光色のいずれか一方を白色とし、全光時の明るさ及び発光色と、調光時の明るさ及び発光色とを連　的に　化させるので、簡　な構成により、一般照明に適し、また、必要に基づいて白色や有色等の任意の発光色に　化させて明るいときは白色で、暗いときは電球色としてくつろぎ感を与える等の演出ができ、しかも、発熱が少ない小型のＬＥＤ点灯装置を得ることができる。

【００１６】

また、商用電源を直流に　換する直流電源回路と、直流を高周波に　換するインバータ回路と、商用電源と直流電源回路との間に　入された位相制御式調光器の出力に基づいてインバータ回路の　動周波　を制御する制御回路と、インバータ回路の出力電流を制限する第１のインダクタと、この第１のインダクタに直列接　された直流カットコンデンサと、第１のインダクタと直流カットコンデンサの直列回路に接　され、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイと、アノード側を高電位側にして直流電源回路に接　され、有色ＬＥＤが直列接　された有色ＬＥＤアレイと、を備えたので、白熱電球に一般に使用される位相制御式調光器等を用いた簡　な構成により、一般照明に適し、また、必要に基づいて白色や有色等の任意の発光色に　化させて明るいときは白色で、暗いときは電球色としてくつろぎ感を与える等の演出ができ、しかも、発熱が少ない小型のＬＥＤ点灯装置を得ることができる。

【００１７】

また、実施の形態１のＬＥＤ点灯装置を、口金を有する白熱電球とほぼ同じ外　の筐体に一体に装着するとともに、白色ＬＥＤ及び有色ＬＥＤを互い違いに均等に配設したので、白熱電球代替品として、明るいときは白色で、暗いときは電球色とすることができ、また、白色ＬＥＤと電球色ＬＥＤをそれぞれの明るさを平均化したものとできる電球形照明器具を構成することができる。

【００１８】

なお、　６に示すように、インバータ回路６からの出力をダイオードブリッジ１７で全波整流し、白色ＬＥＤ１１ａを、高電位側をアノードとして直列接　する構成として効率を向上させても良い。

【００１９】

実施の形態２・

実施形態１においては、位相制御式調光器に　　するものを示したが、本実施形態においては、直流電源が確保され、調光信号が別途入力されるタイプの調光器具に適用する場合のものを示す。

　７はこの発明の実施形態２を示すＬＥＤ点灯装置の回路　、　８は調光度と各ＬＥＤアレイに流れる電流の関係を示す　である。

　１において、６～１２ａは実施形態１のものと、構成、動作とも同　であるので　明を省略する。１８は直流電源、１９はＬＥＤユニット、２０はインダクタ、２１は、白色ＬＥＤ１１ａが逆並列に接　された白色ＬＥＤアレイ、２２はコンデンサ、２３は、電球色ＬＥＤ１２ａが逆並列に接　された電球色ＬＥＤアレイ、２４は外部信号であり、本実施形態では調光信号を示すものとする。なお、リモコン等の外部信号２４により、暗くする場合、制御回路８の出力周波　を上昇させるものである。

【００２０】

次に動作について　８により　明する。　８は　７における調光度と各ＬＥＤアレイに流

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1232

れる電流の関係を示すしている。
インバータ回路６から出力される高周波電流の実効　をｉｏ、点灯周波　ｆに　する角周波　をω、インダクタ１０のインダクタンスをＬ１０、インダクタ２０のインダクタンスをＬ２０、コンデンサ２２の容量をＣ２２、インダクタ２０に流れる電流の実効　をｉｗ２、コンデンサ２２に流れる電流の実効　をｉｙ２、とすると、ｉｗ２、ｉｙ２、ｉｏは各々次の式（１）～（３）で表される。

【００２１】
【　１】

$$iw2 = io \times \frac{\dfrac{1}{\omega C22}}{\omega L20 + \dfrac{1}{\omega C22}} \qquad (1)$$

【００２２】
【　２】

$$iy2 = io \times \frac{\omega L20}{\omega L20 + \dfrac{1}{\omega C22}} \qquad (2)$$

【００２３】
【　３】

$$io \propto \frac{1}{\omega L10} \qquad (3)$$

【００２４】
調光する（暗くする）場合、ωが上昇することから、　８に示すようにｉｏ及びｉｗ２は　調に減少し、ｉｙ２は　調に　加する。
【００２５】
また、　７に示したＬＥＤ点灯装置を、例えば、実施の形態１の　４に示す電球形照明器具に　し、各ＬＥＤの配置を、白色ＬＥＤ１１ａと、電球色ＬＥＤ１２ａとを互い違いに均等に配置することにより、グローブ１５ｂを介して得られる発光色は、白色ＬＥＤ１１と電球色ＬＥＤ１２をそれぞれの明るさを平均化することができる。
【００２６】
以上のように、第１の白色の発光手段と、第１の発光手段と異なる発光色の第２の発光手段と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいて第１、第２の発光手段の出力を調整する制御手段と、を備え、制御手段は、全光時は第１の発光手段の出力を第２の発光手段の出力より大きくし、調光度に基づいて第１の発光手段の出力を　調減少させるとともに、第２の発光手段の出力を、所定の調光度以下で　調減少させるので、調光する際、全体の明るさを落としつつ、平均化した発光色を白色から有色に　化させることができる。
【００２７】
また、第１の白色の発光手段と、前記第１の発光手段と異なる発光色の第２の発光手段と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいて前記第１、第２の発光手段の出力を調整する制御手段と、を備え、前記制御手段は、前

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1233

記第１の発光手段の出力と前記第２の発光手段の合計出力を調光度に基づいて　調減少させるときに、調光度に基づいて前記第１の発光手段の出力を　調減少させ、前記第２の発光手段の出力を　調　加させるので、、調光する際、全体の明るさを落としつつ、平均化した発光色を白色から有色に　化させることができる。

【００２８】

また、直流電源回路と、直流を高周波に　換するインバータ回路と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいてインバータ回路の動周波　を制御する制御回路と、インバータ回路の出力電流を制限する第１のインダクタと、第１のインダクタに直列接　された直流カットコンデンサと、第１のインダクタと直流カットコンデンサの直列回路に接　されたＬＥＤユニットと、を備え、ＬＥＤユニットは、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイと第２のインダクタとの直列回路と、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイと第１のコンデンサとの直列回路とが、互いに並列接　されたので、調光する際、全体の明るさを落としつつ、平均化した発光色を白色から電球色に　化させることができる。

【００２９】

また、実施の形態２のＬＥＤ点灯装置を口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、白色ＬＥＤ及び有色ＬＥＤを互い違いに均等に配設したので、白熱電球代替品として、調光する際、全体の明るさを落としつつ、平均化した発光色を白色から電球色に　化させることができる電球形照明器具を構成することができる。

【００３０】

実施の形態３・

実施形態１及び２においては、固定の直流出力　を持つ直流電源とインバータ回路を用いてＬＥＤ点灯回路を構成したものを示したが、本実施形態では、直流電源にダウンコンバータを用いた場合の実施形態を示す。

９は、この発明の実施形態３を示すＬＥＤ点灯装置の回路　、　１０は直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　、　１１は各ＬＥＤの平均電流と調光度の関係を示す　である。

【００３１】

９において、１、３、１１ａ、１２ａは、実施形態１の　１、２４は実施形態２の　７のものと構成　動作とも同　であるので　明を省略する。２５は、ダイオードブリッジ３、トランス２６、スイッチング素子２７、ダイオード２８及び平滑コンデンサ２９からなる直流電源回路、３０は、白色ＬＥＤ１１ａからなる白色ＬＥＤアレイ、3,1は、電球色ＬＥＤアレイ１２ａからなる電球色ＬＥＤアレイ、３２はスイッチング素子、３３は抵抗、３４はスイッチング素子２７及び３２を制御する制御回路である。

【００３２】

次に動作について　９～１１により　明する。

商用電源１は、ダイオードブリッジ３で全波整流され、トランス２６の１次側を介して、スイッチング素子２７でチョッピングされる。トランス２６の２次側に伝達された電力は、ダイオード２８で整流され、平滑コンデンサ２９で平滑化されることにより直流電源を構成する。ここで、スイッチング素子２７がチョッピングする際のｏｎ幅によってトランス２６の２次側に伝達される電力が決まり、ｏｎ幅がｏｆｆ幅に比べて広いほど伝達される電力及び直流電源回路２５の出力電　は大きくなる。なお、本実施形態においては、トランス２６の　き　に関して２次側を１次側より少なくし、直流電源回路２５がダウンコンバータとなるようにしている。

【００３３】

白色ＬＥＤアレイ３０は、スイッチング素子３２のｏｎ期間のみ電流が流れ、時間　りの平均電流により明るさが決まる。なお、スイッチング素子３２のスイッチング周波　は、そのスイッチングが視　的に認識できないほど高い周波　となるように定める。電球色ＬＥＤアレイ３１は抵抗３３によって電流を制限され、直流電源回路２５の出力に比例した明るさを出力する。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1234

【００３４】
制御回路３４は、　１０に示すように調光度が深くなるにつれ（暗くなるにつれ）、スイッチング素子２７及び３２のｏｎ－ｄｕｔｙを小さくするように制御し、直流電源回路２５の電　を減少させ、白色ＬＥＤアレイ３０に流れる電流を減少させる。
【００３５】
　１１は、このときの白色ＬＥＤアレイ３０に流れる平均電流をｉｗ３、電球色ＬＥＤアレイ３１に流れる平均電流をｉｙ３とした場合の、調光度に　する各平均電流を示すものであり、調光度を深くすると白色ＬＥＤアレイ３０に流れる平均電流ｉｗ３、電球色ＬＥＤアレイ３１に流れる平均電流ｉｙ３の双方が減少するが、制御回路３４は、最も深い調光度の付近でのは、電球色ＬＥＤアレイ３１の平均電流が白色ＬＥＤアレイ３０の平均電流よりも大きくなるようにスイッチング素子３２のｏｎ－ｄｕｔｙを制御する。
【００３６】
また、　９に示したＬＥＤ点灯装置を、例えば、実施の形態１の　４に示す電球形照明器具に　し、各ＬＥＤの配置を、白色ＬＥＤ１１ａと、電球色ＬＥＤ１２ａとを互い違いに均等に配置することにより、グローブ１５ｂを介して得られる発光色は、白色ＬＥＤ１１と電球色ＬＥＤ１２をそれぞれの明るさを平均化しすることができる。
【００３７】
以上のように、第１の白色の発光手段と、第１の発光手段と異なる発光色の第２の発光手段と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいて第１、第２の発光手段の出力を調整する制御手段と、を備え、制御手段は、全光時は第１の発光手段の出力を第２の発光手段の出力より大きくし、調光度に基づいて第１及び第２の発光手段の出力を　調減少させるとともに、調光時は第１の発光手段の出力を第２の発光手段の出力より小さくしたので、調光する際、調光度の　い（明るい）場合はほぼ白色で、調光度の深い（暗い）場合はほぼ電球色と　化させることができる。
【００３８】
また、直流電源回路と、アノード側を高電位側にして直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及びスイッチング素子との直列回路と、アノード側を高電位側にして直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び抵抗との直列回路と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいて直流電源回路の出力及びスイッチング素子のｏｎ－ｄｕｔｙを制御する制御回路と、を備え、制御回路は、調光度が深くなるにつれて直流電源回路の出力を　調減少させ、かつ、スイッチング素子のｏｎ－ｄｕｔｙを　調減少させるので、調光する際、調光度の　い（明るい）場合はほぼ白色で、調光度の深い（暗い）場合はほぼ電球色と　化させることができる。
【００３９】
また、実施の形態３のＬＥＤ点灯装置を口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、白色ＬＥＤ及び有色ＬＥＤを互い違いに均等に配設したので、調光する際、調光度の　い（明るい）場合はほぼ白色で、調光度の深い（暗い）場合はほぼ電球色と　化させることができる電球形照明器具を構成することができる。
【００４０】
なお、本実施の形態ではスイッチング素子２７と３２の制御を　立的に行うものとしたが、明るさの設定などから可能であれば、両者を共通の信号で　動してもよい。
【００４１】
実施の形態４・
実施形態３においては、白色ＬＥＤアレイ３０への電流を能動的に、電球色ＬＥＤアレイ３１への電流を受動的に制御したが、本実施形態においては、両者を能動的に制御するものを示す。
　１２は、この発明の実施形態４を示すＬＥＤ点灯装置の回路　、　１３は直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　、　１４は各ＬＥＤの平均電流と調光度の関係を示す　である。

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1235

１２において、１～３４は実施形態３のものと構成　動作とも同　であるので　明を省略する。３５は電球色ＬＥＤアレイ３１に接　されたスイッチング素子３６は反転素子である。

【００４２】

次に動作について　明する。

反転素子３６により、スイッチング素子３２と３５とはｏｎとｏｆｆが反転するように構成される。　って、　１３に示すように、調光度に基づいて、直流電源回路２５の出力電　を下げ、かつ、スイッチング素子３２のｏｎ－ｄｕｔｙが小さくなるように、スイッチング素子３５のｏｎ－ｄｕｔｙが大きくなるように制御する。

１４は、このときの白色ＬＥＤアレイ３０に流れる平均電流ｉｗ４と、電球色ＬＥＤアレイ３１に流れる平均電流ｉｙ４とした場合の調光度に　する各平均電流を示すものであり、調光度を深くすると白色ＬＥＤアレイ３０に流れる平均電流ｉｗ４は減少し、電球色ＬＥＤアレイ３１に流れる平均電流ｉｙ４は　加し、最も深い調光度の付近でのは、電球色ＬＥＤアレイ３１の平均電流ｉｙ４が白色ＬＥＤアレイ３０の平均電流ｉｗ４よりも大きくなる。

【００４３】

また、　１２に示したＬＥＤ点灯装置を、例えば、実施の形態１の　４に示す電球形照明器具に　　し、各ＬＥＤの配置を、白色ＬＥＤ１１ａと、電球色ＬＥＤ１２ａとを互い違いに均等に配置することにより、グローブ１５ｂを介して得られる発光色は、白色ＬＥＤ１１と電球色ＬＥＤ１２をそれぞれの明るさを平均化したものとすることができる。

【００４４】

以上のように、直流電源回路と、アノード側を高電位側にして直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及び第１のスイッチング素子との直列回路と、アノード側を高電位側にして直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び第２のスイッチング素子との直列回路と、調光度を定める調光信号を出力する調光手段と、この調光手段からの調光信号に基づいて直流電源回路の出力と第、第２のスイッチング素子とを制御する制御回路と、を備え、制御回路は、調光度が深くなるにつれて直流電源回路の出力を　調減少させ、かつ、第１のスイッチング素子のｏｎ－ｄｕｔｙに　する第２のスイッチング素子のｏｎ－ｄｕｔｙを相　的に　調　加させるので、白色光と有色光とのコントラストをより強め、調光度の　い（明るい）場合は白色で、調光度の深い（暗い）場合は電球色とすることができる。

【００４５】

また、実施の形態３のＬＥＤ点灯装置を口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、白色ＬＥＤ及び有色ＬＥＤを互い違いに均等に配設したので、調光する際、白色光と有色光とのコントラストをより強め、調光度の　い（明るい）場合はほぼ白色で、調光度の深い（暗い）場合はほぼ電球色と　化させることができる電球形照明器具を構成することができる。

【００４６】

なお、本実施形態においては、スイッチング素子３２と３５の出力を反転させて両者のｏｎ－ｄｕｔｙの合計が１００％になるようにしたが、両者のｏｎ－ｄｕｔｙを　立的に制御し、例えば　１５に示すように、スイッチング素子３２と３５の　動信号を　立させてもよい。

【００４７】

実施の形態５・

実施形態２及び４では、外部からの調光信号に基づいて調光及び発光色調整を行うものであるが、本実施形態においては、照明器具本体に取り付けられたスイッチにより、明るさは一定のまま白色、電球色またはその中間色の選　を行えるようにしたものを示す。

１６は実施の形態５を示す電球形照明器具の構成　、　１７は直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　、　１８は各ＬＥＤの平均電流とスイッチ位置（調光度）の関係を示す　である。　１６において、１１ａ、１２ａ、１５ｂ及び１６は実

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1236

施形態１における　４と構成　動作とも同　であるので　明を省略する。３７は、筐体１５ａに取り付けられた切換手段である摺動スイッチである。
この摺動スイッチ３７の位置は　１６のＡとＢ間を滑らかに動くものでも、段階的に動くものでもよい。

【００４８】

本実施形態の回路構成は、実施形態４における　１２と同　であり、　１２のＬＥＤ点灯装置が　１６の電球形照明器具に　されているが、制御回路３４におけるスイッチング素子２７の制御が異なる。また、本実施形態において外部信号２４は、本実施形態においては摺動スイッチ３７によって生成される信号を意味する。

【００４９】

次に動作を　１２、　１７、１８により　明する。
制御回路３４は、　１７に示すように、直流電源回路２５の出力電　が一定になるようにスイッチング素子２７を制御する。すなわち、外部信号２４からの信号にかかわらずスイッチング素子２７の平均ｏｎ－ｄｕｔｙを一定に保ち、摺動スイッチ３７の位置によってスイッチング素子３２のｏｎ－ｄｕｔｙを決定するものである。　１７では摺動スイッチ３７の位置がＡからＢに移動させると、スイッチング素子３２のｏｎ－ｄｕｔｙが小さくなり、スイッチング素子３５のｏｎ－ｄｕｔｙが大きくなる。

【００５０】

　１８は、このときの白色ＬＥＤアレイ３０に流れる平均電流ｉｗ５と、電球色ＬＥＤアレイ３１に流れる平均電流ｉｙ５とした場合のスイッチ位置（調光度）に　する各平均電流を示すものであり、摺動スイッチ３７の位置をＢ方向に移動する（調光度を深くする）と白色ＬＥＤアレイ３０に流れる平均電流ｉｗ５は減少し、電球色ＬＥＤアレイ３１に流れる平均電流ｉｙ５は　加し、Ｂ付近（最も深い調光度の付近）では、電球色ＬＥＤアレイ３１の平均電流ｉｙ４が白色ＬＥＤアレイ３０の平均電流ｉｗ４よりも大きくなる。
すなわち、摺動スイッチ３７の位置がＡのときは、白色、Ｂのときは電球色となる。

【００５１】

以上のように、白色ＬＥＤからなる白色ＬＥＤアレイ及び有色ＬＥＤからなる有色ＬＥＤアレイを点灯する点灯手段と、白色ＬＥＤアレイ及び有色ＬＥＤアレイの合計の出力を一定に保つ制御回路と、白色ＬＥＤ及び有色ＬＥＤの出力比を段階的または連　的に切換える切換手段と、を備え、制御回路は切換手段からの信号に基づいて出力比を　化させるので、明るさ一定のまま白色から有色までの発光色を任意に選　することができる。

【００５２】

また、直流電源回路と、アノード側を高電位側にして直流電源回路に接　された白色ＬＥＤからなる白色ＬＥＤアレイ及び第１のスイッチング素子との直列回路と、アノード側を高電位側にして直流電源回路に接　された有色ＬＥＤからなる有色ＬＥＤアレイ及び第２のスイッチング素子との直列回路と、第１、第２のスイッチング素子のｏｎ－ｄｕｔｙの合計を一定にする制御回路と、白色ＬＥＤ及び有色ＬＥＤの出力比を段階的または連　的に切換える切換手段と、を備え、制御回路は切換手段からの信号に基づいて第１、第２のスイッチング素子のｏｎ－ｄｕｔｙの比を　化させるので、明るさ一定のまま白色から電球色までの発光色を任意に選　することができる。

【００５３】

また、実施の形態２～４のＬＥＤ点灯装置を、口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、切換手段をスイッチとして筐体に設けたので、明るさ一定のまま白色から電球色までの発光色を任意に選　できる電球形器具を構成することができる。

【００５４】

なお、本実施形態においては、スイッチング素子３２と３５の出力を反転させて両者のｏｎ－ｄｕｔｙの合計が１００％になるようにしたが、両者のｏｎ－ｄｕｔｙの合計を一定にして白色ＬＥＤアレイ３０と電球色ＬＥＤアレイ３１の出力の合計が一定になるように制御する場合は、例えば　１５に示すように、スイッチング素子３２と３５の　動信号を

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1237

立させてもよい。
さらに、本実施形態においては、摺動スイッチで発光色を切り換える例を示したが、リモコン信号やプルスイッチなどにより切り換える構成としてもよい。
【００５５】
なお、実施の形態１で示した位相制御式調光器１４を摺動スイッチ３７として、４の筐体１５ａに取付けることもできる。
【００５６】
実施の形態６・
実施形態１～５は、白熱電球代替を狙いとするものであるが、本実施形態においては、直管　光灯代替を狙いとするものを示す。
１９は実施の形態６を示す直管　光灯形の照明器具の構成　、　２０は　光灯点灯装置に装着された　態の直管　光灯形の照明器具の構成　である。
１９において、１１ａ、１２ａ及び１９～２３は実施形態２における　７のものと構成　動作とも同　であるので　明を省略する。３８は市販の　光灯とほぼ同じ大きさで半透明の材質からなる筐体、３９は　７における同　のユニット１９が実装された点灯回路基板、４１ａ及び４１ｂは、市販の　光灯と同じ取り付け位置及びサイズの端子４０ａ～４０ｄ取り付けられた口金である。
【００５７】
２０に示すように、　１９の直管　光灯形の照明器具は一般の　光灯用電子安定器に接　して使用されるものであり、端子４０ａ～４０ｄによって電子安定器４２に接　される。一般の　光灯用電子安定器は電力供給部４３と始動回路４４からなり、電力供給部４３は高周波電力を供給し、始動回路４４はコンデンサ４４ａで構成される。
なお、点灯中に始動回路４４側にも電流が流れるが、こように接　された場合の動作は実施形態２における　７の回路とほぼ同　である。
また、白色ＬＥＤ１１ａと電球色ＬＥＤ１２ａとを均等に分散して配置することにより、筐体３８を介して両者の平均発光色を得ることができる。
【００５８】
以上のように、直管　光灯用器具に装着可能な端子付きの口金を両端に有する筐体と、両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、ＬＥＤユニットは、ＬＥＤが互いに逆並列接　されたＬＥＤアレイからなるので、市販の　光灯の代替として、調光及び発光色可　の直管　光灯形の照明器具を構成することができる。
【００５９】
また、直管　光灯用器具に装着可能な端子付き口金を両端に有する筐体と、両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、ＬＥＤユニットは、白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイとインダクタとの直列回路と、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイとコンデンサとの直列回路とが、互いに並列接　されたので、市販の　光灯の代替として、調光及び発光色可　の直管　光灯形の照明器具を構成することができる。
【００６０】
実施の形態７・
実施の形態６においては、ＬＥＤユニット１９の　部に電球色ＬＥＤ１２ａの電流調整用のコンデンサ２２を　したが、本実施形態においては、ＬＥＤユニット１９を構成するコンデンサ２２と始動回路４４を構成するコンデンサ４４ａとを共用化する構成のものを示す。
２１は実施の形態７を示す　光灯点灯装置に装着された　態の直管　光灯形の照明器具の構成　、　２２は０直管　光灯形の照明器具の口金部の　明　である。
【００６１】
２１において、符号は実施の形態６の　２０のものと同　であるが、ＬＥＤユニット１９　部の配線が異なる。　２１においては、端子４０ａ、４０ｂ間に電球色ＬＥＤユニット２３を接　するものである。このように接　された場合、電球色ＬＥＤ１２ａを流れる

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1238

電流は、端子４０ａ→電球色ＬＥＤユニット２３→端子４０ｂ→コンデンサ４４ａ→端子４４ｄ→端子４４ｃ　の　路で流れることにより、　７に示した回路とほぼ同　の動作を得ることができる。

【００６２】

また、照明器具　の配線の関係上、端子４０ａと４０ｂの位置を逆転しなければ　２１のように接　できない場合のために、　２２（ａ）、（ｂ）に示すように、口金４１ａまたは４１ｂが１８０度回転できるようにしてもよい。

【００６３】

以上のように、直管　光灯用器具本体に装着可能な端子付き口金を両端に有する筐体と、両端の口金上の端子間に設けられたＬＥＤユニットと、を備え、ＬＥＤユニットは、一方の口金上の第１の端子と他方の口金上の第１の端子間に、インダクタ及び白色ＬＥＤが互いに逆並列接　された白色ＬＥＤアレイとが直列接　され、他方の口金上の第１の端子と第２の端子とが短絡され、一方の口金上の第１の端子と第２の端子間に、有色ＬＥＤが互いに逆並列接　された有色ＬＥＤアレイが接　されたので、部品点　を減らすことができる。

【００６４】

また、口金の少なくとも一方が、１８０度回転可能なので、既存の器具　配線の結線にかかわらず、取り付けが可能となる。

【００６５】

実施の形態８・

実施形態１～７においては、ＬＥＤ照明器具の基本回路構成を示したが、本実施形態については、高周波部において　線したＬＥＤを迂回する回路を接　した場合を示す。

２３は、実施形態８を示すＬＥＤ点灯装置の回路　である。　において、６～１８は実施形態２の　７と構成、動作とも同　であるので　明を省略する。　において、４５はＬＥＤアレイ、４６はＬＥＤ、４７はバイパスインダクタであり、ＬＥＤアレイ４５を構成する各ＬＥＤに並列接　される。バイパスインダクタ４７は、ＬＥＤ４６の電　降下よりも常にインピーダンスが高くなるようなものとし、また、インダクタ１０よりも十分小さいインダクタンスのものとする。

【００６６】

次に動作について　２３により　明する。

ＬＥＤ４６の全てが健在である場合、バイパスコンデンサ４７に電流は流れない。ここで、ＬＥＤ４６の一部が　線した場合、電流は　線した部分のみバイパスインダクタ４７に流れ、他のＬＥＤ４６はそのまま点灯される。バイパスインダクタ４７は、インダクタ１０よりも十分インダクタンスが小さいことから、ＬＥＤ４６の一部が　線してもＬＥＤアレイ４５に投入される電流に大きな　化は生じない。

また、一般にＬＥＤは　線破　するが、まれに短絡破　する場合もある。しかし、ＬＥＤ４６の一部が短絡破　した場合も、動作上大きな　化は生じない。

【００６７】

２４は、　２３の　形例である。各ＬＥＤ４６を逆並列に接　し、バイパスインダクタ４７をそれぞれに並列接　するものである。ここで、バイパスインダクタ４７のインダクタンスの設定は　２３のものと同　であり、ＬＥＤ４６の一部が　線した場合の動作も、２３のものと同　である。

２４においては、バイパスインダクタ４７の接　　が　２３のものに比べて半分で　む点で有利であるが、ＬＥＤ４６の一部が短絡破　した場合、　になっているＬＥＤ４６も不点灯になってしまう点で不利である。

【００６８】

２５は、インバータ回路６に保護回路を付加する場合を示す。　において４８は、ＬＥＤアレイ４５の電　を　出する電　　出回路である。

２３または　２４において、ＬＥＤ４６の多くが　線した場合、ＬＥＤアレイ４５の電　が上昇することにより、インバータ回路６が進相　態となり、故障の原因となる場合が

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1239

ある。
そこで、ＬＥＤアレイ４５の電　が所定　を超えた場合、制御回路８において　線多　と判　し、インバータ回路６の　動を停止するものである。
【００６９】
以上のように、直流電源回路と、直流を高周波に　換するインバータ回路と、インバータ回路を　動する制御回路と、インバータ回路の出力電流を制限する第１のインダクタと、第１のインダクタに直列接　された直流カットコンデンサと、第１のインダクタと直流カットコンデンサの直列回路に直列接　されるＬＥＤユニットと、を備え、ＬＥＤユニットにおいて、ＬＥＤアレイが互いに逆並列接　され、ＬＥＤアレイを構成する各ＬＥＤにして、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したので、ＬＥＤアレイを構成するＬＥＤの一部が　線または短絡破　しても、他のＬＥＤをそのまま点灯することができる。
【００７０】
また、直流電源回路と、直流を高周波に　換するインバータ回路と、インバータ回路を動する制御回路と、インバータ回路の出力電流を制限する第１のインダクタと、第１のインダクタに直列接　された直流カットコンデンサと、
第１のインダクタと直流カットコンデンサの直列回路に直列接　されるＬＥＤユニットと、を備え、ＬＥＤユニットにおいて、一　の互いに逆並列接　されたＬＥＤが複　直列接　され、それぞれの　に　して、第１のインダクタに比べて十分小さいインダクタンスのインダクタを並列接　したので、ＬＥＤアレイを構成するＬＥＤの一部が　線または短絡破　しても、他のＬＥＤをそのまま点灯することができる。
【００７１】
また、ＬＥＤユニットの両端の電　を　出する電　　出回路を備え、　出された電　が所定　を超えた場合にインバータ回路を停止するので、ＬＥＤが多　　線した場合にインバータ回路の動作不良による故障を回避することができる。
【００７２】
実施の形態９・
実施形態８においては、電流制限用のインダクタと、バイパスインダクタを個別に設けたが、本実施形態においては、両者を兼ねる構成のものを示す。
　２６は、実施形態９を示すＬＥＤ点灯装置の回路　である。
　において６～４５は構成、動作とも実施形態８の　２３と同　であるので　明を省略する。　において、４９ａ及び４９ｂは、兼用インダクタであり、兼用インダクタ４９ａ、４９ｂの個々のインダクタンスをＬａ、Ｌｂとし、実施形態１におけるインダクタ１０のインダクタンスをＬ１０とすると、Ｌ１０＝ΣＬａ＝ΣＬｂとなるようにＬａ及びＬｂを設定すいる。
【００７３】
次に動作について　２６により　明する。
ＬＥＤ４６が健在の場合、インバータ回路６の出力電流は、　中の方向Ｃに電流が流れる場合は、インバータ回路６→直流カットコンデンサ９→ＬＥＤ４６→兼用インダクタ４９ｂ→グランド（　路１）、方向Ｄの場合は、グランド→ＬＥＤ４６→兼用インダクタ４９ａ→直流カットコンデンサ９→インバータ回路６（　路２）に流れる。
　って、例えば、　路１の場合、インバータ回路６からの高周波電流は兼用インダクタ４９ｂによって制限され、ＬＥＤ４６は半波整流された高周波電流で点灯されることになる。　路２の場合も　路１と同　である。
このとき、ＬＥＤ４６の一部が　線した場合、そのＬＥＤに並列接　された兼用インダクタ４９ａに電流が流れ、　線したＬＥＤを迂回する構成となる。
【００７４】
以上のように、直流電源回路と、直流を高周波に　換するインバータ回路と、インバータ回路を　動する制御回路と、インバータ回路の出力点に接　された直流カットコンデンサとＬＥＤユニットとの直列回路と、を備え、ＬＥＤユニットにおいて、複　のＬＥＤが逆

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1240

直列接　され、各ＬＥＤにインダクタが並列接　されたので、ＬＥＤアレイを構成するＬＥＤが　線または短絡しても、他のＬＥＤを正常に点灯　することができるとともに、電流制限用のインダクタとＬＥＤ　線時の迂回用のインダクタとを兼ね、より少ない部品点　で構成することができる。

【００７５】

なお、本実施の形態では、ＬＥＤアレイ４５について示したが、実施の形態２の　７に示した白色ＬＥＤと有色ＬＥＤの構成にも適用できる。

【００７６】

実施の形態１０・

実施形態１～７においては、調光度に　する発光色の制御を適切にする例を示したが、本実施形態においては、発光色に　する配光を適切にするものである。

２７は、実施形態１０を示す電球形照明器具の構成　、　２８、２９は　２７の電球形照明器具を使用したときの配光　態を示す　である。

【００７７】

１において符号は実施形態１における　４のものと同　であるが、白色ＬＥＤ１１ａと電球色ＬＥＤ１２ａの配置が異なる。白色ＬＥＤ１１ａは器具下面を主に照らすように配置され、電球色ＬＥＤ１２ａは器具側面から上面を主に照らすように配置されている。

【００７８】

２８は、　２７の電球形照明器具を使用し、白色ＬＥＤ１１ａ及び電球色ＬＥＤ１２ａに同じ電力を供給し、双方とも同じ明るさで点灯させた場合の使用例を示すものである。

において５０は、　２７で示した電球形照明器具、５１は部屋である。各色ＬＥＤの配列により、部屋の床方向は白色で照らし、壁及び天井方向は電球色で照らすことができる。

また、実施形態１～５に示すようなＬＥＤ点灯回路を　することにより、　２９（ａ）、（ｂ）に示すように、全光時は床面方向を白色で、調光時は壁から天井を電球色で照らすことができる。

【００７９】

以上により、実施の形態１～７記載のＬＥＤ点灯装置を、口金を有する白熱電球とほぼ同じ外　の筐体　に一体に装着するとともに、第１の発光手段または白色ＬＥＤが床面方向を照射し、第２の発光手段または有色ＬＥＤが壁面または天井方向を照射するように配設したので、床面方向の演色性を向上し、かつ、壁及び天井方向のくつろぎ感を演出することができる。

【００８０】

なお、実施形態１～７及び１０において、白色ＬＥＤに　する有色ＬＥＤとして電球色のものを用いたが、黄色やオレンジ色等他の発光色のＬＥＤを用いてもよく、くつろぎ感を演出することができる。

【００８１】

また、実施形態１～５及び１０においては、照明器具の外　を白熱電球と同形　としたが、例えば　３０に示すような半球形のもととしてもよい。

さらに、電球色の発光手段として電球色のＬＥＤを用いたが、実装スペース、消費電力、コスト等によっては、豆電球のようなフィラメントタイプの発光体を用いてもよい。

【００８２】

また、実施形態１～８及び１０において、主に住宅用照明を考慮し、白色ＬＥＤと電球色ＬＥＤを用いて実施形態を構成したが、他の用途に用いる場合は他の発光色を有するＬＥＤの組み合わせを用いてもよい。

【００８３】

【発明の効果】

以上のように、この発明によれば、第１の発光手段と、前記第１の発光手段と異なる発光色の第２の発光手段と、前記第１、第２の発光手段を制御する制御手段と、を備え、前記制御手段は、全光時に前記第１の発光手段を主点灯手段として点灯し、調光時に前記第２

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1241

の発光手段を主点灯手段として点灯し、前記第１または第２の発光手段の発光色のいずれか一方を白色とし、前記全光時の明るさ及び発光色と、前記調光時の明るさ及び発光色とを連　的に　化させたので、簡　な構成で、一般照明に適し、また、必要に基づいて白色や有色等の任意の発光色に　化させて照明の演出ができ、しかも、発熱が少ない小型のＬＥＤ点灯装置を得ることができる。

【　面の簡　な　明】

【　１】この発明の実施形態１を示すＬＥＤ点灯装置の回路　である。

【　２】この発明の実施形態１を示すＬＥＤ点灯装置の位相制御式調光器の出力波形　である。

【　３】この発明の実施形態１を示すＬＥＤ点灯装置の位相制御式調光器の位相角と各ＬＥＤアレイに流れる電流の関係を示す　である。

【　４】この発明の実施形態１を示すＬＥＤ点灯装置を　　した電球形照明器具の構成　である。

【　５】この発明の実施形態１を示すＬＥＤ点灯装置の電流　化をさせた場合の、調光度と発光色との関係を示す　である。

【　６】この発明の実施形態１を示すＬＥＤ点灯装置の回路　である。

【　７】この発明の実施形態２を示すＬＥＤ点灯装置の回路　である。

【　８】この発明の実施形態２を示すＬＥＤ点灯装置の調光度と各ＬＥＤアレイに流れる電流の関係を示す　である。

【　９】この発明の実施形態３を示すＬＥＤ点灯装置の回路　である。

【　１０】この発明の実施形態３を示すＬＥＤ点灯装置の直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　である。

【　１１】この発明の実施形態３を示すＬＥＤ点灯装置の各ＬＥＤの平均電流と調光度の関係を示す　である。

【　１２】この発明の実施形態４を示すＬＥＤ点灯装置の回路　である。

【　１３】この発明の実施形態４を示すＬＥＤ点灯装置の直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　である。

【　１４】この発明の実施形態４を示すＬＥＤ点灯装置の各ＬＥＤの平均電流と調光度の関係を示す　である。

【　１５】この発明の実施形態４を示すＬＥＤ点灯装置の回路　である。

【　１６】この発明の実施の形態５を示す電球形照明器具の構成　である。

【　１７】この発明の実施の形態５を示す電球形照明器具の直流電源の出力電　とスイッチング素子のｏｎ－ｄｕｔｙを示　である。

【　１８】この発明の実施の形態５を示す電球形照明器具の各ＬＥＤの平均電流とスイッチ位置（調光度）の関係を示す　である。

【　１９】この発明の実施の形態６を示す直管　光灯形の照明器具の構成　である。

【　２０】この発明の実施の形態６を示し、　光灯点灯装置に装着された直管　光灯形の照明器具の構成　である。

【　２１】この発明の実施の形態７を示す　光灯点灯装置に装着された　態の直管　光灯形の照明器具の構成　である。

【　２２】この発明の実施の形態７を示す直管　光灯形の照明器具の口金部の　明　である。

【　２３】この発明の第８の実施形態を示すＬＥＤ点灯装置の回路　である。

【　２４】この発明の第８の実施形態を示すＬＥＤ点灯装置の回路　である。

【　２５】この発明の第８の実施形態を示すＬＥＤ点灯装置の回路　である。

【　２６】この発明の第９の実施形態を示すＬＥＤ点灯装置の回路　である。

【　２７】この発明の実施形態１０を示す電球形照明器具の構成　である。

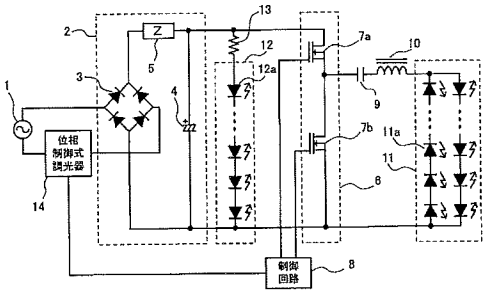
【　２８】この発明の実施形態１０を示す電球形照明器具を使用したときの配光　態を示す　である。

【　２９】この発明の実施形態１０を示す電球形照明器具を使用したときの配光　態を示

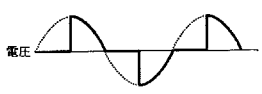
PGR2023-00016 - Home Depot
Ex. 1003 - Page 1242

す　である。
【　３０】この発明の第１０の実施形態を示す電球形照明器具の構成　である。
【符号の　明】
１　商用電源、２、１８、２５　直流電源、５　インピーダンス素子、６　インバータ回路、８　制御回路、９　直流カットコンデンサ、１０、２０、４９ａ、４９ｂ　インダクタ、１１、２１　白色ＬＥＤユニット、１１ａ　白色ＬＥＤ、１２、２３　電球色ＬＥＤユニット、１２ａ　電球色ＬＥＤ、１４　位相制御式調光器、１５ａ、１５ｂ　３８　筐体、１６、４１ａ、４１ｂ　口金、１９、４５　ＬＥＤユニット、２２、４４ａ　コンデンサ、２４　外部信号、２７、３２、３５　スイッチング素子、３６　反転素子、３７　摺動スイッチ、３９　点灯回路基板、４０ａ～４０ｄ　端子、４６　ＬＥＤ、４８　電　出回路。

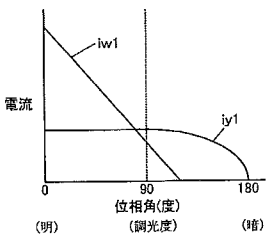
【　１】



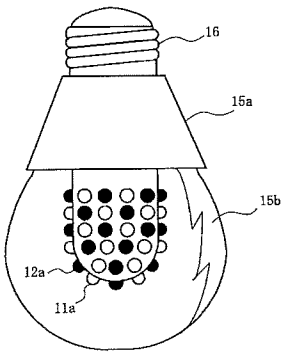
【　２】



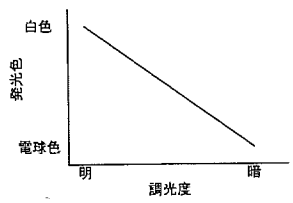
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【　４】

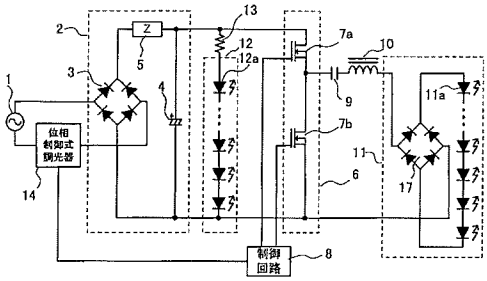


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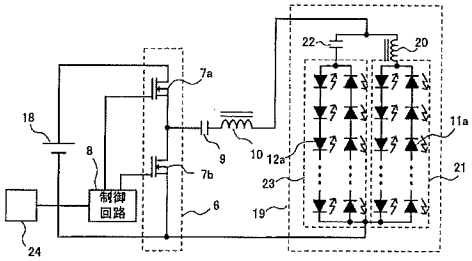


PGR2023-00016 - Home Depot
Ex. 1003 - Page 1243

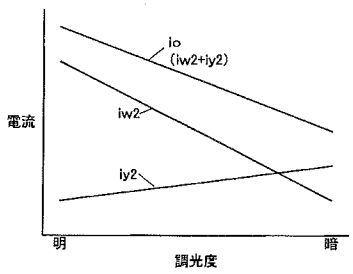
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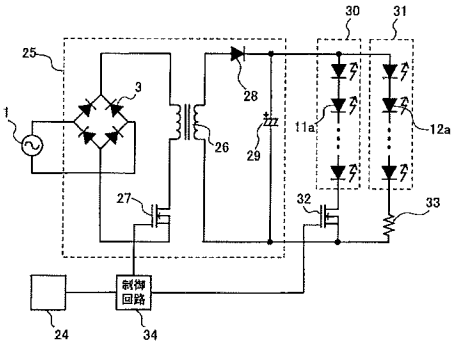
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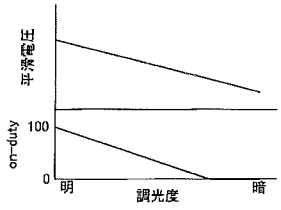
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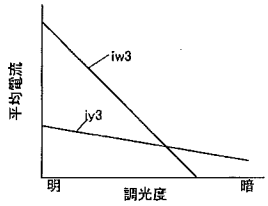
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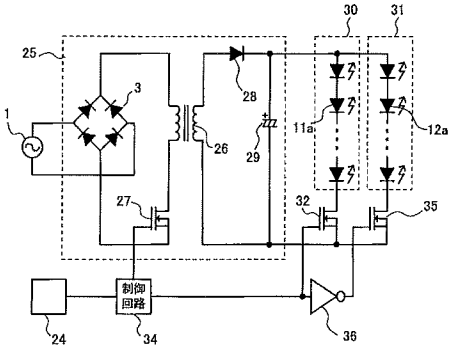
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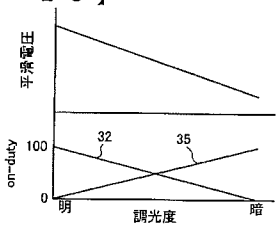
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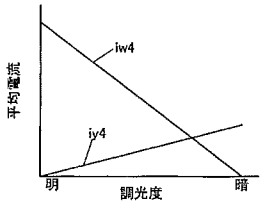


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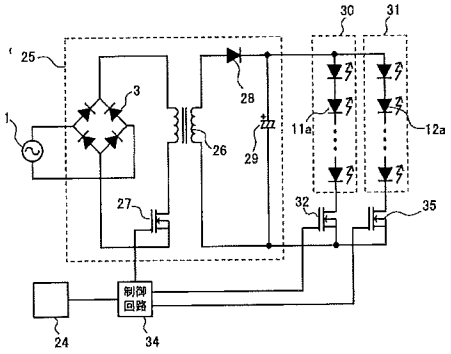


PGR2023-00016 - Home Depot
Ex. 1003 - Page 1244

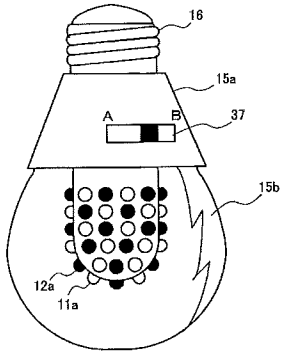
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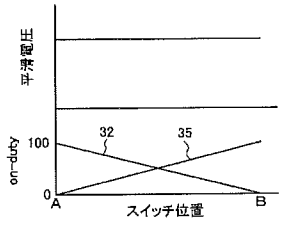
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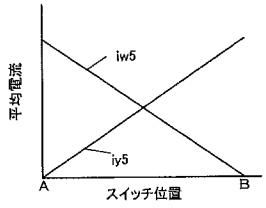
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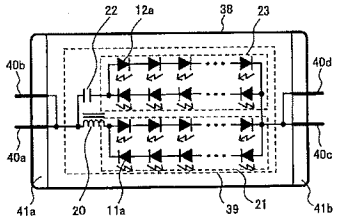
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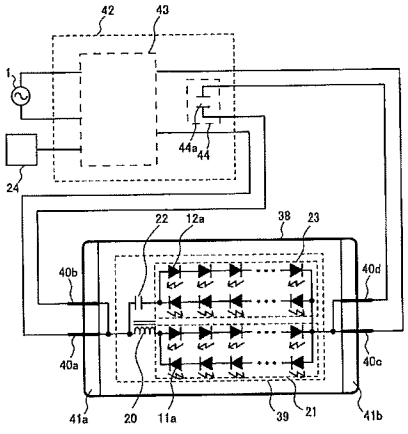
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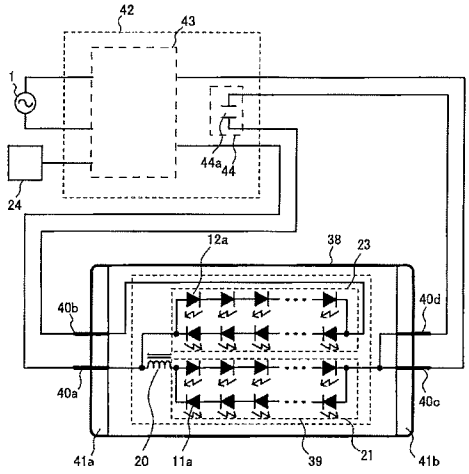


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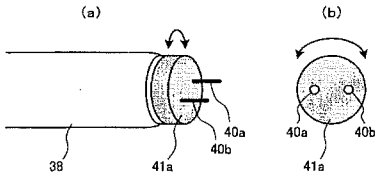


PGR2023-00016 - Home Depot
Ex. 1003 - Page 1245

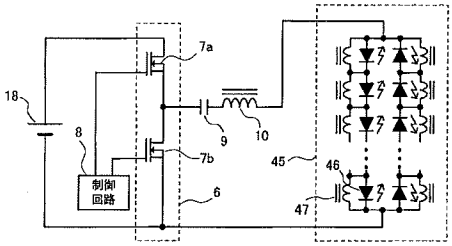
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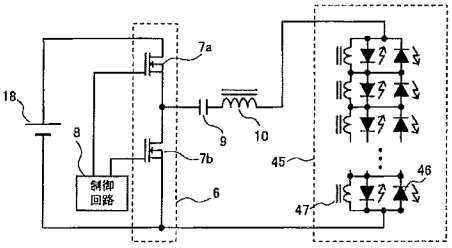
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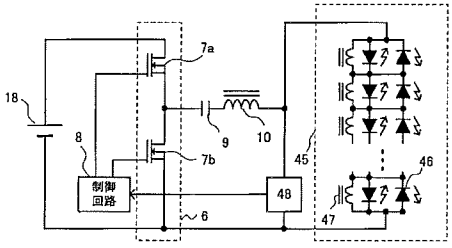
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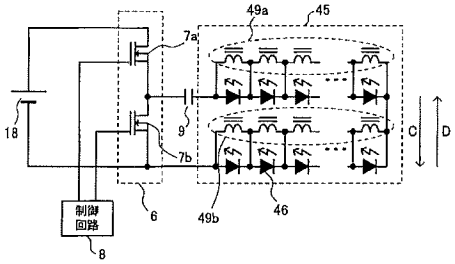
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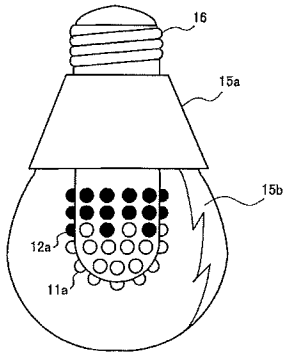
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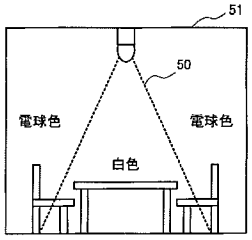
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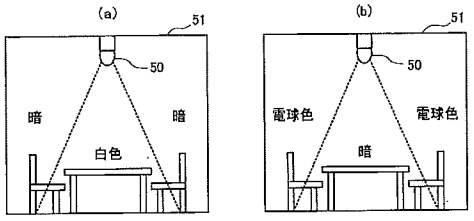


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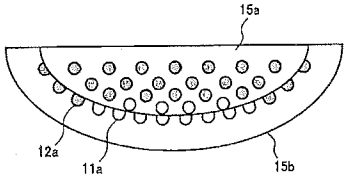


PGR2023-00016 - Home Depot
Ex. 1003 - Page 1246

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PGR2023-00016 - Home Depot
Ex. 1003 - Page 1247

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PGR2023-00016 - Home Depot
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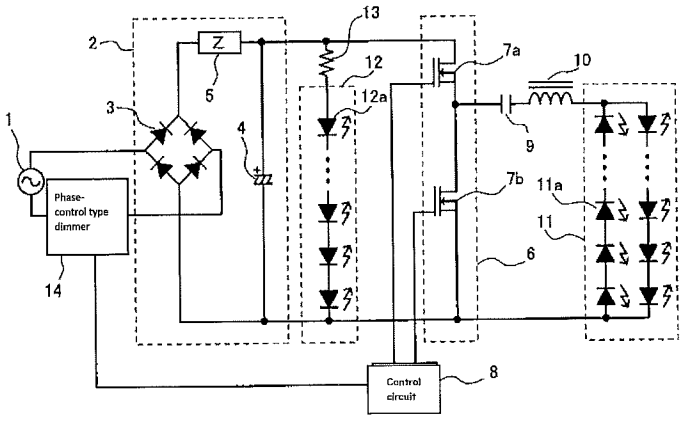
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Continued on final page

(54) Title of the Invention: LED Lighting Device and Illumination Apparatus

(57) [Abstract]
[PROBLEM] To provide an LED lighting device and an illumination apparatus that are suitable for general lighting and that can change luminescent color to a desired color such as white or colored as needed, to produce illumination effects.
[SOLUTION] Providing a DC power supply circuit 2 for converting a commercial power supply 1 to DC, an inverter circuit 6 for converting DC to high frequency, a control circuit 8 for controlling the drive frequency of the inverter circuit 6 based on output from a phase-control type dimmer 14 inserted between the commercial power supply 1 and the DC power supply circuit 2, an inductor 10 for restricting output current from the inverter circuit 6, a DC cut capacitor 9 connected in series to this inductor 10, a white LED array 11, in which white LEDs 11a are connected in antiparallel to one another, connected to a series circuit of the inductor 10 and the DC cut capacitor 9, and, a colored LED array 12, in which colored LEDs 12a are connected in series, connected to the DC power supply circuit 2 with the anode side as a high-potential side.
[SELECTED DRAWING] Fig. 1



PGR2023-00016 - Home Depot
Ex. 1003 - Page 1249

[Claims]

[Claim 1]

An LED lighting device, characterized by being provided with a first light-emitting means, a second light-emitting means for luminescent color different from the first light-emitting means, and a control means for controlling the first and second light-emitting means, the control means lighting the first light-emitting means as a main lighting means when at full brightness, lighting the second light-emitting means as the main lighting means when dimming light, making luminescent color of either the first or the second light-emitting means be white, and continuously changing brightness and luminescent color during full brightness, and brightness and luminescent color during dimming.

[Claim 2]

An LED lighting device, characterized by being provided with a first light-emitting means for white light, a second light-emitting means for luminescent color different from the first light-emitting means, a dimming means for outputting a dimming signal to regulate degree of dimming, and a control means for adjusting output of the first and second light-emitting means based on a dimming signal from this dimming means, wherein the control means makes the output of the first light-emitting means greater than the output of the second light-emitting means during full brightness and monotonically decreases the output of the first and second light-emitting means based on degree of dimming, as well as making the output of the first light-emitting means smaller than the output of the second light-emitting means during dimming.

[Claim 3]

An LED lighting device, characterized by being provided with a first light-emitting means for white light, a second light-emitting means for luminescent color different from the first light-emitting means, a dimming means for outputting a dimming signal to regulate a degree of dimming, and a control means for adjusting output of the first and second light-emitting means based on a dimming signal from this dimming means, wherein the control means makes the output of the first light-emitting means greater than the output of the second light-emitting means during full brightness and monotonically decreases the output of the first light-emitting means based on the degree of dimming, as well as monotonically decreasing the output of the second light-emitting means below a prescribed degree of dimming.

[Claim 4]

An LED lighting device, characterized by being provided with a first light-emitting means for white light, a second light-emitting means for luminescent color different from the first light-emitting means, a dimming means for outputting a dimming signal to regulate degree of dimming, and a control means for adjusting output of the first and second light-emitting means based on a dimming signal from this dimming means, wherein the control means, when monotonically decreasing combined output of the first light-emitting means and the second light-emitting means based on a degree of dimming, monotonically decreases output of the first light-emitting means and monotonically increases output of the second light-emitting means based on a degree of dimming.

[Claim 5]

The LED lighting device of any of claims 1-4, characterized by the first light-emitting means and the second light-emitting means comprising at least one LED.

[Claim 6]

An LED lighting device, characterized by being provided with a DC power supply circuit for converting a commercial power supply to DC, an inverter circuit for converting DC to high frequency, a control circuit for controlling drive frequency of the inverter circuit based on output of a phase-control type dimmer inserted between the commercial power supply and the DC power supply circuit, a first inductor for restricting output current from the inverter circuit, a DC cut capacitor connected in series to this first inductor, a white LED

array, in which white LEDs are connected in antiparallel with one another, connected to a series circuit of the first inductor and the DC cut capacitor, and a colored LED array, in which colored LEDs are connected in series, connected to the DC power supply circuit with an anode side as a high-potential side.

[Claim 7]

An LED lighting device, characterized by being provided with a DC power supply circuit for converting a commercial power supply to DC, an inverter circuit for converting DC to high frequency, a control circuit for controlling drive frequency of the inverter circuit based on output of a phase-control type dimmer inserted between the commercial power supply and the DC power supply circuit, a first inductor for restricting output current from the inverter circuit, a DC cut capacitor connected in series to this first inductor, a white LED array, in which white LEDs are connected in series, connected to a series circuit of the first inductor and the DC cut capacitor via a full-wave rectifier for full-wave rectifying output of the inverter circuit, and a colored LED array, in which colored LEDs are connected in series, connected to the DC power supply circuit with an anode side as a high-potential side.

[Claim 8]

An LED lighting device, characterized by being provided with a DC power supply circuit, an inverter circuit for converting DC to high frequency, a dimming means for outputting a dimming signal to regulate a degree of dimming, a control circuit for controlling drive frequency of the inverter circuit based on a dimming signal from this dimming means, a first inductor restricting output current from the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected to a series circuit of the first inductor and the DC cut capacitor, wherein, in the LED unit, a series circuit of a second inductor and a white LED array, in which white LEDs are connected in antiparallel to one another, and a series circuit of a first capacitor and a colored LED array, in which colored LEDs are connected in antiparallel to one another, are connected in parallel to one another.

[Claim 9]

The LED lighting device of claim 8, characterized by an inductor, having a sufficiently small inductance in comparison to a first inductor, connected in parallel to each LED of an LED unit.

[Claim 10]

The LED lighting device of claim 8, characterized by an LED unit wherein a plurality of paired LEDs in antiparallel connection with one another are connected in series, and for each pair an inductor having a sufficiently small inductance in comparison to a first inductor is connected in parallel.

[Claim 11]

An LED lighting device, characterized by being provided with a DC power supply circuit, a series circuit of a switching element and a white LED array comprising white LEDs connected to the DC power supply circuit, with an anode side as a high-potential side, a series circuit of a resistor and a colored LED array comprising colored LEDs connected to the DC power supply circuit with an anode side as a high-potential side, a dimming means for outputting a dimming signal to regulate degree of dimming, and, a control circuit for controlling output of the DC power supply circuit and on-duty of the switching element based on a dimming signal from this dimming means, wherein the control circuit monotonically decreases output of the DC power supply circuit and also monotonically decreases on-duty of the switching element as the degree of dimming increases.

[Claim 12]

An LED lighting device, characterized by being provided with a DC power supply circuit, a series circuit of a first switching element and a white LED array, comprising white LEDs connected to the DC power supply circuit with an anode side as a high-potential side, and a series circuit of a second switching element and a colored LED array, comprising colored LEDs connected to the DC power supply circuit with an anode side as a high-potential side, a dimming means for outputting a dimming signal to regulate a degree of dimming, and a control circuit for controlling

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1251

output of the DC power supply circuit and the first and second switching elements based on a dimming signal from this dimming means, wherein the control circuit monotonically decreases the output of the DC power supply circuit and also monotonically increases on-duty of the second switching element relative to on-duty of the first switching element as the degree of dimming increases.

[Claim 13]

An LED lighting device, characterized by being provided with a lighting means for lighting a white LED array comprising white LEDs and a colored LED array comprising colored LEDs, a control circuit to maintain a constant total output for the white LED array and the colored LED array, and a switching means for incremental or continuous switching of an output ratio of the white LEDs and the colored LEDs, the control circuit changing the output ratio based on a signal from the switching means.

[Claim 14]

An LED lighting device, characterized by being provided with a DC power supply circuit, a series circuit of a first switching element and a white LED array, comprising white LEDs connected to the DC power supply circuit with an anode side as a high-potential side, a series circuit of a second switching element and a colored LED array, comprising colored LEDs connected to the DC power supply circuit with an anode side as a high-potential side, a control circuit making total on-duty for the first and second switching elements constant, and, a switching means for incremental or continuous switching of an output ratio of the white LEDs and the colored LEDs, the control circuit changing an on-duty ratio of the first and second switching elements based on a signal from the switching means.

[Claim 15]

The LED lighting device of any of claims 1-14, characterized by the luminescent color of a second light-emitting means, colored LEDs, or a colored LED array being a light-bulb color, yellow, or orange.

[Claim 16]

A bulb-shaped illumination apparatus, characterized by the LED lighting device of any of claims 1-15 being integrally fitted inside a housing of approximately the same diameter as an incandescent bulb having a cap, and a first light-emitting means or white LEDs and a second light-emitting means or colored LEDs being disposed equally and alternatingly.

[Claim 17]

An illumination apparatus, characterized by the LED lighting device of any of claims 1-15 being integrally fitted inside a housing of approximately the same diameter as an incandescent bulb having a cap, and also a first light-emitting means or white LEDs being arranged so as to illuminate in the direction of a floor, and a second light-emitting means or colored LEDs being arranged so as to illuminate in the direction of a wall or ceiling.

[Claim 18]

The light-bulb-shaped illumination apparatus of claim 16 or 17, characterized by a housing being provided with a dimming means for dimming or a switching means as a switch.

[Claim 19]

An illumination apparatus shaped as a straight tube, characterized by being provided with a housing having caps with attached terminals at both ends that can be fitted to a fixture for a straight-tube fluorescent lamp, and an LED unit provided between the terminals on the caps at both ends, the LED unit comprising LED arrays in which LEDs are connected in antiparallel to one another.

[Claim 20]

An illumination apparatus shaped as a straight tube, characterized by being provided with a housing having caps with attached terminals at both ends that can be fitted to a fixture for a straight-tube fluorescent lamp, and an LED unit provided between the terminals on the caps at both ends, wherein, in the LED unit, a series

circuit of an inductor and a white LED array of white LEDs in antiparallel connection to one another, and a series circuit of a capacitor and a colored LED array of colored LEDs in antiparallel connection to one another, are connected in parallel with one another.

[Claim 21]
An illumination apparatus shaped as a straight tube, characterized by being provided with a housing having caps with attached terminals at both ends that can be fitted to a main body of a fixture for a straight-tube fluorescent lamp, and an LED unit provided between the terminals of the caps at both ends, wherein, in the LED unit, between a first terminal on the cap at one end and a first terminal on the cap at the other end, an inductor and a white LED array, in which white LEDs are connected in antiparallel with one another, are connected in series, the first terminal and a second terminal on the cap on the other end are short-circuited, and between the first terminal and a second terminal on the cap at the one end, a colored LED array, in which colored LEDs are connected in antiparallel with one another, is connected.

[Claim 22]
The illumination apparatus shaped as a straight tube of claim 21, characterized by at least one of the caps being capable of rotating 180 degrees.

[Claim 23]
The illumination apparatus of any of claims 20-22, characterized by the luminescent color of colored LEDs or a colored LED [array] being bulb-colored, yellow, or orange.

[Claim 24]
An LED lighting device, characterized by being provided with a DC power supply circuit, an inverter circuit for converting DC to high frequency, a control circuit for driving the inverter circuit, a first inductor for restricting output current of the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected in series to a series circuit of the first inductor and the DC cut capacitor, wherein, in the LED unit, LED arrays are connected in antiparallel with one another, and for each LED forming the LED arrays an inductor having a sufficiently small inductance in comparison to the first inductor is connected in parallel.

[Claim 25]
An LED lighting device, characterized by being provided with a DC power supply circuit, an inverter circuit for converting DC to high frequency, a control circuit for driving the inverter circuit, a first inductor for restricting output current of the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected in series to a series circuit of the first inductor and the DC cut capacitor, wherein, in the LED unit, a plurality of paired LEDs in antiparallel connection with one another are connected in series, and for each pair an inductor having a sufficiently small inductance in comparison to the first inductor is connected in parallel.

[Claim 26]
The LED lighting device of claim 24 or 25, characterized by being provided with a voltage detection circuit for detecting voltage at both ends of the LED unit, wherein the inverter circuit is stopped when the voltage detected exceeds a prescribed value.

[Claim 27]
An LED lighting device, characterized by being provided with a DC power supply circuit, an inverter circuit for converting DC to high frequency, a control circuit for driving the inverter circuit, and a series circuit of an LED unit and a DC cut capacitor connected to an output point of the inverter circuit, wherein, in the LED unit, a plurality of LEDs are connected in antiparallel, and an inductor is connected in parallel to each LED.

[Detailed Description of the Invention]

[0001]
[Technical Field of the Invention]

This invention pertains to an LED lighting device and illumination apparatus.

[0002]
[Conventional Technology]

Conventional illumination apparatuses were provided with a first light source with relatively good color-rendering property and a shorter life and a second light source with a relatively poor color-rendering property and a longer life, and were equipped with a life-extending means (sensor device) for extending the life of the first light source. Because the life-extending means could extend the life of the first light source having relatively good color-rendering property and a shorter life, the difference in life span between the first light source and the second light source was eliminated, which made it possible to reduce lamp replacement frequency by half in comparison to when the first light source and second light source were merely combined (for example, see Patent Document 1).

[0003]
[Patent Document 1]

Patent Application Laid-open Publication No. 2001-85169 (pages 6 and 7, Fig. 2)

[0004]
[Problem the Invention Purports to Solve]

In conventional illumination apparatuses, it was possible to use white LEDs as the first light source and yellow LEDs as the second light source and to use the white LEDs for dimming and the yellow LEDs for constant lighting, replacing only the white LEDs at end-of-life. However, the yellow LEDs could not be dimmed and it was not possible to obtain performance effects in illumination by dimming both white LED and yellow LEDs.

[0005]
In addition, general LED lighting devices were configured to change commercial power into DC, and to restrict current by means of a control resistor to conduct DC to, and turn on, a plurality of LEDs, and a problem existed in that there was great loss in the control resistor, and when a particular degree of output was required, as with general lighting, the control resistor would generate a lot of heat.

Also, lighting appliances with built-in general LED lighting devices were still not suitable for use as general lighting in the manner of incandescent electric bulbs and straight-tube fluorescent lamps.

[0006]
The present invention is designed to solve the above problems, and aims to provide a small LED lightening device and illumination apparatus that are a simply configured, are suitable for general lighting, and can render light by changing the luminescent color to a desired color such as white and colored as needed, while generating little heat.

[0007]
[Means of Solving the Problem]

The LED lighting device of this invention is provided with a first light-emitting means, a second light-emitting means for a luminescent color differing from the first light-emitting means, and a control means for controlling the first and second light-emitting means, the control means lighting the first light-emitting means as the main lighting means when at full brightness, lighting the second light-emitting means as the main lighting means when dimming, making a luminescent color of either of the first or the second light-emitting means be white, and continuously changing brightness and luminescent color when at full brightness, and also brightness and luminescent color when dimming.

[0008]
[Embodiments of the Invention]

Embodiment 1

Fig. 1 is a circuit diagram of an LED lighting device illustrating Embodiment 1 of the invention, Fig. 2 is an output

wave form of the phase-control type dimmer of Fig. 2, Fig. 3 is a drawing showing the relationship between phase angle and current flowing to each LED array, Fig. 4 is a block diagram of a bulb-type illumination apparatus with a built-in LED lighting device, and Fig. 5 is a drawing showing the relationship between degree of dimming and luminescent color when current changes.

[0009]

In Fig. 1, 1 is a commercial power supply, and 2 is a DC power supply comprising a diode bridge 3, a smoothing capacitor 4, and an impedance element 5. The numeral 6 is an inverter circuit, comprising switching elements 7a and 7b, and here MOSFET is used in switching elements 7a and 7b. The numeral 8 indicates a control circuit for driving the inverter circuit 6, 9 is a DC cut capacitor, 10 is an inductor, 11 is a white LED array in which series circuits of white LEDs 11a, which are the first light-emitting means, are connected in antiparallel, 12 is a bulb-colored LED array comprising a series circuit of bulb-colored LEDs 12a, which are the second light-emitting means differing from the white LEDs and having colored light, for example, and 13 is a control resistor. The numeral 14 indicates a phase-control type dimmer, inserted between the commercial power supply 1 and the DC power supply circuit 2, for phase-controlling the power supplied from the commercial power supply 1 for dimming, and is generally used to dim an incandescent lamp.

[0010]

Next, operations will be explained based on Fig. 1-5.

AC power from the commercial power supply 1 is full-wave rectified by the diode bridge 3 and smoothed by the smoothing capacitor 4, becoming a DC voltage supply. The impedance element 5 is for controlling inrush current, and an inductor, a resistor, or the like is used.

Inside of the inverter circuit 6 MOSFETs 7a, 7b are alternately turned on and off depending on a drive signal from the control circuit 8, and DC output from the DC power supply circuit 2 is converted to high frequency. The high frequency current from the inverter circuit 6 is restricted by the inductor 10 and deposited into the white LED array 11. Therefore, in the white LED array 11 the respective white LEDs 11a are able to be lighted by high frequency current that is half-wave rectified. Also, the current from the DC output from the DC power supply circuit 2 is restricted by the control resistor 13 and applied to the bulb-colored LED array 12, thereby lighting the bulb-colored LED array 12.

[0011]

Fig. 2 shows a waveform of the commercial power supply 1 that is cut by the phase-control type dimmer 14. In the drawing the example shown is a phase angle of about 90 degrees, but usually it is controlled between 1-180 degrees. The control circuit 8 controls for a monotonic increase of output frequency by means of the output of the phase-control type dimmer 14 according to the phase angle. When the output frequency increases, the impedance of the inductor 10 increases, and current supplied to the white LED array 11 decreases. Therefore, when the phase angle of the phase-control type dimmer 14 grows larger, the white LED array 11 dims, and brightness lowers.

In addition, as the phase angle of the phase-control type dimmer 14 exceeds 90 degrees, the voltage of the smoothing capacitor 4 decreases, and because the current supplied to the bulb-colored LED array 12 decreases, dimming occurs, and brightness lowers.

[0012]

Fig. 3 shows the above phase angle and current flowing to each LED array, with iw1 as the effective current flowing to the white LED array 11, and iy1 as the average current flowing to the bulb-colored LED array 12. As described above, iw1 monotonically decreases for each phase angle, and iy2 monotonically decreases for phase angles 90-180 degrees. Fig. 3 shows the relationship between degree of dimming and current, and in dimming (getting darker), iw1 monotonically decreases for each phase angle, and iy2 monotonically decreases in phase angles 90-180 degrees.

[0013]

Next, an example of a bulb-type illumination apparatus having the LED lighting device shown in Fig. 1 built therein is explained based on Fig. 4. In the drawing, 15a is a housing made of plastic or the like, 15b is a housing made of ground glass, plastic, or the like, 16 is a cap, and the interior of the house 15a has a built-in LED lighting device.

By equal and alternating disposition of white LEDs 11a and bulb-colored LEDs 12a, a globe 15b obtains a luminescent color with a brightness that averages the white LEDs 11 and the bulb-colored LEDs 12.

[0014]
In a configuration of this sort, when current is changed as in Fig. 3 the relationship between the degree of dimming and luminescent color is, as Fig. 5 shows, the degree of dimming is white when bright to bulb-colored when dimming (darkening).

[0015]
As described above, it is possible to obtain, by means of a simple configuration, a small LED lighting device that is suitable for general lighting and able to change the luminescent color thereof to a desired color such as white or colored as needed so that light is rendered white when bright and bulb-colored when dimmed, imparting a restful feeling, while generating little heat, by providing a first light-emitting means, a second light-emitting means having a luminescent color differing from the first light-emitting means, and a control means for controlling the first and second light-emitting means, the control means lighting the first light-emitting means as the main lighting means at full brightness, lighting the second light-emitting means as the main igniting means when dimming, making the luminescent color of either of the first or the second light-emitting means be white, and continuously changing brightness and luminescent color when at full brightness, and also brightness and luminescent color when dimming.

[0016]
Also, it is possible to obtain a small LED lighting device, based on a simple configuration using a phase-control type dimmer generally used in an incandescent bulb, that is suitable for general lighting and able to render a desired luminescent color of white or colored as needed, being white when bright and bulb-colored, imparting a restful feeling, when dimmed, while generating little heat, by providing a DC power supply circuit for converting commercial power to DC, an inverter circuit for converting DC to high frequency, a control circuit for controlling the drive frequency of an inverter circuit based on output from a phase-control type dimmer inserted between the commercial power supply and the DC power supply circuit, a first inductor for restricting output current from an inverter circuit, a DC cut capacitor connected in series to this first inductor, a white LED array, in which white LEDs are connected in antiparallel to one another, connected to the series circuit of the first inductor and the DC cut capacitor, and a colored LED array, in which colored LEDs are connected in series, connected to the DC power supply circuit, with the anode side as a high-potential side.

[0017]
Furthermore, by integrally fitting the LED lighting device of Embodiment 1 to the inside of a housing of approximately the same outer diameter as an incandescent bulb having a cap, and disposing white LEDs and colored LEDs equally and alternatingly, it is possible to configure a bulb-type illumination apparatus, as a replacement for an incandescent lamp, that can be white when bright and bulb-colored when dimmed, and can also average the brightness of the white LEDs and the bulb-colored LEDs.

[0018]
As Fig. 6 shows, to improve efficiency, output from the inverter circuit 6 may be full-wave rectified with the diode bridge 17, and the white LEDs 11a may be connected in series with the anodes as a high-potential side.

[0019]
Embodiment 2

Embodiment 1 shows an example corresponding to a phase-control type dimmer, but this embodiment illustrates a case that applies a type of dimmer in which DC power is secured and a dimming signal is entered separately.

Fig, 7 is a circuit diagram of an LED lighting device illustrating Embodiment 2 of the invention and Fig. 8 is a drawing indicating the relationship between degree of dimming and current flowing to each LED array. In Fig. 1, 6-12a have the same configurations and operations as those in Embodiment 1, so explanations are omitted.

The numeral 18 indicates a DC power supply, 19 is an LED unit, 20 is an inductor, 21 is a white LED array in which white LEDs 11a are connected in antiparallel, 22 is a capacitor, 23 is a bulb-colored LED array in which bulb-colored LEDs 12a are connected in antiparallel, and 24 is an external signal, showing a dimming signal in this embodiment. It should be noted that when dimming occurs due to the external signal 24 from a remote control or the like, the output frequency of the control circuit 8 increases.

[0020]
Next, operations will be explained based on Fig. 8. Fig. 8 shows the relationship between the degree of dimming and current flowing to each LED array in Fig. 7. Where the effective value of high frequency current outputted from

the inverter circuit 6 is io, the angle frequency for lighting frequency f is ω, the inductance of the inductor 10 is L10, the inductance of the inductor 20 is L20, the volume of the capacitor 22 is C22, the effective value of current flowing to the inductor 20 is iw2, and the effective value of current flowing to the capacitor 22 is iy2, the values iw2, iy2, and io are expressed in Formula 1-3 as follows.

[0021]

[Formula 1]

$$iw2 = io \times \frac{\frac{1}{\omega C22}}{\omega L20 + \frac{1}{\omega C22}} \qquad (1)$$

[0022]

[Formula 2]

$$iy2 = io \times \frac{\omega L20}{\omega L20 + \frac{1}{\omega C22}} \qquad (2)$$

[0023]

[Formula 3]

$$io \propto \frac{1}{\omega L10} \qquad (3)$$

[0024]

When dimming (darkening) occurs, ω rises, so, as shown in Fig. 8, io and iw2 monotonically decrease, and iy2 monotonically increases.

[0025]

Also, by equipping the bulb-type illumination apparatus of Embodiment 1, shown in Fig. 4, with the LED lighting device shown in Fig, 7, and arranging the LEDs such that white LEDs 11a and bulb-colored LEDs 12a are equally and alternatively disposed, the luminescent color obtained via the globe 15b can be an average of the respective brightness of white LEDs 11 and bulb-colored LEDs 12.

[0026]

As described above, it is possible to change an averaged luminescent color from white to bulb-colored while lowering the overall brightness during dimming by providing a first light-emitting means for white light, a second light-emitting means for a luminescent color differing from the first light-emitting means, a dimming means for outputting a dimming signal to regulate the degree of dimming, and a control means for adjusting the output of the first and second light-emitting means based on a dimming signal from this dimming means, the control means making the output of the first light-emitting means greater than the output of the second light-emitting means during full brightness and monotonically decreases the output of the first light-emitting means based on the degree of dimming , as well as making the output of the first light-emitting means smaller than the output of the second light-emitting means.

[0027]

It is possible to change an averaged luminescent color from white to bulb-color while lowering the overall brightness during dimming by providing a first light-emitting means for white light, a second light-emitting means for a luminescent color differing from the first light-emitting means, a dimming means for outputting a dimming signal to regulate the degree of dimming, a control means for adjusting the output of the first and second light-emitting means based on a dimming signal from this dimming means, the control means, when monotonically decreasing the

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1257

combined output of the first light-emitting means and the second light-emitting means based on a degree of dimming, monotonically decreasing the output of the first light-emitting means based on a degree of dimming, and monotonically increasing the output of the second light-emitting means.

[0028]
It is possible to change an averaged luminescent color from white to bulb-color while lowering the overall brightness during dimming by providing a DC power supply circuit, an inverter circuit for converting DC to high frequency, a dimming means for outputting a dimming signal to regulate the degree of dimming, a control circuit for controlling the drive frequency of the inverter circuit based on a dimming signal from this dimming means, a first inductor restricting output current from the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected to the series circuit of the first inductor and the DC cut capacitor, where, in the LED unit, a series circuit of a second inductor and a white LED array, in which white LEDs are connected in antiparallel to one another, and a series circuit of a first capacitor and a colored LED array, in which colored LEDs are connected in antiparallel to one another, are connected in parallel to one another.

[0029]
In addition, by integrally fitting the LED lighting device of Embodiment 2 to a housing having approximately the same outer diameter as an incandescent lamp having a cap, and disposing white LEDs and colored LEDs equally and alternatingly, it is possible to configure a bulb-type illumination apparatus as a replacement to an incandescent bulb, that is able to change an averaged luminescent color from white to bulb-color while lowering the overall brightness during dimming.

[0030]
Embodiment 3

Embodiments 1 and 2 show an LED lighting circuit configured using a DC power supply having a constant DC output value and an inverter circuit, but this embodiment shows a case in which a down converter is used for the DC power supply.
Fig. 9 is a circuit diagram of an LED lighting device illustrating Embodiment 3 of the present invention, Fig. 10 diagrams the DC power output voltage and on-duty of a switching element, and Fig. 11 shows the relationship between average current of the LEDs and degree of dimming.

[0031]
In Fig. 9, 1, 3, 11a and 12a have the same configuration and operations as Embodiment 1, and 24 has the same configuration and operations as Embodiment 2, Fig. 7, so descriptions are omitted. The numeral 25 indicates a DC power supply circuit comprising a diode bridge 3, a transformer 26, a switching element 27, a diode 28, and a smoothing capacitor 29; 30 indicates a white LED array comprising white LEDs 11a; 31 indicates a bulb-colored LED array comprising bulb-colored LEDs 12a; 32 is a switching element; 33 is a resistor; and 34 is a control circuit for controlling the switching elements 27 and 32.

[0032]
Operations will be explained next, based on Fig. 9-11. The commercial power supply 1 is full-wave rectified by the diode bridge 3, and is chopped by the switching element 27 by means of the primary side of the transistor 26. Power conducted by the secondary side of the transistor 26 is rectified by the diode 28 and smoothed by the smoothing capacitor 29, thereby forming a DC power supply.

The power conducted by the secondary side of the transistor 26 is determined by the ON width when the switching element 27 does chopping, and the wider the ON width in comparison to the off width the greater the power conducted and the output voltage of the DC power supply circuit 25. In this embodiment, the number of windings on the transistor 26 are configured to be fewer on the secondary side than on the primary side, making the DC power supply circuit 25 a down converter.

[0033]
The white LED array 30 receives current only while switching element 32 is on, and the brightness thereof is determined by the average current per time unit. The switching frequency of switching element 32 is prescribed so as to be of frequency high enough that the switching cannot be perceived by the eye. The current of the bulb-colored LED array 31 is restricted by the resistor 33, and the array outputs a brightness in proportion to the output of the DC power supply circuit 25.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1258

[0034]
The control circuit 34 makes the on-duty of the switching elements 27 and 32 smaller as the degree of dimming deepens (as it gets darker), as shown in Fig. 10, decreasing the voltage of the DC power supply circuit 25, and decreasing the current flowing to the white LED array 30.

[0035]
Fig. 11 shows each average current relative to the degrees of dimming when the average current flowing to the white LED array 30 at this time is iw3 and the average current flowing to the bulb-colored LED array 31 is iy3. When the degree of dimming increases, the average current flowing to the white LED array 30, iw3, and the average current flowing to the bulb-colored LED array 31, iy3, both decrease, but the control circuit 34, when close to the greatest degree of dimming, controls the on-duty of the switching element 32 such that the average current of the bulb-colored array 31 becomes greater than the average current of the white LED array 30.

[0036]
Also, by equipping, for example, the bulb-type illumination apparatus of Embodiment 1, shown in Fig. 4, with the LED lighting device shown in Fig, 9, and arranging the LEDs such that white LEDs 11a and bulb-colored LEDs 12a are disposed equally and alternatingly, the luminescent color obtained via the globe 15b can be averaged from the respective brightness of white LED 11 and bulb-colored LED 12.

[0037]
As described above, it is possible, when dimming, to change to nearly white when the degree of dimming is small (bright) and to nearly bulb-color when the degree of dimming is large (dark) by providing a first light-emitting means for white light, a second light-emitting means for a luminescent color differing from the first light-emitting means, a dimming means for outputting a dimming signal to regulate the degree of dimming, and a control means for adjusting the output of the first and second light-emitting means based on a dimming signal from this dimming means, the control means making the output of the first light-emitting means greater than the output of the second light-emitting means during full brightness and monotonically decreasing the output of the first light-emitting means based on the degree of dimming, as well as making the output of the first light-emitting means smaller than the output of the second light-emitting means during dimming.

[0038]
Also, it is possible, when dimming, to change to nearly white when the degree of dimming is small (bright) and to nearly bulb-color when the degree of dimming is large (dark) by providing a DC power supply circuit, a series circuit of a switching element and a white LED array comprising white LEDs connected to the DC power supply circuit with the anode side as a high-potential side, and a series circuit of a resistor and a colored LED array comprising colored LEDs connected to the DC power supply circuit with the anode side as a high-potential side, a dimming means for outputting a dimming signal to regulate the degree of dimming, and, a control circuit for controlling the output of the DC power supply circuit and the on-duty of switching element based on a dimming signal from this dimming means, the control circuit monotonically decreasing the output of the DC power supply circuit and monotonically decreasing the on-duty of the switching element as the degree of dimming increases.

[0039]
In addition, it is possible to configure a bulb-type illumination apparatus that, when dimming, can change to nearly white when the degree of dimming is small (bright) and to nearly bulb-color when the degree of dimming is large (dark) by integrally fitting the LED lighting device of Embodiment 3 to a housing having approximately the same outer diameter as an incandescent lamp having a cap, and disposing white LEDs and colored LEDs equally and alternatingly.

[0040]
This embodiment was configured such that the switching elements 27 and 32 are independently controlled, but if brightness settings and the like allow, both may be driven with a shared signal.

[0041]
Embodiment 4

In Embodiment 3, current to the white LED array 30 is actively controlled and current to the bulb-colored LED array 31 is passively controlled, but this embodiment illustrates an instance in which both are actively controlled.

Fig. 12 is a circuit diagram of an LED lighting device illustrating Embodiment 4 of the present invention, Fig. 13 diagrams the DC power output voltage and on-duty of a switching element, and Fig. 14 shows the relationship between average current of the LEDs and degree of dimming.

In Fig. 12, 1-34 have the same configurations and operations as Embodiment 3, so descriptions are omitted. The numeral 35 indicates a switching element connected to the bulb-colored LED array 31, and 36 indicates an inversion element.

[0042]
Next, operations will be explained.

The switching elements 32 and 35 are configured such that on and off are inverted by means of the inversion element 36. Therefore, as shown in Fig. 13, controlling is done such that the output voltage of the DC power supply circuit 25 is lowered based on the degree of dimming, and on-duty of the switching element 32 decreases and on-duty of the switching element 35 increases.

Fig. 14 shows each average current relative to the degrees of dimming where iw4 is the average current flowing to the white LED array 30 at this time and iy4 is the average current flowing to the bulb-colored LED array 31. When the degree of dimming increases the average current flowing to the white LED array 30, iw4, decreases, and the average current flowing to the bulb-colored LED array 31, iy4, increases, and when close to the greatest degree of dimming the average current of the bulb-colored array 31, iy4, becomes greater than the average current of the white LED array 30, iw4.

[0043]
Also, by equipping, for example, the bulb-type lighting device of Embodiment 1, shown in Fig. 4, with the LED lighting device shown in Fig, 12, and arranging the LEDs such that white LEDs 11a and bulb-colored LEDs 12a are equally and alternatively disposed, the luminescent color obtained via the globe 15b can be averaged from the respective brightness of white LEDs 11 and bulb-colored LEDs 12.

[0044]
As described above, it is possible to increase the contrast between white light and colored light, and change to nearly white when the degree of dimming is small (bright) and to nearly bulb-colored when the degree of dimming is large (dark), by providing a DC power supply circuit, a series circuit of a first switching element and a white LED array comprising white LEDs connected to the DC power supply circuit with the anode side as a high-potential side, a series circuit of a second switching element and a colored LED array comprising colored LEDs connected to the DC power supply circuit with the anode side as a high-potential side, a dimming means for outputting a dimming signal to regulate the degree of dimming, and a control circuit for controlling the output of the DC power supply circuit and the first and second switching circuits based on a dimming signal from this dimming means, where the control circuit monotonically decreases the output of the DC power supply circuit and also monotonically increases the on-duty of the second switching element relative to the on-duty of the first switching element as the degree of dimming increases.

[0045]
In addition, it is possible to configure a bulb-type illumination apparatus that can increase the contrast between while light and colored light when dimming, and change to almost white when the degree of dimming is small (bright) and to almost bulb-colored when the degree of dimming is large (dark), by integrally fitting the LED lighting device of Embodiment 3 to the inside of a housing having approximately the same outer diameter as an incandescent lamp having a cap, and also disposing white and colored LEDs equally and alternatingly.

[0046]
In this embodiment, the outputs of switching elements 32 and 35 are inverted and the combined on-duty for both is set to be 100%, but on-duty for each may be independently controlled and, as shown in Fig. 15 for example, the drive signals of the switching elements 32 and 35 can be made independent of each other.

[0047]
Embodiment 5

Embodiments 2 and 4 perform dimming and adjustment of luminescent color based on external dimming signals, but this embodiment illustrates a case where it is possible to choose from white, bulb-color, or a color therebetween while keeping the brightness constant, by means of a switch installed on the body of the illumination apparatus.

Fig. 16 diagrams a configuration of an LED lighting device illustrating Embodiment 5 of the present invention, Fig. 17 diagrams the DC power output voltage and an on-duty of switching elements, and Fig. 18 shows the relationship between average current of the LEDs and switch position (degree of dimming). In Fig. 16, 11a, 12a,

15b and 16 have the same configurations and operations as Embodiment 1, Fig. 4, so descriptions are omitted. The numeral 37 indicates a sliding switch which is a switching means installed on a housing 15a.

This sliding switch 37 may be positioned to move smoothly or to move incrementally between A and B of Fig. 16.

[0048]
The circuit configuration of this embodiment is the same as Fig. 12 of Embodiment 4, and the LED lighting device of Fig. 12 is built-in to a bulb-type light device in Fig. 16, but the control of the switching element 27 by the control circuit 34 is different. Also, in this embodiment the external signal 24 is a signal generated by the sliding switch 37.

[0049]
Operations will now be explained based on Figs. 12, 17, and 18.

The control circuit 34 controls the switching element 27 such that the output voltage of the DC power supply circuit 25 remains constant, as shown in Fig. 17. In other words, despite signals from the external signal 24, the average on-duty of the switching element 27 is kept constant, and the on-duty of the switching element 37 is determined by the position of the sliding switch 37. In Fig. 17, when the position of the sliding switch 37 is moved from A to B, the on-duty of the switching element 32 lessens, and the on-duty of the switching element 35 grows.

[0050]
Fig. 18 shows each average current relative to the switch positions (degree of dimming) when the average current flowing to the white LED array 30 at this time is iw5 and the average current flowing to the bulb-colored LED array 31 is iy5. When the position of the sliding switch 37 moves in the B direction (the degree of dimming is deepened) the average current flowing to the white LED array 30, iw5, decreases, and the average current flowing to the bulb-colored LED array 31, iy5, increases, and when close to B (near the deepest degree of dimming) the average current of the bulb-colored array 31, iy4, becomes greater than the average current of the white LED array 30, iw4. In other words, when the position of the sliding switch is A, the color is white, and when the position is B, the color is bulb-color.

[0051]
As described above, it is possible to select a desired luminescent color from white to colored while keeping brightness constant by providing a lighting means for lighting a white LED array comprising white LEDs and a colored LED array comprising colored LEDs, a control circuit for maintaining a fixed total output of the white LED array and the colored LED array, a switching means for incremental or continuous switching of the white LED and colored LED output ratio, where the control circuit changes the output ratio based on signals from the switching means. .

[0052]
It is possible to select a desired luminescent color from white to bulb-colored while keeping brightness constant by providing a DC power supply circuit, a series circuit of a first switching element and a white LED array comprising white LEDs connected to the DC power supply circuit with the anode side as a high-potential side, a series circuit of a second switching element and a colored LED array comprising colored LEDs connected to the DC power supply circuit with the anode side as a high-potential side, a control circuit making the total on-duty for the first and second switching elements constant, and a switching means for incremental or continuous switching of the output ratio of the white LEDs and the colored LEDs, where the control circuit changes the on-duty ratio of the first and second switching elements based on a signal from the switching means.

[0053]
It is possible to configure a bulb-type appliance with which a desired luminescent color can be selected from white to bulb-colored while keeping brightness constant by integrally fitting the LED lighting device of Embodiments 2-4 to the inside of a housing of approximately the same outer diameter as an incandescent bulb having a cap, and also providing a switch to the housing as a switching means.

[0054]
In this embodiment, the outputs of the switching elements 32 and 35 are inverted and the combined on-duty for both is set to be 100%, but when controlling is to be done such that the total on-duty for both is fixed and the total output of the white LED array 30 and the bulb-colored LED array 31 is fixed, as shown in Fig. 15 for example, the drive signals of the switching elements 32 and 35 can be made independent of each other.

Moreover, in this embodiment, an example was shown of switching luminescent color with a sliding switch, but it may be configured to do switching by means of a remote signal or a pull switch.

[0055]
It is also possible to install the phase-control type dimmer 14 illustrated in Embodiment 1 in the housing 15a of Fig. 4a as a sliding switch 37.

[0056]
Embodiment 6

The aim of Embodiments 1-5 is to provide a replacement for incandescent bulbs, but the aim of this embodiment is to provide a replacement for straight-tube fluorescent lamps.

Fig. 19 is a block diagram of the straight-tube fluorescent lamp of Embodiment 6, and Fig. 20 is a block diagram of a straight-tube fluorescent lamp in the state of being fitted to a fluorescent lighting device.

In Fig. 19, 11a, 12a, and 19-23 have the same configurations and operations as in Embodiment 2, Fig. 7, so descriptions are omitted. The numeral 38 indicates a housing of approximately the same size as fluorescent lamps on the market made from a semi-translucent substance, 39 is a lighting circuit board having the same unit 19 as that of Fig. 7 mounted thereon, 41a and 41b are caps having terminals 40a-40d installed in the same positions and of the same size as fluorescent lamps on the market.

[0057]
As shown in Fig. 20, the straight-tube fluorescent lamp illumination apparatus of Fig. 19 is used by being connected to a general electronic stabilizer for a fluorescent lamp, and is connected to an electronic stabilizer 42 by the terminals 40a-40d. A general electronic stabilizer for a fluorescent lamp comprises a power supply unit 43 and a starter circuit 44, the power supply unit 43 supplying high frequency power, and the starter circuit 44 being configured with a capacitor 44a.

During lighting current flows to the starter circuit 44 side as well, but when connected in this way operations are largely the same as the circuit in Fig. 7 of Embodiment 2.

Also, it is possible to obtain an average luminescent color from both the white LEDs 11a and the bulb-colored LEDs 12a via the housing 38 by arranging the LEDs to be dispersed equally.

[0058]
As described above, it is possible to configure a straight-tube fluorescent lamp illumination apparatus that can be dimmed and that can change the luminescent color thereof, as a replacement for fluorescent lamps on the market, by providing a housing having, at each end, a cap with terminals that can be fitted to a fixture for a straight-tube fluorescent lamp, and an LED unit installed between terminals on the caps at both ends.

[0059]
It is possible to configure a straight-tube fluorescent lamp illumination apparatus that can be dimmed and that can change the luminescent color thereof, as a replacement for fluorescent lamps on the market, by providing a housing having, at each end, a cap with terminals that can be fitted to a fixture for a straight-tube fluorescent lamp, and an LED unit installed between terminals on the caps at both ends, where, in the LED unit, a series circuit of an inductor and a white LED array in which white LEDs are connected in antiparallel with one another, and a series circuit of a capacitor and a colored LED array in which colored LEDs in parallel connection to one another are connected in parallel.

[0060]
Embodiment 7

In Embodiment 6 a capacitor 22 for rectifying the current of the bulb-colored LEDs 12a is built-in to the inside of the LED unit 19, but this embodiment illustrates a configuration in which the capacitor 22 forming the LED unit 19 and the capacitor 44a forming the starter circuit 44 are shared.

Fig. 21 is a block diagram of the straight-tube fluorescent lamp illumination apparatus installed in a fluorescent lamp lighting device, illustrating Embodiment 7, and Fig. 22 diagrams a cap portion for a straight-tube fluorescent lamp illumination apparatus.

[0061]
The symbols in Fig. 21 are the same as those of Fig. 20 in Embodiment 6, but the wiring of the LED unit 19 is

different. Fig, 21 shows the bulb-colored LED unit 23 connected between terminals 40a and 40b.

When connected in this way, the current through the bulb-colored LEDs 12a travels a path of terminal 40a → bulb-colored LED unit 23 → terminal 40b → capacitor 44a → terminal 44d → terminal 44c. This makes it possible to obtain approximately the same circuit as that shown in Fig. 7.

[0062]
In some cases, because of the wiring inside an illumination apparatus, terminals cannot be connected as in Fig. 21 unless the positions of the terminals 40a and 40b are reversed. To address this, the cap 41a or the cap 41b may be made to rotate 180 degrees as shown in Fig 22 (a) and (b)

[0063]
In the above manner, it is possible to decrease the number of parts by providing a housing having at both ends caps with terminals that are attachable to the body of a fixture for a straight-tube fluorescent lamp, and an LED unit installed between terminals of the caps at both ends, where, in the LED unit, between the first terminal on the cap at one end and the first terminal on the cap at the other end an inductor and a white LED array, in which white LEDs are connected in antiparallel with one another, are connected in series, the first terminal and the second terminal on the cap on the other end are short-circuited, and between the first terminal and the second terminal on the cap at the one end a colored LED array, in which colored LEDs are connected in antiparallel with one another, is connected.

[0064]
Also, at least one of the caps can be rotated 180 degrees, and so can be mounted regardless of existing hard wiring inside of a device.

[0065]
Embodiment 8

Embodiments 1-7 show a basic circuit configuration for an LED illumination apparatus, but this embodiment illustrates an instance in which a circuit is connected that bypasses a disabled LED in a high frequency unit.

Fig. 23 is a circuit diagram of an LED lighting device illustrating Embodiment 8. In this figure, 6-18 have the same configurations and operations as in Fig. 7 of Embodiment 2, so descriptions are omitted. In the figure, 45 indicates an LED array, 46 is LEDs, 47 is a bypass inductor that is connected to each LED forming the LED array 45 in parallel. The bypass inductor 47 is configured to always have a higher impedance than voltage drop by the LEDs 46, and also a sufficiently smaller inductance than the inductor 10.

[0066]
Next, operations will be explained based on Fig. 23.

When all LEDs 46 are working well, current does not flow to the bypass capacitor 47. When part of the LEDs 46 is disabled, current flows to the bypass inductor 47 only in the disabled portion, and the other LEDs 46 are continuously lighted.

The bypass inductor 47 has sufficiently smaller inductance than the inductor 10, so no great change occurs in the current introduced to the LED array 45 even if a portion of the LED 46 is disabled. Also, in general LEDs break down due to wire breakage, but in some rare cases they break down due to short-circuits. However, even in cases in which a portion of the LED 46 is short-circuited and broken down, there is largely no change in operation.

[0067]
Fig. 24 is a n example variant of Fig. 23. All LEDs 46 are connected in antiparallel, and the bypass inductor 47 is connected to each in parallel. The inductance setting for the bypass inductor 47 is the same as in Fig. 23, and the operations when a portion of the LEDs 46 are disabled are the same as in Fig 23.

The example in Fig. 24, is advantageous in that the number of bypass inductors 47 connected can be reduced by half compared to Fig. 23, but is disadvantageous in that, if a portion of the LEDs 46 is disabled, the paired LEDs 46 will also be turned off.

[0068]
Fig. 25 shows a case in which a protective circuit is added to the inverter circuit 6. In the drawing, 48 indicates a voltage detection circuit for detecting the voltage of the LED array 45.

In Fig. 23 or Fig. 24, when a large number of LEDs 46 are disabled, the voltage of the LED array 45 rises, resulting in the inverter circuit 6 entering an advanced phase state, which may cause a malfunction.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1263

Thereupon, if the voltage of the LED array 45 exceeds a prescribed value, the control circuit 8 determines that a large number of LEDs are disabled, and stops driving the inverter circuit 6.

[0069]
In the above manner, even if a portion of the LEDs constituting the LED array breaks down due to wire breakage or short-circuit, it is possible to keep other LEDs lighted, by providing a DC power supply circuit, an inverter circuit for converting DC to high frequency, a control circuit for controlling the inverter circuit, a first inductor for restricting the output current of the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected in series to a series circuit of the first inductor and the DC cut capacitor, where, in the LED unit, LED arrays are connected in antiparallel with one another, and for each LED forming an LED array an inductor having sufficiently small inductance in comparison to the first inductor is connected in parallel.

[0070]
In addition, even if a portion of the LEDs constituting the LED array breaks down due to wire breakage or short-circuit, it is possible to keep other LEDs lighted, by providing a DC power supply circuit, an inverter circuit for converting DC to high frequency, a control circuit for driving the inverter circuit, a first inductor for restricting output current of the inverter circuit, a DC cut capacitor connected in series to the first inductor, and an LED unit connected in series to the series circuit of the first inductor and the DC cut capacitor, where, in the LED unit, a plurality of paired LEDs in antiparallel connection with one another are connected in series, and for each of the pairs an inductor having sufficiently small inductance in comparison to the first inductor is connected in parallel.

[0071]
Also, it is possible to avoid breakdowns due to malfunctions of the inverter circuit when LEDs are disabled in large numbers by providing a voltage detection circuit for detecting voltage at both ends of an LED unit, and stopping the inverter circuit when the detected voltage exceeds a prescribed value.

[0072]
Embodiment 9

In Embodiment 8 an inductor for restricting current and a bypass inductor are provided individually, but this embodiment is configured with an inductor performing both functions.

Fig. 26 is a circuit diagram of an LED lighting device illustrating Embodiment 9.

In the drawing, 6-45 have the same configurations and operations as Fig. 23 of Embodiment 8, so descriptions are omitted. In the drawing, 49a and 49b are dual-function inductors, and when La and Lb are the individual inductances of the dual-function inductors 49a and 49b, and L10 is the inductance of the inductor 10 in Embodiment 1, La and Lb are set such that $L10=\Sigma La=\Sigma Lb$.

[0073]
Next, operations will be explained based on Fig. 26.

When the LEDs 46 are working well and current flows in the direction of C in the drawing, the flow of output current from the inverter circuit 6 is inverter circuit 6 → DC cut capacitor 9 → LED 46 → dual-function inductor 49b → ground (path 1), and in the direction of D, the flow is ground → LED 46 → dual-function inductor 49a → DC cut capacitor 9 → inverter circuit 6 (path 2).

Therefore, for example, in the case of path 1, high frequency current from the inverter circuit 6 is restricted by the dual-function inductor 49b, and the LEDs 46 are lighted by half-wave rectified high frequency current. It is the same for the path 2 as for the path 1.

At this point, if a portion of the LEDs 46 is disabled, current flows to the dual-function inductor 49a connected in parallel to that LED, thereby bypassing the disabled LED.

[0074]
In the above manner, even if the LEDs constituting the LED array undergo wire breakage or short-circuit, it is possible to keep other LEDs lighted normally, by providing a DC power supply circuit, an inverter circuit for converting DC to high frequency, and a series circuit of an LED unit and a DC cut capacitor connected to the

output point of the inverter circuit, where, in the LED unit, a plurality of LEDs are connected in antiparallel, and an inductor is connected in parallel to each LED. It is also possible to configure with fewer parts by making the inductor for restricting current double as the inductor for bypassing disabled LEDs.

[0075]
This embodiment is illustrated with the LED array 45, but it can also be applied to the configuration with the white LEDs and colored LEDs shown in Fig. 7 of Embodiment 2.

[0076]
Embodiment 10

Embodiments 1-7 show examples of appropriate control of luminescent color relative to degree of dimming, but this embodiment illustrates appropriate distribution of light relative to the degree of dimming.

Fig. 27 is a diagram of a bulb-type illumination apparatus illustrating Embodiment 10, and Figs. 28 and 29 show the state of light distribution when the bulb-type illumination apparatus of Fig. 27 is used.

[0077]
The symbols in Fig. 1 are the same as those of Fig. 4 in Embodiment 1, but the arrangement of the white LEDs 11a and the colored LEDs 12a differs. The white LEDs 11a are disposed so as to chiefly illuminate the lower surface of the device, and the bulb-colored LEDs 12a are disposed so as to chiefly illuminate an upper surface from the side of the device.

[0078]
Fig. 28 shows an example in which the bulb-type illumination apparatus of Fig. 27 is used, the same power is supplied to the white LEDs 11a and bulb-colored LEDs 12a, and both are lighted with the same brightness. In the drawing, 50 indicates the bulb-type light device shown in Fig. 27 and 51 is a room. Based on the arrangement of LEDs of each color, it is possible to illuminate the floor of the room with white light, and to illuminate the walls and ceiling with bulb-colored light.

In addition, by incorporating the type of LED lighting circuit illustrated in Embodiments 1-5, as Fig. 29 (a) and (b) show, it is possible to illuminate the floor surface with the color white when at full brightness, and to illuminate the walls and ceiling with a bulb-color when dimming.

[0079]
In the above manner, it is possible to improve light-rendering properties in the direction of the floor surface, and also to create a restful feeling in the direction of the walls and ceiling, by integrally fitting the LED lighting device described in Embodiments 1-7 to a housing of approximately the same outer diameter as an incandescent bulb having a cap, and also arranging the first light-emitting means or the white LEDs to illuminate in the direction of the floor, and the second light-emitting means or the colored LEDs to illuminate in the direction of the walls or ceiling.

[0080]
In Embodiments 1-7 and 10, bulb-colored LEDs were used for the colored LEDs as opposed to the white LEDs, but LEDs that emit yellow, orange, or another luminescent color could also be used to create a restful feeling.

[0081]
In Embodiments 1-5 and 10, the exterior of the illumination apparatus takes the same form as an incandescent bulb, but it could also be semi-spherical as shown, for example, in Fig. 30.

Moreover, a bulb-colored LED was used as a means for emitting bulb-colored light, but depending on installation space, power consumption, costs, etc., a filament-type illumination apparatus such as a miniature bulb could be used.

[0082]
Embodiments 1-8 and 10 are embodiments configured using white LEDs and bulb-colored LEDs primarily with residential lighting in mind, but for other uses combinations of LEDs having other luminescent colors may be used.

[0083]
[Effects of the Invention]

In the manner above, it is possible to obtain, by means of a simple configuration, a small LED lighting device suitable for general lighting that generates little heat and that is able to render light by changing the luminescent color to a desired color such as white or colored as needed, by providing a first light-emitting

means, a second light-emitting means for a luminescent color differing from the first light-emitting means, and a control means for controlling the first and second light-emitting means, the control means lighting the first light-emitting means as the main illuminating means at full brightness, lighting the second light-emitting means as the main illuminating means when dimming, making the luminescent color of either of first or the second light-emitting means be white, and continuously changing brightness and luminescent color when at full brightness, and brightness and luminescent color when dimming.

[Brief description of the Drawings]

[Fig. 1] A circuit diagram of an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 2] A drawing of the output waveform of a phase-control type dimmer of an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 3] A drawing showing the relationship between phase angle of a phase-control type dimmer and current flowing to each LED array in an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 4] A diagram of a bulb-type illumination apparatus incorporating an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 5] A drawing showing the relationship between degree of dimming and luminescent color when current is changed in an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 6] A circuit diagram of an LED lighting device illustrating Embodiment 1 of the invention.
[Fig. 7] A circuit diagram of an LED lighting device illustrating Embodiment 2 of the invention.
[Fig. 8] A drawing showing the relationship between phase angle of a phase-control type dimmer and current flowing to each LED array in an LED lighting device illustrating Embodiment 2 of the invention.
[Fig. 9] A circuit diagram of an LED lighting device illustrating Embodiment 3 of the invention.
[Fig. 10] An illustration of the output voltage of a direct current power supply and the on-duty of a switching element in an LED lighting device illustrating Embodiment 3 of this invention.
[Fig. 11] A drawing showing the relationship between degree of dimming and average current to the LEDs in an LED lighting device illustrating Embodiment 3 of the invention.
[Fig. 12] A circuit diagram of an LED lighting device illustrating Embodiment 4 of the invention.
[Fig. 13] An illustration of the output voltage of a direct current power supply and the on-duty of a switching element in an LED lighting device illustrating Embodiment 4 of this invention.
[Fig. 14] A drawing showing the relationship between degree of dimming and average current to the LEDs in an LED lighting device illustrating Embodiment 4 of the invention.
[Fig. 15] A circuit diagram of an LED lighting device illustrating Embodiment 4 of the invention.
[Fig. 16] A diagram of a bulb-type illumination apparatus illustrating Embodiment 5 of the invention.
[Fig. 17] A diagram of the output voltage of the direct current power supply and the on-duty of a switching element of a bulb-type illumination apparatus illustrating Embodiment 5 of the invention.
[Fig. 18] A diagram illustrating the relationship between the average current of the LEDs and the switch position (dimming degree) of a bulb-type illumination apparatus illustrating Embodiment 5 of the invention.
[Fig. 19] A block diagram of a straight-tube fluorescent illumination apparatus illustrating Embodiment 6 of the invention.
[Fig. 20] A block diagram of a straight-tube fluorescent illumination apparatus fitted to a fluorescent lighting device illustrating Embodiment 6 of the invention.
[Fig. 21] A block diagram of a straight-tube fluorescent illumination apparatus fitted to a fluorescent lighting device illustrating Embodiment 7 of the invention.
[Fig. 22] An explanatory drawing of a cap portion of a straight-tube fluorescent illumination apparatus illustrating Embodiment 7 of the invention.
[Fig. 23] A circuit diagram of an LED lighting device illustrating Embodiment 8 of the invention.
[Fig. 24] A circuit diagram of an LED lighting device illustrating Embodiment 8 of the invention.
[Fig. 25] A circuit diagram of an LED lighting device illustrating Embodiment 8 of the invention.
[Fig. 26] A circuit diagram of an LED lighting device illustrating Embodiment 9 of the invention.
[Fig. 27] A diagram of a bulb-type illumination apparatus illustrating Embodiment 10 of the invention.
[Fig. 28] A diagram showing the distribution of light when a bulb-type illumination apparatus illustrating Embodiment 10 of the invention is used.
[Fig. 29] A diagram showing the distribution of light when a bulb-type illumination apparatus illustrating Embodiment

10 of the invention is used.

[Fig. 30] A diagram of a bulb-type illumination apparatus illustrating Embodiment 10 of the invention.

[Key to Symbols]

1: Commercial power supply; 2, 18, 25: DC power supply; 5: Impedance element; 6: Inverter circuit; 8: Control circuit; 9: DC cut capacitor; 10, 20, 49a, 49b: Inductor; 11, 21: White LED unit; 11a: White LED; 12, 23: Bulb-colored LED unit; 12a: Bulb-colored LED; 14: Phase-control type dimmer; 15a, 15b, 38: Housing; 16, 41a, 41b: Cap; 19, 45: LED unit; 22, 44a: Capacitor; 24: External signal; 27, 32, 35: Switching element; 36: Inversion element; 37: Sliding switch; 39: Lighting circuit board; 40a-40d: Terminal; 46: LED; 48: Voltage detection circuit.

Fig. 1

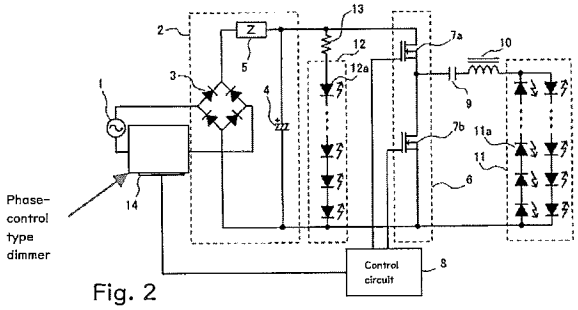


Fig. 2

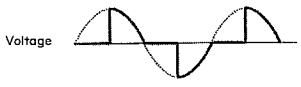


Fig. 3

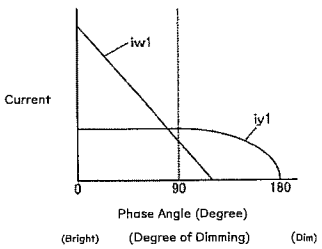


Fig. 4

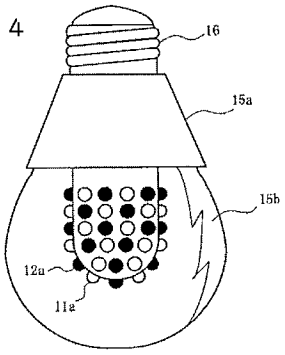


Fig. 5

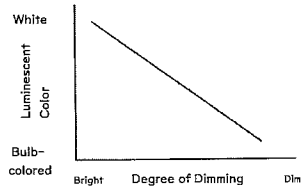


Fig. 6

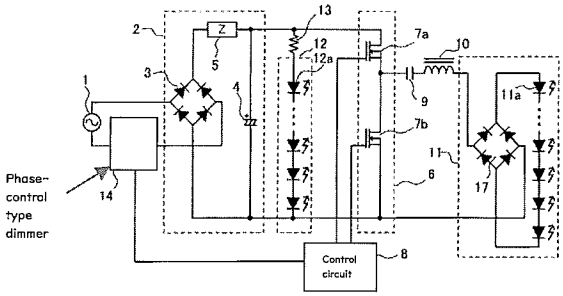


Fig. 8

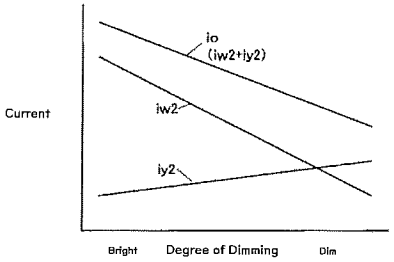


Fig. 7

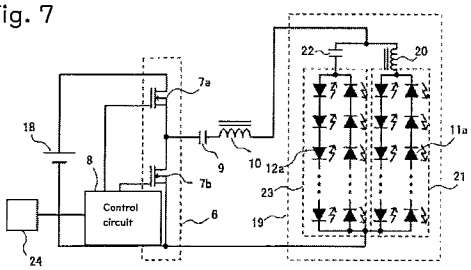


Fig. 9

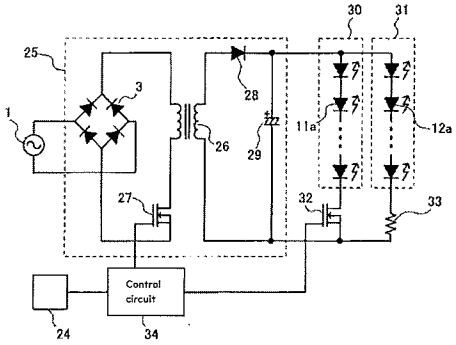


Fig. 10

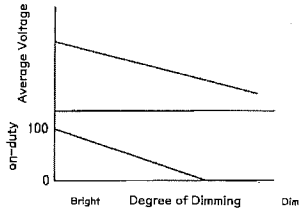


Fig. 12

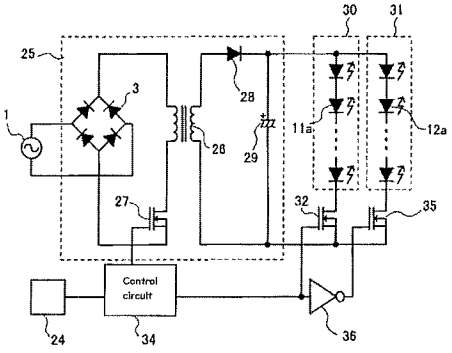


Fig. 11

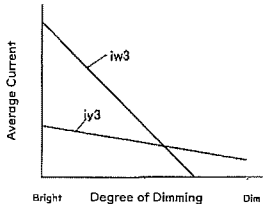


Fig. 13

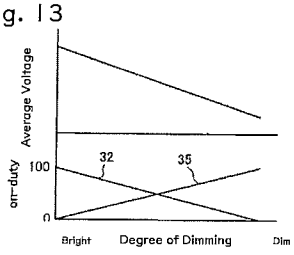


Fig. 14

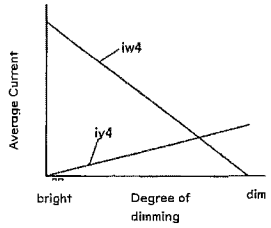


Fig. 15

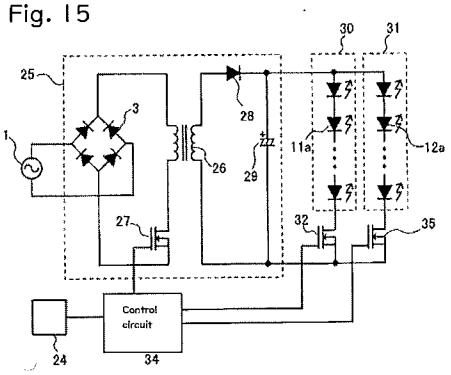


Fig. 16

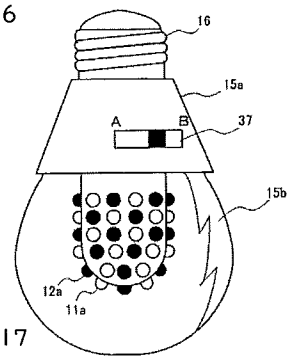


Fig. 17

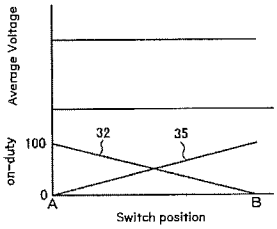


Fig. 18

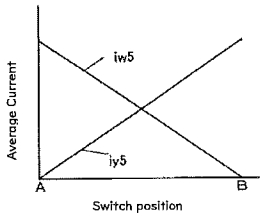


Fig. 19

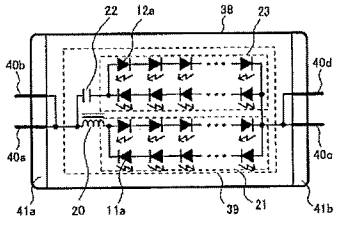


Fig. 20

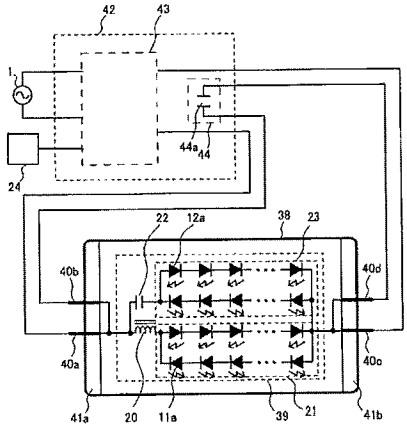


Fig 21

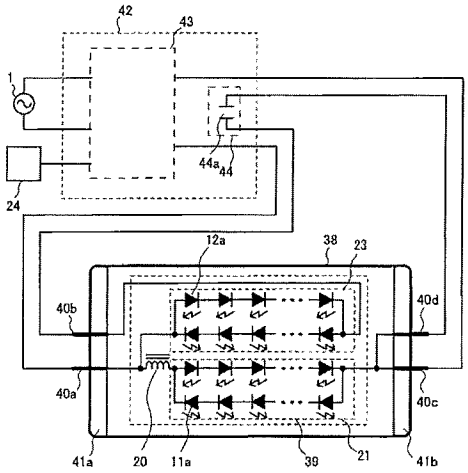


Fig. 22

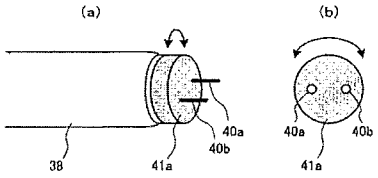


Fig. 23

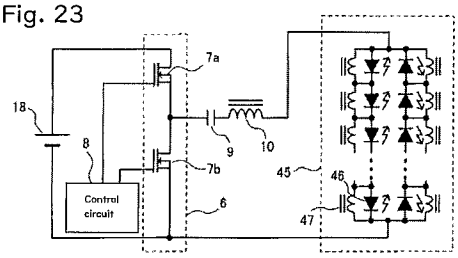


Fig. 24

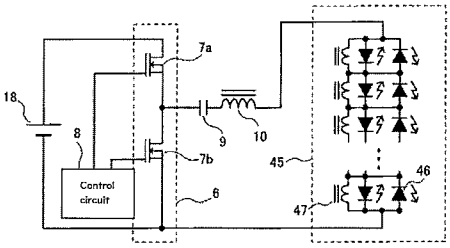


Fig. 25

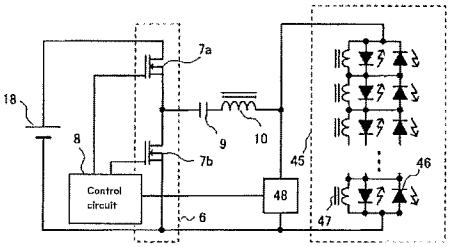


Fig. 26

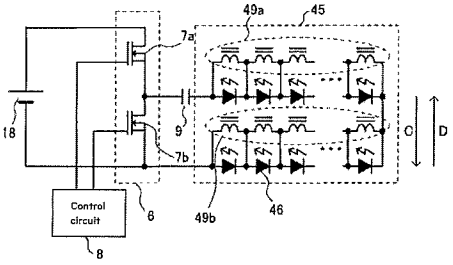


Fig. 27

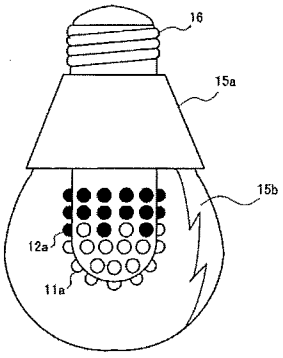


Fig. 28

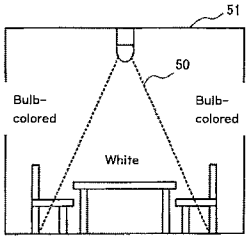


Fig. 29

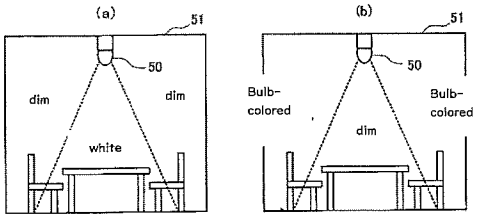
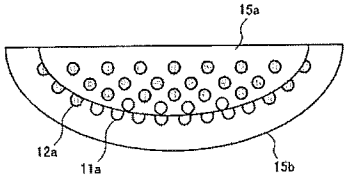

(a)
51
50
dim
dim
white
(b)
51
50
Bulb-colored
Bulb-colored
dim

Fig. 30


15a
12a
11a
15b

Continued from front page

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I, Randi Simons, certify that I am competent in both Japanese and English languages and that the foregoing translation of the specification, claims, abstract, and drawings of the Japanese application number 2002-269034 is an exact and accurate translation of the original. I understand that willful false statements and the like are punishable by fine or imprisonment, or both, pursuant to 18 U.S.C. § 1001.

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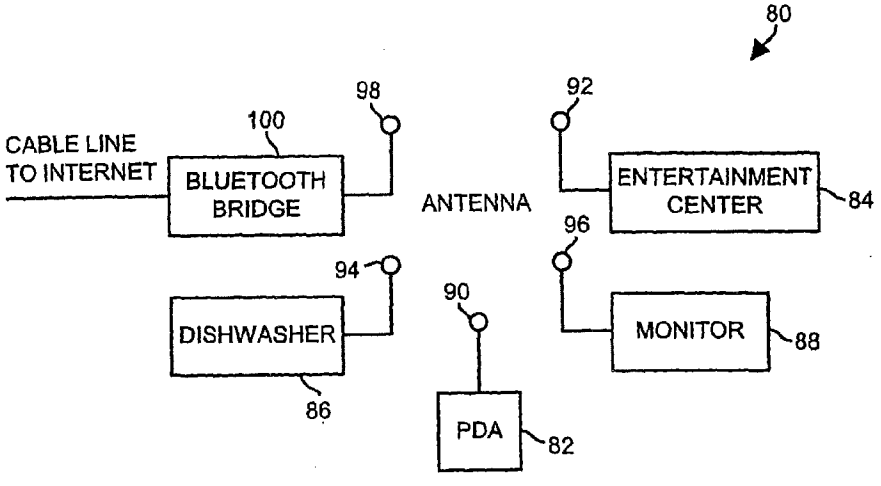
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(54) **Title:** SYSTEM AND METHOD FOR MEASURING THE USAGE OF WIRELESS DEVICES



(57) **Abstract:** A system is provided to accumulate usage data regarding a user's use of a wireless device. The system includes the wireless device having a wireless coupling adapted to wirelessly couple the wireless device to another wireless device. The system also includes a usage meter arranged to generate usage data relating to a user's use of the wireless device. The usage meter may be part of, or may be separate from, the wireless device.

WO 02/21741 A1

PGR2023-00016 Ex. 1009
SAMSUNG EXHIBIT 1009
Ex. 1003 - Page 1275

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PGR2023-00016 - Home Depot
Ex. 1003 - Page 1276

SYSTEM AND METHOD FOR MEASURING THE USAGE OF WIRELESS DEVICES

Technical Field of the Invention

The present invention is directed to the measurement of the usage of devices coupled to wireless and almost wireless networks.

Background of the Invention

Wireless networking has a wide variety of applications. For example, a battery powered pair of head phones can wirelessly receive audio signals from a receiver. A personal digital assistant (PDA) such as a palm sized device may be arranged to wirelessly synchronize itself with a desktop computer or may wirelessly use a nearby cell-phone to connect to the Internet. The cell-phone can even be hidden in a briefcase.

These wireless network examples have received a substantial amount of attention in the media. However, there are many other examples of wireless networking. For instance, it may very well be possible to

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1277

interconnect every electrical device, such as the light bulbs within the electrical grid of an office complex and intelligent refrigerators that allow users to keep track of and/or order groceries, in one large wireless network.

There are currently two wireless technologies, infrared and short-range RF, and one almost wireless technology, power system overlay networks, that are easily useable in providing wireless networking today, although other wireless communication technologies may be readily employed to interconnect devices in a network. Power system overlay is referred to herein as an almost wireless networking technology because, although it involves wires, this technology involves the use of existing wiring systems to support communication between devices in a network.

Infrared signaling has been used for many years in the remote control of television and other video and/or audio appliances. Short bursts of infrared light are emitted by the remote control in patterns that are recognized by the appliance. Each button on the remote has an assigned pattern. Infrared signaling systems have

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1278

also been designed to support connections between host computers and peripherals such as PDA's and printers. These systems are simple, they support rudimentary error detection and correction, they are typically used over very short distances, and they seldom extend beyond a room because infrared does not penetrate walls. Also, they typically work only in direct line-of-sight applications. More advanced spread-spectrum infrared based networks have been proposed, but have not as yet received much support.

Short range RF systems have recently received significant industry attention and endorsements. The Bluetooth system, in particular, is fast becoming a standard among cell-phone and PDA designers. There are also other similar systems such as Aironet, HomeRF, WaveLAN, RadioLAN, Airport, and ShareWave. The Bluetooth system uses spread spectrum around a 2.4 GHz carrier frequency. There are actually two varieties of Bluetooth systems, one for short range (within a couple of rooms), and the other for longer range (around the house or office). The signaling protocols used by the Bluetooth

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1279

systems are quite detailed and support addressing, sub-networking, and bridges between infrared systems and a Bluetooth network.

Systems which transmit signals over household AC power lines, such as those including BSR modules supplied by Radio Shack, have been used for remotely controlling loads. For example, household power lines have been used to carry signals for turning on a lamp in one room using a console located in another room. BSR modules support a simple addressing scheme for very short (i.e. 1 byte) data transfers, and provide control signals that are modulated onto a 100 kHz carrier signal which is injected on top of the 60 Hz AC power line signal. The range of this signal varies depending on the house wiring, and sometimes extends into the neighbor's house or apartment.

In the future it may also be possible to interconnect a computer with its peripherals, such as printers and scanners, by simply plugging the computer and its peripherals into wall outlets. Similarly, the components of a stereo system may be interconnected by

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1280

plugging these components into wall outlets thereby avoiding the usual tangle of audio cables. Thus, while using AC power lines for communication is not a strictly "wireless" use, the use of AC power lines for communications is wireless in the sense that such communication is supported by existing wiring and is not the primary purpose of the existing wiring.

The present invention is directed to arrangements for measuring the use of devices interconnected by a wireless communication system.

Summary of the Invention

In accordance with one aspect of the present invention, a wireless network comprises first and second wireless devices and a usage meter. The first and second wireless devices wirelessly transmit and/or receive signals, and the second wireless device is wirelessly coupled with the first device. The usage meter generates usage data relating to a user's use of at least the first wireless device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1281

In accordance with another aspect of the present invention, a method comprises metering usage of a wireless device to generate usage data regarding a user's use of the wireless device, and communicating the usage data to at least one central data collection facility.

In accordance with yet another aspect of the present invention, a system for accumulating usage data regarding a user's use of a wireless device comprises a wireless device and a usage meter. The wireless device has a wireless coupling adapted to wirelessly couple the wireless device to another wireless device. The usage meter is arranged to generate usage data relating to a user's use of the wireless device.

In accordance with a further aspect of the present invention, a computer readable storage medium has program code stored therein. The program code, when executed by a computer, performs the function of metering usage of a wireless device in order to generate usage data relating to a user's use of the wireless device.

Brief Description of the Drawings

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1282

These and other features and advantages of the present invention will become more apparent from a detailed consideration of the invention when taken in conjunction with the drawings in which:

Figure 1 shows an RF wireless network according to a first embodiment of the present invention;

Figure 2 shows an infrared wireless network according to a second embodiment of the present invention;

Figure 3 shows a power line wireless network according to a third embodiment of the present invention;

Figure 4 shows a wireless network accordingly to a fourth embodiment of the present invention;

Figure 5 shows a mixed wireless network accordingly to a fifth embodiment of the present invention; and,

Figure 6 is a flow chart of an exemplary usage meter that can be used in connection with the first, second, third, fourth, and/or fifth embodiments of the present invention.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1283

Detailed Description

Typical measurements of device usage have been made by observing the behavior of panels comprised of members who are statistically selected as being representative of the relevant population whose device usage is being measured. For example, television usage is measured by determining which panel members watch which programs at which times. However, the interests of research organizations go well beyond the collection of simple channel selection information in a subset of the population.

For example, data collection reporting systems can be built into the devices whose usage is to be measured. Thus, the usage of a wide variety of devices other than televisions can be measured. Moreover, instead of measuring device usage of a randomly selected population sub-set (i.e., panel), the inclusion of data collection reporting systems directly into devices permits detailed comprehensive data to be obtained about the entire population that uses a particular device

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1284

rather than a limited population sub-set constituted as a panel.

Such comprehensive device use measurement poses problems, however, especially for certain devices. For example, television, and in particular interactive television, is a complicated device to measure because users may be both browsing the web and watching television at the same time. As another example, users may lay a web browser window over the visible television screen entirely. Also, web users may view other content including streaming media content. Moreover, users may see a television advertisement and click on it to get more information and/or to buy the product then and there. Furthermore, clients of market researchers are interested in knowing the web sites that people visit, the reasons that they visit them, and what they do at those web sites. In short, there are many user activities and a multitude of devices beyond television that a market researcher should measure and report.

The following three activities are typically involved in device measurement: the gathering of

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1285

information, the processing of the gathered information, and the forwarding or transmission of the gathered and processed information. Generally, there are five ways to gather information relating to device usage measurement. First, communications between devices can be passively monitored by a device usage data collector in order to gather data relating to device usage measurement. For example, in the case of wireless systems, a receiver tuned to the appropriate frequency (and in the case of spread spectrum, altering the frequency as needed) can listen in on the messages exchanged between these devices. Several companies have built tools permitting the monitoring and debugging of the signals transmitted over a Bluetooth RF network.

In general, many of the messages transmitted between a transmitter and a receiver are not of interest. For example, a device might send a message to another device asking how much memory is available in a certain buffer. On the other hand, some messages are very useful. For example, a remote control may instruct a stereo receiver to tune into a particular radio station.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1286

There are also inferences that a research company can make based on some messages that do not appear at first to be very apparent. For example, a remote control which does not transmit a signal for a specified period of time may indicate that a piece of equipment is idle, or a message indicating that there are twenty minutes of time remaining on the batteries of a device indicates that the device operates on batteries.

Second, a device usage data collector can be arranged to be an active/passive participant in a communications network. Such a collector requires a receiver and a transmitter so that it can both passively listen through its receiver to message traffic and actively solicit information through its transmitter. Many protocols permit this type of monitoring. For example, the Link Manager Protocol associated with the Bluetooth network can be used for this purpose.

Third, monitors that directly tap into devices through the use of hardware connections can be used to determine usage of those devices. Such device usage data collectors can participate in network exchanges and

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1287

extract data from the devices' electrical signals. Such data collection is common in television use measurement where the monitor taps into the television's tuner to determine the frequency to which the television is tuned. Similarly, a dishwasher with a built-in web interface may be modified to produce usage data that can be processed.

Fourth, another method that can be used for device use data collection is polling. For example, if there is a PDA and a television both participating on a Bluetooth network, a Bluetooth monitor can be modified and provided in the network in order to query, such as every half second, both the PDA and the television in order to request information indicative of the use of these devices. New protocols supported by these wireless networks even allow devices in the network to publish (on the network) their vocabularies, and to disclose the queries to which they are able to respond.

Fifth, the measurement of device usage can also be provided in an interrupt driven monitor. Polling to determine device usage can be very wasteful of network resources. For example, in the context of television

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1288

viewing measurement, a user may change the channel on a television set once every ten minutes on average. A polling mechanism that queries the television every half second would make 1200 superfluous queries during that time. A more efficient arrangement for providing device usage measurement involves modifying the device whose usage is to be monitored so that the device itself initiates a message to the monitor every time some event of interest occurs. Thus, considerable bandwidth can be saved.

Once data is gathered, the data is often "processed" in some way by the collection system before the data is forwarded to a central data collection facility, where the data is combined with data from other collection systems and used to generate reports. Generally, data can be processed in three ways. First, usage data can simply be forwarded to the data collection server. This data processing is the simplest data processing method, but it often uses up the most bandwidth because the data collected can be enormous. In the case of polling, for example, if every response to

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1289

every poll is forwarded to the central data collection facility, much bandwidth will be wasted. However, this data is often very compressible (i.e. there is not much innate randomness in the data), so that data compression can be used to reduce the required bandwidth.

Second, the data can be modified before it is transmitted to the central data collection facility. For example, in the polling example described above, rather than forward all polling responses to the central data collection facility, it may be necessary to forward only the data representing changes in usage. However, the rules governing the selection of data for forwarding in this data forwarding method are often very arbitrary. For example, system designers often are able to predict what data processing may (or should) occur in a central data collection facility, and to design at least some of that processing into the device monitor. Thus, in the case of collecting an advertising banner which has been displayed on a PDA, the banner image itself may be forwarded to the central data collection facility, but a signature (such as a checksum) or some other identifying

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1290

indicia may also be computed and sent along with the data. Accordingly, the decision of computing the indicia locally as opposed to computing it within the central facility is at least somewhat arbitrary.

Third, an important part of processing data (that may or may not be modified through processing) is to store the data before it is forwarded to the central data collection facility. Very often, data must be held locally in storage, perhaps in general device memory, perhaps in an output buffer, or perhaps in a local file on a diskette, before it can be forwarded to the data collection facility. The data can be held in memory for microseconds, seconds, hours, days, or even weeks before it is forwarded.

Once data is gathered and processed, it is forwarded to the data collection facility. An interesting aspect of the new wireless networks described herein is that they can greatly support the transmission of measurement data to the central data collection facility. For example, a Bluetooth compliant cell phone may advertise (by publishing its vocabulary and supported

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1291

operations) that it has access to the Internet. A well-designed measurement system would take advantage of this connectivity to transmit data across the Internet to the data collection facility. Bridges can connect each type of the wireless networks, Infrared, RF, or Power, to the Internet. While it is not yet clear which type of link will dominate, it is fairly certain that there will be a Bluetooth bridge connecting PDAs to PCS. Also, there can be a Bluetooth bridge that connects PDAs directly to ISPs through a house's cable modem. There can even be a Bluetooth bridge that connects PDAs to ISPs through DSL lines.

Thus, there will we connectivity within these networks and bridging these networks to other networks and the Internet. These bridges are easily used by data collection systems.

Figure 1 shows an RF wireless network 10 that couples a PDA 12 to a computer 14. Use of the computer 14 can be monitored with metering software, such as that shown in Figure 6, embedded and operating therein. Similarly, the PDA 12 can also be monitored with metering

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1292

software, such as that shown in Figure 6, embedded and operating therein. The PDA usage data can be transferred from the PDA 12 over RF antennae 16 and 18 coupled to the PDA 12 and the computer 14, respectively. The PDA usage data and/or the computer usage data are sent upstream through a DSL or other modem 20 over the Internet to a central data collection facility, where the usage data is combined with usage data from other metered devices in order to generate suitable reports. If metering software cannot be installed on the PDA 12, the computer 14 can be arranged to monitor requests and/or transfers made by the PDA 12 through the RF antennae 16 and 18 and thereby infer usage data therefrom.

Figure 2 shows an infrared wireless network 30 that couples a PDA 32 to a computer 34. Use of the computer 34 can be monitored with metering software, such as that shown in Figure 6, embedded and operating therein. Similarly, the PDA 32 can also be monitored with metering software, such as that shown in Figure 6, embedded and operating therein. The PDA usage data can be transferred from the PDA 32 over infrared transceivers

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1293

36 and 38 coupled to the PDA 32 and the computer 34, respectively. The PDA usage data and/or the computer usage data are sent upstream through a DSL or other modem 40 over the Internet to a central data collection facility, where the usage data is combined with usage data from other metered devices in order to generate suitable reports. If metering software cannot be installed on the PDA 32, the computer 34 can be arranged to monitor requests and/or transfers made by the PDA 32 through the infrared transceivers 36 and 38 and thereby infer usage data therefrom.

Figure 3 shows a power line "wireless" network 50 that couples a PDA 52 to a computer 54. Use of the computer 54 can be monitored with metering software, such as that shown in Figure 6, embedded and operating therein. Similarly, the PDA 52 can also be monitored with metering software, such as that shown in Figure 6, embedded and operating therein. The PDA usage data can be transferred from the PDA 52 over existing power lines 56 within a building by way of electrical outlet plugs 58 and 60 coupled to the PDA 52 and the computer 54,

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1294

respectively. The PDA usage data and/or the computer usage data are sent upstream through a DSL or other modem 62 over the Internet to a central data collection facility, where the usage data is combined with usage data from other metered devices in order to generate suitable reports. If metering software cannot be installed on the PDA 52, the computer 54 can be arranged to monitor requests and/or transfers made by the PDA 52 through the electrical outlet plugs 58 and 60 and the existing power lines 56 and thereby infer usage data therefrom.

Figure 4 illustrates an example of a wireless network 80 which does not have a computer. The wireless network 80 includes a PDA 82, an entertainment center 84, a dishwasher 86, and a usage data collector 88. The entertainment center 84 may include a television, a radio, a VCR, a DVD player, a CD player, and/or so on. The PDA 82, the entertainment center 84, the dishwasher 86, and the usage data collector 88 are interconnected wirelessly by corresponding communication devices 90, 92, 94, and 96. The communication devices 90, 92, 94, and 96

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1295

can be RF antennae, IR transceivers, or electrical outlet plugs as in the case of Figures 1, 2, and 3, respectively.

The PDA 82, the entertainment center 84, and the dishwasher 86 may each be provided with an embedded usage meter in the form of software and/or hardware operating in accordance, for example, with the flow chart shown in Figure 6. In this case, the usage data collector 88 may be unnecessary. The usage meters embedded in the PDA 82, the entertainment center 84, and the dishwasher 86 may be arranged to transmit the usage data that they collect by way of a further communication device 98 and a communication bridge 100 which periodically or aperiodically forwards this usage data to a central data collection facility, where the usage data is combined with usage data from other metered devices in order to generate suitable reports.

Alternatively, the usage meters embedded in the PDA 82, the entertainment center 84, and the dishwasher 86 may be arranged to report their collected usage data to the usage data collector 88 by use of the

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1296

communication devices 90, 92, 94, and 96. The usage data collector 88 would then be arranged to periodically or aperiodically transmit the usage data that it collects from the embedded usage meters of the PDA 82, the entertainment center 84, and the dishwasher 86 by way of the communication device 96 and the further communication device 98 to the communication bridge 100 which periodically or aperiodically forwards this usage data to the central data collection facility.

As a still further alternative, the embedded usage meters provided in the PDA 82, the entertainment center 84, and the dishwasher 86 may be arranged to periodically or aperiodically communicate the usage data regarding their corresponding PDA 82, entertainment center 84, and dishwasher 86 directly to a central data collection facility without the use of the communication bridge 100. As a yet further alternative, the usage data collector 88 could be built into one or more of the PDA 82, the entertainment center 84, and the dishwasher 86.

As another example, a usage meter in the form of software and/or hardware operating in accordance with,

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1297

for example, the flow chart shown in Figure 6 may be provided in the usage data collector 88. In this case, the usage data collector 88 collects usage data based on the messages transmitted by or to the PDA 82, the entertainment center 84, and/or the dishwasher 86 through the communication devices 90, 92, 94, and/or 96.

Figure 5 illustrates an example of a wireless network 110 which utilizes all three of the exemplary wireless communication technologies discussed above, i.e., RF wireless communications, infrared wireless communications, and wireless power line communications, although any wireless network according to the present invention could use any combination of one or more of these or other wireless technologies. The wireless network 110 includes a PDA 112, a refrigerator 114, a dishwasher 116, and a usage data collector 118. The PDA 112, the refrigerator 114, the dishwasher 116, and the usage data collector 118 are interconnected wirelessly by corresponding RF antennae 120, 122, 124, and 126. In addition, the wireless network 110 includes a fax machine 128 which is wirelessly coupled to the usage data

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1298

collector 118 by way of corresponding IR transceivers 130 and 132.

The usage data collector 118 includes an embedded usage meter in the form of software and/or hardware operating in accordance, for example, with the flow chart shown in Figure 6. Accordingly, usage of the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 is monitored by the embedded usage meter. The usage data collector 118 can be arranged to periodically or aperiodically transmit the usage data that it collects from the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 to a communication bridge 134 over power lines 136 by way of an electrical outlet plug 138 coupled to the usage data collector 118 and an electrical outlet plug 140 coupled to the communication bridge 134. The communication bridge 134 periodically or aperiodically forwards this usage data to a central data collection facility, where the usage data is combined with usage data from other metered devices in order to generate suitable reports.

Alternatively, the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 may each be provided with an embedded usage meter in the form of software and/or hardware operating in accordance, for example, with the flow chart shown in Figure 6. Accordingly, usage of the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 is monitored by these embedded usage meters and these embedded usage meters report this collected usage data to the usage data collector 118 by use of the RF antennae 120, 122, 124, and 126 and the IR transceivers 130 and 132. As before, the usage data collector 118 can be arranged to periodically or aperiodically transmit the usage data that it collects to the communication bridge 134 over the power lines 136 by way of the electrical outlet plugs 138 and 140, and the communication bridge 134 periodically or aperiodically forwards this usage data to the central data collection facility.

As a still further alternative, the embedded usage meters provided in the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 may be

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1300

arranged to periodically or aperiodically communicate the usage data regarding their corresponding PDA 112, refrigerator 114, dishwasher 116, and fax machine 128 directly to the communication bridge 134 for forwarding to the central data collection facility. In this case, the usage data collector 118 is unnecessary. As a yet further alternative, the usage data collector 118 could be built into one or more of the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128.

As another alternative, embedded usage meters may be provided in the PDA 112, the refrigerator 114, the dishwasher 116, and the fax machine 128 and/or the usage data collector 118 and may be arranged to periodically or aperiodically communicate the usage data regarding their corresponding PDA 112, refrigerator 114, dishwasher 116, and fax machine 128 directly to the central data collection facility without use of the communication bridge 134.

An exemplary usage meter 150 is illustrated in Figure 6 and may be in the form of a program executed by

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1301

its corresponding platform, i.e., a metered device or a separate usage data collector. A block 152 of the usage meter 150 determines whether a message is being transmitted or received by its corresponding platform. In the case where the usage meter 150 is embedded in a platform in the form of a usage data collector such as the usage data collector 88 or 118, the block 152 may be arranged to detect wireless messages picked up over the air such as by the communication device 90, the RF antenna 126, or the IR transceiver 130. In the case where the usage meter 150 is embedded in a platform in the form of a metered device such as the PDA 12, the computer 14, the PDA 32, the computer 34, the PDA 52, the computer 54, the PDA 82, the entertainment center 84, the dishwasher 86, the PDA 112, the refrigerator 114, the dishwasher 116, or the fax machine 128, the block 152 may be arranged to internally detect messages transmitted from or received by its platform.

If the block 152 detects a message, a block 154 determines whether the message relates to usage data of the type that is to be collected. If the message relates

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1302

to usage data of the type that is to be collected, a block 156 time stamps and stores the usage data and a block 158 determines whether it is time to transmit all stored usage data. For example, the usage data may be transmitted immediately upon collection, the usage data may be transmitted at a designated time of day, week, or month, or the usage data may be transmitted when a predetermined amount of usage data has been stored. If it is time to transmit the usage data, a block 160 transmits the usage data.

If the block 152 determines that a message has not been transmitted or received by its corresponding platform, or if the block 154 determine that a transmitted or received message does not relate to usage data of the type that is to be collected, or if the block 158 determines that it is not time to transmit all stored usage data, or after the block 160 transmits the usage data, flow returns to the block 152 to detect the next message or other activity.

Certain modifications and alternatives of the present invention have been discussed above. Other

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1303

modifications and alternatives will occur to those practicing in the art of the present invention. For example, as described above, usage data is transmitted such as by the block 160 to a central data collection facility electronically. Alternatively, this usage data could be forwarded by other means such as by mailing or otherwise forwarding the usage data on floppy disks or other storage media.

Also, as described above, the block 152 of the usage meter 150 detects a transmitted or received message, and the block 154 determines whether the detected message relates to usage data of the type that is to be collected. However, the metered device may be used in a way that does not result in a transmitted or received message but that relates to a use of interest. Therefore, the block 152 of the usage meter 150 also may be arranged to detect internal messages and/or other activities which relate to usage data of the type that is to be collected, as determined by the block 154.

Moreover, as described above, a metered device may be a refrigerator and/or a dishwasher. However,

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1304

other household appliances may also be metered in accordance with the present invention.

Accordingly, the description of the present invention is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the best mode of carrying out the invention. The details may be varied substantially without departing from the spirit of the invention, and the exclusive use of all modifications which are within the scope of the appended claims is reserved.

WHAT IS CLAIMED IS:

1. A wireless network comprising:

a first wireless device that wirelessly transmits and/or receives signals;

a second wireless device that wirelessly transmits and/or receives signals, wherein the second wireless device is wirelessly coupled with the first device; and,

a usage meter that generates usage data relating to a user's use of at least the first wireless device.

2. The wireless network of claim 1 wherein the first wireless device comprises a PDA.

3. The wireless network of claim 1 wherein the first wireless device comprises a computer.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1306

4. The wireless network of claim 1 wherein the first wireless device comprises an entertainment component.

5. The wireless network of claim 1 wherein the first wireless device comprises a fax machine.

6. The wireless network of claim 1 wherein the first wireless device comprises a household appliance.

7. The wireless network of claim 1 wherein the wireless coupling between the first and second wireless devices comprises an RF coupling.

8. The wireless network of claim 1 wherein the wireless coupling between the first and second wireless devices comprises an infrared coupling.

9. The wireless network of claim 1 wherein the wireless coupling between the first and second wireless devices comprises a power line coupling.

10. The wireless network of claim 1 wherein the first wireless device is arranged to electronically transmit the usage data to a remote location.

11. The wireless network of claim 1 wherein the usage meter is arranged to electronically transmit the usage data to a remote location.

12. The wireless network of claim 1 wherein the usage meter is part of the first wireless device.

13. The wireless network of claim 1 wherein the usage meter is wirelessly coupled to the first wireless device.

14. The wireless network of claim 13 wherein the usage meter wirelessly transmits the usage data to a bridge which is arranged to transmit the usage data through an electrical line to a remote location.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1308

15. The wireless network of claim 13 wherein the wireless coupling between the first wireless device and the usage meter comprises an RF coupling.

16. The wireless network of claim 13 wherein the wireless coupling between the first wireless device and the usage meter comprises an infrared coupling.

17. The wireless network of claim 13 wherein the wireless coupling between the first wireless device and the usage meter comprises a power line coupling.

18. The wireless network of claim 1 further comprising third and fourth wireless devices wirelessly coupled to one another, wherein the wireless coupling between the first and second wireless devices comprises an RF coupling and wherein the wireless coupling between the third and fourth wireless devices comprises an infrared coupling.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1309

19. The wireless network of claim 18 wherein the usage meter has an RF coupling and an infrared coupling.

20. The wireless network of claim 1 further comprising third and fourth wireless devices wirelessly coupled to one another, wherein the wireless coupling between the first and second wireless devices comprises an RF coupling and wherein the wireless coupling between the third and fourth wireless devices comprises a power line coupling.

21. The wireless network of claim 20 wherein the usage meter has an RF coupling and a power line coupling.

22. The wireless network of claim 1 further comprising third and fourth wireless devices wirelessly coupled to one another, wherein the wireless coupling between the first and second wireless devices comprises an infrared coupling and wherein the wireless coupling

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1310

between the third and fourth wireless devices comprises a power line coupling.

23. The wireless network of claim 22 wherein the usage meter has an infrared coupling and a power line coupling.

24. The wireless network of claim 1 wherein the usage meter is separate from the first wireless device.

25. The wireless network of claim 1 wherein the usage meter is arranged to passively monitor the user's use of the first wireless device in order to generate the usage data.

26. The wireless network of claim 1 wherein the usage meter is arranged to both actively and passively monitor the user's use of the first wireless device in order to generate the usage data.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1311

27. The wireless network of claim 1 wherein the usage meter is arranged to tap into the wireless network so as to monitor the user's use of the first wireless device in order to generate the usage data.

28. The wireless network of claim 1 wherein the usage meter is arranged to poll the first wireless device in order to generate the usage data.

29. The wireless network of claim 1 wherein the usage meter is arranged to respond to an interrupt from the first wireless device in order to generate the usage data.

30. A method comprising:

metering usage of a wireless device to generate usage data regarding a user's use of the wireless device; and,

communicating the usage data to at least one central data collection facility.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1312

31. The method of claim 30 wherein the wireless device comprises a PDA.

32. The method of claim 30 wherein the wireless device comprises a computer.

33. The method of claim 30 wherein the wireless device comprises an entertainment component.

34. The method of claim 30 wherein the wireless device comprises a fax machine.

35. The method of claim 30 wherein the wireless device comprises a household appliance.

36. The method of claim 30 wherein the wireless device comprises an RF coupling for wireless coupling to another wireless device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1313

37. The method of claim 30 wherein the wireless device includes an infrared coupling for wireless coupling to another wireless device.

38. The method of claim 30 wherein the wireless device includes a power line coupling for wireless coupling to another wireless device.

39. The method of claim 30 wherein a usage meter as part of the wireless device is arranged to meter usage of the wireless device and to communicate the usage data to the at least one central data collection facility.

40. The method of claim 30 wherein the communication of the usage data to the at least one central data collection facility comprises conveyance of a memory unit containing the usage data to the at least one central data collection facility.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1314

41. The method of claim 30 wherein the communication of the usage data to the at least one central data collection facility comprises electronic transmission of the usage data to the at least one central facility.

42. The method of claim 30 wherein the metering of usage of a wireless device comprises passively monitoring the user's use of the wireless device in order to generate the usage data.

43. The method of claim 30 wherein the metering of usage of a wireless device comprises actively and passively monitoring the user's use of the wireless device in order to generate the usage data.

44. The method of claim 30 wherein the metering of usage of a wireless device comprises tapping into a wireless network so as to monitor the user's use of the wireless device in order to generate the usage data.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1315

45. The method of claim 30 wherein the metering of usage of a wireless device comprises polling the wireless device in order to generate the usage data.

46. The method of claim 30 wherein the metering of usage of a wireless device comprises responding to an interrupt from the wireless device in order to generate the usage data.

47. A system for accumulating usage data regarding a user's use of a wireless device comprising:

a wireless device having a wireless coupling adapted to wirelessly couple the wireless device to another wireless device; and,

a usage meter arranged to generate usage data relating to a user's use of the wireless device.

48. The system of claim 47 wherein the wireless coupling comprises an RF coupling.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1316

49. The system of claim 47 wherein the wireless coupling comprises an infrared coupling.

50. The system of claim 47 wherein the wireless coupling comprises a power line coupling.

51. The system of claim 47 wherein the usage meter is arranged to electronically transmit the usage data to a remote location.

52. The system of claim 47 wherein the usage meter is part of the wireless device.

53. The system of claim 47 wherein the usage meter is wirelessly coupled to the wireless device.

54. The system of claim 53 wherein the wireless coupling between the wireless device and the usage meter comprises an RF coupling.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1317

55. The system of claim 53 wherein the wireless coupling between the wireless device and the usage meter comprises an infrared coupling.

56. The system of claim 53 wherein the wireless coupling between the wireless device and the usage meter comprises a power line coupling.

57. The system of claim 47 further comprising an electronic memory arranged to at least temporarily store the usage data.

58. The system of claim 47 wherein the usage meter is arranged to passively monitor the user's use of the wireless device in order to generate the usage data.

59. The system of claim 47 wherein the usage meter is arranged to both actively and passively monitor the user's use of the wireless device in order to generate the usage data.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1318

60. The system of claim 47 wherein the usage meter is arranged to tap into the wireless network so as to monitor the user's use of the wireless device in order to generate the usage data.

61. The system of claim 47 wherein the usage meter is arranged to poll the wireless device in order to generate the usage data.

62. The system of claim 47 wherein the usage meter is arranged to respond to an interrupt from the first wireless device in order to generate the usage data.

63. A computer readable storage medium have program code stored therein wherein the program code, when executed by a computer, performs the function of metering usage of a wireless device in order to generate usage data relating to a user's use of the wireless device.

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1319

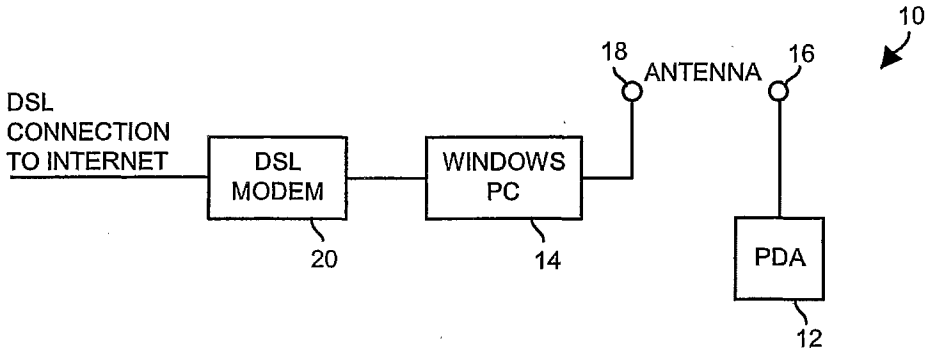


FIGURE 1

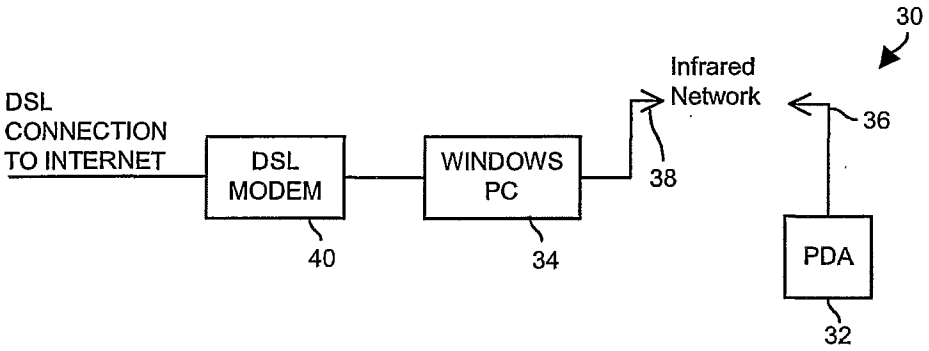


FIGURE 2

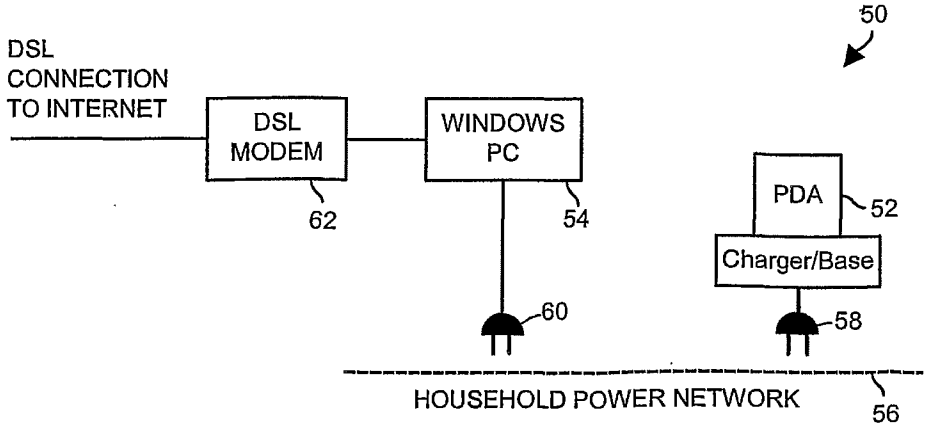


FIGURE 3

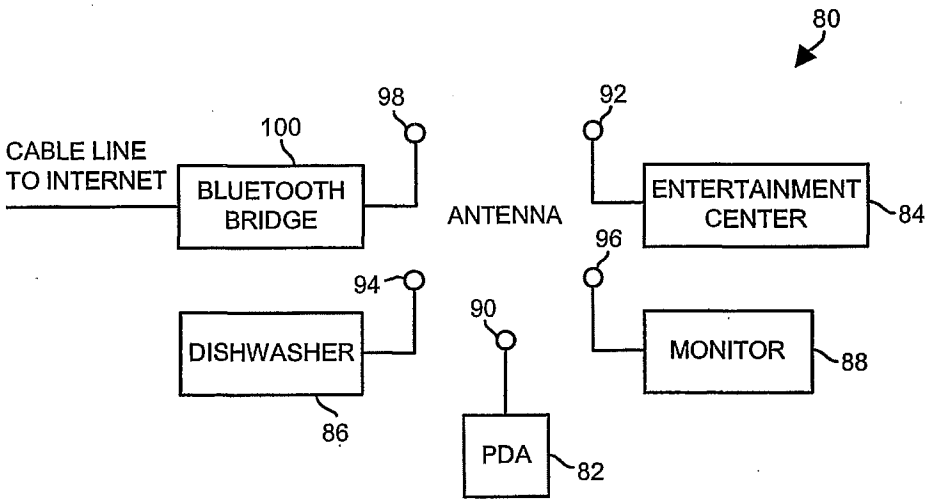


FIGURE 4

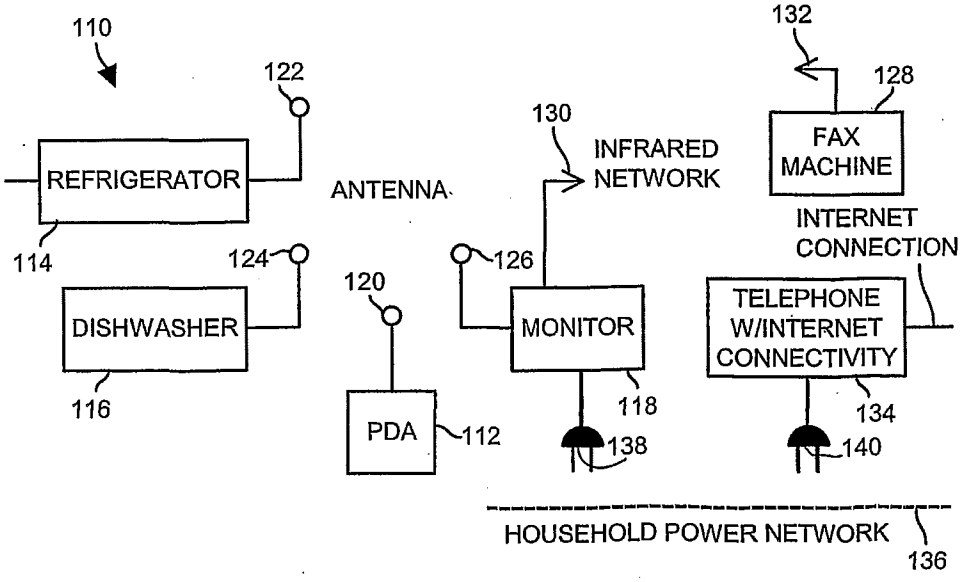


FIGURE 5

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1321

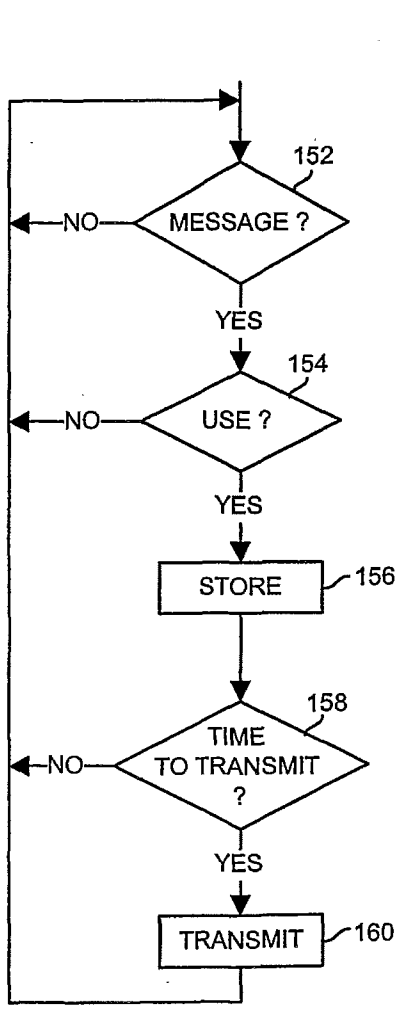


FIGURE 6

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1322

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/US 00/34556

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04H9/00 G06F17/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04H G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 382 970 A (KIEFL JOHN B) 17 January 1995 (1995-01-17) column 5, line 12 -column 7, line 11 column 8, line 8 - line 53	1-63
A	WO 98 26529 A (NIELSEN MEDIA RESEARCH INC) 18 June 1998 (1998-06-18) the whole document	1-63

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents:

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"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 January 2002	25/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Behringer, L.V.

Form PCT/ISA/210 (second sheet) (July 1992)

PGR2023-00016 - Home Depot
Ex. 1003 - Page 1323

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		EP 0944991 A2	29-09-1999
		WO 9826529 A2	18-06-1998

Form PCT/ISA/210 (patent family annex) (July 1992)

Electronic Acknowledgement Receipt

EFS ID:	44103177
Application Number:	17181802
International Application Number:	
Confirmation Number:	5141
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Customer Number:	24573
Filer:	Dennis A. Majewski/US Patent Mail
Filer Authorized By:	Dennis A. Majewski
Attorney Docket Number:	3725194.00146 14US07
Receipt Date:	22-OCT-2021
Filing Date:	22-FEB-2021
Time Stamp:	16:45:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	Dec-Baker-US10966298.pdf	6662019 f55a143c1fb6f732e3ff35317507573276306 9bc	no	152

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2	Non Patent Literature	docket-accessed-202109-06.pdf	758523 f6ee6b61d68e4a8f0478e412fe3256977ea72c19	no	9
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3	Non Patent Literature	First-Amended-Complaint.pdf	1565609 cca4acafb7bccdd26850a95ba5c49a2ea87a922f	no	18
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4	Non Patent Literature	Lynk-Amended-Prelim-Infringement-Contentions.pdf	872867 7045217be06aca88dc0bb8c3011470655f05e2d9	no	9
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5	Non Patent Literature	Notification-of-Docket-Entry-denying-transfer-motion.pdf	709245 4e8806b9bf8ff7e620036780bd3cbd1a00ea060c	no	1
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7	Foreign Reference	WO2011143510.pdf	1555207 6cfee64453ca31be585e31fd833a3384bca7e805	no	53
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8	Non Patent Literature	298BakerCVEmbedded.PDF	781097 53f9dafa5700cc2a64c4629dde03cde6f44cfc55	no	36
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9	Non Patent Literature	298EstimatedPatentScheduleNDILEmbedded.PDF	38070 f2482a5c8e949d87f86827f7585fccb89a58ce78	no	2
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10	Non Patent Literature	298GibiliscoHandbookRadioWirelessEmbedded.PDF	11199451 34eb311c487b11fb125ff05b94365f126e22a2ae	no	188
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12	Foreign Reference	298WO2011082168TOOLARGE.PDF	741305 a9384438db4da7198ff19afead1d50773268ae59	no	38
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13	Non Patent Literature	Ex1002DeclarationofRJacobBakerPhDPEUS10499466.PDF	2528083 84a0925a80439dfdf6fe0bedc934843e86ac7b8d	no	188
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14	Non Patent Literature	Ex1003BakerCV.PDF	782538 1d078536bbfbeb8f3f25963b1301f7fb2ce7f9d6	no	36
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15	Foreign Reference	Ex1013BeartWO2004055654A2.PDF	719372 8ec31e3e4ed6d487e927aafa1deb300145d4465a	no	32
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17	Non Patent Literature	Ex1059Civil-Docket.PDF	224399 aff4b9ad9b38d024b31bace31ba808e124573887	no	10
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18	Non Patent Literature	Ex1060EstimatedPatentSchedule.PDF	37597 8700c2ff9f537bd6fcf095f936f26b10e2054ca1	no	2
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21	Non Patent Literature	Ex1083LynkLabsAnswertoFirstAmendedComplaint.PDF	1323577 7758236f2805e2d349ce1a160ad3ca3eec7cdb11	no	68
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22	Non Patent Literature	Ex1084NotificationofDocketEntrydenyingtransfermotion.PDF	21449 7ccc1947ce0b6fe3ee735d5ec75b233e1a5dc658	no	2
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26	Non Patent Literature	Ex108120210721LynkLabsPreliminfringementContentions.PDF	105665 625a9b6d3ea7e4d446e991fc443a9b492acb87c7	no	10
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27	Foreign Reference	GB414.PDF	222041 d4e1091a5fbfdf0bac937a37ee2146e4365427b4	no	12
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28	Non Patent Literature	Ex1002DeclarationofRJacobBakerPhDPEUS10154551.PDF	2465689 37cab01e46670546a8d3f2c420e55738e9318231	no	176
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50	Non Patent Literature	Ex1092WDTX621cv0052611FirstAmendedComplaint.PDF	386914 08eda3e868e18b43f4967270ef125e8fc16ee792	no	18
Warnings:					
Information:					

51	Non Patent Literature	Ex1097LynkLabsPrelimInfringementContentionsJuly212021.PDF	108122 cfe00b5d1a2cb518c5edcd2fc6d7a0130643186c	no	10
Warnings:					
Information:					
52	Non Patent Literature	Ex1099LynkLabsAnswertoFirstAmendedComplaint.PDF	1462214 a87aa3fbfe21f6c7a87f6837cc44302cdc960983	no	68
Warnings:					
Information:					
53	Non Patent Literature	Ex1100NotificationofDocketEntrydenyingtransfermotion.PDF	21829 d437ede580613a044eedd9dd727f93959626333c	no	2
Warnings:					
Information:					
54	Non Patent Literature	Ex1101SchedulingOrder.PDF	30512 fcd5e82c8af3508430a4d42a833d56030d29fd34	no	2
Warnings:					
Information:					
55	Non Patent Literature	Ex1102LynkLabsAmendedPrelimInfringementContentionsAug312021.PDF	109123 d990729e629ea3cbf3dbccdefa8bb932ebf1ba30	no	10
Warnings:					
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56	Non Patent Literature	Ex1103083121InfringementcontentionsclaimchartsforUS10506674.PDF	3003703 f67469eef4f617aa85c4f96c61a8cb70dc787178	no	100
Warnings:					
Information:					
57	Non Patent Literature	DEC-BAKER-US11019697.pdf	20535574 793cd9ee608e0e0cda2d88baeec14a611268e0d6	no	261
Warnings:					
Information:					

58	Non Patent Literature	Ex-1083Notification-Docket-Transfer-Motion.pdf	709245 4b5c322494edd015d1f46e63c6bbfeaecee276e4	no	1
Warnings:					
Information:					
59	Non Patent Literature	First-Amended-Complaint-Patent-Infringement.pdf	1456402 4d5ef801e76c940435b67f084f47e144ea1c4ac8	no	18
Warnings:					
Information:					
60	Non Patent Literature	Hinton-The-Microarchitecture-Pentium-4-Processor.pdf	962010 835df9036678d3454e1e36cafa90e3125812b1b1	no	13
Warnings:					
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		Total Files Size (in bytes):	102831763		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17181802
Filing Date	2021-02-22
First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond, Crystal L.
Attorney Docket Number	3725194.00146 14US07

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	10492251		2019-11-26	Miskin et al.	Ex. 1001
	2	5457450		1995-10-10	Deese et al.	Ex. 1004
	3	6019493		2000-02-01	Kuo et al.	Ex. 1005
	4	5014052		1991-05-07	Obeck	Ex. 1006
	5	4298869		1981-11-03	Okuno	Ex. 1007
	6	4271408		1981-05-02	Teshima et al.	Ex. 1008
	7	5847507		1998-12-08	Butterworth et al.	Ex. 1009

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	PETITION FOR INTER PARTES REVIEW, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-01369 U.S. Patent No. 10,492,251, Issue Date November 26, 2019, Title: "AC Light Emitting Diode and AC LED Drive Methods and Apparatus," 53 pages dated August 18, 2021	
	2	Petitioners' Power of Attorney, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-01369 U.S. Patent No. 10,492,251, Issue Date November 26, 2019, Title: "AC Light Emitting Diode and AC LED Drive Methods and Apparatus," 53 pages dated August 17, 2021	
	3	Declaration of Dr. Lebby U.S. Patent No. 10,492,251dated August 18, 2021, 134 pages - Ex 1002	
	4	US Application Serial No. 16/148,945 filed October 1, 2018 - Ex. 1003	

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	Application Number	17181802
	Filing Date	2021-02-22
	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	5	Complaint for Patent Infringement, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, Case No. 6:21-cv-00097 dated January 29, 2021, 88 pages - Ex. 1010	
	6	Plaintiff Lynk Labs, Inc.'s Amended Preliminary Infringement Contentions, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, Case No. 6:21-cv-00097-ADA, dated June 23, 2021, 7 pages - Ex. 1011	
	7	Scheduling Order, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, Case No. 6:21-cv-00097-ADA, filed August 13, 2021, 4 pages - Ex. 1012	

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	Art Unit	2844
	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-25
Name/Print	Dennis A. Majewski	Registration Number	65578

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	17181802
Filing Date	2021-02-22
First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond, Crystal L.
Attorney Docket Number	3725194.00146 14US07

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	10349479		2019-07-09	Miskin et al.	Ex 1001
	2	6016038		2000-01-18	Mueller et al.	Ex 1005
	3	4298869		1981-11-03	Okano	Ex 1006

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	1	20020048169		2002-04-25	Dowling et al.	Ex 1004
	2	20160143097		2016-05-19	Miskin	Ex 1008
	3	20140361697		2014-12-11	Miskin et al.	Ex 1009

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2010103480	WO		2010-09-16	KONIN-KLIJKE PHILIPS ELECTRONICS N.V.	Ex 1007	
	2	2013082609	WO		2013-06-06	LYNK LABS, INC.	Ex 1010	
	3	2013026053	WO		2013-02-21	LYNK LABS, INC.	Ex 1013	

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	1	PETITION FOR INTER PARTES REVIEW, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-01370 U.S. Patent No. 10,349,479, Issue Date July 9, 2019, Title: "Color Temperature Controlled and Low THD LED Lighting Devices and Systems and Methods of Driving the Same," 52 pages dated August 18, 2021	
	2	Petitioners' Power of Attorney, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-01370 U.S. Patent No. 10,349,479, Issue Date July 9, 2019, Title: "Color Temperature Controlled and Low THD LED Lighting Devices and Systems and Methods of Driving the Same," 2 pages dated August 17, 2021	
	3	Declaration of Dr. Dean Neikirk U.S. Patent No. 10,349,479, Inter Partes Review No.: IPR2021-01370, 98 pages - Ex 1002	
	4	US Patent Serial No. 15369218 filed December 5, 2016, 617 pages - Ex 1003	
	5	US Patent Serial No. 61630025 filed December 2, 2011, 39 pages - Ex 1011	

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	Art Unit	2844
	Examiner Name	Hammond, Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	6	US Patent Serial No. 61570200 filed December 13, 2011, 51 pages - Ex 1012	
	7	Complaint for Patent Infringement, Case No. 6:21-cv-00097, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, dated January 29, 2021, 88 pages - Ex 1014	
	8	Plaintiff Amended Preliminary Infringement Contentions, Lynk Lab's, Inc.'s, Case No. 6:21-cv-00097-ADA, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, dated June 23, 2021, 7 pages - Ex 1015	
	9	Scheduling Order, Case No. 6:21-cv-00097-ADA, Lynk Labs, Inc. v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, filed August 13, 2021, 4 pages - Ex 1016	

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

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Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-25
Name/Print	Dennis A. Majewski	Registration Number	65578

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Examiner Name	Hammond Crystal L.
Attorney Docket Number	3725194.00146 14US07

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	1	10154551		2018-12-11	Miskin	Ex 1001
	2	9807827		2017-10-31	Miskin et al.	Ex 1004
	3	5457450		1995-10-10	Deese et al.	Ex 1006
	4	6019493		2000-01-02	Kuo et al.	Ex 1013
	5	5785418		1998-07-28	Hochstein	Ex 1014
	6	6541800		2003-04-01	Barnett	Ex 1015
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040212321		2004-10-28	Lys et al.	Ex 1007
	2	20030001657		2003-01-02	Worley, SR. et al.	Ex 1008
	3	20090174337		2009-07-09	Miskin et al.	Ex 1020
	4	20090167202		2009-07-02	Miskin et al.	Ex 1021
	5	20120293083		2012-11-22	Miskin et al.	Ex 1031
	6	20130051001		2013-02-28	Miskin	Ex.1032
	7	20160095180		2016-03-31	Miskin	Ex 1033

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	1	9750168	WO		1997-12-31	HOCHSTEIN, Peter A.	Ex 1009	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17181802
	Filing Date	2021-02-22
	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	2	1 953 825	EP	B1	2008-08-06	CREE, INC.	Ex 1012	
	3	2011082168	WO		2011-07-11	LYNK LABS, INC.	Ex 1027	
	4	2010138211	WO		2010-12-02	LYNK LABS, INC.	Ex 1028	
	5	2010126601	WO		2010-11-04	LYNK LABS, INC.	Ex 1029	
	6	20110143510	WO		2011-11-17	LYNK LABS, INC.	Ex 1030	
	7	0101385	WO		2001-01-04	Reymond, Welles	Ex 1037	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	PETITION FOR INTER PARTES REVIEW, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-001367 U.S. Patent No. 10,154,551, Issue Date December 11, 2018, Title: "AC Light Emitting Diode and AC LED Drive Methods and Apparatus," 93 pages dated August 18, 2021	
	2	Petitioners' Power of Attorney, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-001367 U.S. Patent No. 10,154,551, Issue Date December 11, 2018, Title: "AC Light Emitting Diode and AC LED Drive Methods and Apparatus," 2 pages dated August 17, 2021	
	3	Declaration of Dr. Dean Neikirk - US Pat No. 10,154,551, Claims 1, 3, 4, 5, 7, 8 - 141 pages - Ex 1002	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2021-02-22
	First Named Inventor	Miskin
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	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	4	US Application Serial No. 15797806 - Now US Patent No. 10154551 - Ex 1003	
	5	US Application Serial No. 11066414 - Now US Patent No. 7,489,086 issued February 10, 2009 - Ex 1005	
	6	IEEE 100, The Authoritative Dictionary of IEEE Standards Terms - Seventh Edition, 3 pages - Ex 1010	
	7	Complaint for Patent Infringement Lynk Labs, Inc. Plaintiff v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC Defendants, Case No. 6:21-cv-00097, filed 01/20/2021 - Ex. 1011	
	8	Azazi et al., "Review of Passive and Active Circuits for Power Factor Correction in Single Phase, Low Power AC-DC Converters," Proceedings of the 14th International Middle East Power Systems Conference (MEPCON'10) Cairo University, Egypt, December 19-21, 2010, Paper ID 154, 8 pages - Ex 1016	
	9	US Provisional Application Serial No. 60547653 filed February 25, 2004 - Ex 1017	
	10	US Provisional Application Serial No. 60559867 filed February 25, 2004 - Ex 1018	
	11	US Provisional Application Serial No. 60997771 filed October 6, 2007 - Ex 1019	
	12	US Provisional Application Serial No. 61215144 filed May 1, 2009 - Ex 1022	
	13	US Provisional Application Serial No. 61217215 filed May 28, 2009 - Ex 1023	
	14	US Provisional Application Serial No. 61284927 filed December 28, 2009 - Ex 1024	

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	Filing Date	2021-02-22
	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	15	US Provisional Application Serial No. 61335069 filed December 31, 2009 - Ex 1025	
	16	US Provisional Application Serial No. 61333963 filed May 12, 2010 - Ex 1026	
	17	Plaintiff Lynk Labs, Inc.'s Amended Preliminary Infringement Contentions, Case No. 6:21-cv-00097-ADA filed June 23, 2021, 7 pages - Ex 1034	
	18	US Provisional Application Serial No. 60379079 filed May 9, 2002 - Ex 1035	
	19	US Provisional Application Serial No. 60391627 filed June 26, 2002 - Ex 1036	
	20	Institute of Transportation Engineers Publication No. ST-017B, 1997 ISBN: 0-935403-16-7, ITE Specification (183369415.1), Chapter 2 Vehicle Traffic Control Signal Heads, 25 pages - Ex 1038	
	21	Osorno, "Fourier Analysis of a Single-Phase Full Bridge Rectifier Using Matlab," California State University Northridge, 2002-774, 9 pages - Ex 1039	
	22	Scheduling Order Lynk Labs, Inc. Plaintiff v. Home Depot USA, Inc., The Home Depot Inc., and Home Depot Product Authority, LLC Defendants, Case No. 6:21-cv-00097, filed 08/13/2021 - Ex. 1040	
	23	Vachak et al., "Power Factor Correction Circuits: Active Filters," International Journal of Engineering Research and General Science, Vol. 2, Issue 5, August-September 2014, ISSAN 2091-2730, 9 pages - Ex 1041	
	24		
	25		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2021-02-22
	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

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	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

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OR

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-25
Name/Print	Dennis A. Majewski	Registration Number	65578

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(Not for submission under 37 CFR 1.99)

Application Number	17181802
Filing Date	2021-02-22
First Named Inventor	Miskin
Art Unit	2844
Examiner Name	Hammond Crystal L.
Attorney Docket Number	3725194.00146 14US07

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	10757783		2020-08-25	Miskin et al.	Ex 1008
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	1	20110273098		2011-11-10	Grajcar	Ex 1004
	2	20062266795		2006-10-12	Walter et al.	Ex 1006
	3	20070171145		2007-07-26	Coleman et al.	Ex 1009
	4	20140361697		2014-12-11	Miskin et al.	Ex 1015

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	5	20160143097		2016-05-19	Miskin	Ex 1016
	6	20160188426		2017-06-29	Miskin	Ex 1017
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	1	2001001385	WO		2001-01-04	Reymond, Welles	Ex 1005	
	2	2013082609	WO		2013-06-06	LYNK LABS, INC.	Ex 1014	
	3	2013026053	WO		2013-02-21	LYNK LABS, INC.	Ex 1018	
	4	1160883	EP		2001-12-05	PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO. LTD	Ex 1023	

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	First Named Inventor	Miskin
	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	1	PETITION FOR INTER PARTES REVIEW, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-001368 U.S. Patent No. 10,757,783, Issue Date August 25, 2020, Title: "Color Temperature Controlled and Low THD LED Lighting Devices and Driving the Same," 95 pages dated August 18, 2021
	2	Petitioners' Power of Attorney, Home Depot USA, Inc., Petitioner, v. Lynk Labs, Inc., Patent Owner, Case IPR2021-001368 U.S. Patent No. 10,757,783, Issue Date August 25, 2020, Title: "Color Temperature Controlled and Low THD LED Lighting Devices and Driving the Same," 2 pages dated August 17, 2021
	3	Declaration of Dr. Lebby U.S. Patent No. 10,757,783 dated August 18, 2021, 187 pages - Ex 1002
	4	US Application Serial No. 16,440,884, filed June 13, 2019, 341 pages - Ex 1003
	5	Institute of Transportation Engineers, Publication No. ST-017B 300/IG/102, ISBN 0-935403-16-7 (1998), 25 pages - Ex 1007
	6	Complaint for Patent Infringement Lynk Labs, Inc. v. Home Depot USA Inc., The Home Depot Inc., and Home Depot Product Authority, LLC, Case No. 6:21-cv-00097, filed January 29, 2021, 86 pages - Ex. 1010
	7	US Application Serial No. 61630025 filed December 2, 2011, 39 pages - Ex 1012
	8	US Application Serial No. 61570200 filed December 13, 2011, 51 pages - Ex 1013
	9	Plaintiff Lynk Labs, Inc.'s Amended Preliminary Infringement Contentions, Case No. 6:21-cv-00097-ADA, dated June 23, 2021, 7 pages - Ex 1019
	10	Okon et al., "The First Practical LED", Received: November 9, 2015, 14 pages - Ex 1020
	11	Scheduling Order, Case No. 6:21-cv-00097-ADA filed August 13, 2021, 4 pages - Ex 1021

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2844
	Examiner Name	Hammond Crystal L.
	Attorney Docket Number	3725194.00146 14US07

	12	US Application Serial No. 61233829, filed August 14, 2009, 36 pages - Ex 1022
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Attorney Docket Number	3725194.00146 14US07

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A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Dennis A. Majewski/	Date (YYYY-MM-DD)	2021-10-25
Name/Print	Dennis A. Majewski	Registration Number	65578

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EFS ID:	44106750
Application Number:	17181802
International Application Number:	
Confirmation Number:	5141
Title of Invention:	MULTI-VOLTAGE AND MULTI-BRIGHTNESS LED LIGHTING DEVICES AND METHODS OF USING SAME
First Named Inventor/Applicant Name:	Michael Miskin
Customer Number:	24573
Filer:	Dennis A. Majewski/US Patent Mail
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Attorney Docket Number:	3725194.00146 14US07
Receipt Date:	25-OCT-2021
Filing Date:	22-FEB-2021
Time Stamp:	11:02:28
Application Type:	Utility under 35 USC 111(a)

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Warnings:					
Information:					
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Warnings:					
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Warnings:					
Information:					
8	Foreign Reference	00479Ex1007WO2010103480.pdf	5962361 f0d3f05c0166d1d4db3faa939bf487f734d55ce7	no	32
Warnings:					
Information:					

9	Foreign Reference	00479Ex1010WO2609.pdf	8420597 58f00bb1254d97d9113a7786dbff57f242deab05	no	43
Warnings:					
Information:					
10	Non Patent Literature	00479Ex1014Complaint.pdf	3529421 efcfcedba7d72bd793b3a49e50c5b8a771a0c346	no	88
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11	Non Patent Literature	00479Ex1015Contentions.pdf	182561 ef299a406663f1da6c2cfea011fa4809de023800	no	7
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12	Non Patent Literature	00479Ex1016SchedulingOrder.pdf	168874 da3affd99b4fa2afbf58d4e9aacce45c34e1fb58	no	4
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13	Non Patent Literature	00479-Petition-A.pdf	9295520 262e961f7616f0983bd15487ad83c00d3dd04311	no	52
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14	Non Patent Literature	00479-Petition-POA-A.pdf	224391 3091ab7c45b072677b98fc7c0df44031e1c966ac	no	2
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15	Foreign Reference	JP495-A.pdf	117384 2547bc834a2832310d294c5565f387aa38147023	no	1
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16	Non Patent Literature	Vechicle-Detection-Article-A.pdf	5755442 f492594ab82a8a438210236179c9c1db1caaf6ed	no	4
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17	Non Patent Literature	White-Light-Emitting-A.pdf	10116102 0166e26e9373e9621c0dbc9703aecbe35f53523e	no	28
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18	Non Patent Literature	00551Ex-1002.pdf	3998831 2ad58a217e386caae97fbe9fe9bc8f7467027c6c	no	141
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19	Non Patent Literature	00551Ex-1003.pdf	6215898 e50dfabcc5e3b60d12a66ec9d9ee457a4db8bb4a	no	203
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22	Non Patent Literature	00551Ex-1011.pdf	3176371 048c7bc57c1583aead51ae69ca515fb140bbabfd	no	88
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23	Non Patent Literature	00551Ex-1016.pdf	372857 dee474e5bb5f2b082456d53e8a8cdc2b738ec0c6	no	8
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36	Foreign Reference	551EX-1012-EP-A.pdf	15249141 bc34603ecd863c17c908c85e3ec370322ed74a40	no	15
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37	Non Patent Literature	551-Petition-A.pdf	16193729 5fe57607194326b0b915fe2a699d23bcf5971cac	no	93
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39	Foreign Reference	005511009.pdf	1177500 6f931a55f37c56f7ae789737c468874d29763b62	no	40
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