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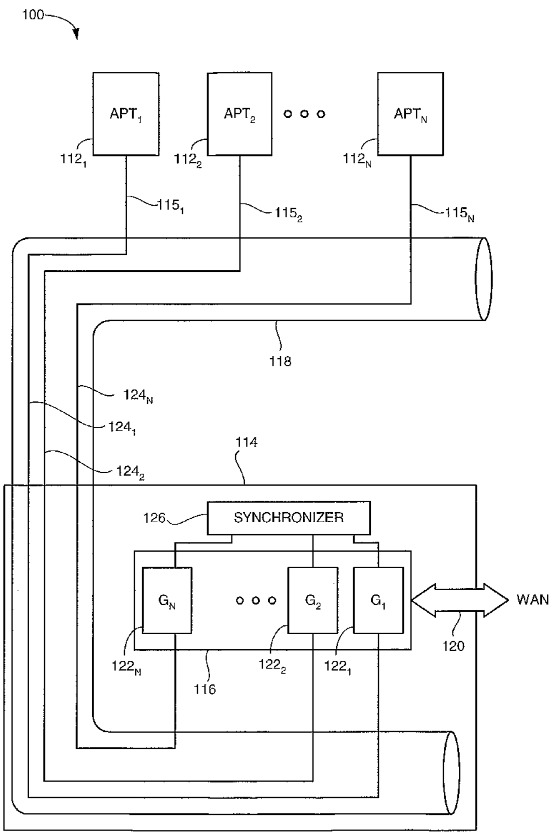
(54) Title: HPNA HUB



(57) Abstract: Analog HPNA hub including at least one group of coils, the coils inducing HPNA signals there between, a plurality of filters, each of the filters coupled with a respective one of the coils and further coupled, via respective telephone wiring, with at least a respective HPNA node, wherein each of the filters enables transmission of HPNA data signals there through, and wherein each of the filters prevents transmission of conventional telephony signals there through.

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HPNA HUB

FIELD OF THE DISCLOSED TECHNIQUE

The disclosed technique relates to communication networks in general, and to MxU network architectures, in particular.

BACKGROUND OF THE DISCLOSED TECHNIQUE

MxU networking architecture is known in the art and is used to provide communication services to a site (e.g., an apartment building) which includes a plurality of substantially independent sections (e.g., a plurality of apartments), each associated with a different subscriber. In general, the MxU networking architecture defines a separate local area network (LAN) for each of the sections.

MxU networks which are based Home Phoneline Networking Alliance (HPNA), use the telephone lines of the telephone wire network, already installed in the MxU. Each of the LANs includes the telephone wires which are associated with a selected section (e.g., apartment) and a plurality of HPNA nodes coupled with the telephone outlets. Telephone network voice communication and data communication services can be used simultaneously, using a technique known as frequency division multiplexing (FDM). Accordingly, data signals are transmitted using a different (higher) frequency than voice data signals, whereby these signals, can be separated using a frequency splitter.

Reference is now made to Figure 1, which is a schematic illustration of an apartment building network, generally referenced 10, which is known in the art. It is noted that Figure 1 is not drawn to scale.

Apartment building network 10 includes intra-apartment networks APT_1 (referenced 12_1), APT_2 (referenced 12_2) and APT_N (referenced 12_N), and gateways G_1 (referenced 22_1), G_2 (referenced 22_2) and G_N (referenced 22_N). Gateways 22_1, 22_2 and 22_N are mounted on a platform 16. A broadband source 20 couples each of gateways 22_1, 22_2 and 22_N with a wide area network (WAN) such as the Internet, via a broadband link such as xDSL, cable, fiber-optic, satellite, Local Multipoint Distribution System (LMDS), and the like.

Each of intra-apartment networks 12_1, 12_2 and 12_N includes several network nodes (not shown). Each one of gateways 22_1, 22_2 and 22_N is coupled with a respective one of intra-apartment networks 12_1, 12_2 and 12_N, via respective telephone wires 14_1, 14_2 and 14_N. Each one of the gateways 22_1, 22_2 and 22_N, and a respective one of intra-apartment networks 12_1, 12_2 and 12_N, together form a respective one of local-area networks (LAN) 14_1, 14_2 and 14_N. Each of LANs 14_1, 14_2 and 14_N is further coupled with telephone service lines 24_1, 24_2 and 24_N, respectively.

Reference is now made to Figure 2A and 2B. Figures 2A and 2B schematically illustrate an apartment building network, generally referenced 40, which is known in the art. Figures 2A and 2B show a first and second example of NEXT in an MxU network, respectively. It is noted that Figures 2A and 2B are not drawn to scale.

With reference to Figure 2A, apartment building network 40 includes intra-apartment networks APT_1 (referenced 42_1), APT_2 (referenced 42_2) and APT_N (referenced 42_N), gateways G_1 (referenced 52_1), G_2 (referenced 52_2) and G_N (referenced 52_N), and phone wires 54_1, 54_2 and 54_N. A wire binder 48 runs from a basement 44 of the apartment building, to the vicinity of intra-apartment networks 42_1, 42_2 and 42_N. A platform 46 is located in basement 44. Gateways 52_1, 52_2 and 52_N are mounted on platform 46. A broadband source 50 couples each of gateways 52_1, 52_2 and 52_N with a WAN such as the Internet, via a broadband link such as xDSL, cable, fiber-optic, satellite, Local Multipoint Distribution System (LMDS), and the like.

Each of intra-apartment networks 42_1, 42_2 and 42_N includes several network nodes (not shown), as shall be described in further detail with reference to Figure 2C. Each one of gateways 52_1, 52_2 and 52_N is coupled with a respective one of intra-apartment networks 42_1, 42_2 and 42_N, via respective phone wires 54_1, 54_2 and 54_N. Each combination of one of the gateways 52_1, 52_2 and 52_N, the respective one of phone wires 54_1, 54_2 and 54_N, and the respective one of intra-apartment networks 42_1, 42_2 and 42_N, together form a respective one of local-area networks (LANs) 45_1, 45_2 and 45_N. Phone wires 54_1, 54_2 and 54_N are bound together in binder 48.

Gateway 52_1 transmits a data signal 56 to intra-apartment network 42_1. Simultaneously, intra-apartment network 42_2 transmits another data signal 58 to gateway 52_2. In a region 62, located in the vicinity of platform 46, an electrical disturbance 60, associated with data signal 56 (from phone wire 54_1), is induced in phone wire 54_2, causing an interference in data signal 58.

It is noted that conventionally, the distance between intra-apartment network 42_2 and region 62 is significantly greater than the distance between gateway 52_1 and region 62. Therefore, data signal 58 undergoes a significantly greater attenuation than data signal 56, before these data signals reach region 62, and hence, electrical disturbance 60 may cause a significant interference in data signal 58. This effect is known as near-end crosstalk (NEXT). It is noted that the transfer of disturbance 60 from phone wire 54_1 to phone wire 54_2 is a cumulative effect, which takes place all along phone wires 54_1 and 54_2, with a primary contribution occurring in region 62.

With reference to Figure 2B, gateway 52_1 transmits a data signal 70 to intra-apartment network 42_1. Simultaneously, intra-apartment network 42_2 transmits another data signal 72 to gateway 52_2. In a region 76, located in the vicinity of intra-apartment networks 42_1 and 42_2, an electrical disturbance 74, associated with data signal 72 (from phone wire 54_2), is induced in phone wire 54_1, causing an interference in data signal 70.

It is noted that conventionally, the distance between gateway 52_1 and region 76 is significantly greater than the distance between intra-apartment network 42_1 and region 76. Therefore, data signal 70 undergoes a significantly greater attenuation than data signal 72, before these data signals reach region 76, and hence, electrical disturbance 74 may cause a significant interference in data signal 70.

Reference is further made to Figure 2C, which is an illustration in detail of intra-apartment networks 42_1 and 42_2 of apartment building network 40 (Figures 2A and 2B) and a portion of the binder 48. Figure 2C shows a third example of NEXT in an MxU network. It is noted that Figure 2C is not drawn to scale.

Intra-apartment network 42_1 includes network nodes 80_1, 80_2 and 80_3. Nodes 80_1, 80_2 and 80_3 are coupled there between via phone wire 54_1. Intra-apartment network 42_2 includes nodes 82_1 and 82_2. Nodes 82_1 and 82_2 are coupled there between via phone wire 54_2.

Gateway 52_2 (Figure 2A) transmits a data signal 86, through phone wire 54_2, toward intra-apartment network 42_2. Simultaneously, node 80_1 transmits another data signal 88 toward node 80_2.

It is noted that conventionally, data signal 88 includes a header with source and target attributes. All of the nodes of LAN 45_1 (Figure 2A) receive data signal 88, but only the target node, which is specified in the source-target attributes (i.e., node 80_2) addresses and decodes the data signal. It is noted that in the description that follows and the accompanying drawings, except for the present example, data signals are only shown on their path to their intended receiving node.

Data signal 88 passes through phone wire 54_1 toward binder 48. In a region 84 in the vicinity of intra-apartment networks 42_1 and 42_2, an electrical disturbance 92, associated with data signal 88 (from phone wire 54_1), is induced in phone wire 54_2, causing an interference in data signal 86. Similarly as in the example set forth in Figures 2A and 2B, electrical disturbance 92 may cause a significant interference in data signal 86.

SUMMARY OF THE DISCLOSED TECHNIQUE

It is an object of the disclosed technique to provide a novel HPNA MxU hub, which is operative to share and exchange network resources, and which overcomes the disadvantages of the prior art.

In accordance with the disclosed technique, there is thus provided an analog HPNA hub including at least one group of coils. Each group of coils includes a plurality of coils, inducing HPNA signals there between. The analog HPNA hub further includes a plurality of filters. Each of the filters is coupled with a respective one of the coils, and further coupled, via respective telephone wiring, with at least a respective HPNA node. Each of the filters enables transmission of HPNA data signals there through, and prevents transmission of conventional telephony signals there through.

In accordance with another aspect of the disclosed technique, there is provided an HPNA network, the network including at least one analog HPNA hub, and at least one group of HPNA nodes. Each group is associated with a respective one of the analog HPNA hubs. Each analog HPNA hub includes a plurality of coils, for inducing HPNA signals there between. Each analog HPNA hub further includes a plurality of filters. Each filter is coupled with a respective one of the coils, and further coupled, via respective telephone wiring, with at least an HPNA node in the respective group. Each of the filters enables transmission of HPNA data signals there through, and prevents transmission of conventional telephony signals there through.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed technique will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Figure 1 is a schematic illustration of an apartment building network, which is known in the art;

Figure 2A is a schematic illustration of an apartment building network which is known in the art, showing a first example of NEXT in an MxU network;

Figure 2B is a schematic illustration of the apartment building network of Figure 2A, showing a second example of NEXT in an MxU network;

Figure 2C is an illustration in detail of two of the intra-apartment networks of the apartment building of Figures 2A and 2B and a portion of the binder, showing a third example of NEXT in an MxU network;

Figure 3 is a schematic illustration of an MxU network, constructed and operative in accordance with an embodiment of the disclosed technique;

Figure 4 is a schematic illustration of an apartment building network, constructed and operative in accordance with another embodiment of the disclosed technique;

Figure 5 is a schematic illustration of an apartment building network, constructed and operative in accordance with a further embodiment of the disclosed technique;

Figure 6A is a schematic illustration of a timeslot scheme sequence, constructed in accordance with another embodiment of the disclosed technique;

Figure 6B is a schematic illustration of a timeslot scheme sequence, constructed in accordance with a further embodiment of the disclosed technique;

Figure 6C is a schematic illustration of a timeslot scheme sequence, constructed in accordance with another embodiment of the disclosed technique;

Figure 7A is an illustration in detail of two of the intra-apartment networks of the MxU network of Figure 3, and a portion of the binder, operating during a downstream timeslot, in accordance with a further embodiment of the disclosed technique;

Figure 7B is an illustration in detail of two of the intra-apartment networks of the MxU Figure 3, and a portion of the binder, operating during an upstream+HN timeslot, in accordance with another embodiment of the disclosed technique;

Figure 7C is an illustration in detail of two of the intra-apartment networks of the MxU Figure 3, and a portion of the binder, operating during an "miscellaneous" timeslot, in accordance with a further embodiment of the disclosed technique, and

Figure 8 is a schematic illustration of a method for reducing NEXT in an MxU network, operative in accordance with another embodiment of the disclosed technique;

Figure 9 is a schematic illustration of an MxU network, constructed and operative in accordance with a further embodiment of the disclosed technique;

Figure 10 is an illustration in detail of the analog HPNA hub and a plurality of phone wires of Figure 9;

Figure 11 is a schematic illustration of an analog HPNA hub, constructed and operative in accordance with another embodiment of the disclosed technique, and a plurality of phone wires;

Figure 12 is a schematic illustration of an analog HPNA hub, constructed and operative in accordance with a further embodiment of the disclosed technique, and a plurality of phone wires;

Figure 13 is a schematic illustration of an apartment building network, constructed and operative in accordance with another embodiment of the disclosed technique; and

Figure 14 is a schematic illustration of a network, constructed and operative in accordance with a further embodiment of the disclosed technique.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The disclosed technique overcomes the disadvantages of the prior art by providing a novel analog HPNA hub for an MxU network, which enables data signal transmissions between different HPNA local (i.e., intra-apartment) networks of the MxU network to pass there through, while preventing conventional telephony transmissions between the HPNA local networks, from passing there through.

In the description that follows, the terms MDU (multi-dwelling unit), MTU (multi-tenant unit), MCU (multi-company unit), MHU (multi-hospitality unit), MPU (multi-public unit), MEU (multi-embedded unit), are generally termed MxU. An MxU may be an apartment building, a condominium complex, a hotel, a motel, a resort, an office building, an industrial park, a college or university campus dormitory, a hospital, an airport, a train station, a convention center, a shopping mall, an airplane, a ship, and the like.

Reference is now made to Figure 3, which is a schematic illustration of an MxU network, generally referenced 100, constructed and operative in accordance with an embodiment of the disclosed technique. It is noted that Figure 3 is not drawn to scale. In the present example, MxU network 100 is an apartment building network. It is noted, however, that the disclosed technique is applicable for any type of MxU network.

In the description that follows, the term "phone wire" is defined as a line which can be used for communicating conventional telephony signals and HPNA signals. A phone wire can be constructed by twisting together two insulated copper wires.

Apartment building network 100 includes intra-apartment networks APT_1 (referenced 112_1), APT_2 (referenced 112_2) and APT_N (referenced 112_N), gateways G_1 (referenced 122_1), G_2 (referenced 122_2) and G_N (referenced 122_N), and phone wires 124_1, 124_2 and 124_N. A wire binder 118 runs from a basement 114 of the apartment building, to the vicinity of intra-apartment networks 112_1, 112_2 and 112_N. A platform 116 and a synchronizer 126 are located in communication room 114. Gateways G_1, G_2, and G_N, referenced 122_1, 122_2 and 122_N, respectively, are mounted on platform 116. A broadband source 120 couples gateways 122_1, 122_2 and 122_N with a wide area network (WAN) such as xDSL, cable, fiber-optic, satellite, Local Multipoint Distribution System (LMDS), and the like. Synchronizer 126 is coupled with gateways 122_1, 122_2 and 122_N.

In the present example, communication room 114 is a basement. It is noted, however, that the communication room 114 may be any physical space housing the gateways of the network, such as a basement, a cupboard, a cabinet, and the like. Phone wires 124_1, 124_2 and 124_N are bound together in binder 118.

Platform 116 provides access to gateways 122_1, 122_2 and 122_N, by multiplexing the broadband source 120. It is noted that platform 116 may further provide other functions to gateways 122_1, 122_2 and 122_N, such as routing, switching, dynamic IP address assignment, voice access, power, and the like. For example, platform 116 may be a Digital Subscriber Line Access Multiplexer (DSLAM), a Next Generation Digital Loop Carrier (NGDLC), and the like.

Each of intra-apartment networks 112_1, 112_2 and 112_N includes several network nodes (not shown), as shall be described in further detail with reference to Figures 7A and 7B. Each combination of one of the gateways 122_1, 122_2 and 122_N, the respective one of phone wires 124_1, 124_2 and 124_N, and the respective one of intra-apartment networks 112_1, 112_2 and 112_N, together form a respective one of local-area networks (LANs) 115_1, 115_2 and 115_N.

Data signals transmitted from one of the gateways 122_1, 122_2 or 122_N, to the respective intra-apartment network, are known as downstream data signals. Data signals transmitted from one of the intra-apartment networks 112_1, 112_2 and 112_N, to the respective gateway, are known as upstream data signals. Data signals transmitted and received within one of the intra-apartment networks, are known as home networking (HN) data signals.

Each of gateways 122_1, 122_2 and 122_N operates as a master node of the respective one of LANs 115_1, 115_2 and 115_N (i.e., each gateway is a LAN-master). In other words, each gateway enables or disables all of the nodes in the respective LAN to transmit data signals. Synchronizer 126 synchronizes all of the gateways 122_1, 122_2 and 122_N, so that all of the LANs 115_1, 115_2 and 115_N, transmit upstream, downstream and HN data signals in synchrony, as shall be described in further detail with reference to Figures 6A and 6B.

It is noted that synchronizer 126 may generally be coupled with gateways 122_1, 122_2 and 122_N via wired or wireless connections. It is further noted that synchronizer 126 may generally be located in various locations inside or outside of basement 114, and inside the apartment building or at a remote location.

Reference is now made to Figure 4, which is a schematic illustration of an apartment building network, generally referenced 140, constructed and operative in accordance with another embodiment of the disclosed technique. According to the architecture of network 140, the synchronizer is incorporated within one of the LAN-masters, whereby this LAN-master operates as a master relative to the other LAN-masters of the network.

Apartment building network 140 includes intra-apartment networks APT_1 (referenced 152_1), APT_2 (referenced 152_2) and APT_N (referenced 152_N), gateways G_1 (referenced 162_1), G_2 (referenced 162_2) and G_N (referenced 162_N), and phone wire 164_1, 164_2 and 164_N. A wire binder 158 runs from a basement 154 to the vicinity of intra-apartment networks 152_1, 152_2 and 152_3. Gateways 162_1, 162_2 and 162_N are mounted on a platform 156. A broadband source 160 couples gateways 162_1, 162_2 and 162_N with a WAN. The combinations of intra-apartment networks 152_1, 152_2 and 152_3, phone wires 164_1, 164_2 and 164_N and gateways 162_1, 162_2 and 162_N form LANs 155_1, 155_2 and 155_N, similarly as in apartment building network 100 of Figure 3.

Gateways 162_1, 162_2 and 162_N are coupled there between via a synchronicity link 166. It is noted that synchronicity link 166 may be wired or wireless. Gateway 162_1 operates as a master gateway to the rest of the gateways, which operate as slave gateways (i.e., gateway 162_1 controls when the other gateways, and the nodes of their respective LANs, transmit data signals). Gateway 162_1 synchronizes all of the LANs to transmit upstream, downstream and HN data signals in synchrony, as shall be described in further detail with reference to Figures 6A and 6B.

Reference is now made to Figure 5, which is a schematic illustration of an apartment building network, constructed and operative in accordance with a further embodiment of the disclosed technique. Apartment building network 170 includes intra-apartment networks APT_1 (referenced 152_1), APT_2 (referenced 152_2) and APT_N (referenced 152_N), gateways G_1 (referenced 162_1), G_2 (referenced 162_2) and G_N (referenced 162_N), and phone wires 164_1, 164_2 and 164_N. A wire binder 188 runs from a basement 174 to the vicinity of intra-apartment networks 182_1, 182_2 and 182_3. Gateways 192_1, 192_2 and 192_N are mounted on a platform 186. A broadband source 190 couples gateways 192_1, 192_2 and 192_N with a WAN. The combinations of intra-apartment networks 182_1, 182_2 and 182_3, phone wires 184_1, 184_2 and 184_N and gateways 192_1, 192_2 and 192_N form LANs 185_1, 185_2 and 185_N, similarly as in apartment building network 100 of Figure 3. However, gateway 192_1 does not operate as the master node of LAN 185_1. Rather, a node 194 of intra-apartment network 182_1 is the LAN-master node of LAN 185_1.

LAN-master node 194 and gateways 192_2 and 192_N are coupled there between via a synchronicity link 196. Gateway 192_N operates as a master gateway to the rest of the LANs, similarly as gateway 162_1. However, gateway 192_N synchronizes LAN 185_1 through LAN-master node 194 (and not through gateway 192_1).

It is noted that alternatively, LAN-master node 194 may be linked directly to master gateway 192_N. Further alternatively, a synchronizer such as synchronizer 126 of Figure 3, may be applied to an apartment building network similar to apartment building network 170. Accordingly, LAN-master 194 is coupled to that synchronizer. It is further noted that the disclosed technique may similarly be applied to an MxU network wherein a plurality of LAN-master nodes are not gateways.

Reference is now made to Figure 6A, which is a schematic illustration of a timeslot scheme sequence 200, constructed in accordance with another embodiment of the disclosed technique. Sequence 200 includes cyclic timeslot schemes, of which two schemes 202 and 206 are shown. Timeslot scheme 202 includes timeslots 204_1 and 204_2. Timeslot scheme 206 includes timeslots 208_1 and 208_2. Timeslots 204_1 and 208_1 are allocated for downstream communication. Timeslots 204_2 and 208_2 are allocated for upstream communication and HN communication.

In the example set forth in Figure 3, synchronizer 126 instructs gateways 122_1, 122_2 and 122_N and the nodes of their respective LANs that timeslots 204_1 and 208_1 are allocated for downstream communication only. Accordingly, only gateways 122_1, 122_2 and 122_N shall be able to transmit signals within their respective LANs 115_1, 115_2 and 115_N, during timeslots 204_1 and 208_1. Synchronizer 126 further instructs gateways 122_1, 122_2 and 122_N and the nodes of their respective LANs, that timeslots 204_2 and 208_2 are allocated for upstream and HN communication only. Accordingly, only the nodes of intra-apartment networks 112_1, 112_2 and 112_N shall be able to transmit signals within their respective LANs 115_1, 115_2 and 115_N, during timeslots 204_2 and 208_2.

For example, synchronizer 126 of Figure 3 may include a clock (also known as a sync clock), which is coupled with all of the LAN-master nodes. The LAN-master nodes transmit data only during a certain part of the clock cycle (e.g., during the high level period of the cycle). Thus, the

LAN-master nodes are synchronized with the clock, and hence are synchronized there between.

It is noted that the timeslot scheme may be determined dynamically. Accordingly, the timeslot scheme may change according to the conditions present in MxU network 100, such as the bandwidth used by each network node or LAN, the amount of upstream, downstream and HN communication, and the like. It is further noted that various other timeslot schemes may be employed, such as a timeslot scheme allocating separate timeslot for each LAN or group of LANs, a timeslot scheme involving only those LANs found interfering, and the like.

Reference is now made to Figure 6B, which is a schematic illustration of a timeslot scheme sequence 210, constructed in accordance with a further embodiment of the disclosed technique. Sequence 210 includes repeating timeslot schemes, of which two schemes 212 and 216 are shown. Timeslot scheme 212 includes timeslots 214_1, 214_2 and 214_3. Timeslot scheme 216 includes timeslots 218_1, 218_2 and 218_3. Timeslots 214_1 and 218_1 are allocated for downstream communication. Timeslots 214_2 and 218_2 are allocated for upstream communication and HN communication (also referred to as upstream+HN). Timeslots 214_3 and 218_3 are allocated for other communication.

In the example set forth in Figure 3, during timeslots 214_3 and 218_3, synchronizer 126 instructs gateways 122_1, 122_2 and 122_N and the nodes of their respective LANs, not to generate upstream, downstream, or HN data signals. For example, timeslot 214_3 may be used for communication through the network, using a different communication specification, as shall be described with reference to Figure 7C.

Reference is now made to Figure 6C, which is a schematic illustration of a timeslot scheme sequence 220, constructed in accordance with another embodiment of the disclosed technique. Scheme sequence 220 includes timeslots 222 and 224. Timeslot 222 includes transmission opportunity (TXOP) 225 and gap 226. Timeslot 224 includes TXOPs 227_1, 227_2 and 227_3, and gap 228.

Timeslot 222 is similar to timeslot 204_1 of Figure 6A, allocated for downstream communication. Timeslot 224 is similar to timeslot 204_2 (Figure 6A), allocated for upstream+HN communication. TXOP 225 is allocated for the transmission of a specific data packet or packets, in the downstream direction. Gap 226 separates between TXOP 225 and TXOP 227_1. Each of TXOP 227_1, 227_2 and 227_3 is allocated for specific upstream or HN transmission, such as a specific data stream or a specific network node or group of nodes. Gap 228 separates between TXOP 227_3 and the next timeslot scheme (i.e., the next cycle). It is noted that a system according to the disclosed technique may generally operate using different types of TXOPs and gaps, such as those described in US Patent application no. 10/127,693, which is hereby incorporated by reference.

Reference is now made to Figure 7A, 7B and 7C. Figure 7A is an illustration in detail of intra-apartment networks 112_1 and 112_2 of Figure 3, and a portion of the binder 118, operating during a downstream timeslot such as timeslot 204_1 of Figure 6A, in accordance with a further embodiment of the disclosed technique. Figure 7B is an illustration in detail of intra-apartment networks 112_1 and 112_2 of Figure 3, and a portion of the binder 118, operating during an upstream+HN timeslot such as timeslot 204_2 of Figure 6A, in accordance with another embodiment of the disclosed technique. Figure 7C is an illustration in detail of intra-apartment networks 112_1 and 112_2 of Figure 3, and a portion of the binder 118, operating during an "miscellaneous" timeslot such as timeslot 214_3 of Figure 6B, in accordance with a further embodiment of the disclosed technique.

Intra-apartment network 112_1 includes network nodes 230_1, 230_2 and 230_3. Intra-apartment network 112_2 includes network nodes 232_1, 232_2, 232_3 and 232_4. Nodes 232_1, 232_2, 232_3 and 232_4 are coupled there between via phone wire 124_2. It is noted intra-apartment networks 112_1

and 112_2 may further include various other elements, such as additional nodes and wires, switches, and the like.

Each of network nodes 230_1, 230_2, 230_3, 232_1, 232_2, 232_3 and 232_4 may be any point in the network which can transmit and receive data, such as a computer, a printer, an intercom, a digital telephone, an electrical appliance, and the like. Nodes 230_1, 230_2, 230_3, 232_2, and 232_3 transmit and receive data according to a single, synchronous, predetermined first communication specification, such as HPNA3. Nodes 230_1, 230_2, 230_3, 232_2, and 232_3 may operate according to a synchronous Media Access Control (MAC) as described in the above mentioned US Patent application no. 10/127,693.

Node 232_4 transmits and receives data according to a second communication specification, such as HPNA2. It is noted that the second communication specification may be either synchronous or asynchronous. Node 232_1 is capable of transmitting and receiving data signals of both the first and the second communication specification.

With reference to Figure 7A, gateway 122_1 transmits a data signal 234 through phone wire 124_1, toward node 230_3 of intra-apartment network 112_1. Simultaneously, gateway 122_2 transmits another data signal 236 toward node 232_2 of intra-apartment network 112_2.

With reference to Figure 7B, node 230_1 of intra-apartment network 112_1 transmits a first data signal 250 through phone wire 124_1, toward node 230_2. Node 230_3 of intra-apartment network 112_1 transmits a second data signal 252 through phone wire 124_1, toward gateway 122_1. Node 232_2 of intra-apartment network 112_2 transmits a third data signal 254 through phone wire 124_2, toward node 232_3. Node 232_2 of intra-apartment network 112_2 transmits a fourth data signal 256 through phone wire 124_2, toward gateway 122_2. Data signals 250 and 252 are transmitted synchronously, within LAN 115_1 (Figure 3), during at least one upstream+HN timeslot. Similarly, data signals 254 and 256 are transmitted synchronously, within LAN 115_2 (Figure 3), during at least one upstream+HN timeslot. With reference to Figure 7C, network node 232_4 transmits a data signal 270 through phone wire 124_2 to network node 232_1.

It is noted that synchronizer 126 (Figure 3) may restrict network node 232_1 to transmit only during the miscellaneous timeslot, by creating conditions in network 100, which enable network node 232_1 to transmit data signals only during the miscellaneous timeslot. For example, HPNA2 legacy units (i.e., nodes operating solely according to an older communication specification, and not according to later communication specification such as HPNA3 units), detect the various properties of the network (e.g., voltage, current, frequency spectrum) in order to determine if other nodes are transmitting. An HPNA2 node can transmit signals when it detects that no HPNA signal is being transmitted on the communication line. Hence, either the synchronizer (when directly coupled with the LANs) or the LAN-master nodes, can apply the appropriate signals on the network to prevent legacy units transmitting, during the downstream timeslots and the upstream+HN timeslots. Similarly, during the miscellaneous timeslot, either the synchronizer or the LAN-master nodes, can instruct all of the advanced (non-legacy) nodes, not to produce HPNA signals on the communication line, thereby allowing legacy units to transmit.

Reference is now made to Figure 8, which is a schematic illustration of a method for reducing NEXT in an MxU network, operative in accordance with another embodiment of the disclosed technique. In procedure 300, a timeslot scheme is defined. The timeslot scheme includes a plurality of timeslots, each being allocated for a selected type of signal transmission (i.e., upstream, downstream, HN, miscellaneous, or a certain combination thereof). In the example set forth in Figures 3, 6A and 6B, a timeslot scheme such as 204_1 or 214_1 is either embedded in synchronizer 116 or defined in real-time thereby. It is noted that alternatively, other sources may define the timeslot scheme, such as a node of MxU network 100, an external node of the WAN, a user of MxU network 100, and the like. In the example set forth in Figure 6A, timeslot 204_1 is allocated for downstream transmission, and timeslot 204_2 is allocated for upstream and HN transmission.

In procedure 302, MxU LAN-masters are synchronized according to the timeslot scheme. The synchronization causes all of the nodes in each of the LANs to operate as defined in the timeslot scheme. With reference to Figure 3, synchronizer 116 instructs each one of the LAN-master nodes of MxU network 100 to regulate their respective LANs according to the selected timeslot scheme. Accordingly, gateways 122_1, 122_2 and 122_N are allowed to transmit upstream signals only during timeslot 204_1. Similarly, the nodes of intra-apartment networks 112_1, 112_2 and 112_N are allowed to transmit upstream+HN signals only during timeslot 204_2.

In procedure 304, signals of a selected type are transmitted, during each of the respective timeslots. With reference to Figure 3, gateways 122_1, 122_2 and 122_N transmit upstream signals only during timeslot 204_1 and the nodes of intra-apartment networks 112_1, 112_2 and 112_N transmit upstream+HN signals only during timeslot 204_2. It is noted that procedure 304 is applied repetitively.

In procedure 306, conditions on the network are controlled, thereby enabling transmission of data signals of special types, such as legacy communication signals. In the example set forth in Figures 3 and 5B, synchronizer 126 produces no HPNA signals on the MxU network, during the downstream and upstream+HN timeslots, and an appropriate HPNA signal during miscellaneous timeslot 214_3. The HPNA signal indicates to legacy units that they are not allowed to transmit, as long as they detect it.

It is noted that procedure 306 is optional, and may be omitted in certain networks. For example, in a network comprising solely of nodes operating according to a single communication specification (i.e., non-legacy nodes), there may be no need to control the conditions on the network. It is noted that when applying procedure 306, it has to be integrated with procedure 304, so that both procedures are provided simultaneously. Timeslot scheme 212 (Figure 6B) is an example for integrating both procedures 304 and 306.

Reference is now made to Figure 9, which is a schematic illustration of an MxU network, generally referenced 400, constructed and operative in accordance with a further embodiment of the disclosed technique. It is noted that Figure 9 is not drawn to scale. In the present example, MxU network 400 is an apartment building network. It is noted, however, that the disclosed technique is applicable for any type of MxU network.

Apartment building network 400 includes intra-apartment networks APT_1 (referenced 406_1), APT_2 (referenced 406_2) and APT_N (referenced 406_N), a gateway 402, and an analog HPNA hub 404. Each of intra-apartment networks 406_1, 406_2 and 406_N includes a plurality of network nodes (not shown). A broadband source 412 couples gateway 402 with a wide area network (WAN) such as the Internet, via a broadband link such as xDSL, cable, fiber-optic, satellite, Local Multipoint Distribution System (LMDS), and the like. Analog HPNA hub 404 is coupled with intra-apartment networks 406_1, 406_2 and 406_N, through phone wires 408_1, 408_2 and 408_N, respectively. Analog HPNA hub 404 is further coupled with gateway 402. Analog HPNA hub 404 enables data signal transmissions between intra-apartment networks 406_1, 406_2 and 406_N, to pass there through. Thus, gateway 402 and intra-apartment networks 406_1, 406_2 and 406_N together form a local-area network (LAN).

Analog HPNA hub 404 is further coupled with external telephone lines 410_1, 410_2 and 410_N. External telephone lines 410_1, 410_2 and 410_N provide the intra-apartment networks 406_1, 406_2 and 406_N, respectively, with conventional telephony service. External telephone lines 410_1, 410_2 and 410_N couple network 400 with a telephony exchange system such as a telephone company central office (CO) switch, a public branch exchange (PBX) system , and the like.

It is noted that each of external telephone lines 410_1, 410_2 and 410_N may, alternatively, be coupled directly with the respective phone wire 408_1, 408_2 and 408_N. Analog HPNA hub 404 prevents conventional telephony transmissions between intra-apartment networks 406_1, 406_2 and 406_N, from passing there through.

It is noted that a security mechanism may be incorporated in MxU network 400. For example, in accordance with the techniques disclosed in the above mentioned US Patent application no. 10/127,693, the HPNA nodes of the network may use encryption and decryption keys. Accordingly, the network nodes encrypt and decrypt the transmitted and received data packets, respectively. These techniques may be applied in various communication protocol layers.

Reference is now made to Figure 10, which is an illustration in detail of the analog HPNA hub 404 of Figure 9, and phone wires 408_1, 408_2 and 408_N. Analog HPNA hub 404 includes coils 442, 452_1, 452_2 and 452_N, a core 444, and filters F_1 (referenced 454_1), F_2 (referenced 454_2) and F_N (referenced 454_N).

Coil 442 is coupled with gateway 402 (Figure 9). Each filter 454_i is coupled with a respective coil 452_i, telephone line 410_i and with phone wire 408_1. Coil 442 and coils 452_1, 452_2 and 452_N are wound around core 444. It is noted that Figure 10 provides a schematic representation of core 444, coil 442 and coils 452_1, 452_2 and 452_N.

A signal passing through one of the coils 442, 452_1, 452_2 and 452_N is induced in the rest of the coils 442, 452_1, 452_2 and 452_N. Core 444 enhances this electrical induction between coils 442, 452_1, 452_2 and 452_N. Thus, the combination of core 444 and coils 442, 452_1, 452_2 and 452_N, generally referenced 456, effectively operates as a transformer between gateway 402 (Figure 9) and phone wires 408_1, 408_2 and 408_N. It is noted that transformer 456 provides DC isolation between gateway 402 (Figure 9) and phone wires 408_1, 408_2 and 408_N.

It is noted that various types of transformers may be incorporated in hub 404, instead of transformer 456. It is further noted that the transformer used in hub 404, may be core-less. For example, coils 442, 452_1, 452_2 and 452_N may be intertwined there between, whereby electrical induction occurs without the use of a core. It is still further noted that the hub may include a plurality of cores, as shall be shown herein below with reference to Figure 12.

Each filter 454_i prevents conventional telephony transmissions signals between twisted pair 408_i, telephone line 410_i and coil 452_i from passing there through, while allowing data transmissions between twisted pair 408_i, telephone line 410_i and coil 452_i to pass there through. Thus, conventional telephony transmissions do not interfere there between in MxU network 400.

Reference is now made to Figure 11, which is a schematic illustration of an analog HPNA hub 504, constructed and operative in accordance with another embodiment of the disclosed technique, and a plurality of phone wires 508_1, 508_2 and 508_N. Analog HPNA hub 504 may be incorporated in an MxU network (not shown), generally similar to MxU network 400 (Figure 9). The MxU network includes phone wires 508_1, 508_2 and 508_N, generally similar to phone wires 408_1, 408_2 and 408_N (Figure 9), reaching a plurality of apartment networks (not shown).

Analog HPNA hub 504 includes coils 520, 522, 542, 532_1, 532_2 and 532_N, a core 544, and capacitors 524, 546_1, 546_2, 546_N, 548_1, 548_2 and 548_N. Coil 542 is coupled with a gateway (not shown) of the MxU network. Capacitor 524 is coupled with an external telephone line 510_1, and connected in series between coils 520 and 522. Coils 520 and 522 are further coupled with twisted pair 508_1 and with capacitors 546_1 and 548_1. Each coil 532_i is connected in series between the respective pair of capacitors 546_i and 548_i. The pair of capacitors 546_1 and 548_1 is further coupled with a phone wire 508_1 and with coil 532_1. Each pair of capacitors 546_i and 548_i, wherein i is an integer between 2 and N, is further coupled with respective phone wire 508_i and a respective external telephone line 510_i.

Each pair of capacitors 546_i and 548_i operates as a high-pass filter, similar to filters 454_i (Figure 10). For example, the capacitance of each of capacitors 546_i and 548_i may be 5nF. Accordingly, these capacitors shall provide a rejection of 55dB to conventional telephony signals (i.e., these signals shall undergo a 562-fold amplitude attenuation when passing through the filters). Thus, hub 504 enables data transmissions between the intra-apartment networks of the MxU network to pass there through, while preventing conventional telephony transmissions between the intra-apartment networks from passing there through. The combination of capacitor 524 and coils 520 and 522, serves as an HPNA isolation filter. Accordingly, the combination of capacitor 524 and coils 520 and 522, substantially attenuates HPNA signals transmitted there through. This substantially reduces the risk of misinterpreting a signal transmitted from external telephone line 510_1, as an HPNA signal. For example, NEXT interference from a nearby VDSL line may be substantially eliminated. It is noted that a similar filter may be coupled with each of filters 410_2 and 410_N. The values of the inductance of coils 520 and 522 and the capacitance of capacitor 524 may be, for example, 100 uH, 100 uH and 15nF, respectively.

Reference is now made to Figure 12, which is a schematic illustration of an analog HPNA hub 550, constructed and operative in accordance with a further embodiment of the disclosed technique, and a plurality of phone wires 588_1, 588_2 and 588_N. Analog HPNA hub 550 may be incorporated in an MxU network (not shown), generally similar to MxU network 400 (Figure 9). The MxU network includes phone wires 588_1, 588_2 and 588_N, generally similar to phone wires 408_1, 408_2 and 408_N (Figure 9), reaching a plurality of apartment networks (not shown).

Analog HPNA hub 550 includes coils 582_1, 582_2 and 582_N, 592_1, 592_2 and 592_N, cores 594_1, 594_2 and 594_N, and capacitors 596_1, 596_2, 596_N, 598_1, 598_2 and 598_N. Coils 592_1, 592_2 and 592_N are coupled with a gateway (not shown) of the MxU network. Each coil 582_i is connected in series between the respective pair of capacitors 596_i and 598_i. Each pair of capacitors 596_i and 598_i is further coupled with a respective external telephone line 560_i and respective phone wire 588_i.

Each coil 582_i and each coil 592_i, is wound around a respective core 594_i. Thus, data signals can be communicated between the network apartments, and the gateway. However, data signals communicated directly between the apartments, without the use of the gateway, shall twice undergo the attenuation experienced by data signals communicated between the apartments and the gateway. Parameters of the network, such as the threshold for the allowed data signal amplitudes (i.e., the amplitudes beneath which the signals are regarded as noise) and the number of windings on each coil, may be predetermined so that the twice attenuated signals are beneath the allowed threshold. Thus, the apartments are effectively disabled to communicate there between directly through a core. Rather, the apartments can communicate there between, through the gateway. Since the gateway can monitor and filter some of the data signals, this enhances security in the MxU network.

It is noted that the apartments of the MxU may be divided into groups of apartments, wherein the apartments of each group are allowed to communicate directly there between, while apartments of different groups are effectively disabled to communicate directly there between. For example, coils 592_1 and 592_2, and one of coils 582_1, 582_2, may be wound about a single core (i.e., a single core replaces cores 594_1 and 594_2, and a single coil replaces coils 592_1 and 592_2), while the rest of the coils of hub 550 are wound about another single core.

Reference is now made to Figure 13, which is a schematic illustration of an apartment building network, generally referenced 600, constructed and operative in accordance with another embodiment of the disclosed technique. Apartment building network 600 includes intra-apartment networks $APT_{1,1}$ (referenced 606_1), $APT_{2,1}$ (referenced 606_2) and $APT_{N,1}$ (referenced 606_N), $APT_{1,2}$ (referenced 608_1), $APT_{2,2}$ (referenced 608_2) and $APT_{M,2}$ (referenced 608_M). Apartment building network 600 further includes analog HPNA hubs 602 and 604, gateways G_1 (referenced 612) and G_2 (referenced 614), and phone wires 620_1, 620_2, 620_N, 622_1, 622_2 and 622_M. Gateways 612 and 614 are mounted on a platform 626. A broadband source 610 couples gateways 612 and 614 with a WAN.

Phone wires 620_1, 620_2 and 620_N couple hub 602 with intra-apartment networks 606_1, 606_2 and 606_N, respectively. Phone wires 622_1, 622_2 and 622_M couple hub 604 with intra-apartment networks 608_1, 608_2 and 608_M, respectively. A binder 624 runs from the vicinity of hubs 602 and 604, to the vicinity of intra-apartment networks 606_1, 606_2, 606_N, 608_1, 608_2 and 608_M. Binder 624 binds together phone wires 620_1, 620_2, 620_N, 622_1, 622_2 and 622_M.

Hub 602 is further coupled with gateway 612, external telephone lines 616_1, 616_2 and 616_N and with phone wire 620_1, 620_2, 620_N. Hub 604 is further coupled with gateway 614, external telephone lines 618_1, 618_2 and 618_M and with phone wires 622_1, 622_2, 622_M.

Hubs 602 and 604 are generally similar to hub 404 (Figure 10). Hub 602 enables data signal transmissions between intra-apartment networks 606_1, 606_2 and 606_N to pass there through, thereby coupling those intra-apartment networks in a LAN 628. Hub 602 further prevents conventional telephony transmissions between intra-apartment networks 606_1, 606_2 and 606_N from passing there through. Similarly, analog HPNA hub 604 couples intra-apartment networks 608_1, 608_2 and 608_M in another LAN 630, and further prevents conventional telephony transmission between those apartments from passing there through.

Gateways 612 and 614 operate similarly to gateways 162_1, 162_2 and 162_N of Figure 4 (i.e., in the example of Figure 13, the number of gateways is equal to two). Gateway 612 operates as a master gateway to gateway 614, which operates as a slave gateway. Gateway 612 instructs the nodes of LANs 628 and 630, to operate according to a selected timeslot scheme, thereby reducing NEXT in network 600.

It is noted that an MxU network may similarly be constructed with a greater number gateways and hubs. Accordingly, one gateway operates as a master gateway, and the rest of the gateways operate as slave gateways, similarly as in the example set forth in Figure 4.

Reference is now made to Figure 14, which is a schematic illustration of a network, generally referenced 700, constructed and operative in accordance with a further embodiment of the disclosed technique. Network 700 may be installed in an apartment, an office, and the like. Network 700 includes HPNA nodes N_1 (referenced 730), N_2 (referenced 732), N_3 (referenced 734), N_4 (referenced 736), N_5 (referenced 738), and N_6 (referenced 740), telephony devices 718, 720 and 722, an exchange system 702, an analog HPNA hub 712, external telephone lines 704, 706 and 708, and internal telephone lines 714 and 716.

Telephony devices 718, 720 and 722 are devices able to transmit and receive conventional telephony signals, such as telephones, facsimile machines, dial-up modems and the like. In the present example, telephony devices 718, 720 and 722 are telephones.

Exchange system (e.g., a PABX, a PBX) 702 is a device capable of managing telephony communications between telephone lines coupled therewith. In the present example, exchange system 702 is a private automatic branch exchange (PABX).

PABX 702 is coupled with external telephone lines 704 and 706. Internal telephone line 714 couples PABX 702 with telephone 718 and with HPNA node 734. Internal telephone line 716 couples PABX 702 with telephone 720 and with HPNA nodes 736 and 738. External telephone line 708 is coupled with HPNA node 740 and with telephone 722. It is noted that nodes 736 and 738 may be coupled there between in an HPNA LAN, even without using an analog HPNA hub such as hub 712 and the novel architecture of network 700. As shall be shown herein below, the novel architecture of network 700 links all of the nodes 730, 732, 734, 736, 738 and 740 together in an HPNA LAN.

Analog HPNA hub 712 is generally similar to analog HPNA hub 404 (Figure 10). Analog HPNA hub 712 includes coils 750, 752, 754, 756 and 758, filters F_1 (referenced 742), F_2 (referenced 744) and F_3 (referenced 746) and a core 748. Each of filters 742, 744 and 746 is generally similar to filters 454_1, 454_2 and 454_N of Figure 10. Each of coils 750, 752, 754, 756 and 758 is generally similar to coils 452_1, 452_2 and 452_N of Figure 10.

Coils 750 and 752 are directly coupled with HPNA nodes 730 and 732, respectively. Coils 754, 756 and 758 are coupled with filters 742, 744 and 746. Filter 742 is further coupled with external telephone line 708. Filters 744 and 746 are further coupled with internal telephone lines 714 and 716, respectively.

PABX 702 enables conventional telephony signals between telephones 718, 720 and 722 to pass there through. It is noted that conventionally, PABX 702 exhibits internal low pass filtering and therefore, does not enable high frequency data communication signals (e.g., HPNA transmissions) between the internal telephone lines to pass there through. Hub 712 enables data signal transmissions between nodes 730, 732, 734, 736, 738 and 740 to pass there through, and prevents conventional telephony transmissions from passing there through.

It will be appreciated by persons skilled in the art that the disclosed technique is not limited to what has been particularly shown and described hereinabove. Rather the scope of the disclosed technique is defined only by the claims, which follow.

CLAIMS

1. Analog HPNA hub comprising:

   at least one group of coils, each said group of coils comprising a plurality of coils, said coils inducing HPNA signals there between;

   a plurality of filters, each of said filters coupled with a respective one of said coils and further coupled, via respective telephone wiring, with at least a respective HPNA node,

   wherein each of said filters enables transmission of HPNA data signals there through, and

   wherein each of said filters prevents transmission of conventional telephony signals there through.

2. The analog HPNA hub according to claim 1, wherein at least two of said filters are each further coupled with at least one telephony device, via said respective telephone wiring.

3. The analog HPNA hub according to claim 1, further comprising at least one core, each said at least one core being associated with a respective one of said groups of coils, each said at least one core enhancing induction of HPNA signals between said coils of said respective group.

4. The analog HPNA hub according to claim 1, wherein at least one of said filters is further coupled with an external telephone line.

5. The analog HPNA hub according to claim 1, wherein at least one of said filters is further coupled with a telephony exchange system via said respective telephone wiring.

6. The analog HPNA hub according to claim 1, wherein at least one of said coils is directly coupled with at least another respective HPNA node, via respective wiring.

7. The analog HPNA hub according to claim 6, wherein one of said at least other HPNA nodes, is a gateway node, being further coupled with a wide area network.

8. The analog HPNA hub according to claim 1, wherein at least one of said filters comprises at least one capacitor.

9. The analog HPNA hub according to claim 1, at least one of said filters comprising two capacitors, said respective coil being connected in series between said two capacitors.

10. HPNA network, the network comprising:

at least one analog HPNA hub; and

at least one group of HPNA nodes, each said at least one group being associated with a respective one of said at least one analog HPNA hub,

wherein each said at least one analog HPNA hub includes:

a plurality of coils, for inducing HPNA signals there between, and

a plurality of filters, each of said filters being coupled with a respective one of said coils and further coupled, via respective telephone wiring, with at least an HPNA node in said respective group,

wherein each of said filters enables transmission of HPNA data signals there through, and

wherein each of said filters prevents transmission of conventional telephony signals there through.

11. The HPNA network according to claim 10, wherein for at least one of said analog HPNA hubs, at least two of said filters are each further coupled with at least one telephony device, via said respective telephone wiring.

12. The HPNA network according to claim 10, wherein for at least one of said analog HPNA hubs, at least one of said filters is further coupled with a telephony exchange system, via said respective telephone wiring.

13. The HPNA network according to claim 10, wherein for at least one of said analog HPNA hubs, at least one of said filters is further coupled with an external telephone line.

14. The HPNA network according to claim 10, wherein for at least one of said analog HPNA hubs, at least one of said coils is directly coupled with at least another HPNA node in said respective group.

15. The HPNA network according to claim 14, wherein said at least other HPNA node is a gateway node, being further coupled with a wide area network.

16. The HPNA network according to claim 10, further being deployed in an MxU, the MxU comprising a plurality of units, each said unit housing at least a portion of at least one of said at least one group of HPNA nodes.

17. The HPNA network according to claim 14, deployed in an MxU, the network comprising at least two analog HPNA hubs,

wherein for each of said at least two analog HPNA hubs, one HPNA node of said respective group is a gateway node, being further coupled with a wide area network,

wherein for each of said at least two analog HPNA hubs, a selected one HPNA node of said respective group is defined a LAN-master node,

wherein communication lines coupling each said analog HPNA hub with HPNA nodes of said respective group, are at least partially bound together,

wherein for each of said at least two analog HPNA hubs, the transmission direction within said respective group, by said respective gateway node, is defined downstream,

wherein for each of said at least two analog HPNA hubs, the transmission direction within said respective group, to said respective gateway node, is defined upstream,

wherein for each of said at least two analog HPNA hubs, the transmission direction within said respective group, between nodes other than said respective gateway nodes is defined HN,

wherein for each of said at least two analog HPNA hubs, said LAN-master nodes allow said gateways to transmit downstream signals during at least one timeslot, and

wherein for each of said at least two analog HPNA hubs, said LAN-master nodes allow said nodes other than said gateway nodes to transmit upstream signals or HN signals, during at least another timeslot.

18. The hub according to any of the claims 1-9 substantially as described herein above or as illustrated in any of the drawings.

19. The network according to any of the claims 10-17 substantially as described herein above or as illustrated in any of the drawings.

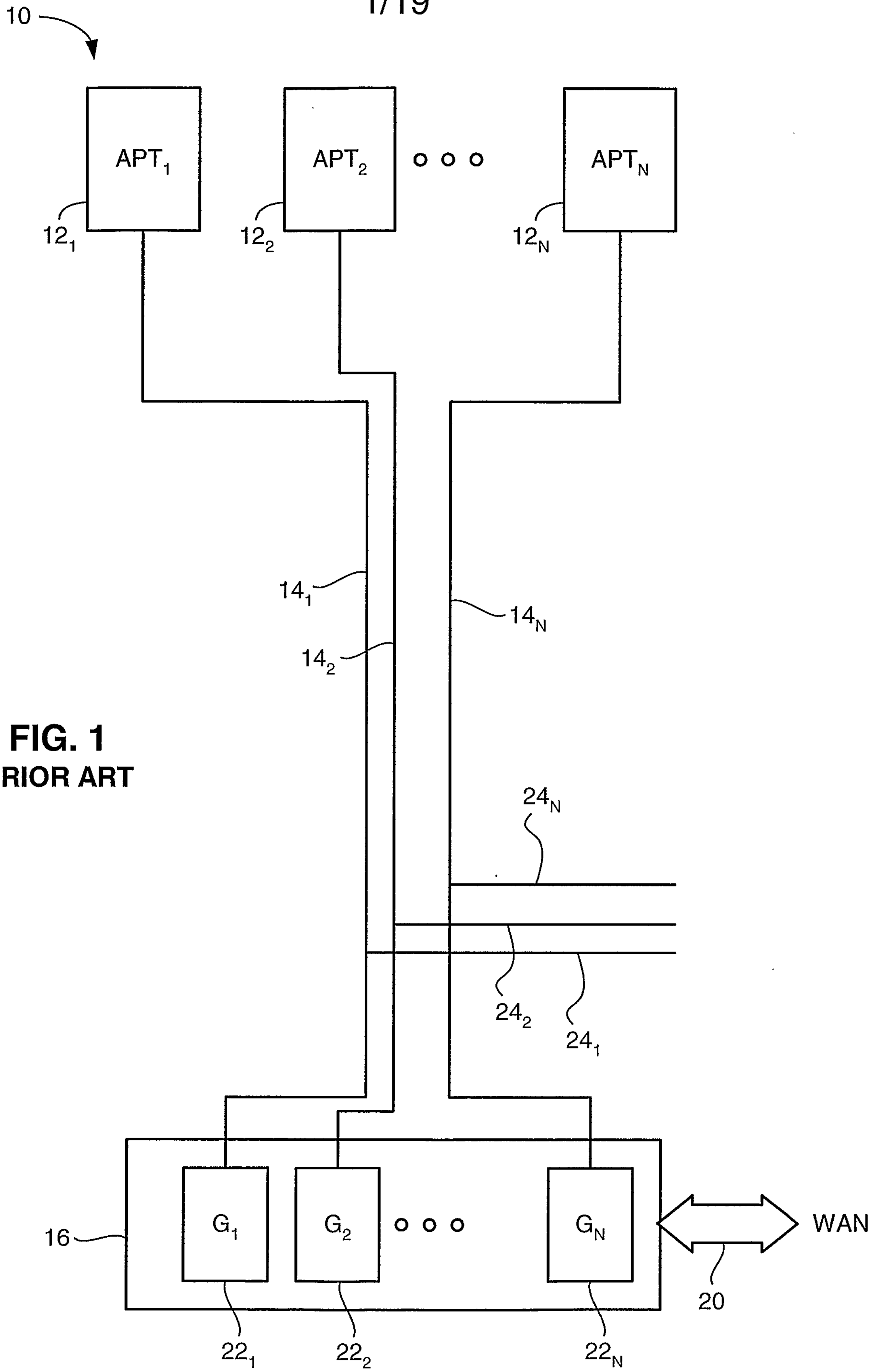


FIG. 1
PRIOR ART

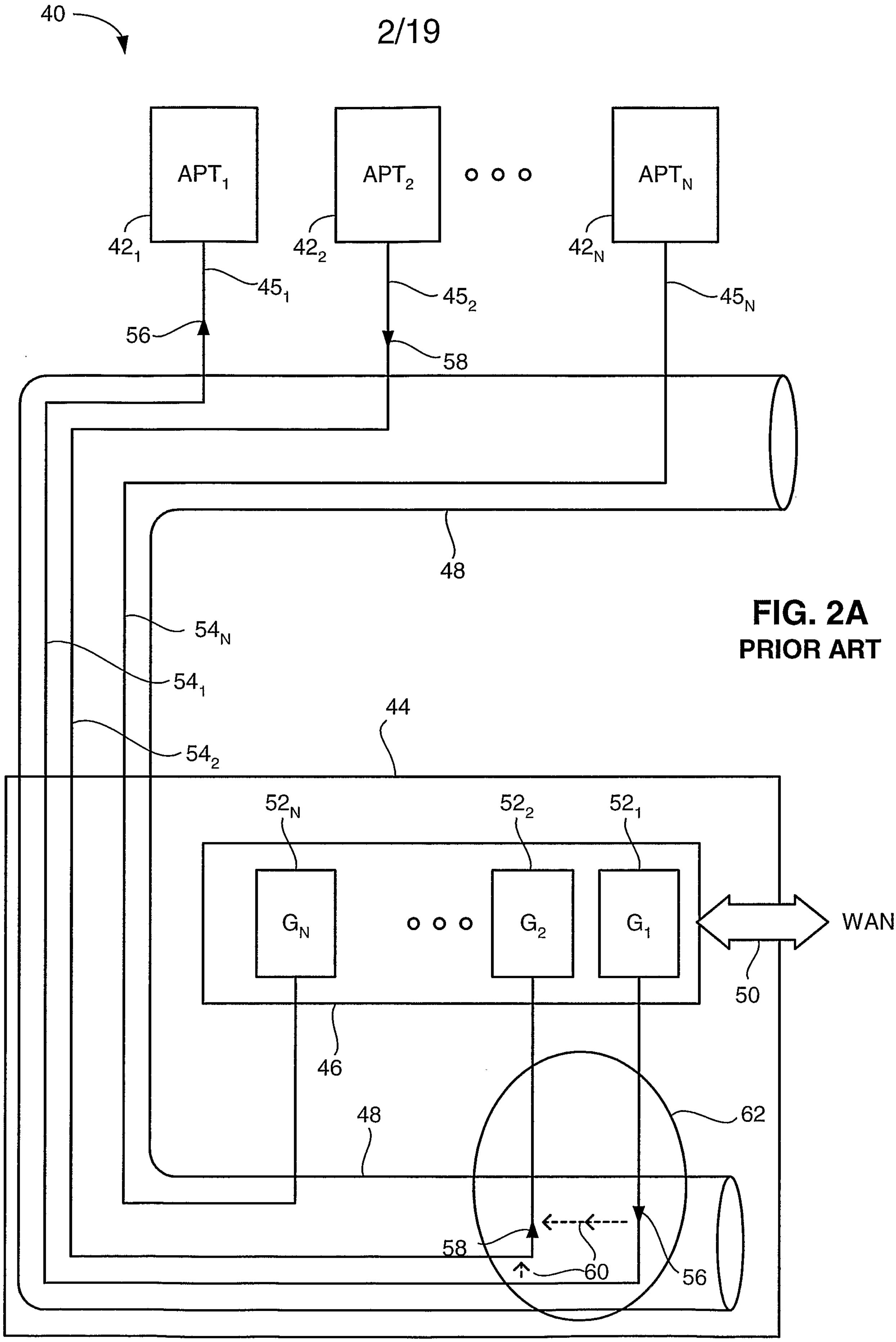


FIG. 2A
PRIOR ART

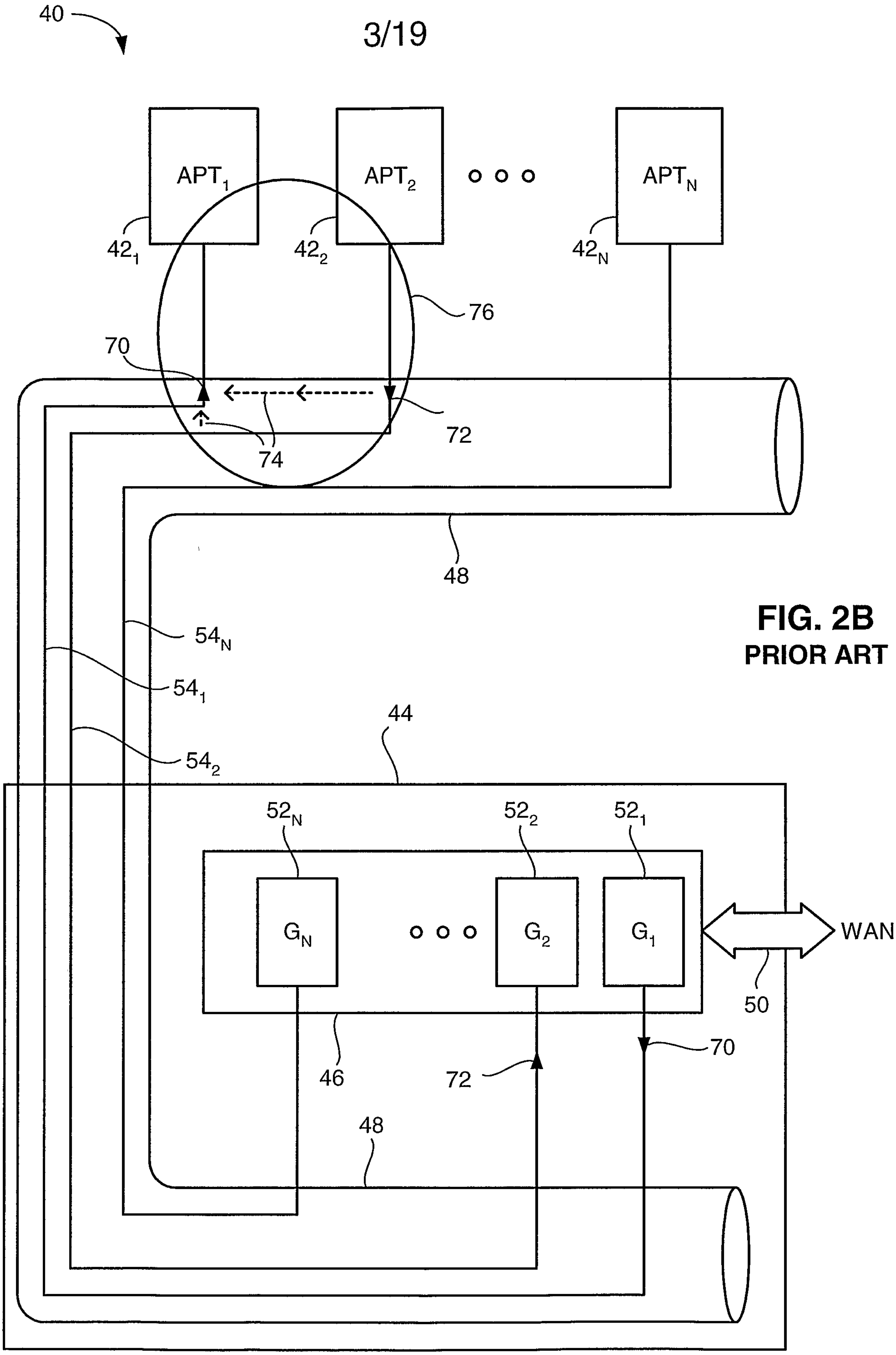


FIG. 2B
PRIOR ART

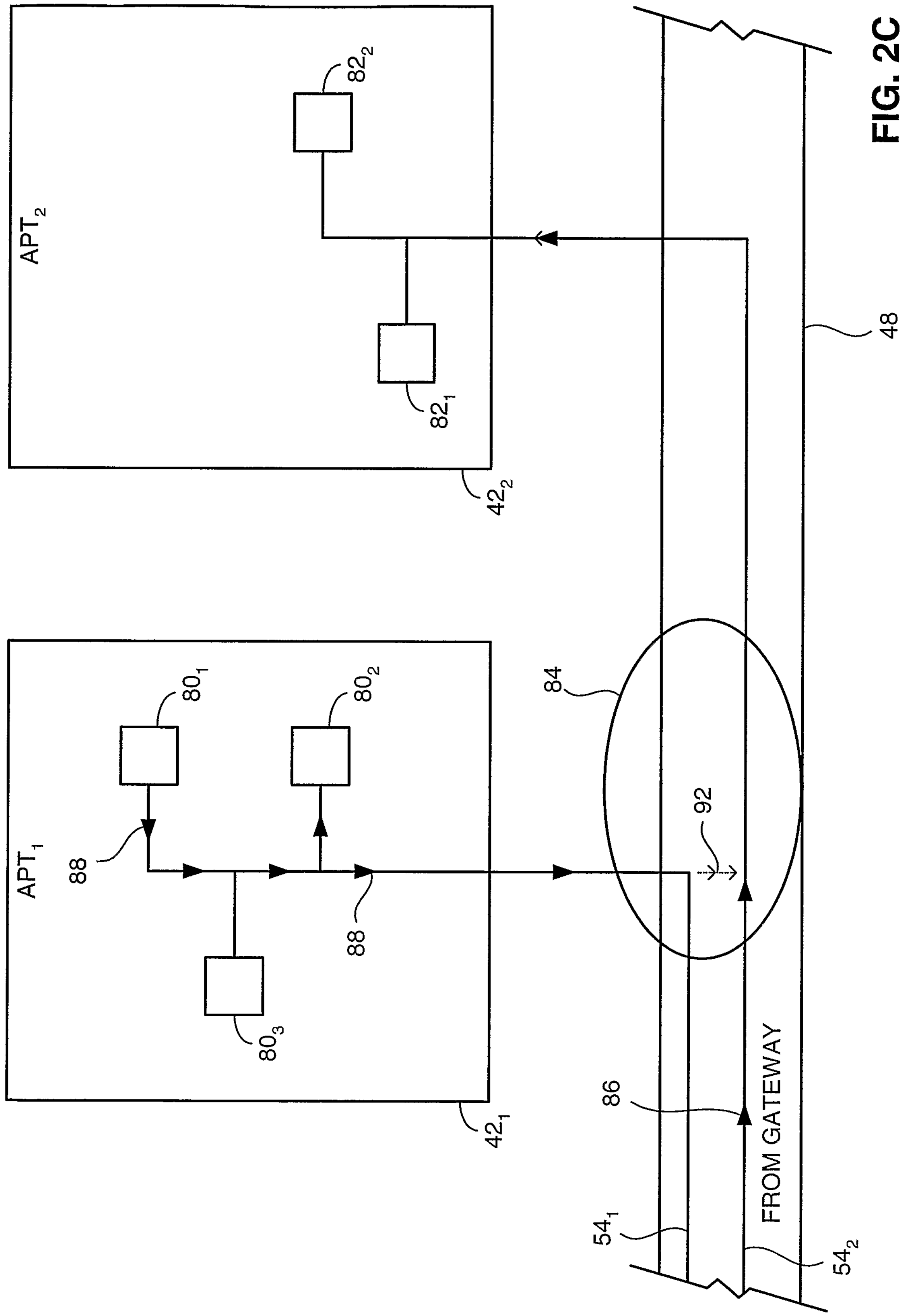


FIG. 2C
PRIOR ART

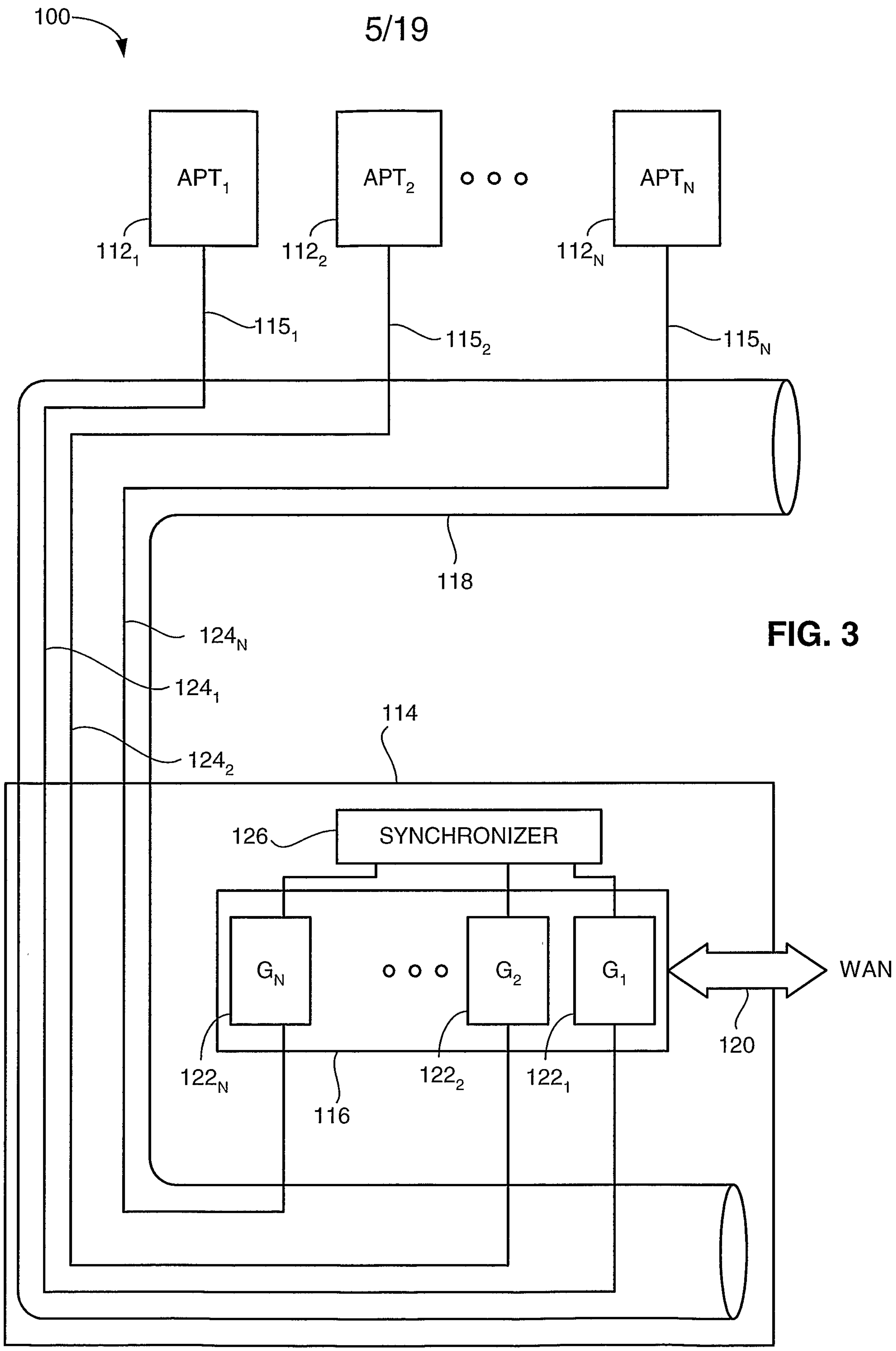
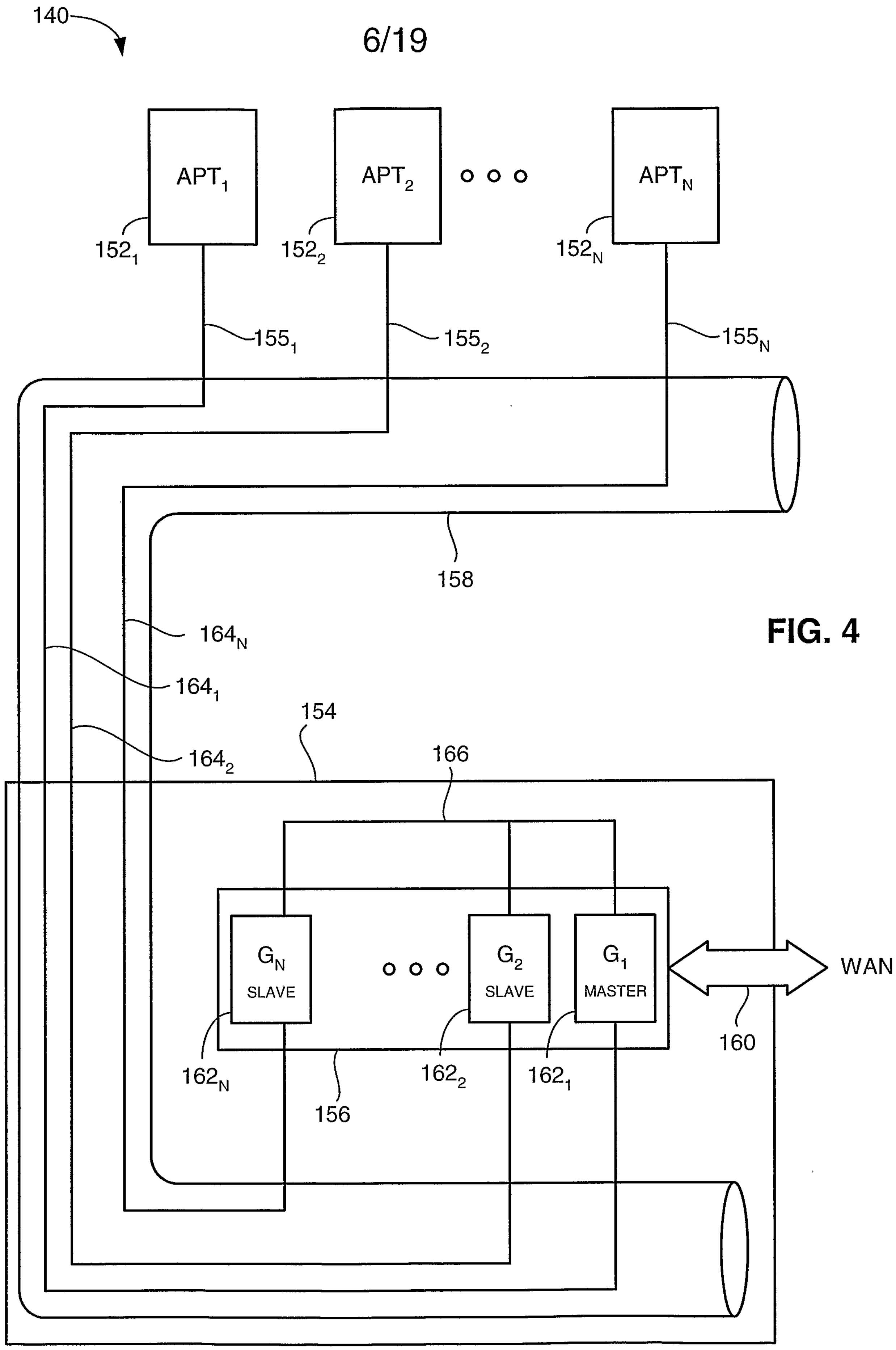

100
APT1
APT2
APTN
112_1
112_2
112_N
115_1
115_2
115_N
118
124_N
124_1
124_2
114
126
SYNCHRONIZER
GN
G2
G1
WAN
120
122_N
122_2
122_1
116

FIG. 3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APT1
APT2
APTN
152₁
152₂
152N
155₁
155₂
155N
158
164N
164₁
164₂
154
166
GN
SLAVE
G2
SLAVE
G1
MASTER
WAN
160
162N
162₂
162₁
156

FIG. 4

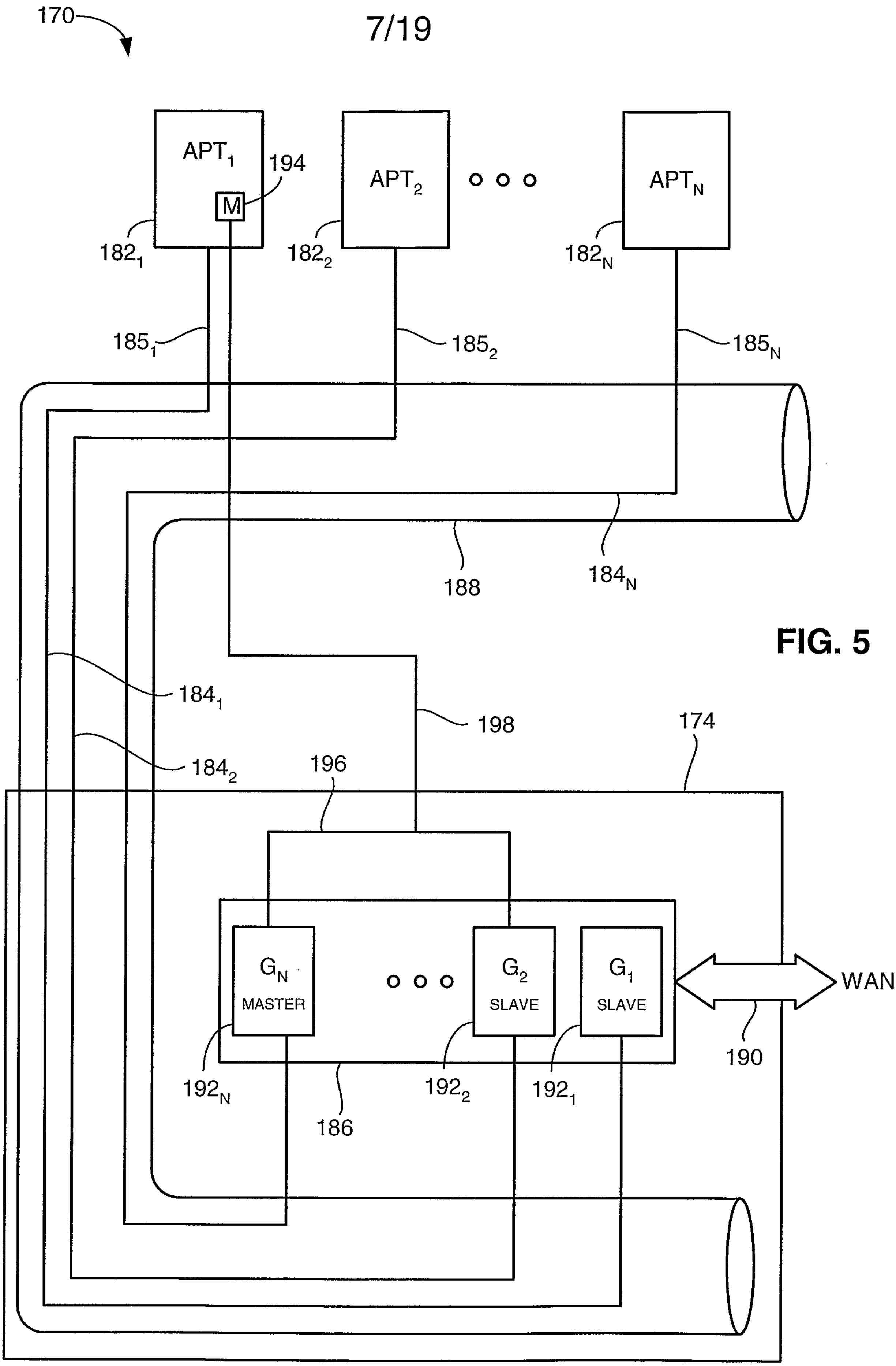

170
APT1
194
M
APT2
APTN
182₁
182₂
182N
185₁
185₂
185N
188
184N
184₁
198
174
184₂
196
GN
MASTER
G2
SLAVE
G1
SLAVE
WAN
190
192N
192₂
192₁
186

FIG. 5

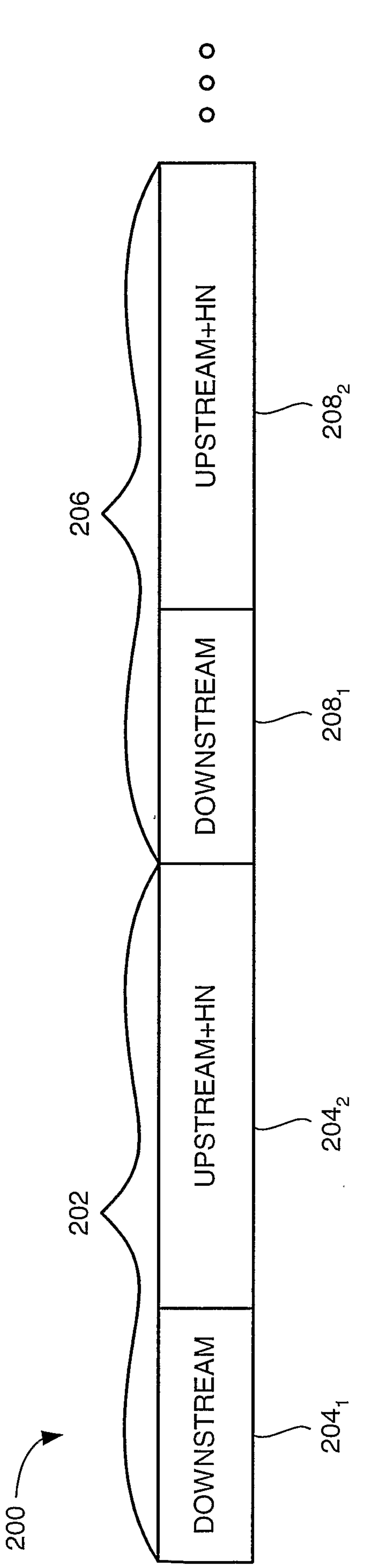
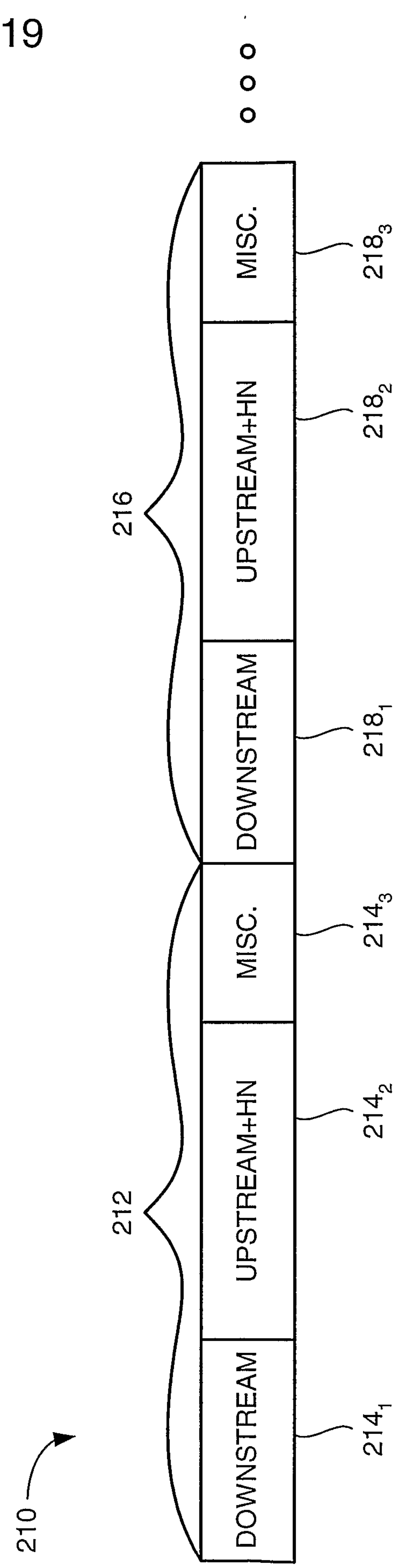

200
202
206
DOWNSTREAM
UPSTREAM+HN
DOWNSTREAM
UPSTREAM+HN
204_1
204_2
208_1
208_2

FIG. 6A


210
212
216
DOWNSTREAM
UPSTREAM+HN
MISC.
DOWNSTREAM
UPSTREAM+HN
MISC.
214_1
214_2
214_3
218_1
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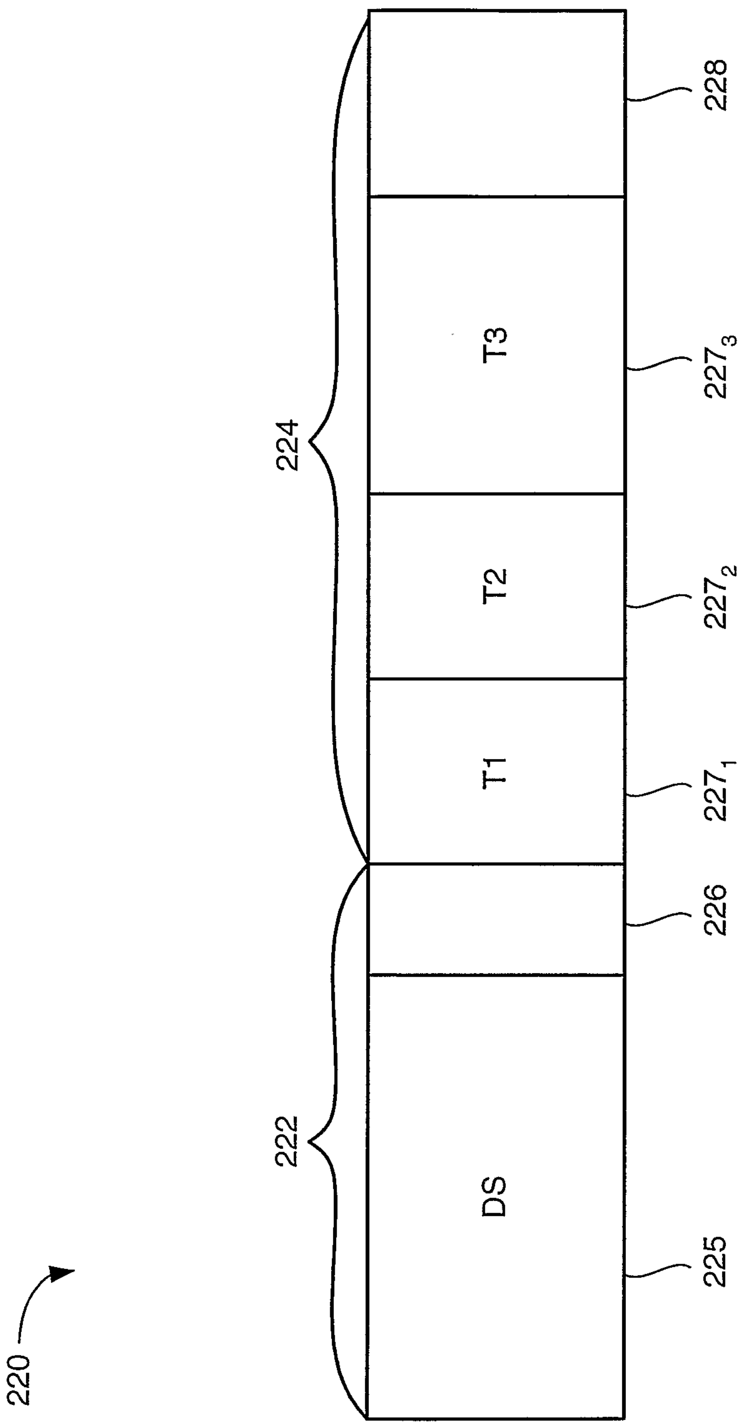
218_3

FIG. 6B

FIG. 6C



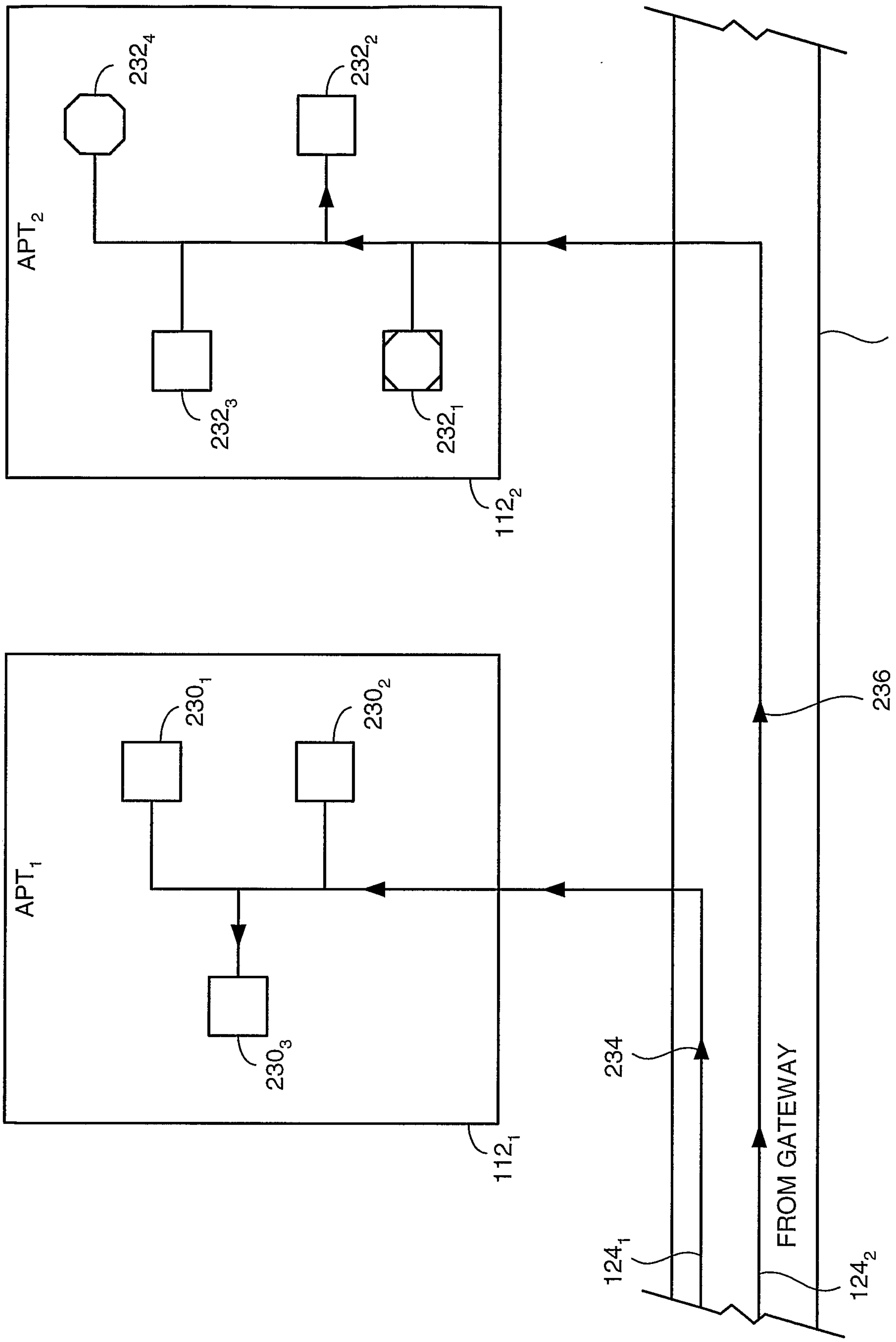
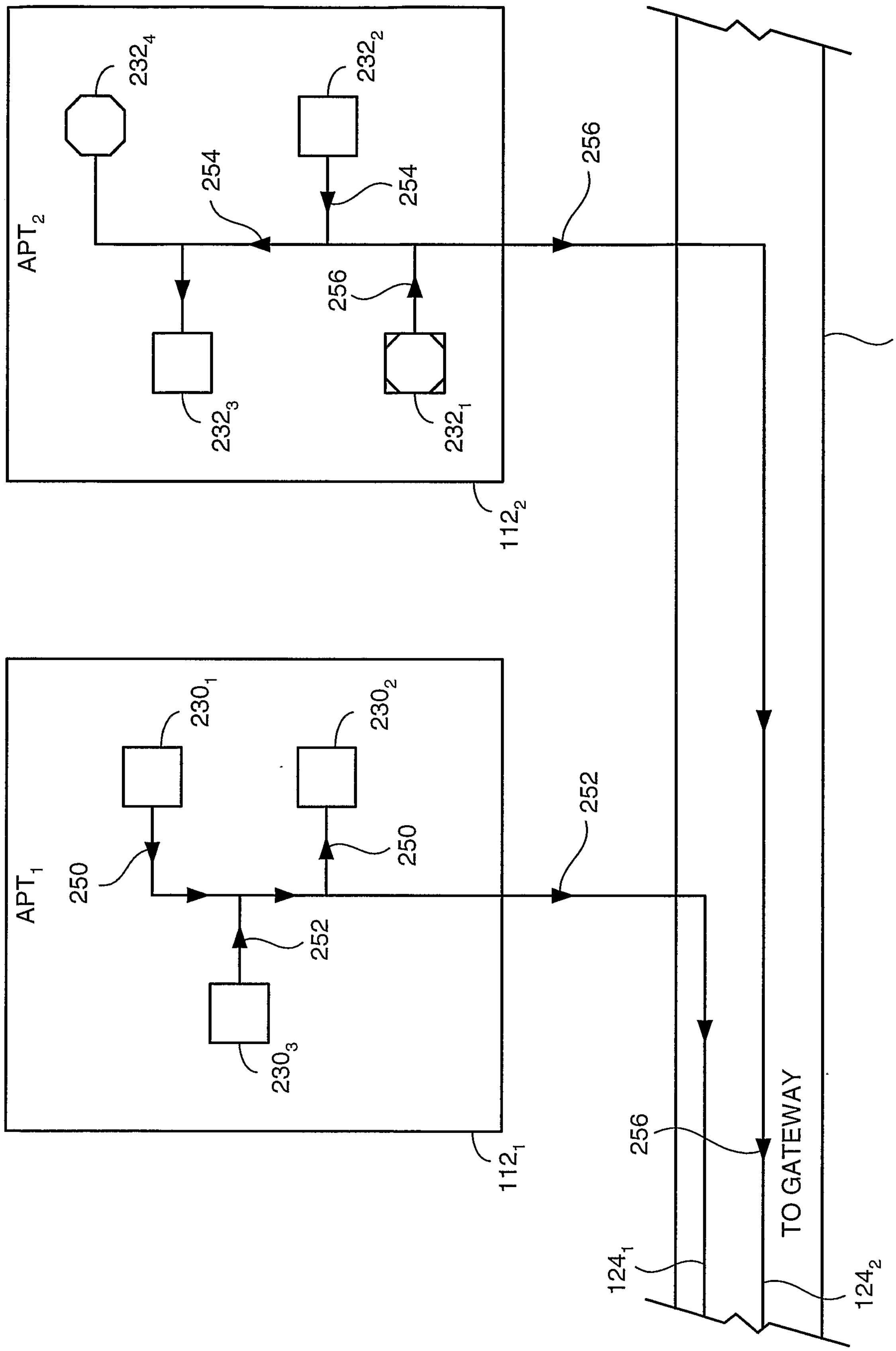

APT_2
232_4
232_2
232_3
232_1
112_2
APT_1
230_1
230_2
230_3
112_1
118
236
234
FROM GATEWAY
124_1
124_2

FIG. 7A



APT$_2$
232_4
232_2
254
254
256
256
232_3
232_1
112_2
118
APT$_1$
230_1
230_2
250
250
252
252
230_3
112_1
256
TO GATEWAY
124_1
124_2

FIG. 7B

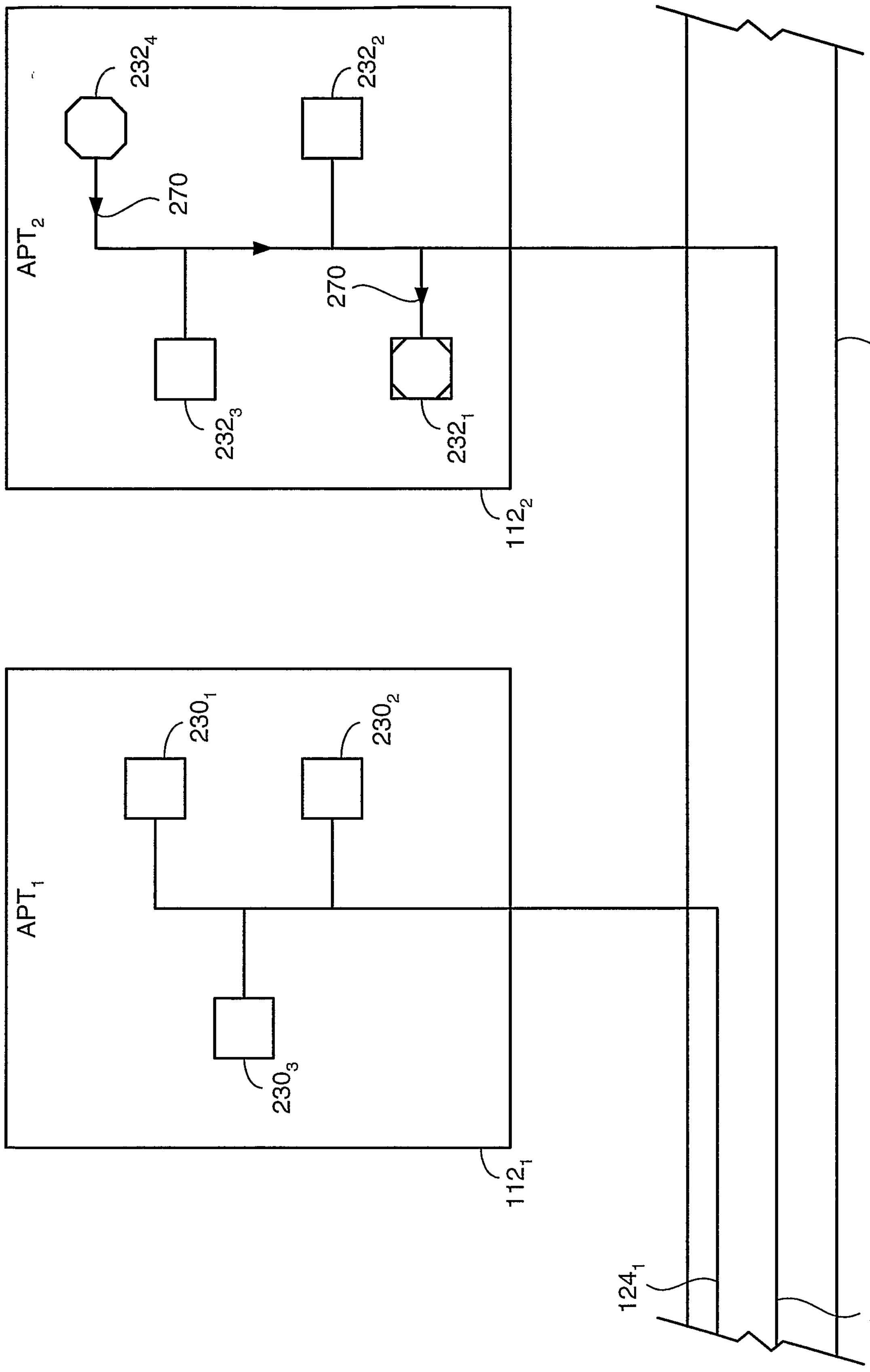

APT_2
232_4
232_2
270
270
232_3
232_1
112_2
118
APT_1
230_1
230_2
230_3
112_1
124_1
124_2

FIG. 7C

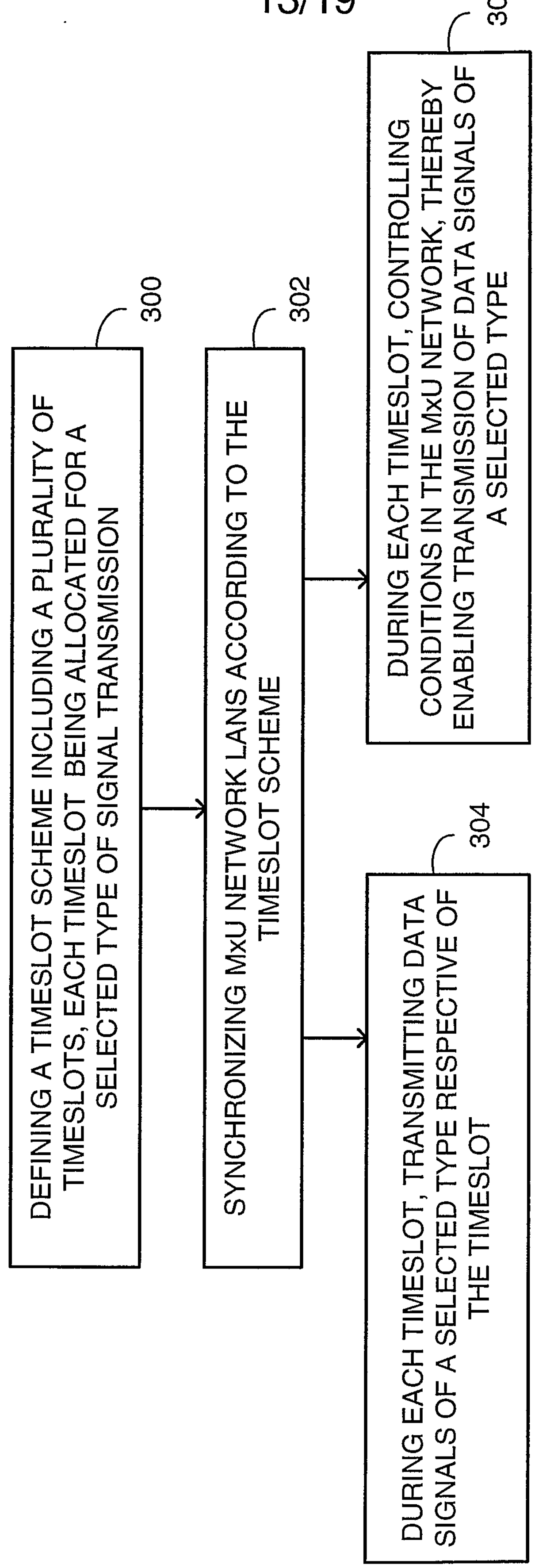

DEFINING A TIMESLOT SCHEME INCLUDING A PLURALITY OF TIMESLOTS, EACH TIMESLOT BEING ALLOCATED FOR A SELECTED TYPE OF SIGNAL TRANSMISSION
300
SYNCHRONIZING MxU NETWORK LANS ACCORDING TO THE TIMESLOT SCHEME
302
DURING EACH TIMESLOT, CONTROLLING CONDITIONS IN THE MxU NETWORK, THEREBY ENABLING TRANSMISSION OF DATA SIGNALS OF A SELECTED TYPE
306
DURING EACH TIMESLOT, TRANSMITTING DATA SIGNALS OF A SELECTED TYPE RESPECTIVE OF THE TIMESLOT
304

FIG. 8

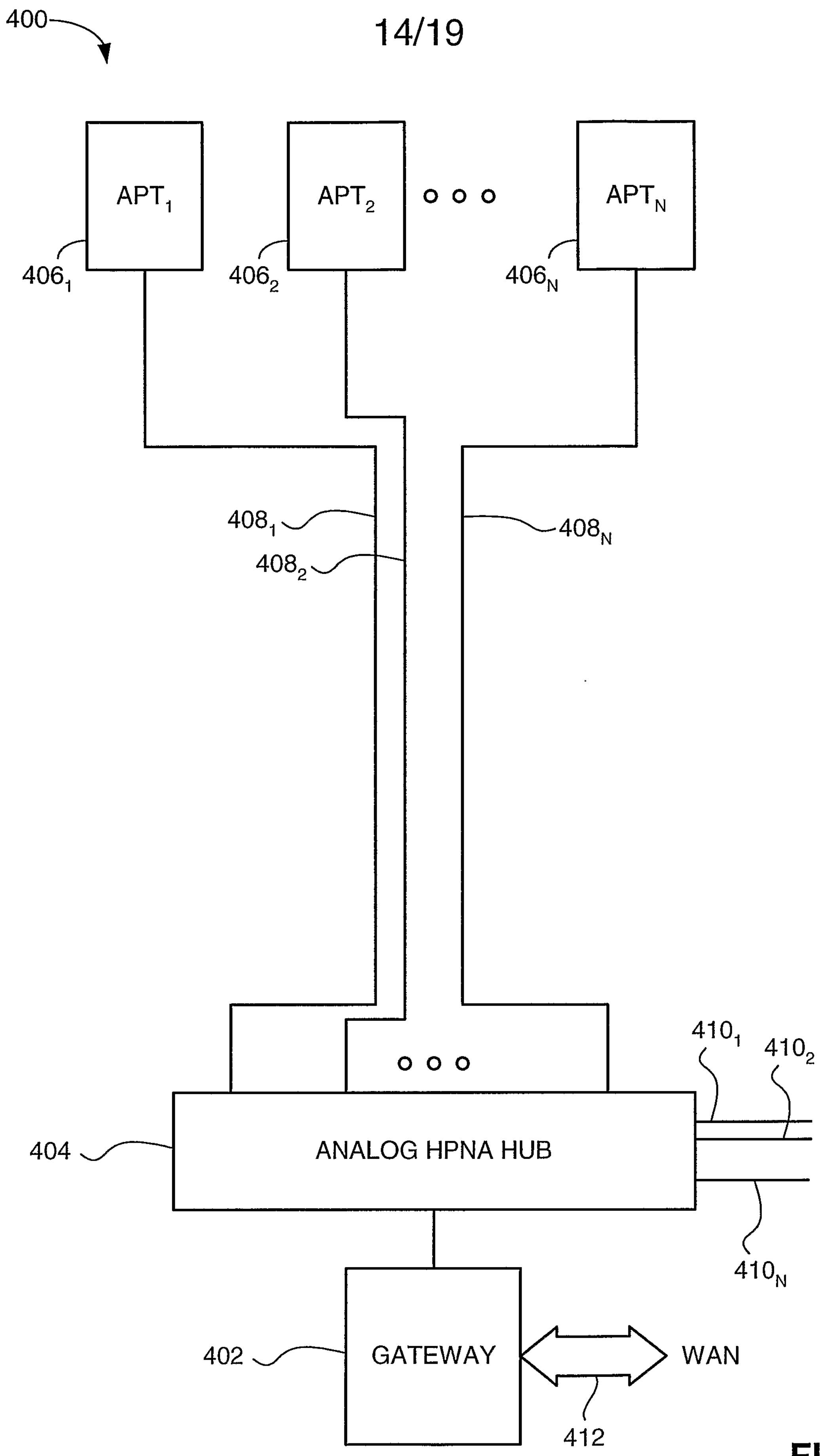
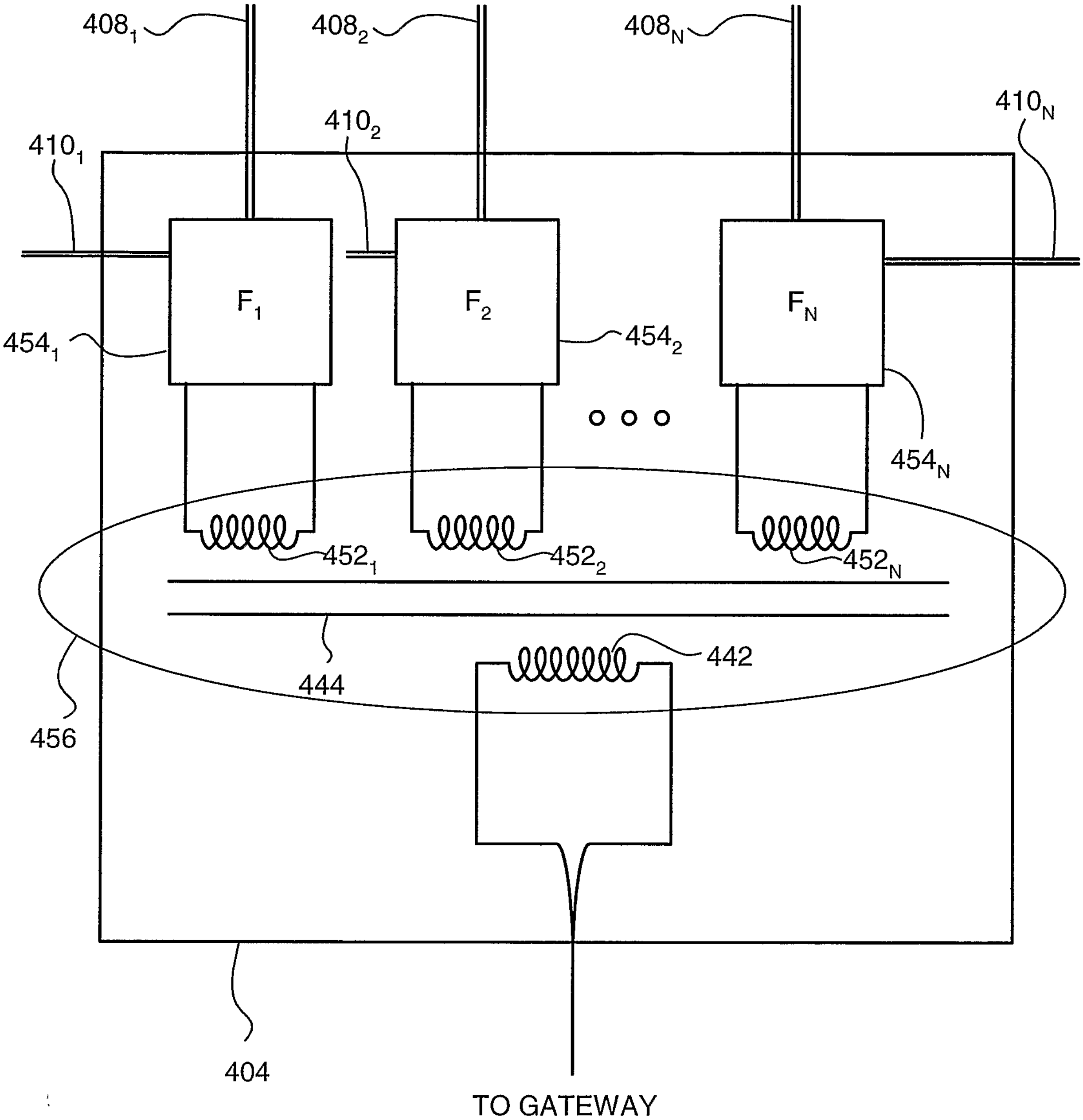
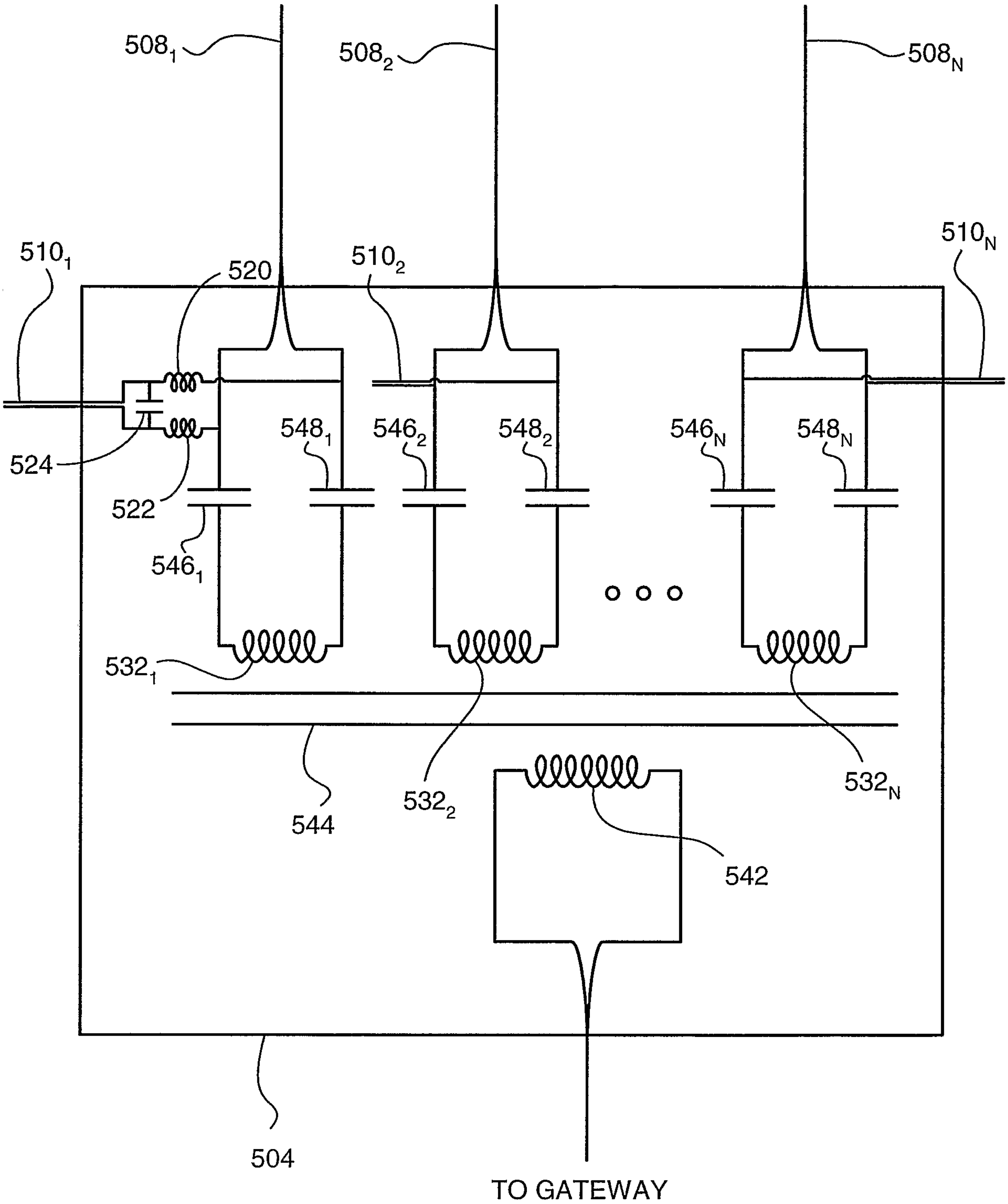

400
APT1
APT2
APTN
4061
4062
406N
4081
4082
408N
4101
4102
410N
404
ANALOG HPNA HUB
402
GATEWAY
WAN
412

FIG. 9



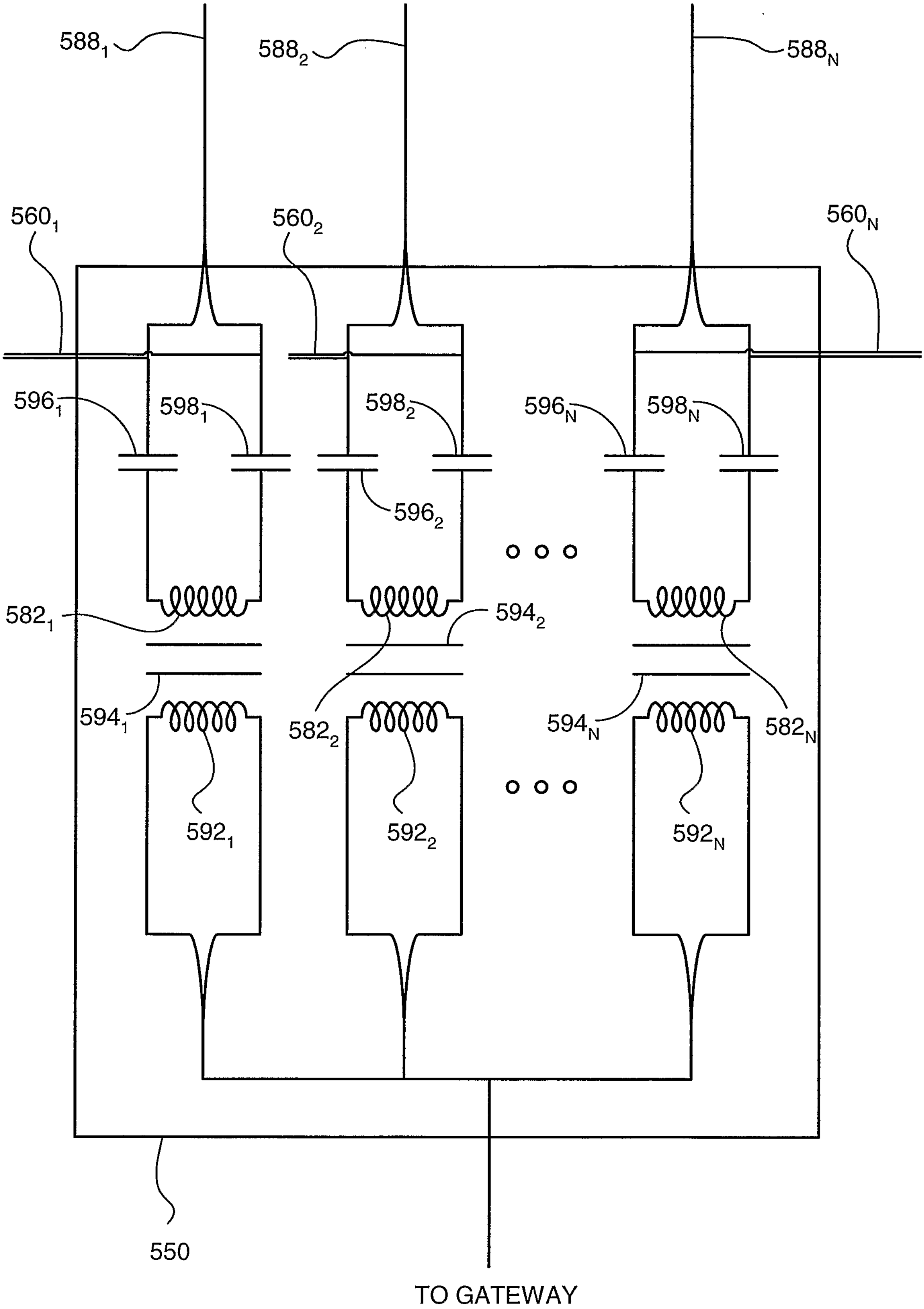
408_1
408_2
408_N
410_1
410_2
410_N
F_1
F_2
F_N
454_1
454_2
454_N
452_1
452_2
452_N
444
442
456
404
TO GATEWAY

FIG. 10



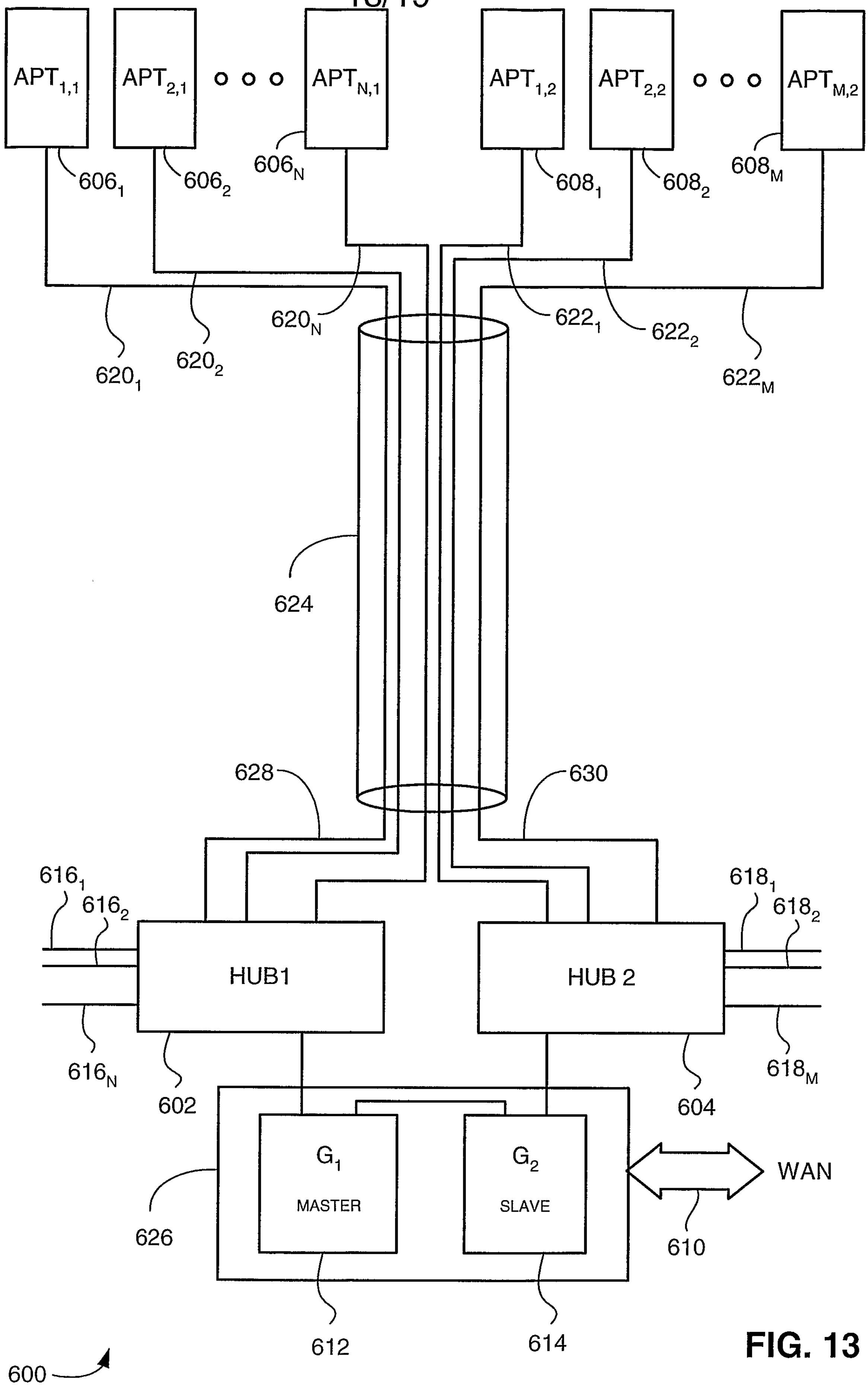
508₁
508₂
508N
510₁
520
510₂
510N
524
522
548₁
546₂
548₂
546N
548N
546₁
532₁
544
532₂
532N
542
504
TO GATEWAY

FIG. 11



588_1
588_2
588_N
560_1
560_2
560_N
596_1
598_1
598_2
596_N
598_N
596_2
582_1
594_2
594_1
582_2
594_N
582_N
592_1
592_2
592_N
550
TO GATEWAY

FIG. 12



APT1,1
APT2,1
APTN,1
APT1,2
APT2,2
APTM,2
6061
6062
606N
6081
6082
608M
6201
6202
620N
6221
6222
622M
624
628
630
6161
6162
616N
6181
6182
618M
HUB1
HUB 2
602
604
G1
MASTER
G2
SLAVE
WAN
610
626
612
614
600

FIG. 13

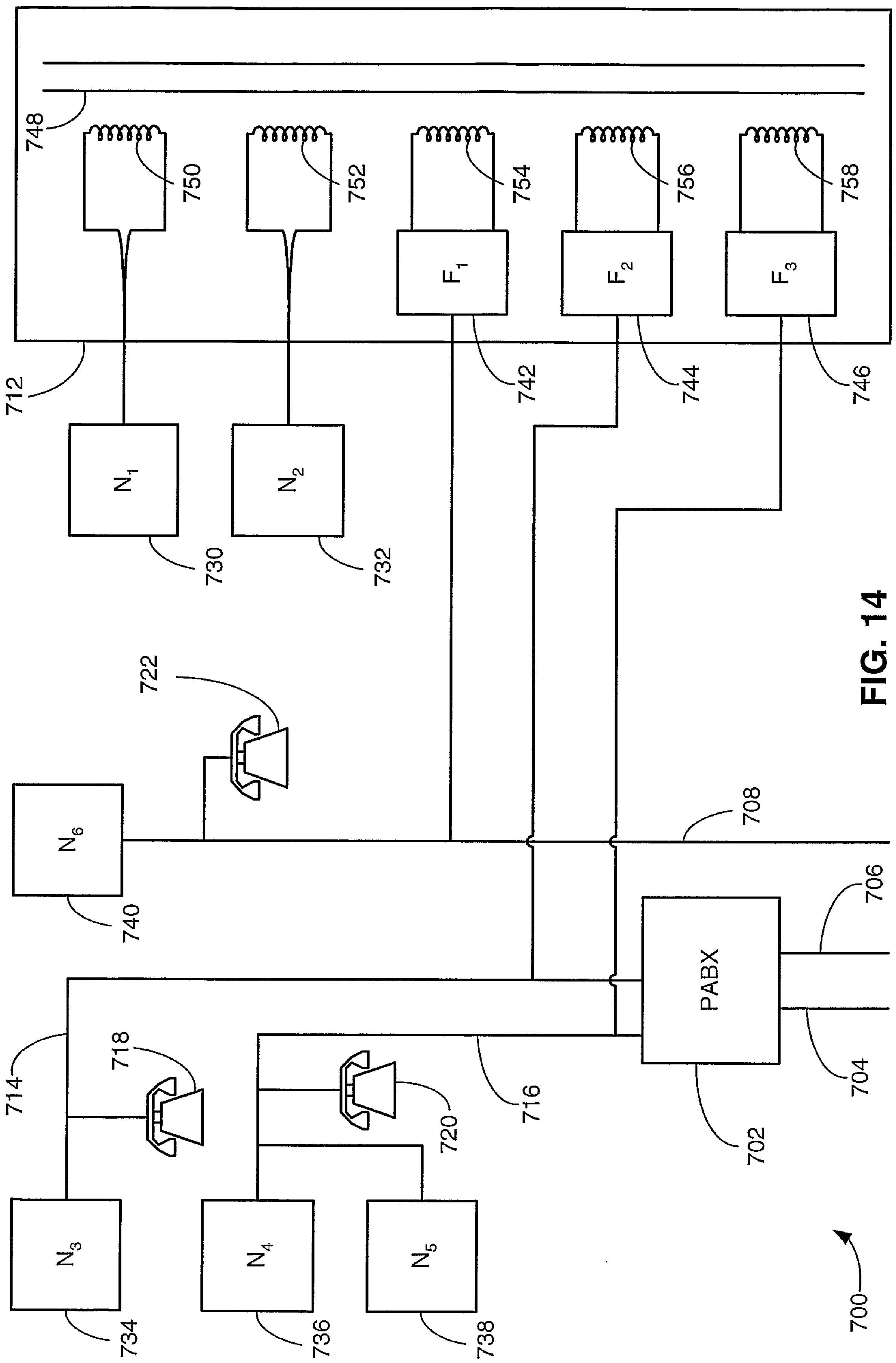

748
750
752
754
756
758
F1
F2
F3
712
742
744
746
N1
N2
730
732
722
N6
740
708
706
PABX
714
718
716
720
704
702
N3
N4
N5
734
736
738
700

FIG. 14