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(71) Applicant: **2WIRE, INC.** [US/US]; 1704 Automation Parkway, San Jose, CA 95131 (US).

(72) Inventors: **SUN, Ting**; 2Wire, Inc., 1704 Automation Parkway, San Jose, CA 95131 (US). **HINMAN, Brian**; 2Wire, Inc., 1704 Automation Parkway, San Jose, CA 95131 (US).

(74) Agents: **YEE, Susan** et al.; Carr & Ferrell LLP, 2225 East Bayshore Road, Suite 200, Palo Alto, CA 94303 (US).

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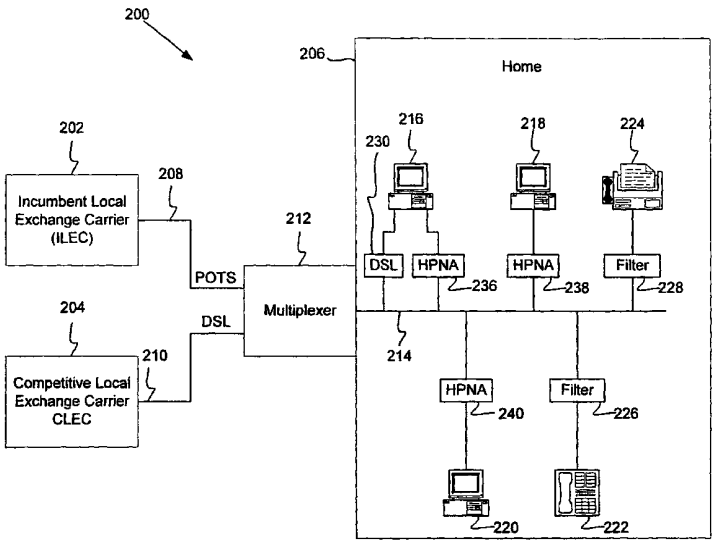

(57) Abstract: A system and method are disclosed for coupling a single home telephone wiring network to a high frequency signal line and a low frequency signal line so that both high and low frequency signals may be multiplexed, or coupled, from the two lines onto the single home telephone wiring network for simultaneous operation thereon. A multiplexer having a high pass filter and a low pass filter is disposed between the single home telephone wiring network and the high and low frequency lines. The high and low pass filters generally prevent cross-talk between the high and low frequency lines while permitting both the high and low frequency signals to pass between the single home telephone wiring network and the respective high and low frequency signal lines. In another configuration, the multiplexer operates as a splitter to split incoming FDM signals, such as DSL and POTS signals, into high and low frequency components.

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SYSTEM AND METHOD FOR MULTIPLEXING A HIGH FREQUENCY SIGNAL AND A LOW FREQUENCY SIGNAL ONTO A SINGLE TELEPHONE WIRING NETWORK

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to and claims priority of U.S. provisional patent application No. 60/150,509 by Ting Sun and Brian L. Hinman, entitled "System and Method for Multiplexing a High Frequency Signal and a Low Frequency Signal onto a Single Telephone Wiring Network," filed August 24, 1999 and is related to co-owned U.S. Patent Application No. 09/353,111 by Ting Sun and Brian L. Hinman, entitled "Odd-Order Low-Pass POTS Device Filter" and filed on July 14, 1999, which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to interfacing telephone lines with a home telephone network and, more particularly, to a system and method for multiplexing a high frequency signal and a low frequency signal from separate lines onto a single telephone wiring network to allow simultaneous operation using frequency domain multiplexing.

2. Description of the Background Art

One method of accessing the Internet is by using Digital Subscriber Line (DSL) technology. Various versions of DSL exist, such as Asymmetric DSL (ADSL), Symmetric DSL (SDSL), Rate Adaptive DSL (RADSL), Very high speed ADSL (VADSL),

Consumer DSL (CDSL), etc. These and other versions of DSL are collectively referred to as DSL.

ADSL is one version of DSL technology that expands the useable bandwidth of existing copper telephone lines, delivering high-speed data communications at rates up to about 8 Mbps without interrupting normal telephone service, also known as POTS (Plain Old Telephone Service). To achieve this end, ADSL uses frequency-division multiplexing (FDM) technology to carry POTS and ADSL channels on the same twisted-pair copper telephone line.

ADSL is a point-to-point connection in that an ADSL termination device, such as a DSL modem, must generally be present on each end of the copper circuit. Since ADSL works over copper, it is an appropriate technology for the "local loop," which comprises the copper circuits running from a local telephone switch into virtually every home and business. Details concerning DSL standards and equipment are found in "Standards Project for Interfaces Relating to Carrier to Customer Connection of Asymmetrical Digital Subscriber Line (ADSL) Equipment," T1E1.4/97-007R6, T1.413 Issue 2, edited by John Bingham and Frank van der Putten, dated September 26, 1997, which is incorporated herein by reference.

Customers typically purchase DSL service from either an Incumbent Local Exchange Carrier (ILEC) or a Competitive Local Exchange Carrier (CLEC). An ILEC is a traditional local telephone company, such as one of the regional bell companies. ILECs usually provide Plain Old Telephone Service (POTS) and may also provide DSL service over a single local loop.

When a customer desires to receive DSL service from a CLEC, however, the CLEC is typically not permitted to couple the CLEC DSL service onto the ILEC local loop. Instead, the CLEC is generally required to install a new local loop between the CLEC and the customer's home and, importantly, install

additional telephone wiring within the customer's home to the location at which the customer desires to receive the DSL service. This configuration is illustrated in FIG. 1.

FIG. 1 illustrates a DSL service network 100 including an ILEC 102, a CLEC 104, and a home 106. According to this configuration, the ILEC 102 provides POTS service to the home 106 over line 108 and the CLEC 104 provides DSL service, such as ADSL service, to the home 106 over line 110, which must usually be installed. In addition to installing the line 110, the CLEC must typically install wiring 112 inside the home to couple the line 110 to a DSL modem 114 associated with a computer 116 at a particular location within the home.

The installation of the line 112 is typically expensive and cumbersome. Further, in the event the customer chooses to change the location of the DSL modem 114 inside the home 106, such as a move from a home office to a bedroom, additional wiring within the home 106 would be required to interconnect the line 110 with the DSL modem 114 at its new location.

As shown, the home telephone wiring network 120 is coupled to the ILEC line 108 for providing POTS service to the telephones 122 and to the facsimile machine 124. Moreover, the computers 126, which may be adapted with analog modems (not shown), are also coupled to the home telephone wiring network 120. In another embodiment (not shown), the facsimile machine 124 has its own dedicated ILEC line, which is separate from the ILEC line 108.

Hence, for a customer to obtain CLEC DSL service using the configuration illustrated in FIG. 1, the customer must have the additional wiring 112 installed inside the home 106 to interconnect the CLEC line 110 and the DSL modem 114. The installation of this additional internal wiring typically involves considerable time, expense, and inconvenience. Moreover, once the additional wiring 112 is installed, the

customer may need to have yet additional wiring installed within the home if the customer desires to change the position of the DSL modem 114 within the home.

Consequently, a need exists for an apparatus and method by which a CLEC may provide DSL service to a home without requiring installation of separate wiring, such as the wiring 112, inside the home. An additional need exists for a system and method for coupling CLEC DSL service inside a home that permits the DSL service to be accessed from different locations within the home without installing additional internal wiring within the home. Indeed, as discussed above, the installation of separate, or additional, internal wiring within the home can be expensive as well as cumbersome.

SUMMARY OF THE INVENTION

The present invention overcomes or substantially alleviates prior problems associated with systems and methods for coupling DSL service from a Competitive Local Exchange Carrier (CLEC) with a home. In general, the present invention provides a FDM multiplexer for coupling POTS signals on a POTS service line and DSL signals on a DSL service line onto a single home telephone wiring network while preventing cross-talk between the POTS and DSL service lines.

An ILEC POTS service line and a CLEC DSL service line are coupled to the multiplexer for multiplexing the POTS service and the DSL service onto a single, presumably preexisting, home telephone wiring network. In this manner, CLEC DSL service may be provided to a home without requiring installation of additional telephone wiring within the home. Hence, the present invention permits CLEC DSL and ILEC POTS service lines to be coupled to the preexisting single telephone wiring network within a home and avoids the need for additional wiring to be installed within the home. Further, the multiplexer of the present invention generally prevents the POTS signals from entering the CLEC DSL service line and prevents the CLEC DSL signals from entering the ILEC POTS service line.

Pursuant to one embodiment, the multiplexer includes a low pass filter coupled to the ILEC POTS service line and a high pass filter coupled to the CLEC DSL service line. Both the low pass filter and the high pass filter are coupled to a single home telephone wiring network to multiplex, or couple, POTS signals and DSL signals onto the single home telephone wiring network. The low pass filter permits POTS signals to pass between the home telephone wiring network and the ILEC while preventing higher

frequency signals, such as DSL signals passing to and from the CLEC, from entering onto the ILEC POTS service line. Similarly, the high pass filter permits DSL signals to pass between the home telephone wiring network and the CLEC while preventing POTS signals, from the ILEC or the home telephone wiring network, from entering onto the CLEC DSL service line.

The method of the current invention includes FDM multiplexing, or coupling, a POTS signal from a POTS service line and a DSL, or other high-speed communications, data signal from a DSL service line onto a single home telephone wiring network. One embodiment of this method includes disposing a multiplexer between an ILEC line, a CLEC line, and a home telephone wiring network. Positioning a high pass filter between the CLEC and the home telephone wiring network and a low pass filter between the ILEC line and the home telephone wiring network to prevent the signals on the CLEC line from entering onto the ILEC line and vice versa, while FDM multiplexing, or coupling, these signals onto the home telephone wiring network. The multiplexer passes POTS signals between the home telephone wiring network and the ILEC line via the low pass filter and passes DSL signals between the home telephone line and the CLEC line via the high pass filter.

The present system and method are advantageous in that they permit a customer to receive DSL service from a CLEC without having to install, or have installed, additional wiring within their home. Indeed, multiplexing CLEC DSL signals and ILEC POTS signals from separate lines onto a single preexisting home telephone wiring network permits a customer to receive DSL service from a CLEC without having to install, or have installed, additional wiring within the home. The present system and method also permit access to

the CLEC DSL service from various locations on the home telephone wiring network.

Moreover, the present invention also prevents cross-talk between the CLEC and ILEC lines. In particular, the high and low pass filters disposed within the multiplexer of the present invention respectively prevent POTS signals from entering onto the CLEC line and DSL signals from entering onto the ILEC line.

An additional advantage of the multiplexer of the present invention is that it may also be employed in a reversed configuration as a splitter. Indeed, the multiplexer may be positioned in a reversed configuration to split high frequency signals from low frequency signals entering a home over a single local loop. In this embodiment, the high frequency signals are routed to a DSL modem while the POTS signals are routed to various POTS devices within the home.

Other advantages and features of the present invention will be apparent from the drawings and detailed description set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating a conventional ILEC/CLEC configuration;

FIG. 2 is a schematic diagram illustrating an ILEC/CLEC configuration in accordance with the present invention;

FIG. 3 schematically illustrates details of the multiplexer of FIG. 2;

FIG. 4 illustrates details of the low pass filter of FIG. 3;

FIG. 5 illustrates details of the high pass filter of FIG. 3;

FIG. 6 illustrates a DSL network system that employs the multiplexer of FIG. 2 in a reversed configuration to operate as a splitter; and

FIG. 7 illustrates details of the multiplexer of FIG. 6 in a reversed configuration to act as a splitter; and

FIG. 8 is a flowchart that illustrates a method of interfacing multiple telephone lines with a single home telephone wiring network in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 2 illustrates a DSL and POTS service network 200 including an ILEC 202, a CLEC 204, and a home 206. The ILEC 202 provides POTS service to the home 206 over line 208 and the CLEC 204 provides DSL service, such as ADSL service, to the home 206 over line 210. A multiplexer 212 is disposed between a single home telephone wiring network 214 and the lines 208 and 210 to interface the lines 208 and 210 with the home telephone wiring network 214.

The home 206 is shown as including computers 216, 218, and 220 coupled to each other and to the multiplexer 212 via the home telephone wiring network 214. As discussed in more detail below, the multiplexer 212 operates to multiplex, or couple, the DSL and POTS signals from the lines 210 and 208 respectively, onto the home telephone wiring network 214 while preventing cross-talk between the lines 210 and 208.

The home 206 also includes POTS devices, such as a telephone 222 and a facsimile machine 224, coupled to the home telephone wiring network 214. Filters 226 and 228 comprise low pass filters and are disposed between the home telephone wiring network 214 and the POTS devices 222 and 224 to isolate the POTS devices from high frequency signals, such as DSL signals, that might be present on the home telephone wiring network 214. The filters 226 and 228 may also be useful in preventing POTS device high-frequency impedance changes between operation states, such as on hook and off hook, from affecting DSL service.

The computer 216 includes a DSL modem 230 for converting analog signals to digital signals and vice versa so that the computer 216 may receive DSL service via the DSL modem 230. The DSL modem 230 is illustrated as being disposed between the computer 216 and the home telephone

wiring network 214. Those skilled in the art will appreciate that the DSL modem 230 may alternatively be disposed inside the computer 216.

The computers 216, 218, and 220 also respectively include HPNA (HomePNA) interface cards 236, 238, and 240 to permit the computers 216, 218, and 220 to communicate across the home telephone wiring network 214. Again, while the HPNA interface cards, or devices, 236, 238, and 240 are shown as being disposed external of the associated computers 216, 218, and 220, those skilled in the art will appreciate that each of these cards, too, may also be disposed inside an associated computer. One advantage of providing the computers 216, 218, and 220 with HPNA interface cards is that the cards permit the computers 218 and 220 to access the DSL service via the computer 216.

FIG. 3 schematically illustrates details of the multiplexer 212. As illustrated, the multiplexer 212 includes a low pass filter 302 and a high pass filter 304. The low pass filter 302 is coupled to the ILEC 202 via the line 208 to permit low frequency POTS signals to pass between the line 208 and the home telephone wiring network 214. The low pass filter 302 also prevents higher frequency signals, such as DSL signals, that might be present on the line 214 from entering onto the line 208. The low pass filter 302 is coupled to the home telephone wiring network 214 via a line 306.

In one embodiment, the low pass filter 302 permits signals having frequencies less than about 6 kHz to pass between the ILEC line 208 and the home telephone wiring network 214 while preventing passage of higher frequency signals, such as DSL signals. Additional details regarding the low pass filter 302 are discussed below with reference to FIG. 4. Those skilled in the art will appreciate that

FIG. 4 schematically illustrates one embodiment of the present invention and that other designs and implementations may be made without departing from the scope of the present invention.

The high pass filter 304 is coupled to the CLEC 204 via the line 210 to permit higher frequency signals, such as DSL signals, to pass between the line 210 and the home telephone wiring network 214. The high pass filter 304 is coupled to the home telephone wiring network 214 via the line 308. In this configuration, the high pass filter 304 permits DSL signals from the CLEC 204 to pass between the line 210 and the home telephone wiring network 214 while preventing the higher frequency DSL signals from entering onto the line 208.

Pursuant to one embodiment, the high pass filter 304 permits signals above about 25 kHz to pass between the line 210 and the home telephone wiring network 214 while preventing passage of lower frequency signals, such as POTS signals. Additional details regarding the high pass filter 304 are discussed below with reference to FIG. 5.

FIG. 4 illustrates the topology of one embodiment of the low pass filter 302 shown in FIG. 3. In this embodiment, the filter 302 of FIG. 4 is a reversible 3-pole, third-order, low-pass filter and includes first and second coupled inductors, or transformers, 402 and 404 with a single capacitor 406 disposed therebetween. Moreover, the filter 302 is shown as having a pair of ferrite beads 408 and a hazardous transient voltage protection circuit 410.

The filter 302 is further illustrated as being disposed between the ILEC 202 and the home telephone wiring network 214. A significant advantage of this embodiment of the filter 302 is that the capacitor 406 is disposed

between the two coupled inductors 402 and 406 so that regardless of which end of the filter 302 is coupled to the home telephone wiring network 214, the capacitor 406 will not short high frequency signals in the transmission path, such as DSL or home networking signals, on the home telephone wiring network 214. This advantage makes the filter 302 reversible in that either end of the filter 302 may be coupled to the home telephone wiring network 214 without shorting high frequency signals across a capacitor or otherwise impairing transmission of high frequency signals. Advantages associated with operating the multiplexer 212, including the low pass filter 302, in a reversed configuration are discussed in more detail below with reference to FIGS. 6 and 7.

The first and second coupled inductors 402 and 404 are shown as being configured identical to one another. The first coupled inductor 402 includes a pair of windings 412 wound around a core 414. Advantageously, each of the windings 412 has an inductance of about 5.5 mH or more. This coupled inductor configuration yields a relatively high inductance as it combines the self inductance of each winding together with the mutual inductance of the coupled inductor and thereby produces better high frequency attenuation.

The ferrite beads 408 reduce high frequency, common mode noise as well as provide EMI suppression. The hazardous transient voltage protection circuit 410 is conventional and is used to protect the associated POTS device from being damaged by transient voltages, such as those that might be produced by a lightning strike, for example.

FIG. 5 illustrates the topology of one embodiment of the high pass filter 304 shown in FIG. 3. As illustrated,

the high pass filter 304 is disposed between the CLEC 204 and the home telephone wiring network 214 to permit higher frequency signals, such as DSL signals, to pass between the CLEC 204 and the home telephone wiring network 214. Advantageously, the high pass filter 304 is configured to prevent POTS, or voice band, signals from passing onto the CLEC line 210 while permitting higher frequency signals, such as DSL signals to pass between the CLEC line 210 and the home telephone wiring network 214. Those skilled in the art will appreciate that POTS signals typically comprise signals below about 6 kHz while DSL signals typically comprise signals in roughly the 25 - 500 kHz range.

The CLEC line 210 comprises DSL positive and DSL negative lines 502 and 504 respectively. The positive line 502 includes capacitors 506, 508, and 510 arranged in series along the positive line 502. Likewise, the negative line 504 includes capacitors 512, 514, and 516 arranged in series along the negative line 504. The high pass filter 304 also includes inductors 520 and 522 arranged in parallel between the positive and negative lines 502 and 504. In particular, the capacitor 520 is disposed between the capacitors 506 and 508 and between the capacitors 512 and 514. Similarly, the capacitor 522 is disposed between the capacitors 508 and 510 and between the capacitors 514 and 516.

The high pass filter 304 also includes a voltage protection circuit 530 to protect against damage due to transient voltages, such as those that might be associated with a lightning strike. The voltage protection circuit 530 is disposed between the positive and negative lines 502 and 504 as shown and preferably comprises a sidactor voltage protection circuit.

FIG. 6 illustrates a DSL service network 600 that includes a central office 602 including a Digital Subscriber Line Access Multiplexer (DSLAM) 603 and a home 604 coupled by a loop 606. As shown, the central office 602 includes a DSL modem 610 and a loop interface 612. The loop interface 612 includes a high pass filter 614 and a low pass filter 616 to split high frequency DSL components of the loop signal and the lower frequency POTS (Plain Old Telephone Service) components of the loop signal. In this configuration, the high pass filter 614 passes signals in the DSL frequency range to the broadband network 620 via the DSL modem 610. Likewise, the low pass filter 616 passes the lower frequency POTS signals to the narrow band network 622 over a PSTN (Public Switched Telephone Network) line.

The home 604 is shown as including the multiplexer 212 disposed in a reversed configuration to function as a splitter, an DSL modem 632, a computer 634, a telephone, or POTS, a home telephone wiring network 636, and POTS devices, such as telephone 638 and facsimile machine 639. Further, personal computers 641 and 643 are illustrated as being coupled to the network 636. The computer 641 is shown as having an external HPNA network interface card 645. The computer 643 has an internal HPNA card (not shown) so that the computers 641 and 643 may communicate using high-frequency home networking signals over the network 636. While the DSL modem 632 is illustrated as being disposed outside of the computer 634, those skilled in the art will appreciate that the DSL modem 632 could also be positioned inside the computer 634.

The multiplexer 212, being disposed in a reversed configuration, splits the incoming signal into high and low frequency components. As discussed in more detail below

with reference to FIG. 7, the multiplexer 212 routes the high frequency component along line 640 to the DSL modem 632, which is coupled to a network device, such as a computer 634, by a line 642. Likewise, the multiplexer 212 routes the low frequency, or POTS, component of the incoming signal to the home telephone wiring network 636 along line 644. The telephone 638, the facsimile machine 639, as well as other POTS devices (*e.g.* 56k modems, etc.) (not shown), are coupled to the home telephone wiring network 636 by lines 648.

A low-pass filter 650 is shown as being disposed between each POTS device and the home telephone wiring network 636. The low-pass filters 650 prevent the home networking high frequency energy on the home telephone wiring network 636 from reaching the POTS voice-band appliances, such as the telephone 638 and the facsimile machine 639. The filters 650 substantially reduce, or eliminate, the non-linear behavior of the voice-band appliances from creating noise onto the home telephone wiring network 636 and protects home networking transports from high-frequency inter-modulation products from the voice-band appliances.

Moreover, the low-pass filters 650 isolate the home networking, or home PNA (Home Phoneline Networking Alliance), transmission medium from the voice-band appliances' impedance changes during their operation. As those skilled in the art will appreciate, voice-band appliances undergo impedance changes as they undergo state changes, such as on /off hook, dialing, ringing, etc. Isolating these impedance changes from the high frequency transmission medium, substantially prevents loss of data transfer rate, and helps to maintain high data throughput for the home networking environment.

FIG. 7 illustrates details of the multiplexer 212 disposed in the reversed configuration depicted in FIG. 6. As discussed above, in the reversed configuration, the multiplexer/splitter 212 operates, or functions, as a splitter that splits an incoming FDM signal into high and low frequency components for separate DSL and POTS service.

The low pass filter 302 and the high pass filter 304 are shown as being coupled to the loop 606 via lines 306 and 308 respectively. The high pass filter 304 permits higher frequency signals, such as DSL signals, to pass from the loop 606 to the DSL modem 632 (FIG. 6) while preventing the lower frequency POTS signals from entering onto the line 640 and potentially interfering with the operation of the DSL modem 632. Similarly, the low pass filter 302 permits the lower frequency POTS signals to pass onto the home telephone wiring network 636 while preventing higher frequency signals, such as DSL signals, from entering onto the home telephone wiring network 636.

FIG. 8 is a flowchart 800 of a method for coupling a low frequency signal line, such as the line 208 (FIG. 2) and a high frequency signal line, such as the line 210 to a single home telephone wiring network, such as the home telephone wiring network 214. The method begins at block 802 by positioning a high pass filter, such as the filter 304 (FIG. 3) between a DSL service line, such as the DSL service line 210, and a single home telephone wiring network, such as the home telephone wiring network 214. In one embodiment, the DSL service line comprises a CLEC DSL service line for providing DSL service from a CLEC, such as the CLEC 204 to a home, such as the home 206.

In addition, pursuant to block 804, a low pass filter, such as the low pass filter 302 (FIG. 3) is positioned between a POTS service line, such as the line 208 (FIG. 2)

and the single home telephone wiring network, such as the home telephone wiring network 214. Pursuant to one embodiment, the POTS service line comprises an ILEC POTS service line for providing POTS service from an ILEC, such as the ILEC 202 to a single home telephone wiring network, such as the home telephone wiring network 214.

Once the high pass filter is positioned between the DSL service line and the home telephone wiring network as described above, DSL signals may then be transmitted from the DSL service line onto the single home telephone wiring network via the high pass filter pursuant to block 806. Likewise, pursuant to block 808, with the low pass filter positioned between the POTS service line and the home telephone wiring network, POTS signals may be transmitted from the POTS service line onto the single home telephone wiring network via the low pass filter.

The low pass filter, such as the low pass filter 302 (FIGS. 3 and 4) then prevents the DSL signals from entering onto the POTS service line pursuant to block 810. Similarly, pursuant to the high pass filter, such as the high pass filter 304 (FIGS. 3 and 5), prevents the POTS signals from entering onto the DSL service line.

Hence, in accordance with the system and method and described above, CLEC DSL service may be provided to a home over a presumably preexisting home telephone wiring network without having to install additional wiring inside the home to couple CLEC DSL service to a particular location within the home. Moreover, the CLEC DSL signals and the ILEC POTS signals are multiplexed, or coupled, onto the home telephone wiring network without incurring cross-talk between the CLEC and ILEC lines.

The invention has been described above with reference to specific embodiments. It will, however, be evident that

various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The foregoing description and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A multiplexer for coupling a first line having POTS service and a second line having DSL service to a single home telephone wiring network, comprising:

a low pass filter coupled to the first line to permit POTS signals to pass therethrough while preventing passage of DSL signals;

a high pass filter coupled to the second line to permit DSL signals to pass therethrough while preventing passage of POTS signals; and

the low pass filter and the high pass filter being coupled to the single home telephone wiring network to multiplex the POTS signals and the DSL signals onto the single home telephone wiring network.

2. The multiplexer of claim 1, wherein the DSL signals further comprise ADSL signals.

3. The multiplexer of claim 1, wherein the POTS signals further comprise signals having frequencies less than or equal to about 6 kHz.

4. The multiplexer of claim 1, wherein the first line further comprises an ILEC line.

5. The multiplexer of claim 1, wherein the second line further comprises a CLEC line.

6. The multiplexer of claim 1, wherein the low pass filter further comprises a reversible odd-order low pass filter comprising:

a first transformer;

a second transformer; and

a single capacitor disposed between the first and second transformer and separated from the single home telephone wiring network by either the first or the second transformer regardless of whether the home telephone wiring network is coupled to the filter adjacent to the first or the second transformer.

7. A DSL and POTS service network, comprising:

an ILEC POTS service line;

a CLEC DSL service line;

a single home telephone wiring network;

a multiplexer disposed between the single home telephone wiring network and the DSL and POTS service lines to couple POTS signals and DSL signals onto the single home telephone wiring network.

8. The DSL and POTS service network according to claim 7, wherein the multiplexer further comprises:

a low pass filter coupled to the ILEC line to permit POTS signals to pass therethrough while preventing passage of DSL signals;

a high pass filter coupled to the CLEC line to permit DSL signals to pass therethrough while preventing passage of POTS signals; and

the low pass filter and the high pass filter being coupled to the single home telephone wiring network to couple the POTS signals and the DSL signals onto the single home telephone wiring network.

9. The DSL and POTS service network according to claim 8, wherein the POTS signals comprise signals having a frequencies less than or equal to about 6 kHz.

10. A method of coupling a high frequency signal line and a low frequency signal line to a single home telephone wiring network, comprising:

positioning a high pass filter between the high frequency signal line and the single home telephone wiring network to permit high frequency signals to pass between the high frequency signal line and the single home telephone wiring network while preventing low frequency signals from passing between the single home telephone wiring network and the high frequency signal line;

positioning a low pass filter between the low frequency signal line and the single home telephone wiring line to permit low frequency signals to pass between the low frequency signal line and the single home telephone wiring network while preventing high frequency signals from passing between the single home telephone wiring network and the low frequency signal line.

11. The method according to claim 10, wherein the high frequency signals further comprise data signals.

12. The method according to claim 10, wherein the high frequency signals further comprise DSL signals.

13. The method according to claim 10, wherein the low frequency signals further comprise POTS signals.

14. The method according to claim 10, wherein the high frequency signals further comprise signals having frequencies above or equal to about 25 kHz.

15. The method according to claim 10, wherein the low frequency signals further comprise signals below or equal to about 6 kHz.

16. A device operable in a first configuration as a multiplexer and operable in a second configuration as a splitter, the device comprising:

a low pass filter; and

a high pass filter;

in the first configuration,

the low pass filter is disposed between a POTS service line and a single home telephone wiring network to permit POTS signals to pass therebetween while preventing data signals from entering onto the POTS service line, and

the high pass filter is disposed between a DSL service line and the single home telephone wiring network to permit data signals to pass therebetween while preventing POTS signals from entering onto the DSL service line;

in the second configuration,

the low pass filter is disposed between a local loop and the single telephone wiring network to permit POTS signals to pass therebetween, and

the high pass filter is positioned between the local loop and a DSL modem to permit data signals to pass therebetween.

17. The device according to claim 16, wherein the low pass filter further comprises:

a first transformer;

a second transformer; and

a single capacitor disposed between the first and second transformer and separated from the single home telephone wiring network by either the first or the second transformer regardless of whether the home telephone wiring network is coupled to the filter adjacent to the first or the second transformer in either the first or the second configuration.

18. The device according to claim 16, wherein the high pass filter is configured to only permit passage of signals above about 25 kHz and the low pass filter is configured to only permit passage of signals below about 6 kHz.

19. A device for coupling a high frequency signal line and a low frequency signal line to a single home telephone wiring network, comprising:

high pass filter means positioned between the high frequency signal line and the single home telephone wiring network to permit high frequency signals to pass between the high frequency signal line and the single home telephone wiring network while preventing low frequency signals from passing between the single home telephone wiring network and the high frequency signal line;

low pass filter means positioned between the low frequency signal line and the single home telephone wiring line to permit low frequency signals to pass between the low frequency signal line and the single home telephone wiring network while preventing high frequency signals from passing between the single home telephone wiring network and the low frequency signal line.

20. The device according to claim 19, wherein the high frequency signals further comprise signals above about 25 kHz and the low frequency signals further comprise signals below about 6 kHz.

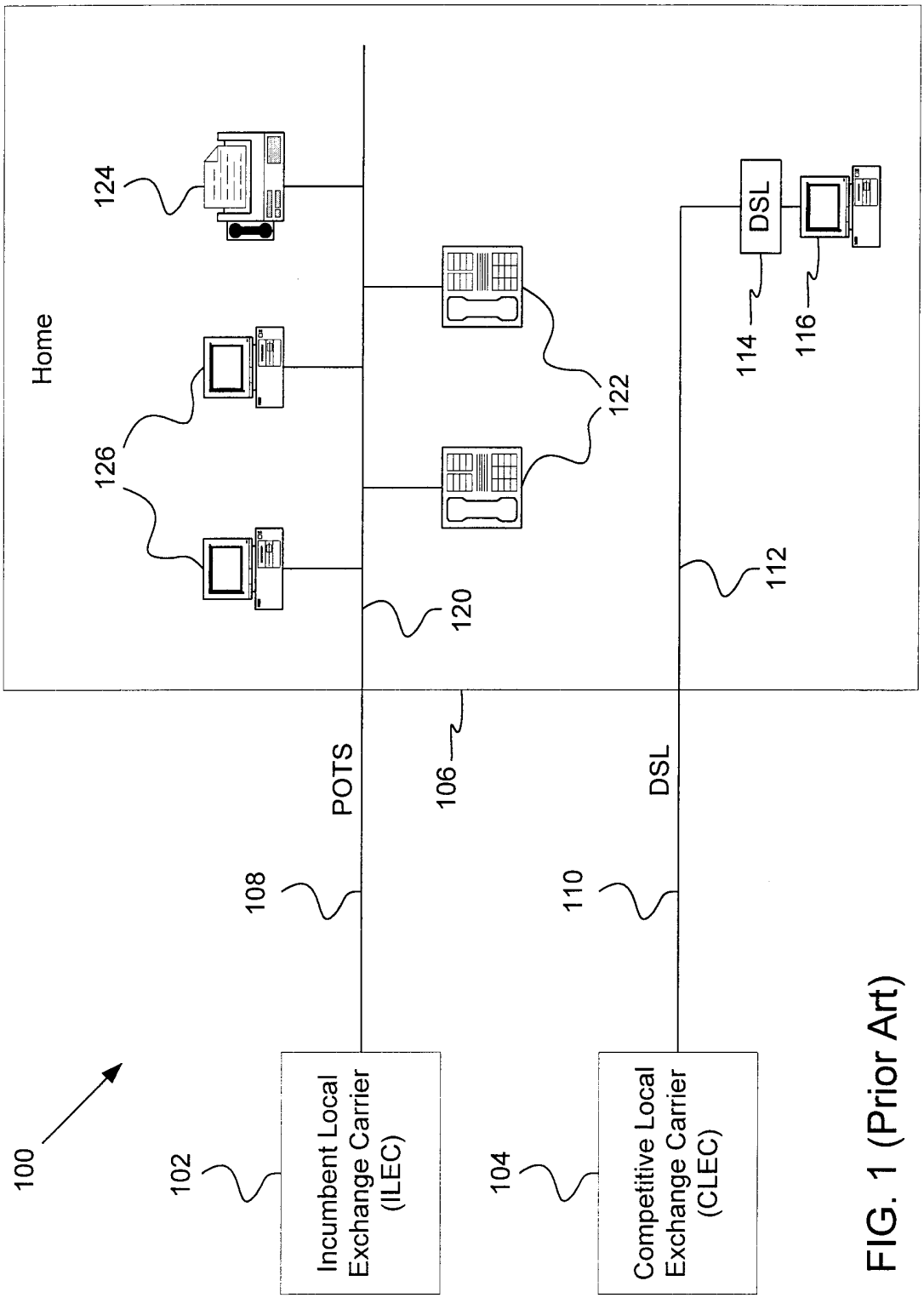

FIG. 1 (Prior Art)

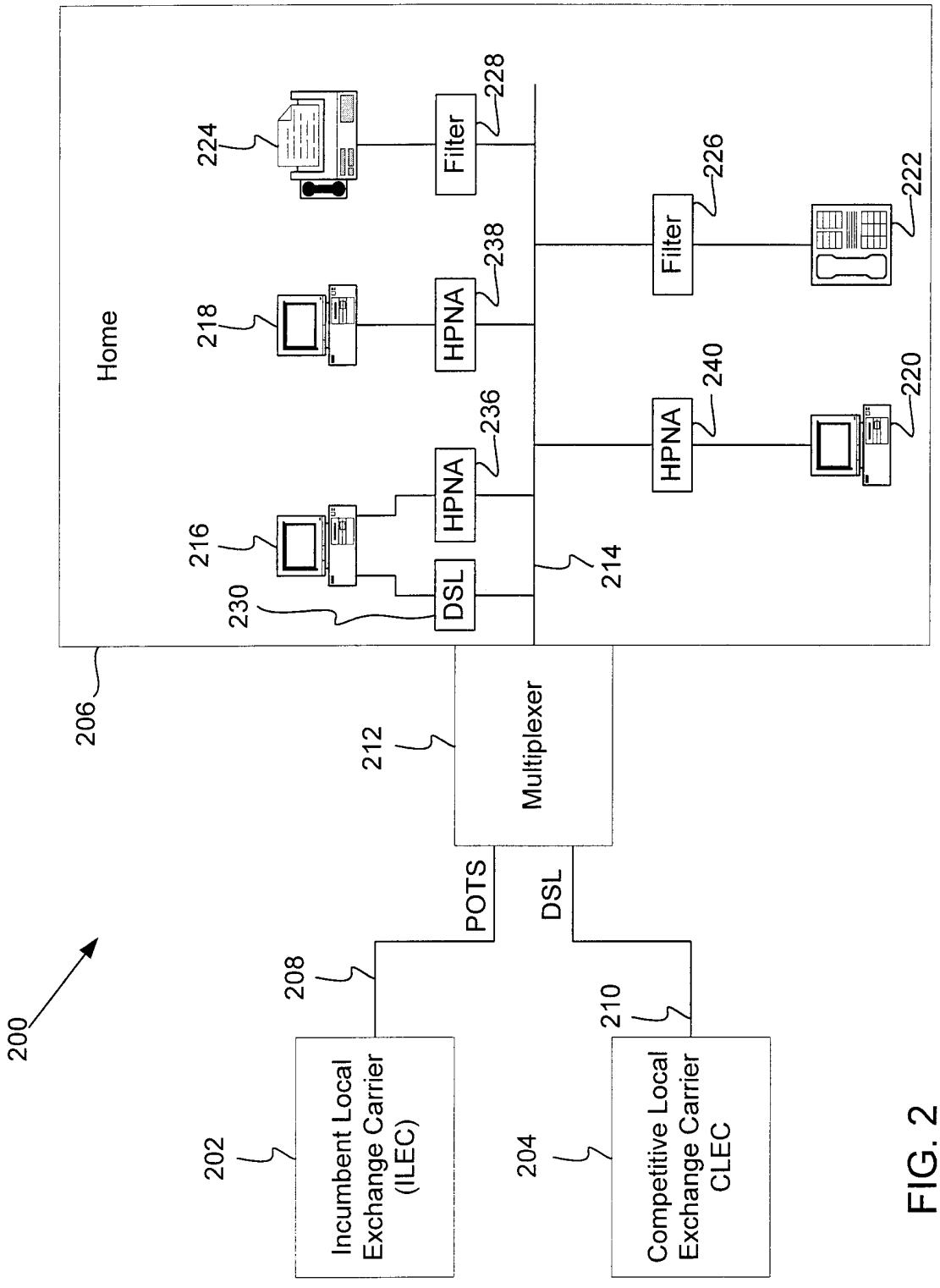
200
Incumbent Local Exchange Carrier (ILEC)
202
208
POTS
DSL
Competitive Local Exchange Carrier CLEC
204
210
Multiplexer
212
206
Home
214
DSL
HPNA
236
HPNA
238
Filter
228
HPNA
240
Filter
226
216
218
224
230
220
222

FIG. 2

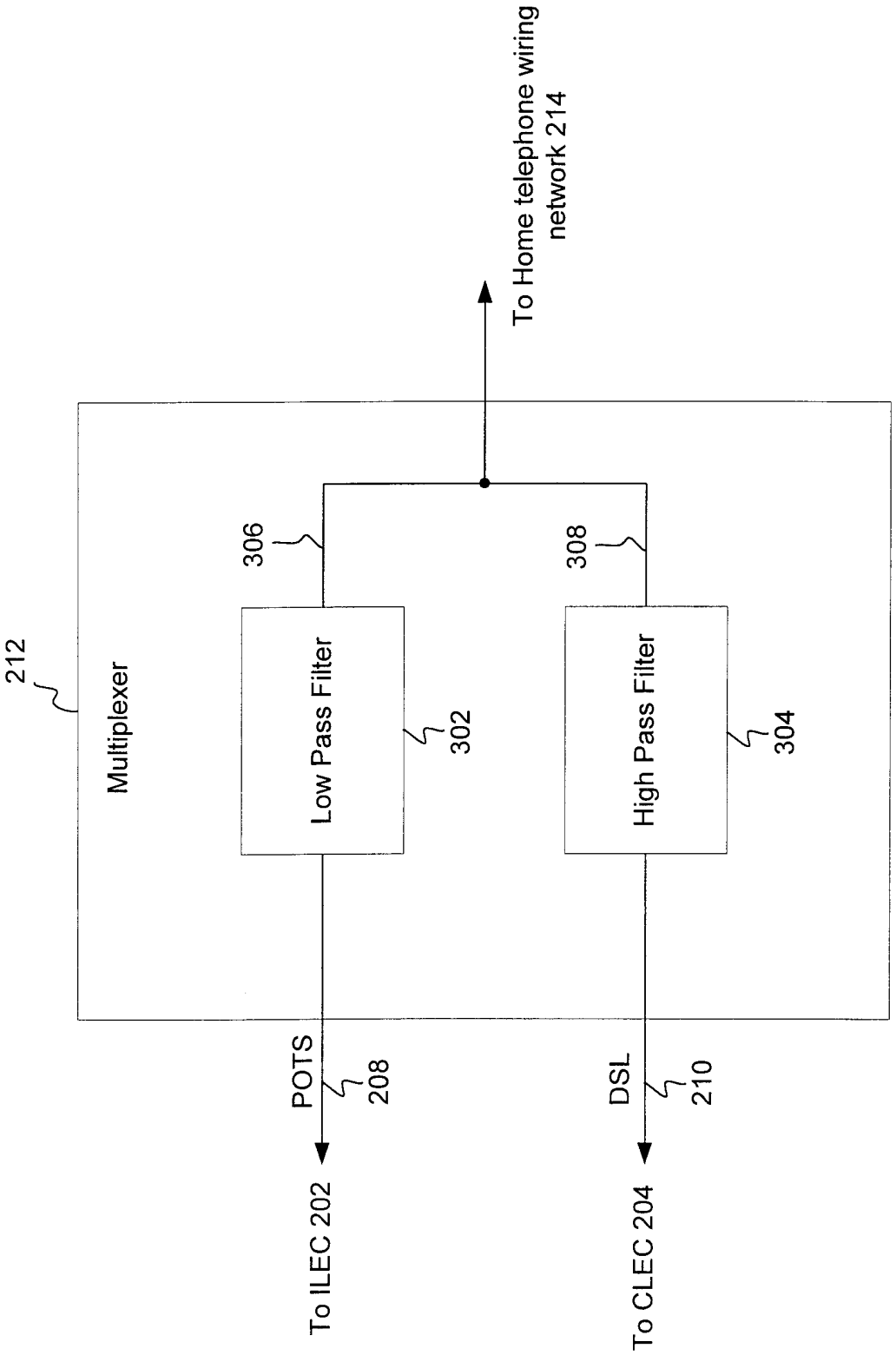
To Home telephone wiring network 214
212
Multiplexer
306
308
Low Pass Filter
302
High Pass Filter
304
POTS
208
DSL
210
To ILEC 202
To CLEC 204

FIG. 3

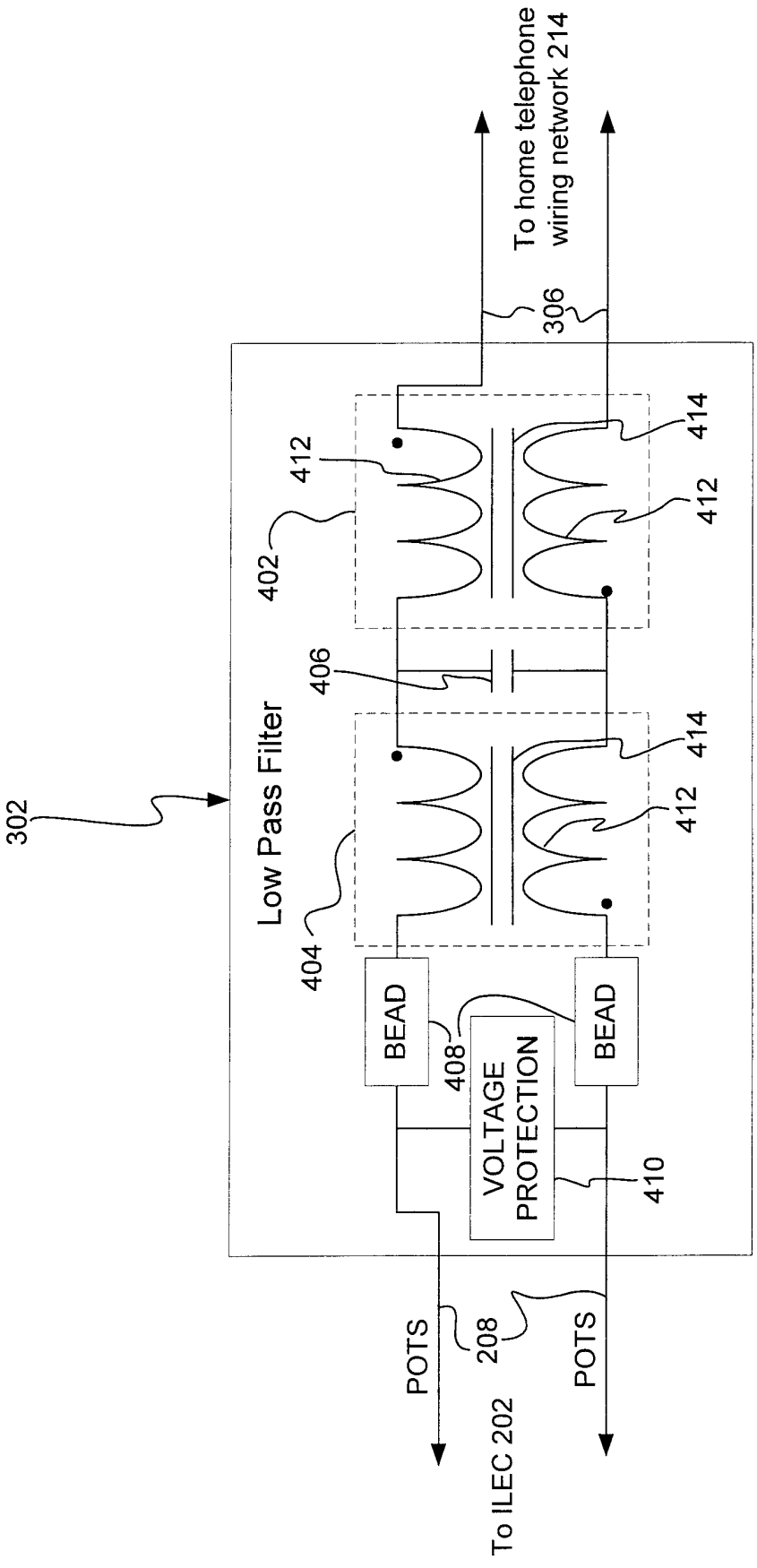
To home telephone wiring network 214
306
414
412
412
402
406
414
412
404
302
Low Pass Filter
BEAD
408
VOLTAGE PROTECTION
BEAD
410
POTS
208
POTS
To ILEC 202

FIG. 4

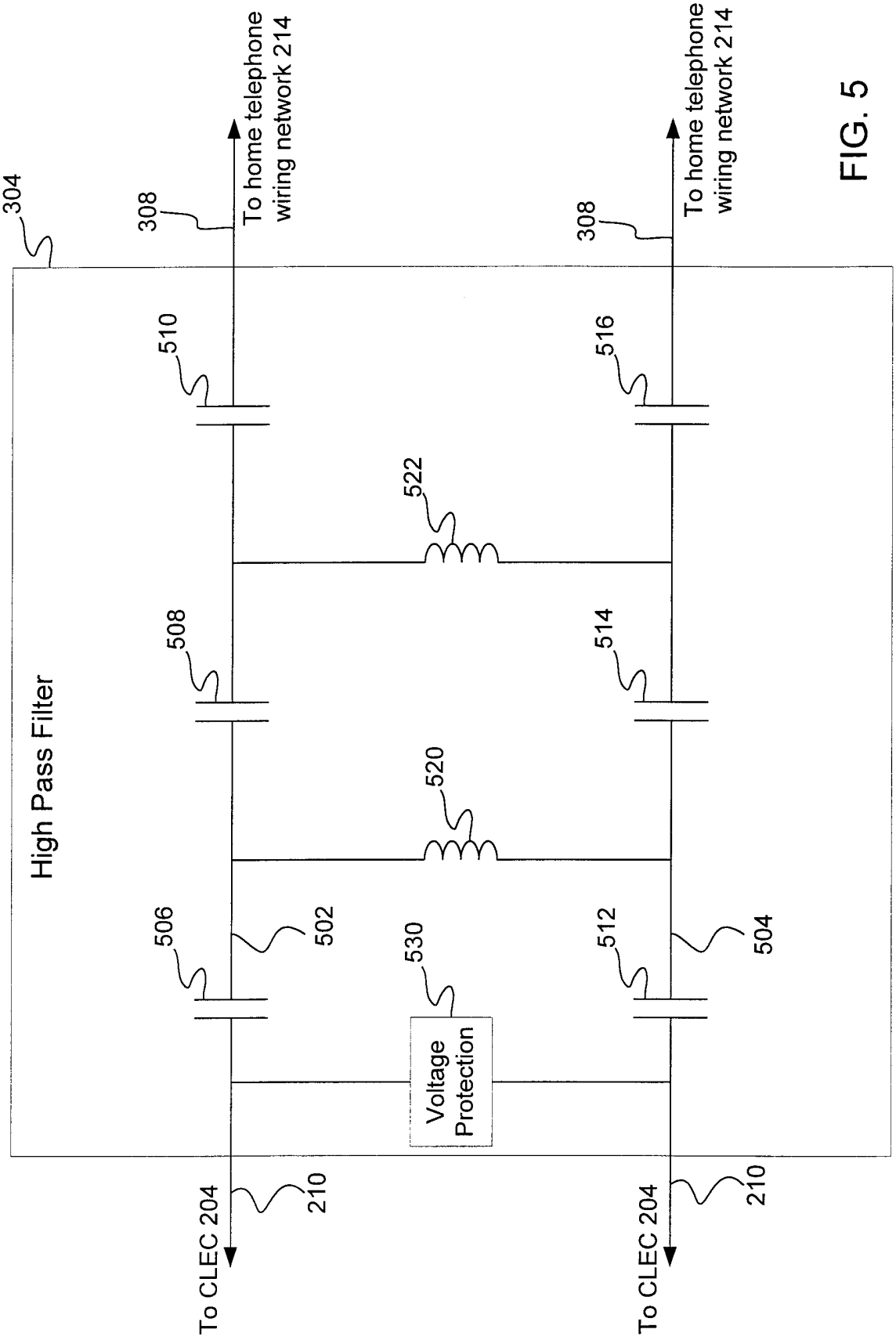
304
308
To home telephone wiring network 214
308
To home telephone wiring network 214
510
516
522
508
514
520
High Pass Filter
506
502
530
512
504
Voltage Protection
To CLEC 204
210
To CLEC 204
210

FIG. 5

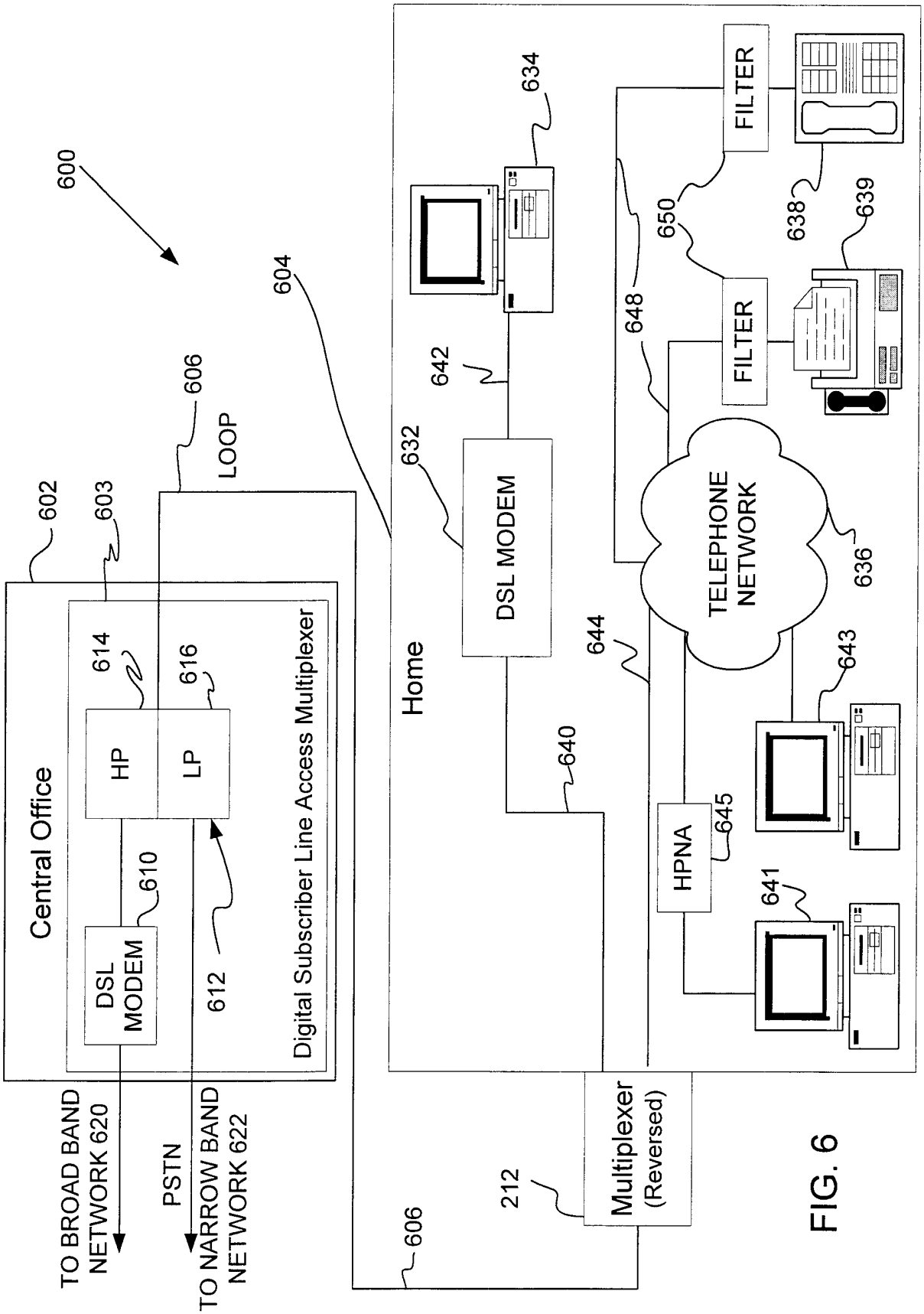
600
604
606
LOOP
602
603
Central Office
614
616
HP
LP
610
DSL MODEM
612
Digital Subscriber Line Access Multiplexer
TO BROAD BAND NETWORK 620
PSTN
TO NARROW BAND NETWORK 622
606
212
Multiplexer (Reversed)
Home
634
642
632
DSL MODEM
640
644
HPNA
645
641
643
TELEPHONE NETWORK
636
648
650
FILTER
FILTER
638
639

FIG. 6

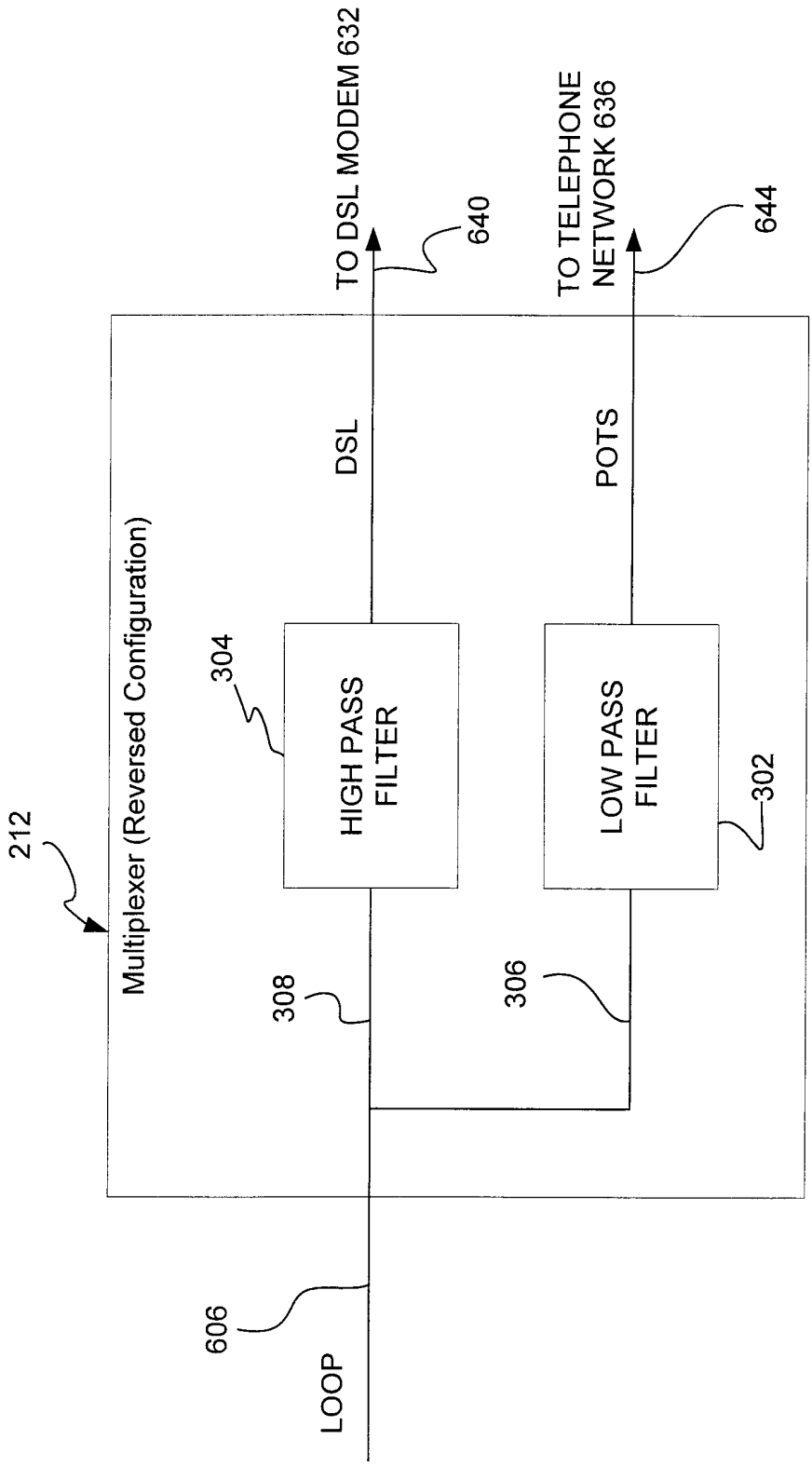
212
Multiplexer (Reversed Configuration)
304
HIGH PASS FILTER
302
LOW PASS FILTER
308
306
606
LOOP
DSL
POTS
TO DSL MODEM 632
640
TO TELEPHONE NETWORK 636
644

FIG. 7

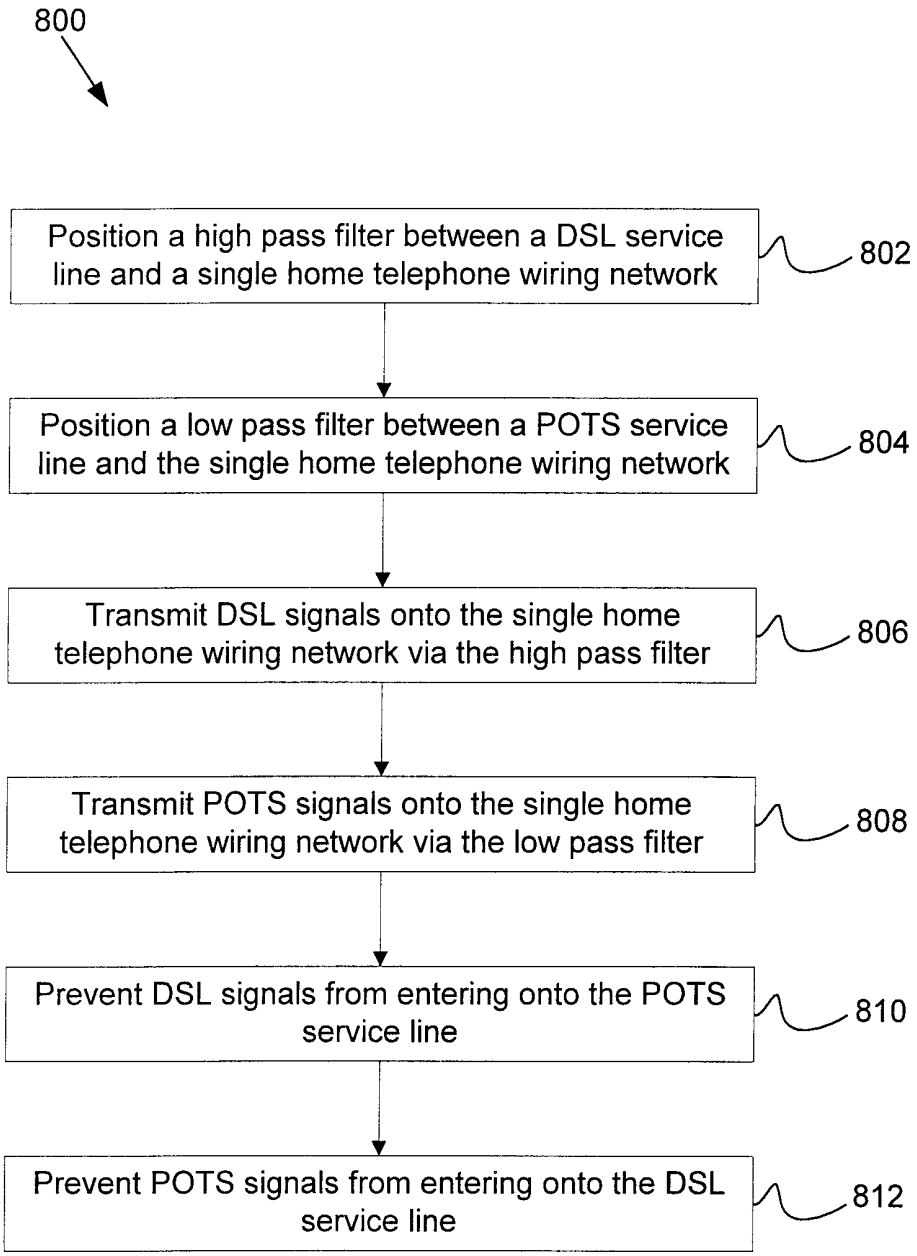
800
Position a high pass filter between a DSL service line and a single home telephone wiring network
802
Position a low pass filter between a POTS service line and the single home telephone wiring network
804
Transmit DSL signals onto the single home telephone wiring network via the high pass filter
806
Transmit POTS signals onto the single home telephone wiring network via the low pass filter
808
Prevent DSL signals from entering onto the POTS service line
810
Prevent POTS signals from entering onto the DSL service line
812

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/23204

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H04M 11/06, 1/00, 9/00, 1/06; H04H 1/04
US CL : 370/493, 494, 495, 496, 497, 488; 379/402, 405, 399, 397, 387

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)
U.S. :

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 practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y,P	US 5,757,803 A (RUSSELL et al) 26 MAY 1998; figures 1A, 1B, 2, 7-9; col. 3, lines 24-49; col. 4, lines 9-67; col. 5, lines 1-65.	1-5, 16, 18, 19, 20 --- 6, 17
Y,P	US 5,974,139 A (MCNAMARA et al) 26 OCTOBER 1999; figure 5; col. 4, lines 62-67; col. 5, lines 1-3; col. 8, lines 7-51; col. 10, lines 30-43.	6, 17
Y,E	US 6,144,734 A (BEEMAN) 07 NOVEMBER 2000; f igures 3A-3D; col. 4, lines 50-65; col. 6, lines 55-67; col. 7 to col. 9; lines 1-63.	6, 17
X, E	US 6,151,335 A (KO et al) 21 NOVEMBER 2000; figures 1-3; col. 6, lines 1-67; col. 7, lines 1-67; col. 8, lines 1-35.	7-9
X,E	US 6,141,356 A (GORMAN) 31 OCTOBER 2000; figures 1, 4; col. 3, lines 16-67; col. 5, lines 8-60.	10-15
A,P	US 6,005,873 A (AMIT) 21 DECEMBER 1999, ALL	1, 7, 16
A,P	US 6,067,316 A (AMRANY et al) 23 MAY 2000; ALL	1, 7, 10, 16, 19
A	US 5,025,443 A (GUPTA) 18 JUNE 1991 ; ALL	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* 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 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
15 December 2000	06 FEB 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Forester Isen Telephone No. (703)305-4700

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Intern...onal application No.

PCT/US00/23204

Continuation of B. FIELDS SEARCHED Item3: US Patent Full-Text Database; JPO Abstracts Database; EPO Abstracts Database; Derwent World Patents Index; IBM Technical Disclosure Bulletins ,
Multiplxer and splitter; POTS splitter; Splitter and DSL same POTS; Splitter and coupling.