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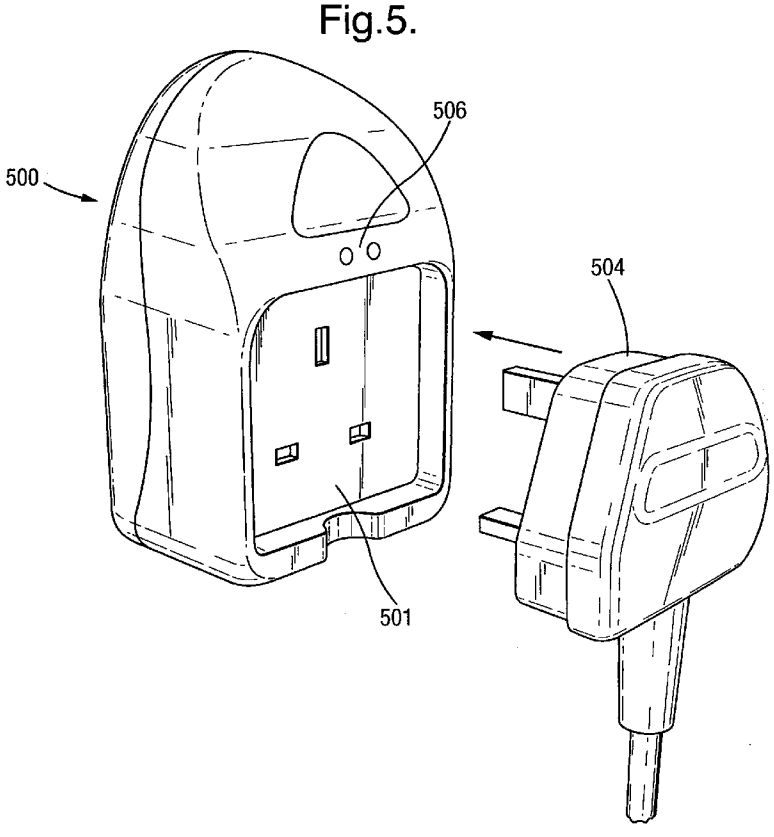

(57) Abstract: An adapter having at least one socket portion and connector means by which a mains power signal can be delivered to or connected with said adapter, characterised in that said adapter is further provided with an electronics module which is not only powered by said mains power but effectively separates a digital signal therefrom, said digital signal being transmitted in conjunction with said mains power signal, and further characterised in that said adapter means provides at least one separate outlet, discrete from the other socket portion by means of which the mains power signal received at the connector means is transmitted.

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POWER SOCKET ADAPTER

Field of the Invention

The present invention relates to a power socket adapter, and more specifically to a power socket adapter having additional functionality.

Background to the Invention

Mains power socket adapters have been in existence for many years, and nowadays there are a myriad of different types of adapter. Referring to figure 1 herein, there is illustrated schematically a known Devolo ® MicroLink dLAN Ethernet high speed 85Mbps Ethernet over mains adapter. The adapter comprises a housing 100 which contains an electronic circuit board having a power mains to Ethernet conversion chip for applying digital communications signals input via an Ethernet socket 101 to a mains power ring main, via a plurality of electrical contract pins 102 which plug into a conventional mains wall socket outlet. Various versions of the known adapter are available, with Ethernet speeds of up to 200Mbps.

The Devolo dLAN product is capable of running a small network in a domestic or commercial premises, and connecting that network over the existing mains ring wiring, without the need to install an additional local area network cabling, for example, an additional CAT5 wiring system.

However, the existing dLAN adapter product has a disadvantage of only permitting one wired Ethernet socket per mains outlet socket. Further, using the known adapter device means that the power socket is used for that device, and is therefore unavailable for use by other devices such as PCs, printers, scanners or the like.

Figure 2 shows another known adapter 200 which not only provides a socket 202 into which the plug of an appliance may be inserted, but also includes

a sensor 204 which in this case is an infra-red sensor for detecting human movement, such as a PIR sensor. By incorporating electronics inside the adapter 200, additional functionality can be provided by allowing for the power supply to the socket 8 to be activated or de-activated internally of the adapter, for example when human motion is detected in front of the sensor 204. In this case, the electronics inside the adapter (not shown, but of entirely known configuration) is not only powered by the mains supply derived from the connection between the adapter plug portion shown generally at 206 and the wall or other power socket (not shown) into which it is inserted, but said electronics also provides an automatic switch function for the adapter.

In a variation of the adapter of figure 2, such an adapter may be controlled by a handheld battery powered remote control device so that the power socket can be turned on and off, without the need for a user to stand up and walk to a power socket.

In terms of the additional functionality in which domestic and commercial premises power cables can be provided, it is already known to piggy-back a variety of different signals on top of such cables. In general, while domestic power cables are intended to carry only a standard 120/240 V 50/60 Hz AC sinusoidal power signal such cables are actually capable of carrying, among other things, data signals, and it is known to utilise existing domestic wiring networks to provide Ethernet networks throughout such premises.

Intellon Corporation of the USA, has established itself as one of the main suppliers of products facilitating the provision of such communications networks internally of domestic, commercial, office and other spaces through their power cabling loops. However, one of the fundamental difficulties perceived by the inventors herefor is that the use of Intellons' equipment necessarily utilises at least one of the sockets of a conventional socket wall plate, and in most cases, and particularly in the case of computer equipment to which an Ethernet connection will usually nowadays always be required, many power supplies are

required. Typically, this has resulted in the dangerous overloading of wall sockets by using many one to many electrical socket devices or extension cables to provide power sources for various devices, such as monitors, printers, modems, and computer base units.

Referring to figure 3 herein, there is illustrated schematically a further known LAN to mains adapter 300, produced by DS2. The DS2 Power Line adapter enables a consumer installed networking at home or in the office and has a built in power socket which frees up the wall outlet socket to which the DS2 adapter is connected, for use by other appliances, by virtue of its "plug through" feature, having a power socket on its externally presented face, in addition to an Ethernet LAN socket.

The Intellion LAN-mains adapter 300 is provided with one or a plurality of light emitting diodes, which flash, to inform the user that the device is working correctly.

Referring to figure 4, an installation of the known LAN-mains adapters of figure 3 is illustrated schematically.

Using the conventional adapter with "pass through" power socket 400 to plug into a mains socket 401 means that a one to many mains extension socket 402 can be used as a power socket plug for many peripheral devices, such as a PC 403, a printer 404, or a DSL modem 405. The Ethernet cable of the modem 405, plugs into the Ethernet socket of the known power line adapter 400. Digital communication signals are passed from the peripheral devices, from the DSL modem 405 and through the adapter 400 into a mains electrical cabling 406, and the signal can be "tapped" at any other mains socket outlet 407, 408 on the same mains electrical cabling network.

Whilst mains wiring based communication networks are becoming more common for home networking or networking of commercial premises, there remains a set of ongoing technical problems including the following.

Existing network to mains adapters continue to be bulky and protrude from the wall. This can put a strain on the electrical connector pins of known mains wall socket power outlets to which the adapters are plugged into.

Modern portable devices such as laptop computers, PDAs, mobile telephones, and consumer appliances increasingly make use of a wide variety of wireless technologies, which are not accommodated by the known network to mains adapters.

Plug congestion at a mains power socket remains a problem, with mains power peripheral devices, such as PCs, scanners, battery charges, monitors and printers, each requiring a separate mains socket adding a plug in network to mains adapter adds to the congestion around known power socket outlets.

Whilst typical known mains wiring is fully capable of carrying data speeds of up to 200Mbps, internally within a domestic or commercial premises, connection to a wide area network of the internet is generally over a lower capacity link, such as a broadband link or coaxial cable which means that the high data rate applies only internally on a local network and cannot easily be extended to a wide area network.

Increased use of wireless technologies for portable devices raises health concerns from human absorption of electromagnetic radiation, the long term effects of which are not yet established.

Increasing use of consumer electronic equipment and computer equipment which may be left on standby mode consumes electrical power and contributes to global climate change.

It is an object of this disclosure to provide an enhancement to existing socket adapters, and in a particular embodiment of the invention, the sockets themselves which take account of the above disadvantages.

Brief Summary of the Disclosure

According to one aspect there is provided an adapter having at least one socket portion and connector means by which a mains power signal can be delivered to or connected with said adapter, characterised in that said adapter is further provided with an electronics module which is not only powered by said mains power but effectively separates a digital signal therefrom, said digital signal being transmitted in conjunction with said mains power signal, and further characterised in that said adapter provides at least one separate outlet, discrete from the socket portion by means of which the mains power signal received at the connector means is transmitted.

Preferably, connector means are in the form of conventionally arranged pins capable of being inserted into a standard socket wall plate provided in domestic or office premises.

Preferably, the separate outlet is a socket capable of accepting an Ethernet cable connector, said electronics module effectively stripping the Ethernet signal from said mains power signal and delivering the Ethernet signal to said socket.

In a preferred embodiment, the adapter is a socket wall plate provided with an outlet being an Ethernet socket and an electronics module incorporated into the wall plate, said connector means being ports provided on the rear face of said wall plate into which mains power cables may be fed, and in which they may be conductively secured.

Preferably, the discrete outlet of the adapter is chosen to be one of:

An Ethernet socket, a Wi-Fi port, a USB port, a video signal connector, an IEEE 1394 outlet, and in each case, the electronics module is configured to strip a particular requisite signal carried by said power signal and deliver the strip signal to the respective outlet.

In a preferred arrangement, the adapter is provided with a plurality of outlets comprising at least one Ethernet outlet and at least one Wi - Fi outlet.

By providing a combination of suitable electronics, suitable digital signal outlets, and at least one conventional mains supply socket portion, the adapter of the current invention provides enhanced functionality.

According to a second aspect there is provided a communications adapter for communicating a digital communications signal over a mains power circuit, said adapter comprising a mains socket wall plate having a face plate comprising at least one mains power socket, and said adapter comprising connector means by which a mains power signal can be delivered to or connected with said mains power socket ,

said adapter being further provided with an electronics module which is powered by said mains power, and which separates said digital communications signal therefrom, said digital communications signal being transmitted and /or received in conjunction with said mains power signal, and

said adapter means provides at least one separate communications outlet, discrete from said mains power socket by means of which the digital communications signal received at the connector means is transmitted and received; and

wherein said electronics module is incorporated behind said face plate of said mains socket wall plate, which is configured to be permanently secured into

a wall or other like structure, such that in use, an outer face of said face plate is unobstructed by said electronics module.

According to a third aspect there is provided a power line signal device capable of applying and retrieving a communication signals onto or from a low frequency mains conductor, said device comprising:

at least one socket portion and connector means by which a mains power signal is connected to said adapter;

at least one mains power outlet, which is connected to said connector means;

a wireless transmitter/receiver capable of transmitting and receiving wireless signals; and

a converter device for converting a communications signal transmitted/ received by said transmitter/receiver device to a signal which appears at the said at least one connector means, and which may be carried by said mains power signal.

According to a fourth aspect there is provided a circuit for a power line device, said circuit having a maximum width dimension of a 130 mm, and a maximum height dimension of 75 mm, said circuit comprising;

a powerline data communications circuit for applying a data communication signal to an electrical mains conductor, and for extracting digital data signals from said mains conductor;

a wireless data communications circuit for converting said data communication signal to a form suitable for wireless communication.

Other aspects are as recited in the claims herein.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a prior art adapter;

Figure 2 shows a perspective view of a mains power adapter of prior art configuration;

Figure 3 shows a known LAN to mains adapter having a pass through mains power connection;

Figure 4 shows schematically a known Ethernet over mains system comprising a ring main power circuit, having a plurality of wall mounted socket power outlets, and a plurality of LAN-mains adapters as shown in figure 3 herein;

Figure 5 shows in perspective view a first adapter according to a first specific embodiment;

Figure 6 shows in view from underneath, the first adapter of figure 5 herein;

Figure 7 shows the first adapter of figure 5 herein in view from one side;

Figure 8 shows in perspective view a second network-mains adapter according to a second specific embodiment;

Figure 9 shows schematically modular functional components of the second network-mains adapter according to the second specific embodiment;

Figure 10 shows schematically deployment of a plurality of network access point device installed in a room of a commercial or domestic building according to a third specific embodiment;

Figure 11 illustrates schematically modular functional components of a third network to mains adapter device according to a third specific embodiment, which incorporates a modem and/or gateway device according to a fourth specific embodiment;

Figure 12 illustrates schematically a practical installation of the third network-mains adapter of figure 11 herein in a powerline system;

Figure 13 shows schematically a fourth network to mains adapter device according to a fifth specific embodiment, incorporating a mains power saving facility;

Figure 14 illustrates schematically in frontal view a variation of the fourth mains-adapter device of figure herein;

Figure 15 herein illustrates schematically the network-mains adapter of figure 14, in view from one side.

Figure 16 herein illustrates schematically a first circuit configuration suitable for partial implementation of the embodiments described with reference to figure 5 to 15 herein;

Figure 17 illustrates schematically a second circuit suitable for partial implementation of the embodiments of figures 5 to 15 herein; and

Figure 18 illustrates schematically a third circuit suitable for partial implementation of the embodiments described with reference to 5 to 15 herein.

Detailed Description

There will now be described by way of example a specific mode contemplated by the inventors. In the following description numerous specific details are set forth in order to provide a thorough understanding. It will be apparent however, to one skilled in the art, that the present invention may be practiced without limitation to these specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the description.

In the specification, the term "power line communications" and devices referred to as "power line devices", which is also referred to sometimes as "power line carrier", "mains communication", "power line telecoms", or "power line networking" means a system for carrying information over electrical power lines. It encompasses the use of home or office mains wiring for interconnection for interconnection of home computers, peripherals or other networked consumer peripherals in accordance with standards developed by the Home Plug Power Alliance, the consumer Electronics Powerline Communication Alliance, the Universal Power Line Association and/or the IEEE P1901 working group. At present, there is no industry consensus for standards for powerline data communication systems. Such communications can have bit rate capacities in the range hundreds of Mbps. The term also encompass "E-line" communications over mains wiring conductors, in the range 200MHz to over 10GHz. The terms also encompass communications conducted from a local premises e.g. a local mains ring, through a transformer over a high voltage National Grid backbone, such as 11kV overhead power head distribution lines, and over higher voltage National Grid backbone lines at 64kV although such communications at correspondingly lower frequencies, typically in the range 9kHz - 500kHz, and in accordance with standard IEEE 643, or at even lower frequencies, in the case of 64kV National Grid backbone lines. Current relevant standards include IEEE 643

- 2004; IEEE 1675; IEEE 1901; The OPERA Standards of the Open PLC European Research Alliance and the EIA - 709.2 Control Network Power Line Charge Specification of the Consumer Electronics R-7.1 Home Networking Sub-Committee (The NonTalk protocol).

The IEEE P1901 working group has been formed to standardise broadband over powerline networks and is aimed at the physical and media access control layers of the standard 7 layer OSI network model. IEEE P1901 addresses data rates of greater than 100 Mbps over the last 1500 meters to the premises.

In this specification, the term "Ethernet" has its commonly understood meaning of when the relevant person skilled in the art, and comprises devices complying with standard IEEE 802.1-3.

In this specification, the term "Bluetooth" means devices which operate in accordance with the Bluetooth specification formalised by the Bluetooth special interest group, and ratified by IEEE standard 802.15, and derivative technologies including high speed Bluetooth based on the Wi media alliance devices.

In this specification, the term "Wi Fi" includes but is not limited to wireless devices operating in accordance to standard IEEE 802.11, and compliant with the inter operability standards set out by the Wi Fi Alliance. In general, Wi Fi is a low transmission power technology, and can drop as low as 0.01% of the general public RF safety limit guidelines for continuous exposures as set out by the World Health Organization. However, even though Wi - Fi is a low emission technology, in some circumstances it may still have higher emissions compared to cordless phone bases or other wireless devices found around the home or commercial premises environment.

In this specification, the term WiMAX includes but is not limited to devices operating in accordance with standard IEEE 802.16, also called Wireless Man,

and includes fixed WiMAX and mobile WiMAX. Devices and technologies certified by the WiMAX forum, including equipment presented as WiMAX ready, or WiMAX compliant, whether or not they are officially certified by the WiMAX forum.

In this specification the term "USB" includes a universal serial bus, including but not limited to USB 1.0 to 3.0, and including both powered and non powered USB ports and connectors. The term includes devices which comply with the standards set out by the USB implementers forum, and includes proprietary devices of the USB type, which although they may not comply with the USB implementers forum standards, will still operate with and/ or are interoperable with devices manufactured to those standards.

In this specification the term "UWB" or Ultra Wide Band is used to describe devices which comply with IEEE standard 802.15.4 and/or IEEE 802.15.3a and/ or ECMA 368 and/or ECMA 369, and includes devices capable of short range indoor low R.F. emission communications.

Referring to figures 5 to 7 herein there is shown an adapter 500 having a mains power socket portion 501 and a mains connection portion 502, in the form of conventionally arranged pins 503. A plug 504 can be inserted into the socket portion in identical manner to that whereby the plug might be inserted into a conventional socket wall plate (not shown).

Inside the adapter 500 is provided an electronics module (not shown, but of standard and known configuration) to which power is fed from the pins 503, or at least corresponding wires inside the adapter connected thereto, and said electronics module also conducts some processing of the mains power signal received through the pins to extract or strip a data or digital signal which is piggy-backed or otherwise carried on top of, or in conjunction with, said power signal.

The extracted data signal is delivered to an Ethernet socket 504 provided in the lower face of the adapter to allow for the connection of a conventional Ethernet cable, and the "cleaned" power signal is simply delivered to appropriate terminals for the socket 501 on the exterior face of the adapter. A plurality of LED's may be provided to indicate parameters such as:

- the correct functioning of the adapter
- the transfer of data through the Ethernet socket
- the transfer data rate of data through the Ethernet socket
- that the Wi Fi transceiver is enabled
- that the powerline injection and extraction is enabled and / or functioning correctly
- that a Bluetooth transceiver is functioning correctly and or is transmitting / receiving a signal.

Referring to figure 8, there is shown a second adapter in the form of a conventional socket wall plate 800 which carries a similar electronics to that described above in relation to figure 5. As can be seen, the wall plate 800 is provided with a pair of conventional sockets 801, an Ethernet outlet socket 802 and, a Wi - Fi outlet or transceiver port 803. Of course, such a port may provide wireless access for a suitably equipped wireless device using any one of a number of currently available wireless technologies or protocols, but in any event, the electronics module strips the data signal from the mains power signals and delivers these for transmission through the said port, either wirelessly or through suitable wires, as is the case in Ethernet traffic.

The electronics module operates in duplex mode, i.e. be capable to two way data communication. In an ideal embodiment, a house, office or other discrete area within premises would be provided with an incoming source of internet or other network traffic. A central node device, e.g. mains power cable enabled switch, hub, router, or the like, then injects the signal into the mains cable network within the premises in identical manner to that when cat 5 UTP cable is

installed and routed to various different locations within the premises when such are being computer network enabled. Of course, the only difference in this case is that no such cables are installed, and network points are automatically created wherever there is a power socket in any part of the premises. The central node device may of course require some indication of the number of different socket outlets present to determine how many connections via remote network equipment, e.g. computers, PDA's, mobile phones etc are allowed within said premises.

By this arrangement, on the one hand, the data signals can be sent along the power cables to remote socket outlets, whereat adapters of the type described separate the network signals from the power signals and deliver both through separate means, and on the other hand, data signals received from the remote devices can be caused by the electronics module to return to the central node device along the power cables such that network traffic can be distributed, carried and returned through the premises in question.

Other signals may be carried in conjunction with power signals, such as digital or analogue video signals, and in such cases, a suitable connector and electronics module would be required to be provided in the adapter or socket wall plate.

Referring to figure 10 herein, there is illustrated schematically in block component form a combination mains socket and communications point according to a third specific embodiment herein.

A network to mains converter device 1000 comprises, contained within and fronted by a face plate, one or a plurality of mains power sockets 1001, 1002, which in the United Kingdom comprise 50 Hz, 240 volts neutral, earth and live connectors, or in Europe or US they comprise the equivalent two or three pin neutral, earth and/or live connectors, the main sockets being connectable to a ring main 1003, when the power line mains adapter is installed in situe in a

domestic or commercial electrical installation; one or more circuit boards 1004 constructed integral with the face plate, and comprising a power line adapter unit 1005 for transferring communication signals onto the mains ring 1003, and for filtering off communication signals from the ring main 1003; the first Ethernet hub 1005 connected to a first physical Ethernet socket 1006; a second Ethernet hub 1007 connected to a second Ethernet connector 1008, a Wi Fi transmitter/receiver 1010 for transmitting and receiving signals according to standard IEEE 802.11 in accordance with the criteria set out by the Wi Fi alliance; a WiMAX transmitter receiver 1011 for sending and receiving wireless signals in accordance with standard IEEE 802.16; and a Bluetooth transmitter/receiver 1012 for transmitting and receiving signals in accordance with the specifications and technical requirements set up by the Bluetooth special interest group.

Wireless fidelity is the term used to describe high speed wireless connection over short distances between mobile computing devices such as laptops, mobile phones, digital cameras, televisions, DVD players and personal digital assistants (PDA's). Wi Fi devices operate according to the IEEE 802.11 standard manufactured by members of the WI Fi alliance whose products pass inter operability tests. Radiation exposure from Wi Fi enabled devices are estimated at around 20 millionths of the international guide line levels of exposure to radiation. Nevertheless, reduction of radiation levels for communication within Wi - Fi networks is an ongoing technical problem.

The Wi - Fi transmitter/receiver is built into the face plate of the power line adapter socket as shown in figure 9 herein. Since a Wi Fi device, for example laptop computer or mobile phone, only transmits a signal when data is being sent, the use of Wi Fi has significant advantages over other technologies, since the power intensity and duty cycle of radio frequency transmissions is minimised.

Referring to figure 10 herein, there is illustrated schematically in plan view from above, a typical installation comprising a plurality of face plate devices as shown with reference to figure 9 herein built into the electrical ring main around a

room of a domestic building or commercial office building. A plurality of power line devices 1000 - 1007 are placed around a room at spaced apart intervals. Typically a modern trend is to have a relatively greater number of power sockets installed in each room, which means that the distances between power socket outlets in a modern mains ring circuit installation is typically of the order 10 mm to 4 meters, with distances greater than 5 meters becoming rarer.

A Wi Fi enabled mobile device 1008, for example a laptop computer, or a mobile phone will select an adjacent Wi Fi enabled power line socket with which it has the best signal level. Typically, that will be the socket which has the least physical distance between the Wi Fi device and the power line socket. Consequently, the Wi Fi device can automatically vary its level of signal to an optimum signal intensity, at which communication with the power line socket can be achieved with sufficient signal to noise ratio, and yet the power intensity of the signal transmitted and received is reduced to a minimum level, in order to avoid unnecessarily high levels of electromagnetic radiation. The more Wi Fi enabled power line sockets there are in a given room, the greater the selection of Wi Fi enabled power line sockets there are to choose from in a room, and therefore the more likely it is that a relatively lower power intensity level of Wi - Fi connection can be made, compared to the situation where there is one Wi - Fi transceiver in a room.

The deployment of a plurality of power line enabled mains outlet sockets in an enclosed environment replaces the need for a relatively higher power wireless enabled device in an environment, and therefore has advantages in allowing relatively lower power intensity radiation emission within an enclosed environment compared to a "plug-in" wireless hub in a room.

Referring to figure 11 herein there is illustrated schematically in block component form a fourth adapter according to a fourth specific embodiment.

The fourth adapter comprises a wall socket having a face plate 1100 comprising one or a plurality of mains outlet socket sockets 1101, 1102, optionally with a mains "on/off" switch per each mains socket; a modem 1103 capable of plugging into a telephone wall socket, such as provided at the end of a local loop of a public service telephone network (PST), the modem being placed behind the adapter face plate, optionally a gateway device 1105 for providing communications with a broadband network; a socket 1105, for example of the Ethernet connector type for accessing the modem from the face plate; a first Ethernet adapter 1106 connected to a first Ethernet outlet 1107 a second Ethernet adapter 1108 connected to a second Ethernet connector socket 1109 which presents on an outward face of the adapter; a Wi Fi module 1110, which may comprise its own transmitter receiver, or which may be connected to a common transmitter receiver 1111 for sending and receiving Wi Fi wireless signals; a WiMAX module 1112, which may comprise its own transmitter receiver, or which may be connected to a common transmitter receiver 1111; a Bluetooth module 1113 which may comprise its own transmitter receiver, or which may be connected to general purpose transmitter/receiver 1111; and a power line adapter 1114 for converting signals received or sent on the modem, Gateway device, Ethernet modules, Wi Fi module, WiMAX module and/or Bluetooth module onto a mains connector 1115, which is connectable to a conventional domestic ring main 1117 carrying 240/120v 50/60Hz mains power signal. Each of the power line adapter module, modem module Gateway device module, Ethernet modules, Wi Fi module, WiMAX module and Bluetooth module and transmitter/receiver may be fabricated on signal circuit board 1117, which is installed behind a common face plate 1100 of the adapter.

The residential gateway 1103 may comprise a router to connect a home network with a wide area network over a broadband connection. The broadband connection may include for example a coaxial cable from an internet service provider, or broadband connection over a local loop of a public service telephone network.

Outwardly, the adapter may be approximately of conventional dimensions. For example in the United Kingdom, a twins main outlet socket has dimensions typically in the range length 140mm - 150mm, height 80mm - 90mm, and depth 5mm - 15mm, with the earth pins of a pair of conventional mains sockets being spaced at a distance of approximately 80mm - 90mm apart from each other.

The mains connector 1115 may comprise conventional mains connectors, such as aperture and screw connectors which accept live, neutral and earth leads from a three core mains lead.

Referring to figure 12 herein, there is illustrated schematically an installation comprising an adapter as shown in figure 11 herein. In this installation, the LAN over mains facility is restricted internally to a ring main of a domestic or commercial building, with external connections to the internet, or a wide area network being made via the internal modem of the adapter, connected to the telephone socket at the end of a local loop to a telephone exchange, and thence to the public service telephone network. From an existing telephone outlet point 1201, connection may be made via an external cable 1302 to an Ethernet type socket into the face plate 1202 of the network-mains adapter 1200, so that the router in the gateway device within the adapter 1200 enables connection of one or a plurality of network access points 1204 to the public service telephone network. Additionally, the adapter 1200 also constitutes a network access point since it may have one or more Ethernet sockets and a transmitter/receiver for wireless connection. Each of the one or plurality of network access points 1204, may also comprise a physical socket for plugging in an Ethernet cable of the computer and may also comprise one or more wireless transmitter/receivers for communicating with terminal devices 1205, for example a laptop computer, personal digital assistant, mobile phone or other wireless enabled equipment.

Alternatively, the external broad band connection may be made via a wireless device communicating via for example a cellular network, or a satellite

transmitter/ receiver, or a co axial cable land line, in which case an appropriate feed point will be provided at the commercial building.

Referring to figure 13 herein, there is illustrated schematically a fourth network to mains adapter device according to a fourth specific embodiment.

The fourth adapter device comprises a housing 1300 which can either comprise a plug in housing having a set of mains connector pins, and a mains socket of the plug-through type as shown with reference to figures 5 to 7 herein, or which can take the form of a face plate which fits into a conventional wall mount box of a conventional mains outlet.

The following description applies either to the external plug in module form, or the face plate form.

The casing 1300 comprises at least one mains socket outlet 1301 (in the case of a plug-through type external mount device, preferably a single socket outlet, and in the case of a face plate device, preferably a pair of sockets); a mains power switch 1302 which controls mains power to the at least one socket 1301; a circuit board 1303, upon which is provided a power line adapter module 1304 for converting a digital communications signal for application onto a two or three core mains ring connector 1305; a modem 1306 connected to a socket 1307 which can communicate with a broadband link for example over the local loop of a PSTN or a cable network, or over a power line network via power line adapter 1304; a gateway device 1308, optionally having one or a plurality of outlet sockets 1309 positioned on the casing 1300 the gateway device comprising a router; one or a plurality of Ethernet modules 1310, 1311, each of which may have a corresponding respective Ethernet socket 1312, 1313, which is positioned on the casing 1300; a Wi Fi module 1315 for handling Wi Fi format signals, Wi Fi module 1315 having its own dedicated transmitter/receiver in built into the module, or alternatively sending and receiving signals through a separate transmitter/receiver 1316; a WiMAX module 1317, the WiMAX module optionally

having its own dedicated transmitter/receiver, or communicating with a separate transmitter/receiver 1316 mounted on the circuit board 1303; a Bluetooth module 1318 for handling Bluetooth signal communications, the Bluetooth module it having its own transmitter/receiver in built, or communicating via separate transmitter/receiver 1316.

Each of the modem, gateway, Ethernet module(s) Wi Fi module, WiMAX module and Bluetooth module are in communication with the power line adapter module 1304, so that in the case of wireless communications between the adapter device and a separate wireless enabled device, those communications are routed through the power line adapter and onto the mains cable 1319, via mains connector 1305. In the case of wired digital communications signals, for example connected to the adapter device via an Ethernet socket 1313, these communicate via the Ethernet module 1310 and power adapter 1304 so that they are carried on the mains ring 1319 via mains connector 1305 and power line adapter 1304.

Modem 1306 and gateway device 1308 have the combined facility for linking a Local Area Network or home network carried over mains ring 1319 with an external PSTN or coaxial cable, via an external socket 1307 or 1309, and/or via power line adapter 1304. Alternatively, modem 1308 may convert Ethernet traffic to a broadband connection carried over the mains 1319 using a power line format.

Switch 1302 comprises a sensing circuit which senses when electric power current is being taken from mains power socket 1301. For example, when a device connected to the power socket 1301 is drawing standby current, the switch 1302 can sense, by means of current sensing circuit integral to the switch that a relatively low level of current is being taken by a device, and can turn off the power socket 1301 after a predetermined time period, when a higher current signifying "wake-up" from standby mode occurs in the meantime. There may be placed a manual switch 1320 which presents externally on the casing, whereby a

user can reactivate a mains power socket that has turned off automatically, for example because a device connected to the switch is on standby. Using automatic current sensing for devices which may be on standby current, the device can be turned off automatically at the mains socket, so that the attached peripheral device does not draw a standby current. By a user activating the switch 1320 on the adapter device, this may reactivate mains power to the socket(s). Each socket may be provided with its own reactivation switch, which may be the same as the normal "on/off" switch provided on the face plate of the adapter, when casing 1300 is manufactured in the form of such a face plate.

Alternatively, a user may use a separate remote control to re-activate power to a mains socket which has reverted "off" mode.

Referring to figure 14 herein, there is illustrated schematically one version of an adapter device of figure 13 herein, in this case showing the option of only one Ethernet socket, for example connected to modem 1306 or gateway 1307 for connecting to a PSTN and showing an LED which indicates whether a wireless transmitter/receiver is active or not.

There are provided two switches 1403, 1404 for turning on/off a respective mains power socket. Where the mains power sockets automatically cut off mains power after a predetermined time, controlled by the current sensing mains controller module, reactivating either of the switches 1403, 1404, may restore power to the corresponding respective mains socket.

Referring to figure 15, herein there is illustrated schematically the wall mountable face plate embodiment of figure 14 herein in view from one side showing a casing and face plate 1500 of size and dimensions suitable for fitting into a conventional mains electrical box for a ring main circuit in a domestic residential or commercial premises. Connection to a conventional three core or two core rings mains power cable 1501 is made by a conventional mains connector consisting of a plurality of tubular apertures with a screw thread

connector to secure a copper mains cable to the mains power electrical connector. All of the components of the electronics module are contained within the casing 1500.

Additionally and / or alternatively to any of the aforementioned wireless modules, there may be provided an Ultra Wideband (UWB) communications device which may enable relatively low power radio frequency communications with a mobile or static device in an indoors environment, and may give a communications band width of the order 500MHz or thereabouts.

In any of the aforementioned embodiments, there may be provided additionally or alternatively to an aforesaid physical communications socket on the adapter device, a USB port into which a USB compatible device may be plugged. In the case of embodiments where the physical ports are provided on a wall plate, the USB connector port may be provided on the outwardly facing face of a wall mounted box, which is designed to be fitted into a conventional mains wiring box for a single or twin mains power socket.

Referring to figure 16 herein, there is illustrated schematically a first circuit configuration suitable for partial implementation of the embodiments described with reference to figures 5 to 15 herein.

Figures 16 herein illustrates schematically a circuit for a basic node which provides UTP 10/100 even access to a power line system. The circuit comprises a known power line integrated circuit 1600; an Ethernet physical layer circuit 1601, coupled to the power line integrated circuit via an MII interface 1602 provided in the power line integrated circuit 1600; and a discrete UTP coupling module 1603 connected to the internet physical layer circuit 1601. The power line integrated circuit 1600 may also be provided with additional flash memory 1604 and additional static and/or random access memory 1605. A power line physical layer circuit 1606 connects the power line integrated circuit to a discrete

power line coupling 1607. Electrical power to the circuits is provided by a conventional power supply circuit 1608.

The circuit shown in figure 16 provides a basic Ethernet bridge functionality. Depending upon the functionality provided in the power line integrated circuit 1600, the sophistication of the bridge may vary, for example a known DS2 based integrated circuit provides a very large area network (VLAN) support with quality of service, and spanning tree bridging algorithms. Other known integrated circuits may provide a subset of those features, or may provide only a simple MAC level interface.

Known power line MAC integrated circuits contain an embedded processor. Some prior art integrated power line MAC integrated circuits provide different software images which support various additional networking functionality and in some cases the integrated circuit vendors supply a software development kit which allows a developer to add their own networking function to the integrated circuit. In other known integrated circuits, the processor is not accessible by the developer, in which case only simple MAC functions are provided.

Referring to figure 17 herein, those illustrated schematically a second circuit, which may comprise a partial implementation of the embodiments of figures 5 to 15 herein, comprising a wireless bridge node configuration.

The second circuit comprises a known power line integrated circuit 1700; a wireless bridging circuit 1701, the wireless bridging connected to the known power line integrated circuit by an MII interface 1702 which (may comprise the power line integrated circuit); in this example an IEEE 802.11 MAC integrated circuit 1703 interfacing with the wireless bridging circuit; an IEEE 802.11 physical layer integrated circuit 1704 interfacing with the IEEE 802.11 MAC integrated circuit 1703; and a radio frequency circuit 1705 connected to an antennae 1706 for transmitting/receiving wireless signals. The power line MAC integrated circuit 1700 interfaces with physical copper mains cabling via a power line physical layer

circuit 1707 and a discrete power line coupling 1708. The power line integrated circuit 1700 may be provided with additional flash memory 1709 and additional static and/or dynamic random access memory 1710, and similarly, the wireless bridging circuit 1701 may also be provided with additional flash memory 1711 and additional static and/or dynamic random access 1712. The circuit components may be comprised on a single circuit board within the power line adapter, in the case of a plug in adapter, within a casing of a plug in adapter, and in the case of a wall socket type adapter, on a circuit board behind the face plate, and contained within the confines of a British standard, or other appropriate standard wall mount box, depending on the country. Power to the circuits is provided by a separate power supply circuit 1713.

Currently, none of the available prior art power line integrated circuits provide a capability to support a wireless bridge directly. Generally, this is because a wireless system requires a significant amount of processing power which is not available in known power line integrated circuit processors. This problem may be overcome by providing an additional processor or carrying out the functionality of wireless bridging. This could be a known processor with interfacing into a known wireless solution, however due to size and power restrictions in the adapters disclosed herein, where the power restrictions are dictated by heat sinking capacity in the casing, a system on-chip (SoC solution) is preferable, in which the wireless bridging circuit and a powerline circuit are combined in the same integrated circuit. .

Current generation power line integrated circuits may require the additional static and/or dynamic random access memory (SDRAN) and flash memory to be added, as well as a wireless MAC, and wireless physical layer integrated circuit. However these modules may be incorporated in to future versions of power line integrated circuits disclosed herein, in order to minimise the space occupied and to reduce power consumption and therefore reduce heat dissipation within the adapter.

Referring to figure 18 herein, there is illustrated a third circuit which may be used for partial implementation of the embodiments described with the references to figures 5 to 15 herein.

The third circuit provides combined wireless and Ethernet bridge functionality and comprises a known power line integrated circuit 1800; a wireless bridging circuit 1801, the wireless bridging circuit 1800 interfacing with the power line integrated circuit 1800 via a MII interface 1802; an Ethernet physical layer 1803 which interfaces with the power line integrated circuit and the wireless bridging circuit; a discrete UTP coupling circuit 1804, communicating with the Ethernet physical layer circuit 1803; an IEEE 802.11 MAC integrated circuit 1805 connected to the wireless bridging circuit; an IEEE 802.11 physical circuit 1806 communicating with the IEEE 802.11 MAC circuit 1805; a radio frequency discrete circuit 1807, and a connected antennae 1808; a power line physical layer circuit 1809 connected to the power line integrated circuit 1800; and a discrete power line coupling circuit 1810 connected to the power line physical layer circuit 1809. Both the power line integrated circuit 1800 and the wireless bridging circuit 1801 may be provided with additional flash memory and additional static and/or dynamic random access memory, 1811 – 1814 as shown. All of the components shown in figure 18 may be provided within a single, or a small number of individual circuit boards within the casing of an externally pluggable adapter or behind the face plate of a wall mounted adapter as described herein as before.

In order to reduce space and reduce power consumption and therefore reduce heat dissipation within the adapter, the wireless bridging circuit 1801, IEE 802 MAC circuit 805, and physical layer circuits may be incorporated within a single incorporated circuit.

Where a node is required to have both wireless and Ethernet interfacing, then the wireless version may be connected to the wireless Ethernet physical layer to be added back to the circuit. Depending upon the power line circuit and

the bridging circuit, the Ethernet physical circuit may be connected to the power line circuit and/or the plug circuit.

Using known power line chip sets, the first and third circuits described herein may be implemented based around known integrated circuits as follows.

A known DS2 power line integrated circuit, combined with a Ubicom IP2303 bridge circuit, and an Atheros wireless circuit, which would give a Wi Fi base span and radio, integrated into the Atheros integrated circuit. External flash memory, SDRAM, and switch filtering circuits may need to be incorporated on to the same circuit board.

Alternative and / or equivalent wireless devices may be sourced or available from a Zigbee Alliance member such as Analog Devices, Cirronet, Crossbow Technology Inc., Freescale Semiconductor Inc., Helicomm, Innovative Wireless Technologies, Integration Associates, Melexis Connectivity Solutions, Millennial Net Inc., Omnex Control Systems Inc., Texas Instruments Inc., Yokogawa Electric Corporation and/ or ZMD.

Alternatively, power line circuits provided by SPiDCOM could be used, comprising an SPC 2000 – e MAC chip with an AD9865 physical layer chip and additional flash memory and SD RAM.

Alternatively, the circuits may be based around the Home Plug AV chip set, or the Intellon INT 6000 chip.

The Ubicom IP3023 device supports IEEE 802.11 a/b/g standards and the Atheros AR 5000 and AP – gs chip support IEEE 802.11 b/g and super G at 108 Mbs.

As implemented either in circuit board combining new combinations of known chip sets, or manufactured as new integrated circuits, the first to third circuits as described above may have maximum heat dissipation 5 Watts or less, and of preferably of 2 Watts or less.

Similarly the physical dimensions of the circuits, including the substrate boards on which the circuits are carried within their housings in the adapter devices are such as to fit within a conventional twin socket wall box, behind a twin socket faceplate. In the UK this means the circuits may have maximum physical dimensions of width up to 130mm, and height up to 75 mm.

In the case of an externally pluggable separate adapter, which plugs into an existing conventional mains socket, the maximum dimensions of the circuit board should be small enough to fit within a suitably sized case, which when installed at a double mains socket, allows a neighboring mains socket still to be used by a conventional mains plug. In the case of the United Kingdom, the circuit should have maximum dimensions of the order, width up to 55 mm, and height up to 75mm, to achieve that objective.

Claims:

1. An adapter having at least one socket portion and connector means by which a mains power signal can be delivered to or connected with said adapter, characterised in that said adapter is further provided with an electronics module which is not only powered by said mains power but effectively separates a digital signal therefrom, said digital signal being transmitted in conjunction with said mains power signal, and further characterised in that said adapter means provides at least one separate outlet, discrete from the other socket portion by means of which the mains power signal received at the connector means is transmitted.

2. An adapter according to claim 1, wherein the connector means are in the form of conventionally arranged pins capable of being inserted into a standard socket wall plate.

3. An adapter according to claim 1 or 2, wherein the separate outlet is chosen from one of:

a socket capable of accepting an Ethernet cable connector, a Wi Fi, infra-red or other wireless data transfer transceiver port, a physical USB port a video signal connector, and/or an IEEE 1394 outlet, an in each case the electronics module is configured to strip a particular requisite and appropriate signal carried by said power signal and deliver said strip signal to the respective separate outlet.

4. An adapter according to claim 3, wherein the separate outlet is an Ethernet port.

5. An adapter according to any preceding claim which is provided with a plurality of outlets comprising at least one Ethernet outlet and at least on Wi Fi outlet.

6. An adapter according to any preceding claim in the form of a conventional socket wall plate having a pair of sockets.

7. An adapter according to claim 6, comprising a pair of separate outlets, one being an Ethernet port and the other being a Wi Fi transceiver port.

8. A communications adapter for communicating a digital communications signal over a mains power circuit, said adapter comprising a mains socket wall plate having a face plate comprising at least one mains power socket, and said adapter comprising connector means by which a mains power signal can be delivered to or connected with said mains power socket ,

said adapter being further provided with an electronics module which is powered by said mains power, and which separates said digital communications signal therefrom, said digital communications signal being transmitted and /or received in conjunction with said mains power signal, and

said adapter means provides at least one separate communications outlet, discrete from said mains power socket by means of which the digital communications signal received at the connector means is transmitted and received; and

wherein said electronics module is incorporated behind said face plate of said mains socket wall plate, which is configured to be permanently secured into a wall or other like structure, such that in use, an outer face of said face plate is unobstructed by said electronics module.

9. An adapter according to claim 8, wherein the separate outlet is chosen from one of:

a socket capable of accepting an Ethernet cable connector;

a Wi - Fi, infra-red or other wireless data transfer transceiver port;

a physical USB port;

a video signal connector, and/or an IEEE 1394 outlet;

and in each case the electronics module is configured to strip a particular requisite and appropriate signal carried by said power signal and deliver said stripped signal to the respective separate outlet.

10. An adapter according to claim 8, wherein the separate outlet comprises an Ethernet port.

11. The adapter as claimed in claim 8, comprising an integrated Wi Fi transmitter/receiver.

12. An adapter according to any one of claims 8 to 10, which is provided with a plurality of outlets comprising at least one Ethernet outlet and at least one Wi - Fi outlet.

13. An adapter according to any one of claims 8 to 10, in the form of a mains power socket wall plate having a pair of sockets.

14. An adapter according to claim 8, comprising a pair of separate outlets, one being an Ethernet port and the other being a Wi - Fi transceiver port.

15. An adapter as claimed in claim 8, comprising an integrated Bluetooth transceiver.

16. The adapter as claimed in claim 8, comprising an integrated WiMAX transmitter and receiver.

17. The adapter as claimed in any one of claims 8 to 16, comprising an ultra wide band transmitter/ receiver.

18. The adapter as claimed in any one of claims 8 to 17, comprising a modem.

19. The adapter as claimed in any one of claims 8 to 18, comprising a router.

20. A power line signal device capable of applying and retrieving a communication signals onto or from a low frequency mains conductor, said device comprising:

a mains electrical connector by which a mains power signal is connected to said device;

at least one mains power outlet, which is connected to said connector;

a data communications circuit for applying a data communication signal to said mains electrical connector, and for extracting digital data signals from said mains electrical connector; and

a wireless data communications circuit for converting said data communication signal to a form suitable for wireless communication.

21. The device as claimed in claim 20, comprising a wireless transmitter/receiver capable of transmitting and receiving wireless signals; and

22. The device as claimed in claim 20 or 21, comprising an integrated bluetooth transceiver.

23. The device as claimed in any one of claims 20 to 22, comprising an integrated WiMAX transmitter and receiver.

24. The device as claimed in any one of claims 20 to 23, comprising an integrated Wi Fi transmitter/receiver.

25. The device as claimed in any one of claims 20 to 23, comprising an ultra wide band transmitter/receiver.

26. The device as claimed in any one of claims 20 to 25, having a wireless circuit comprising:

a wireless bridging circuit;

an IEEE 802.11 MAC circuit; and

an IEEE 802.11 physical layer circuit.

27. The device as claimed in any one of claims 20 to 26, further comprising an Ethernet physical layer circuit, said Ethernet physical layer circuit communicating with said data communications circuit.

28. The device as claimed in any one of claims 20 to 27, further comprising a power line physical layer circuit, configured to interface with said power line data communications circuit.

29. The circuit as claimed in any one of the preceding claims having a circuit board confined within maximum external width and height dimensions of: Width 55 mm; and Height 75 mm.

30. The circuit as claimed in any one of the preceding claims, confined within maximum external dimensions of: Width 55 mm; and Height 75 mm.

31. The circuit as claimed in any one of the preceding claims, having a maximum power dissipation of 5 Watts.

32. The circuit as claimed in any one of the preceding claims, having a maximum power dissipation of 2 Watts.

Fig.1.
(Prior Art)

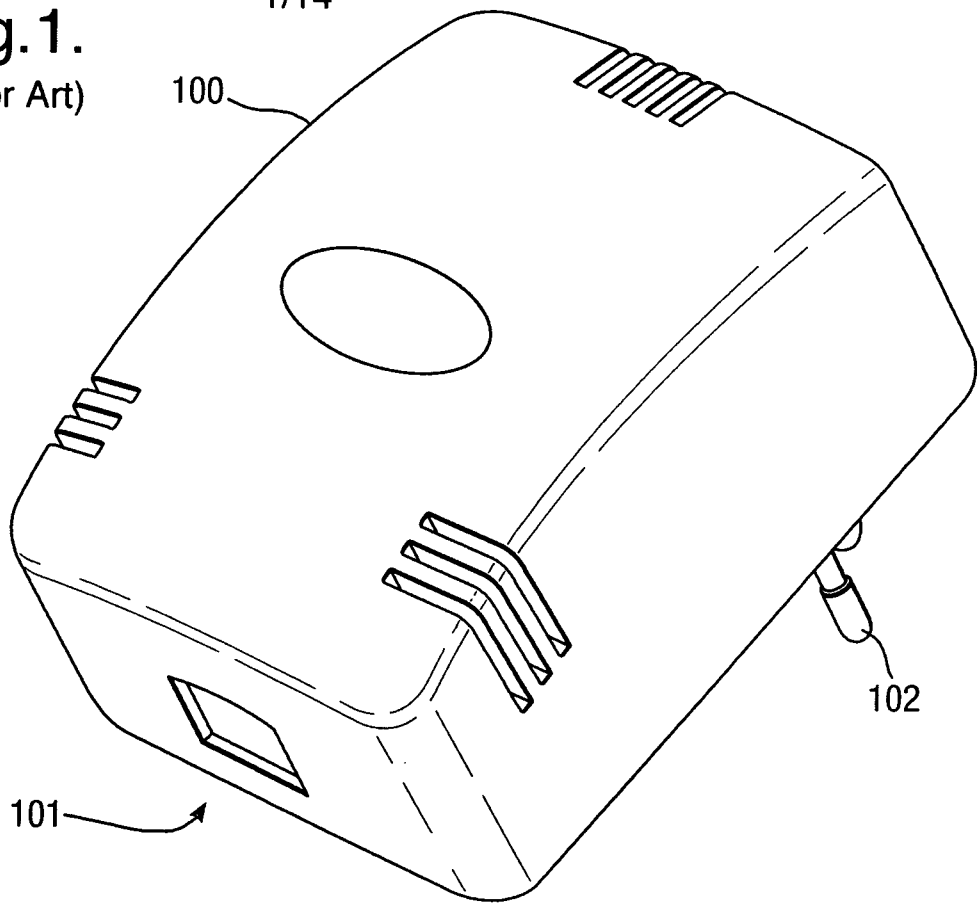


Fig.2.
(Prior Art)

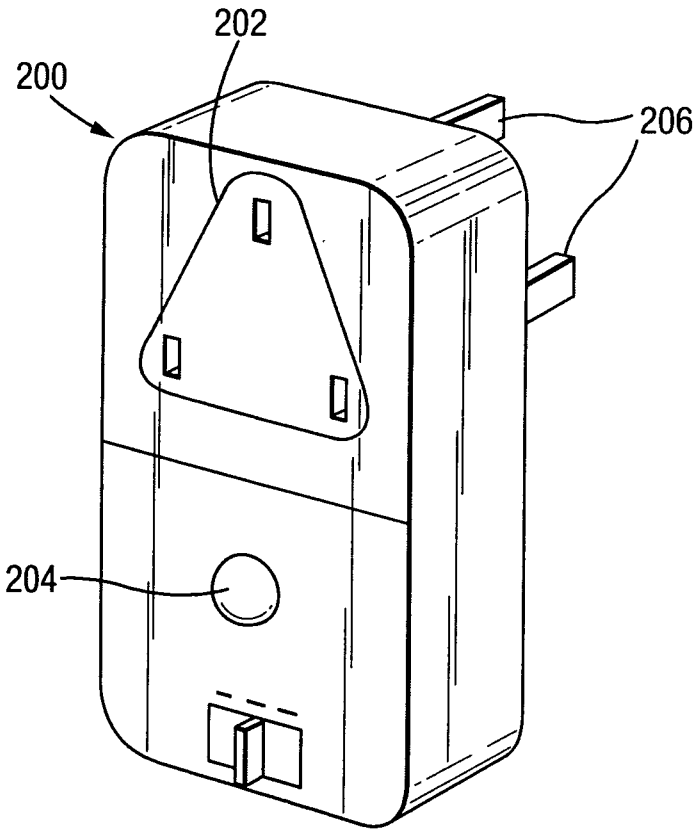
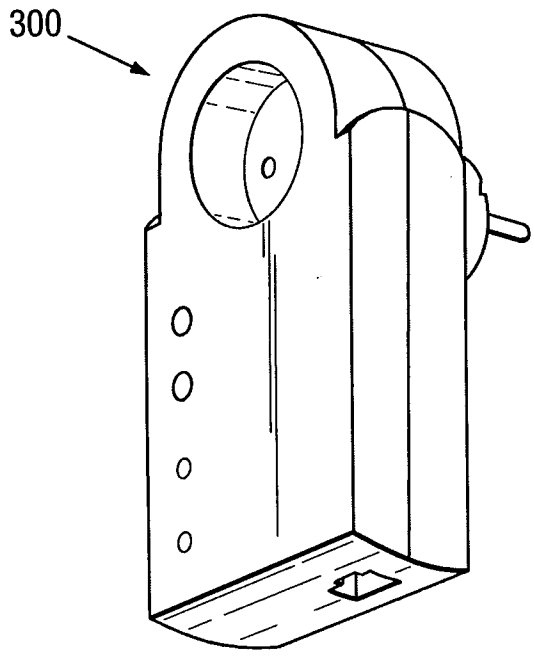


Fig.3.
(Prior Art)



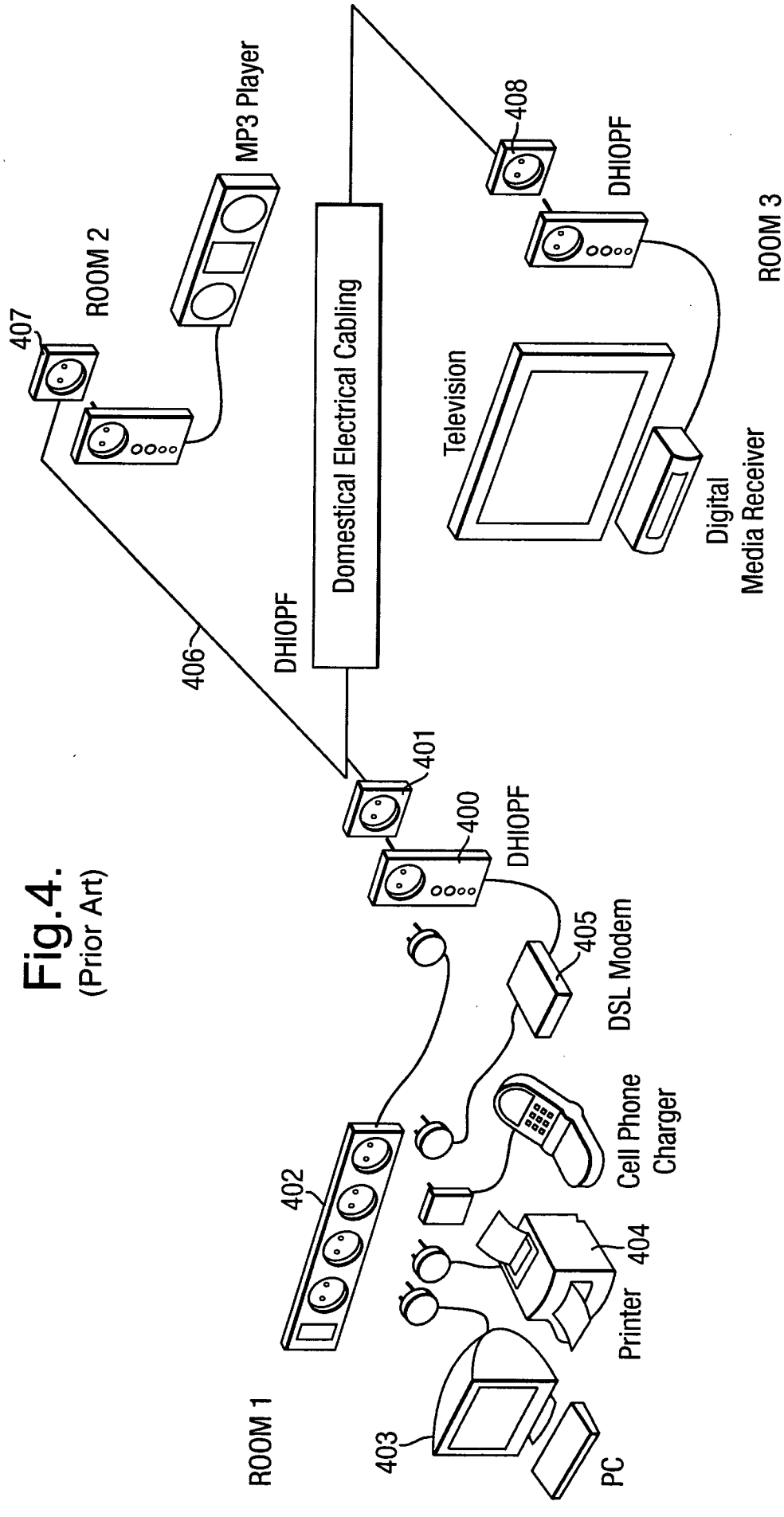


Fig.4.
(Prior Art)

Fig.5.

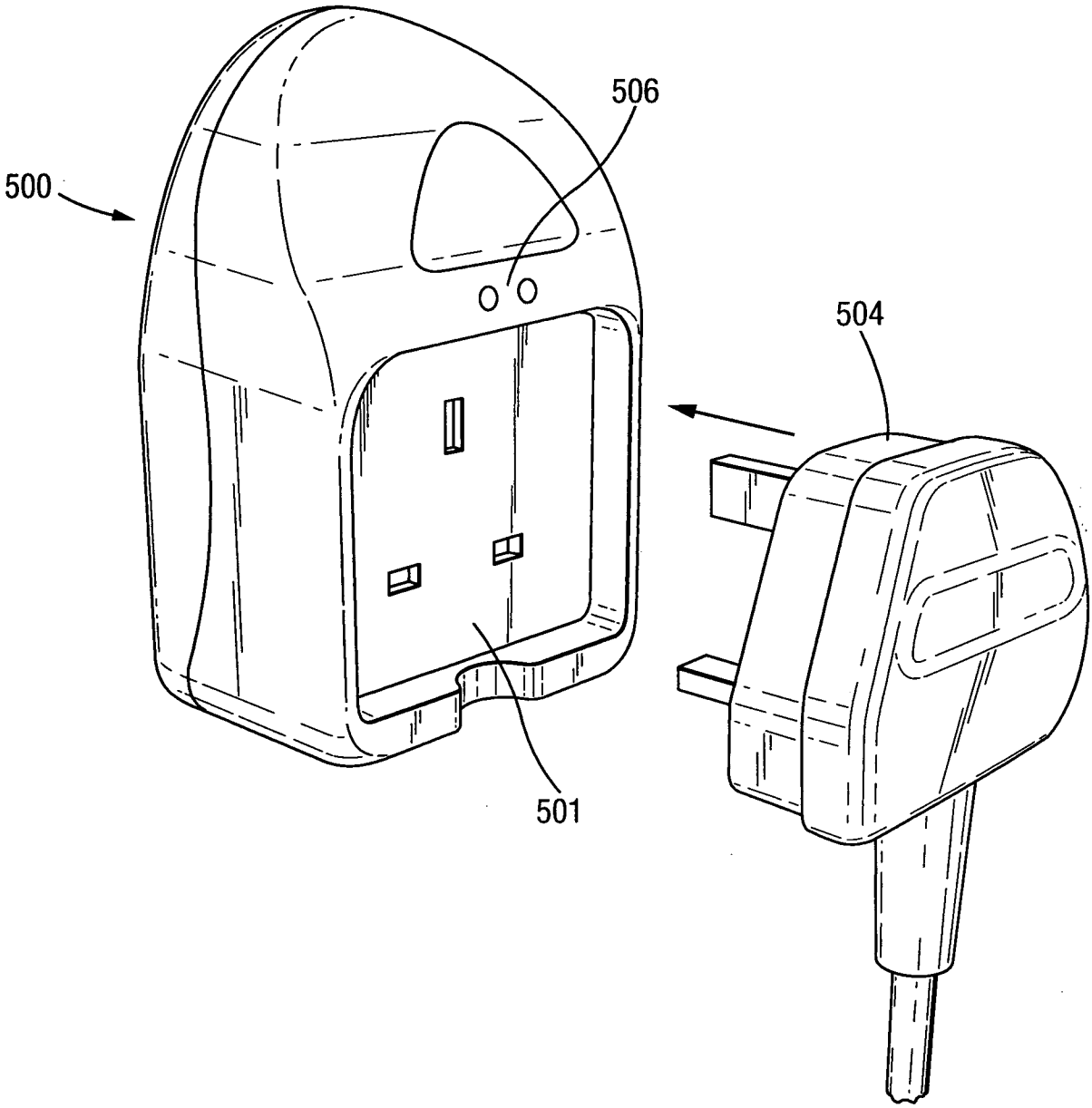


Fig.6.

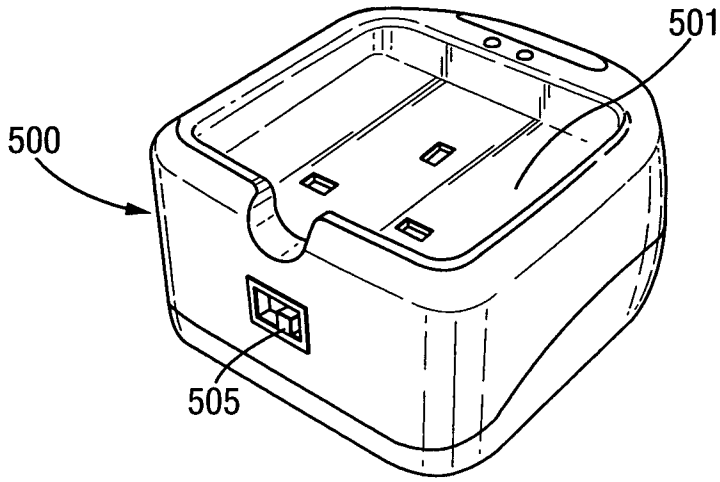


Fig.7.

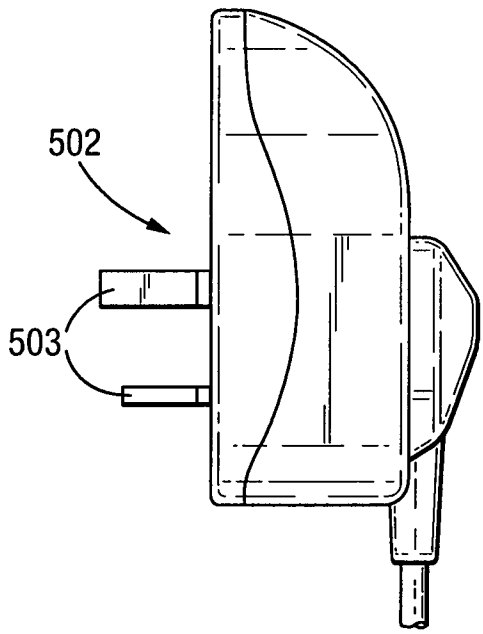


Fig.8.

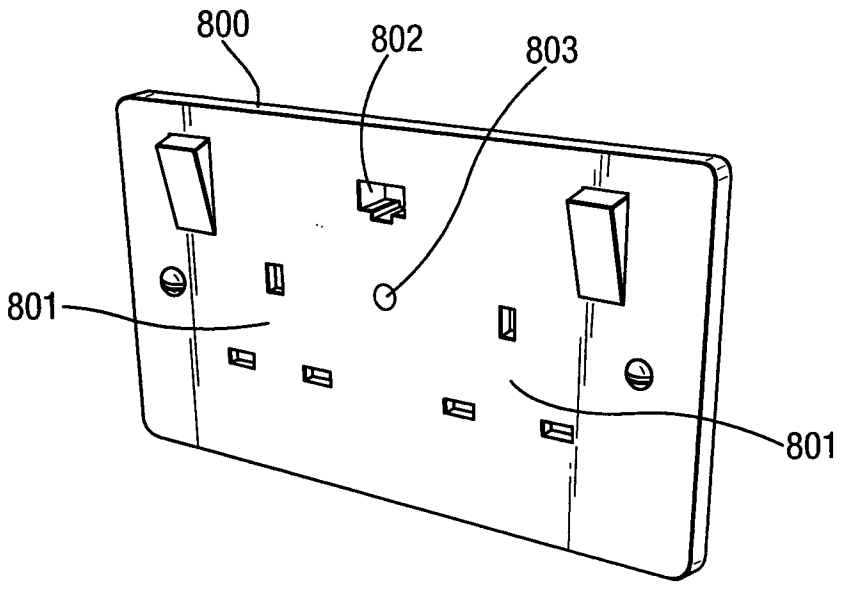


Fig.9.

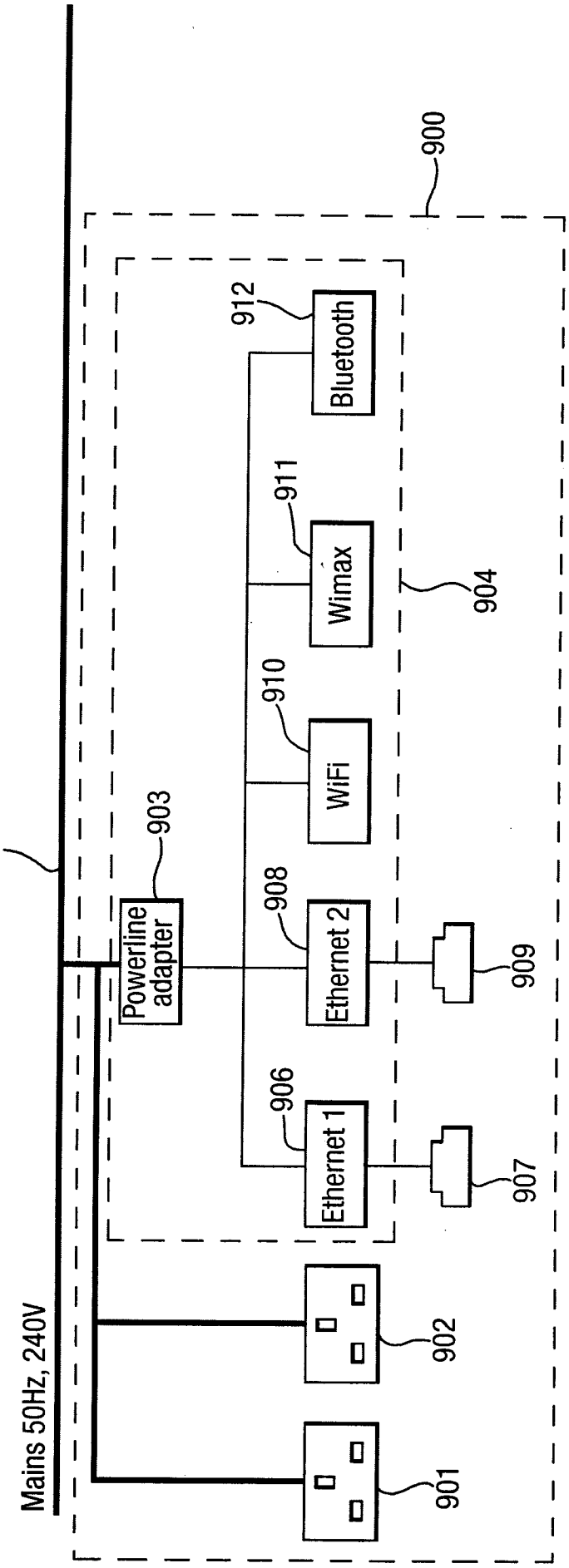

900
912
Bluetooth
911
Wimax
904
910
WiFi
903
903
Powerline adapter
908
Ethernet 2
909
906
Ethernet 1
907
902
901
Mains 50Hz, 240V

Fig.10.

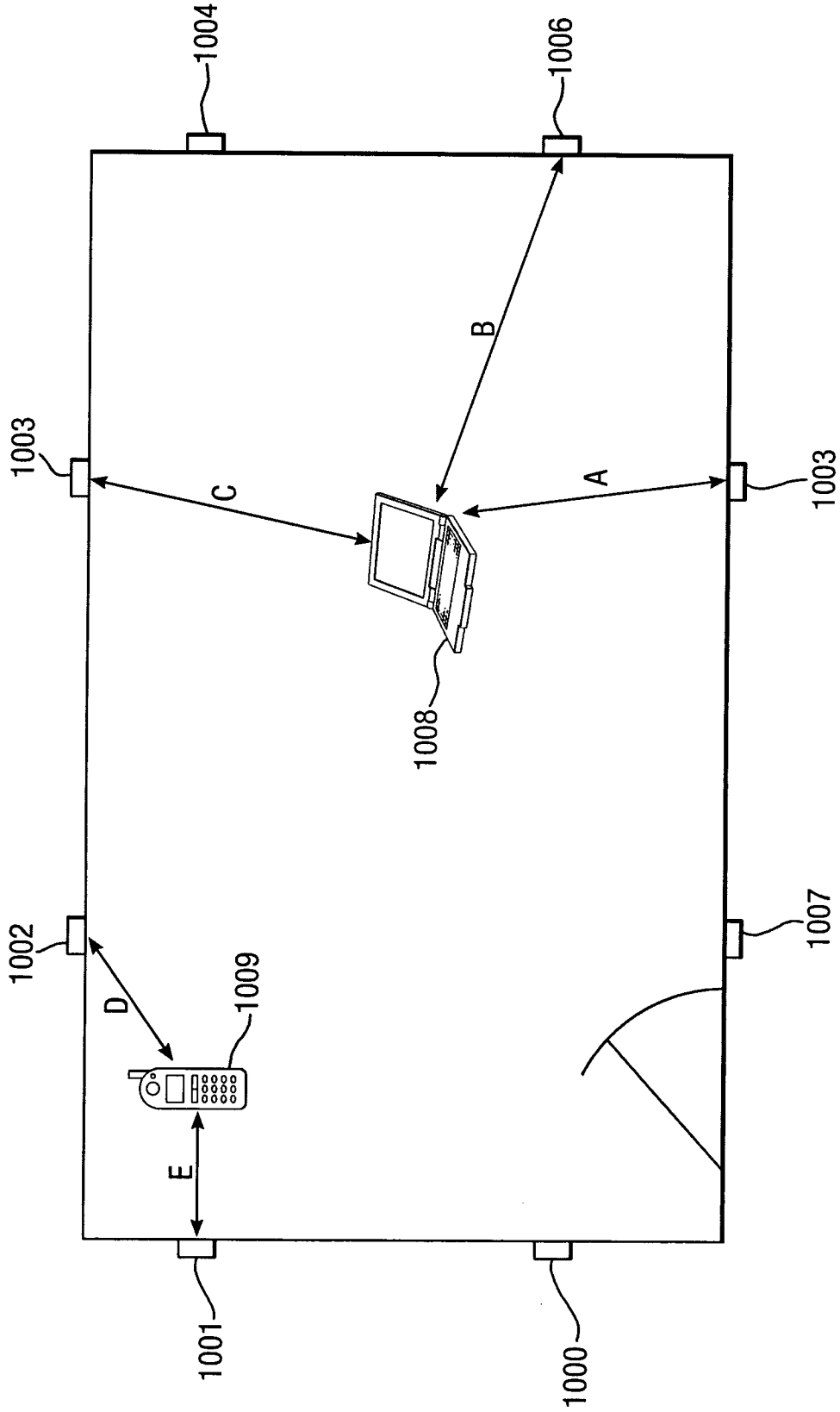


Fig.11.

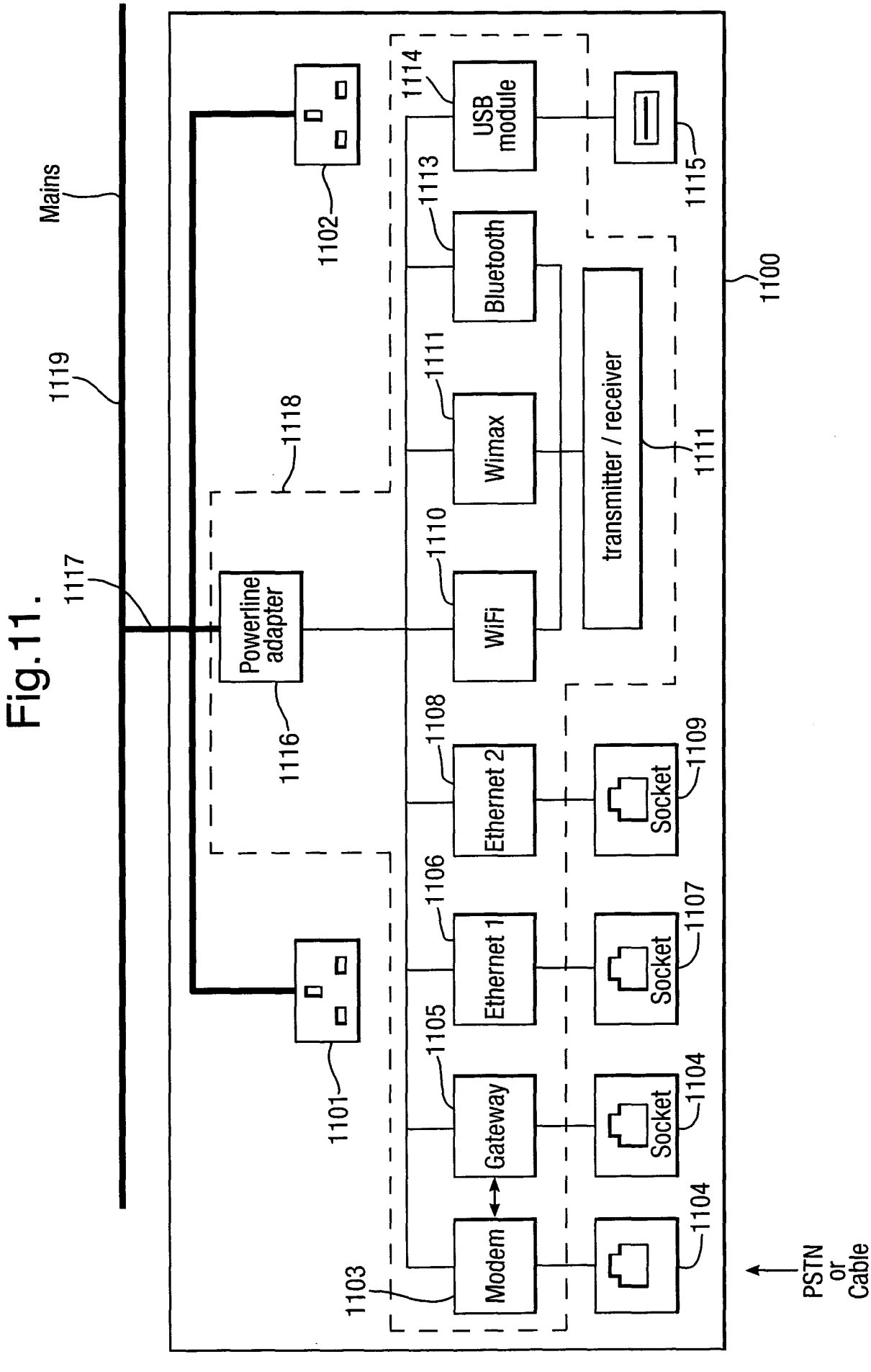

Mains
1119
1117
1118
1102
1114
USB module
1115
1113
Bluetooth
1111
Wimax
transmitter / receiver
1111
1100
1110
WiFi
Powerline adapter
1116
1108
Ethernet 2
1109
Socket
1106
Ethernet 1
1107
Socket
1105
Gateway
1104
Socket
1104
Modem
1103
1101
PSTN or Cable

Fig.12.

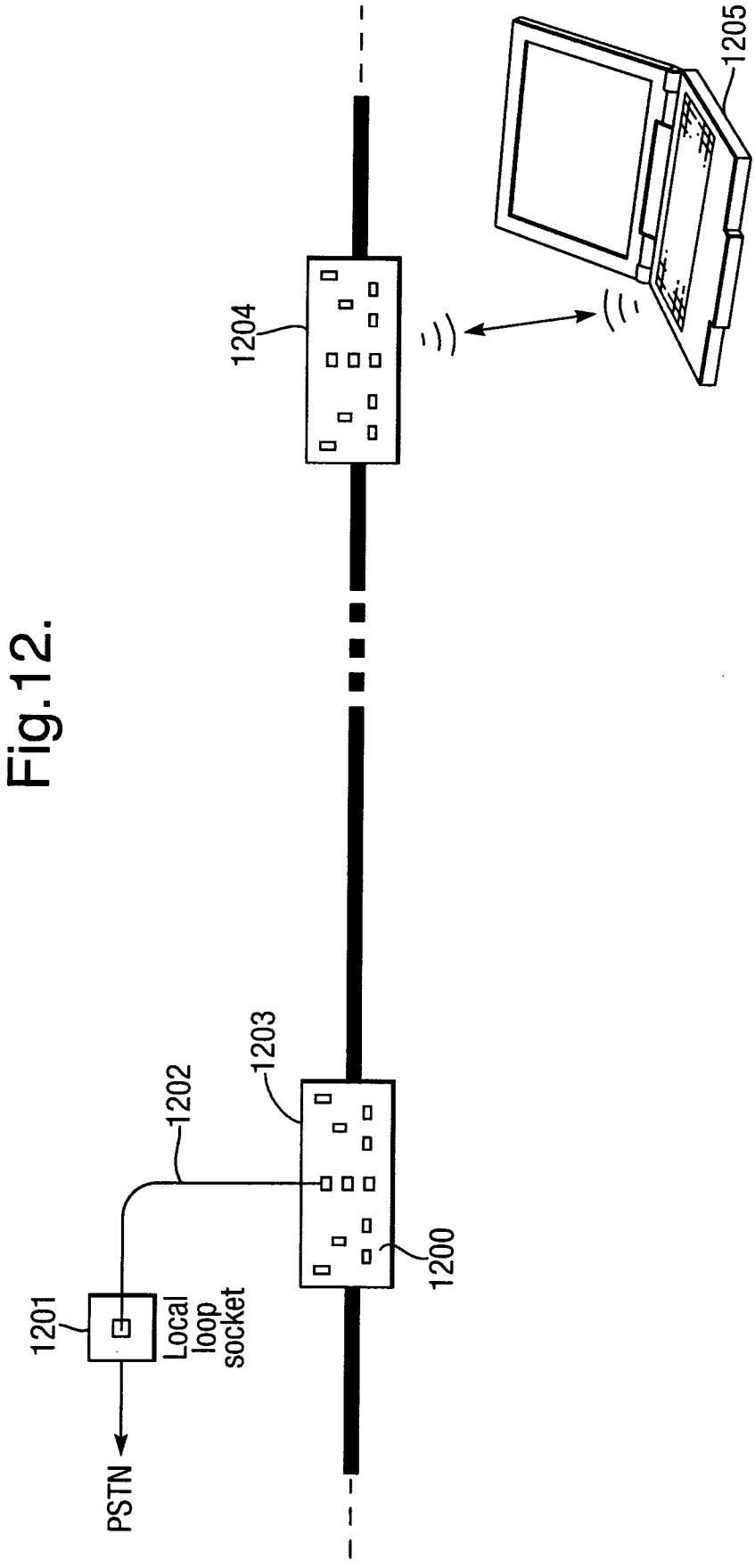


Fig.13.

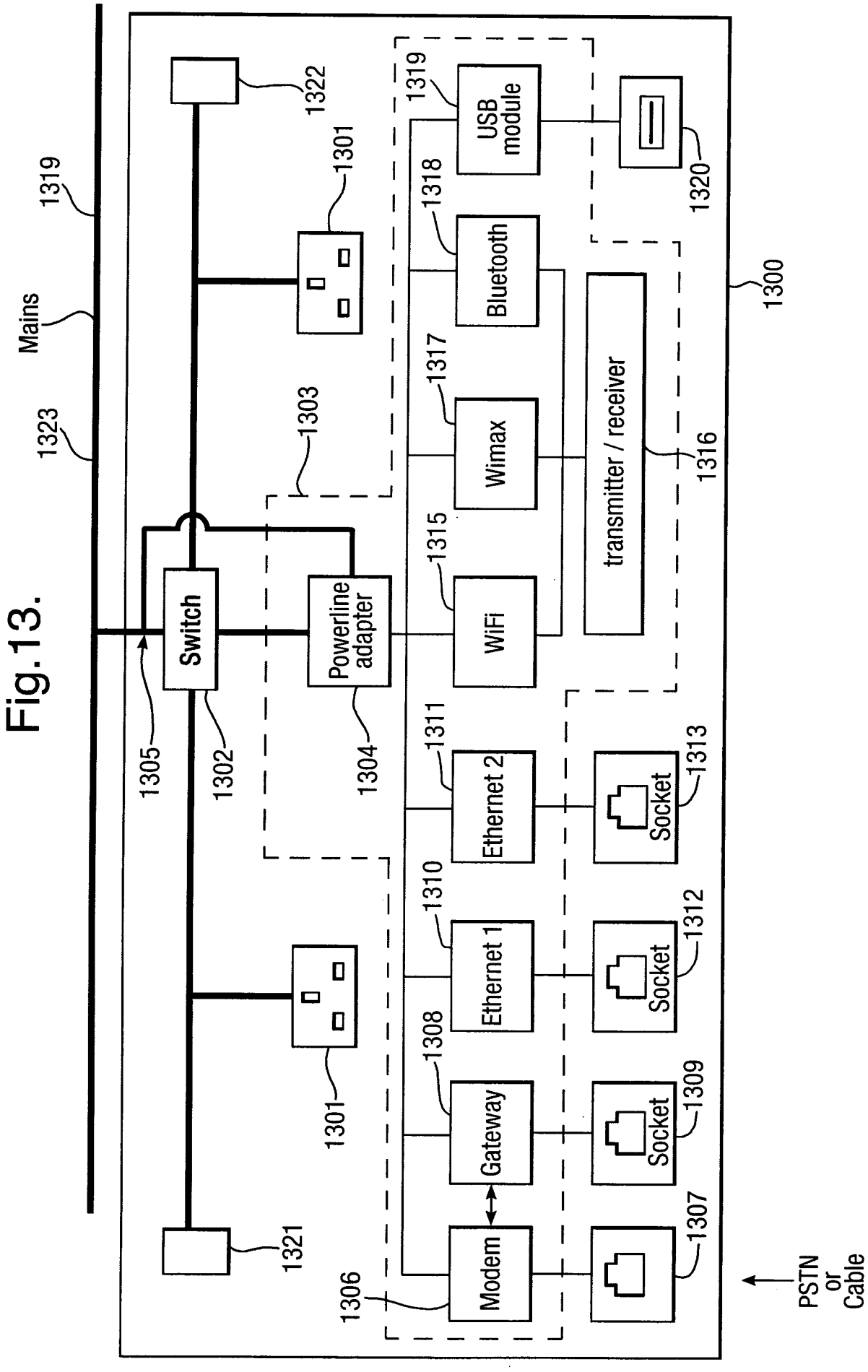

Mains
1319
1323
1322
1301
1303
1319
USB module
1318
Bluetooth
1317
Wimax
1315
WiFi
transmitter / receiver
1316
1320
1300
Switch
1305
1302
Powerline adapter
1304
1311
Ethernet 2
1313
Socket
1310
Ethernet 1
1312
Socket
1308
Gateway
1309
Socket
1307
1301
1321
1306
Modem
PSTN or Cable

Fig.14.

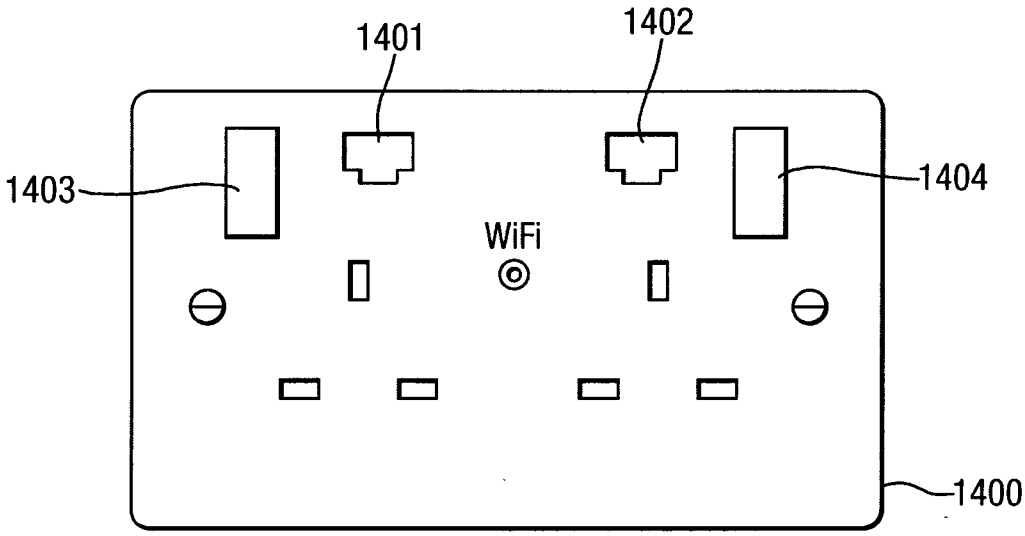
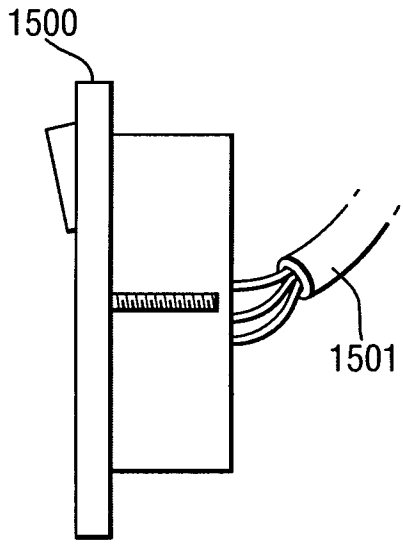


Fig.15.



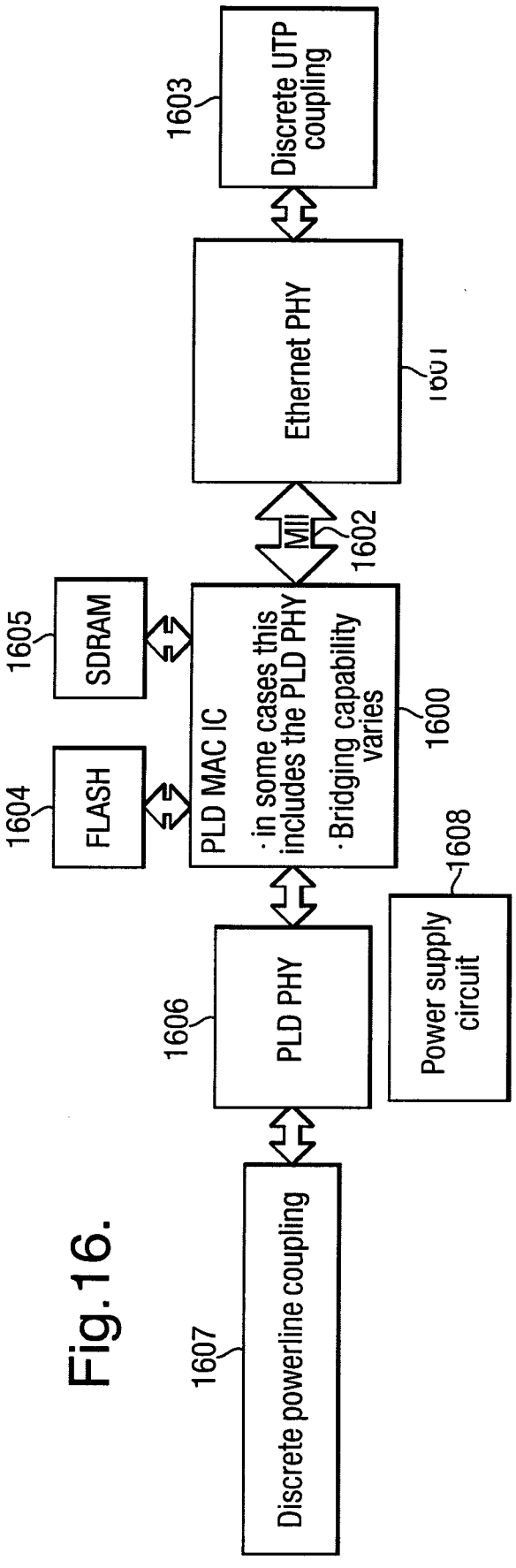

1603
Discrete UTP coupling
Ethernet PHY
1601
MII
1602
1605
SDRAM
1604
FLASH
PLD MAC IC
· in some cases this includes the PLD PHY
· Bridging capability varies
1600
1608
Power supply circuit
1606
PLD PHY
1607
Discrete powerline coupling

Fig.16.

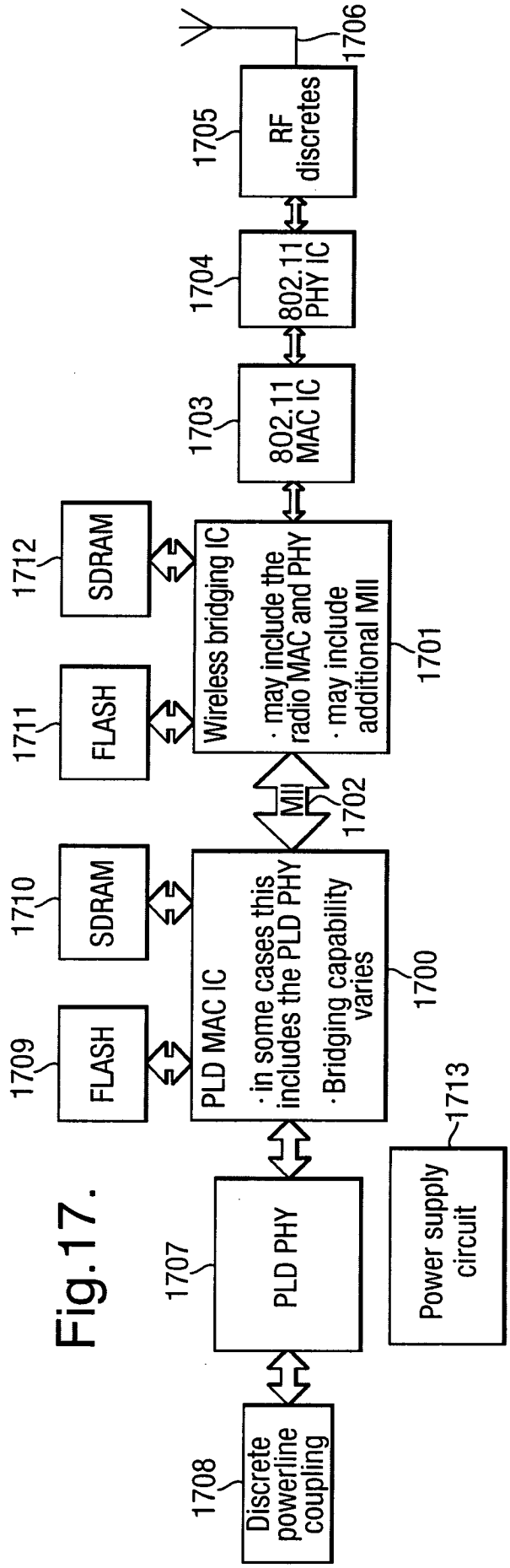
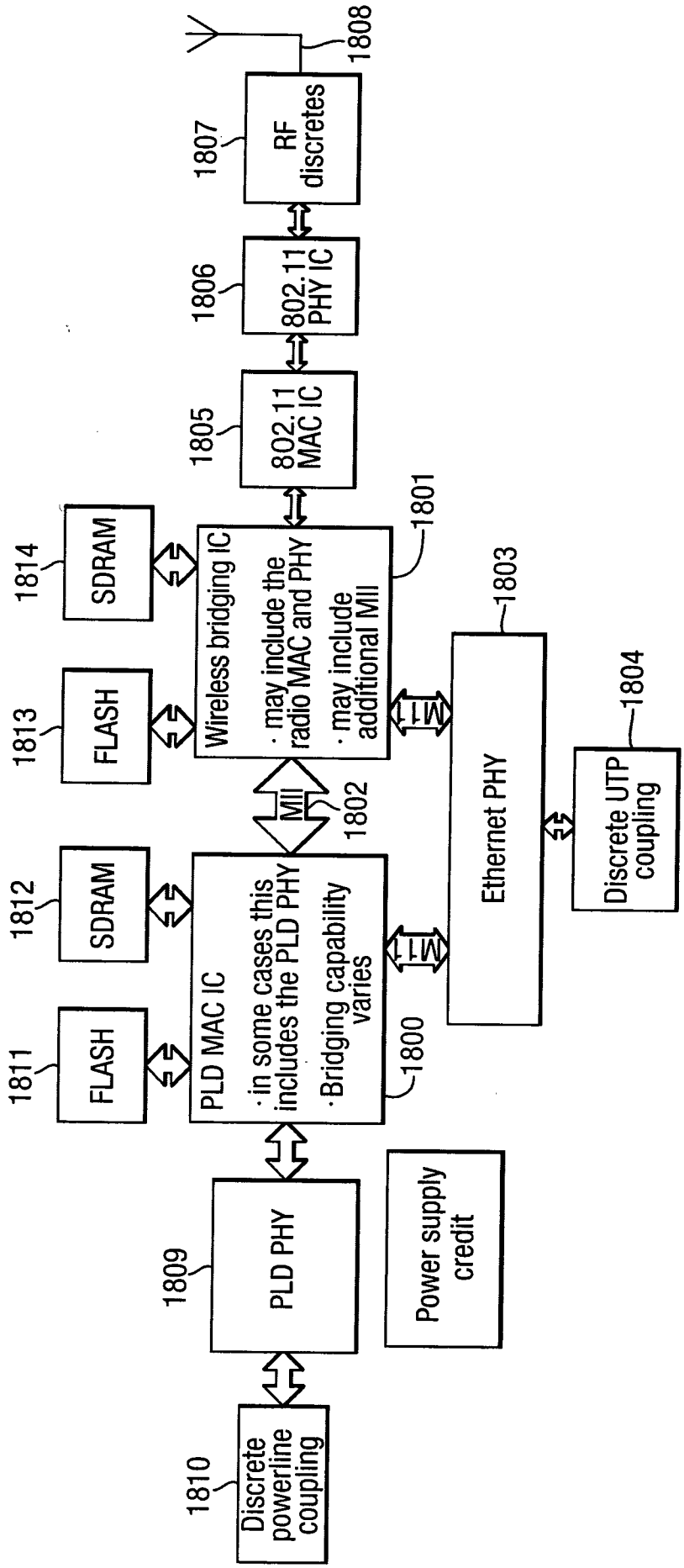

1706
1705
RF discretes
1704
802.11 PHY IC
1703
802.11 MAC IC
1712
SDRAM
1711
FLASH
Wireless bridging IC
· may include the radio MAC and PHY
· may include additional MII
1701
MII
1702
1710
SDRAM
1709
FLASH
PLD MAC IC
· in some cases this includes the PLD PHY
· Bridging capability varies
1700
1713
Power supply circuit
1707
PLD PHY
1708
Discrete powerline coupling

Fig.17.

Fig.18.


1808
1807
RF discretes
1806
802.11 PHY IC
1805
802.11 MAC IC
1801
1814
SDRAM
Wireless bridging IC
· may include the radio MAC and PHY
· may include additional MII
1813
FLASH
MII
1802
1803
MII
Ethernet PHY
1804
Discrete UTP coupling
1812
SDRAM
PLD MAC IC
· in some cases this includes the PLD PHY
·Bridging capability varies
1800
MII
1811
FLASH
1809
PLD PHY
Power supply credit
1810
Discrete powerline coupling