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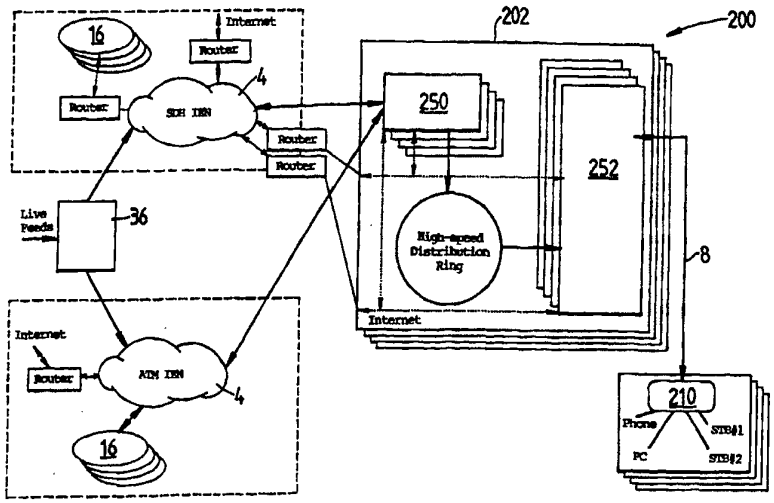

(57) Abstract

A distribution system including a channel distribution system for receiving content signals from a telecommunications transmission network and an access system for accessing the content signals received by the channel distribution system, and multicasting the content signals to customer units on telecommunications lines. The access system includes modulating units, such as ADSL units, for modulating the content signals for a transmission on the telecommunications lines, and a channel access unit for accessing and multicasting the content signals to the modulating units. The modulating units establish with the customer units a bidirectional data channel and a downstream content channel. The content signals transmitted on the downstream channel may be Pay TV, pay per view, free-to-air TV signals, video on demand signals, and even TCP/IP network (Internet) signals. The system can distribute a number of video and/or interactive services by establishing connections to customers over the telecommunications lines and, if necessary, connections to service providers over a telecommunications transmission network. Switching of service channels can be performed by the access system in response to control signals from the customer units.

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A DISTRIBUTION SYSTEM

The present invention relates to a distribution system and, in particular, to a system which enables video and/or interactive services to be distributed over a public switched telephone network (PSTN).

Different techniques and technologies have been proposed for providing a variety of video services to the home, in addition to the existing free-to-air broadcast network. The services include:

1. Video on demand (VOD) where movies and video programs are transmitted to a customer on request. The video signals may be transmitted immediately or at a time selected by the customer. Depending on the video signals transmitted, a communication channel between the video signal provider and the customer may also be used to allow the customer to send control signals to the provider to control transmission functions, such as pause, fast forward and rewind, or in the case of interactive video game, signals which dictate play of a game. This communication channel may also be used to provide interactive capability to other types of services, e.g. educational, home shopping, etc.
2. Pay per view (PPV) where video programs are scheduled for transmission and a customer is only charged for the programs selected to view.
3. Pay TV where a customer is able to access broadcast scheduled video programs and pays a subscription charge per Pay TV channel.

Services such as VOD can also be considered to constitute interactive services as a customer is allowed to generate control signals which dictates how the service is delivered. When customer communication is supported a range of interactive services can be delivered, such as video games and shopping services.

Telecommunications networks can be used to distribute video services. A transmission technology known as asymmetric digital subscriber line (ADSL) technology has been developed to allow the transmission of high bit rate video signals on the existing copper wires of a PSTN. An ADSL line is asymmetric because it allows the transmission of up to 8 to 25 Mb/s or more to customers from a local exchange but only allows low speed (e.g. 16 kbs, 64 kbps or 640 kbps) control signals to be sent to and from the customer and the local exchange. A line carrying ADSL signals also allows simultaneous transmission of plain old telephone system (POTS) services between a customer's telephone and the exchange. Two modulation techniques available for signal transmission on an access line are known as discrete multi-tone (DMT) and carrierless amplitude phase (CAP) modulation. ADSL technology is described in a number of publications, such as:

1. ANSI Standard T1E1.4/94-007 Network and Customer Installation Interfaces. Asymmetric Digital Subscriber Line (ADSL) Metallic Interface.
2. J.J. Werner, Tutorial on Carrierless AM/PM - Part I - Fundamentals and Digital CAP Transmitter UDF Document, 29 September, 1991. Also: Contribution to ANSI X3T9.5 TP/PMD Working Group, Minneapolis, 23 June, 1992.
3. M. Sorbara, J.J. Werner and N.A. Zervos, "Carrierless AM/PM", Contribution T1E1.4/90-154, 24 September, 1990.
4. W.Y. Chen, G.H. Im and S.S. Werper, "Design of Digital Carrierless AM/PM Transceivers", Contribution T1E1.4/92-149, 19 August, 1992.

Whilst ADSL technology has been suggested as a suitable platform for providing video on demand services, an efficient system architecture is required to distribute video and/or interactive services.

In accordance with the present invention there is provided a distribution system, including:

a channel distribution system for receiving content signals from a telecommunications transmission network; and

an access system for accessing the content signals received by said channel distribution

system and multicasting said content signals to customer units on telecommunications lines.

The present invention also provides a distribution system, including:

content signal provider equipment having first telecommunications means for providing content signals to at least one local exchange of a telecommunications network; and

a distribution switch of said at least one local exchange, said distribution switch having means for receiving said content signals, a plurality of exchange units for transmitting content signals to a plurality of respective customer units, and being adapted to multicast the received content signals to said plurality of exchange units for transmission to said customer units.

The present invention further provides a distribution switch for a telecommunications exchange, including:

means for receiving content signals;

means for multicasting said content signals; and

a plurality of exchange units for transmitting the multicast content signals to a plurality of respective customer units.

The present invention also provides a distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider; and

means for multicasting content signals provided by said content signal provider on said telecommunications channel to said exchange units.

The present invention also provides an asymmetric distribution switch for a telecommunications exchange, including:

a plurality of exchange units for receiving low bit rate data from respective customer units and for sending high bit rate data to said customer units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between said at least

one of said exchange units and said high bit rate data provider.

The present invention further provides a distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider to receive applications cyclically broadcast by said video signal provider; and

means for establishing a telecommunications channel with at least one of said customer units to provide said applications thereto when requested.

The present invention also provides a distribution system, including:

means for establishing a telecommunications channel with a content signal provider; and

a plurality of exchange units for communicating with a respective plurality of curb units over optical links, said curb units communicating with respective customer units;

said exchange units including means for multicasting content signals provided by said content signal provider on said telecommunications channel to said curb units.

The present invention further provides a distribution system, including:

a plurality of exchange units for receiving low bit rate data from respective remote units and for sending high bit rate data to said remote units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between at least one of said exchange units and said high bit rate data provider.

Preferred embodiments of the present invention are hereinafter described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram of a first preferred embodiment of a distribution system;

Figure 2 is a more detailed block diagram of the distribution system of Figure 1;

Figure 3 is a block diagram of a distribution switch of the system;

Figure 4 is a block diagram of a channel distribution subrack of the distribution switch;

Figure 5 is a block diagram of a channel interface unit of the channel distribution subrack;

Figure 6 is a block diagram of a channel distribution unit of the channel distribution subrack;

Figure 7 is a block diagram of a channel access subrack of the distribution switch;

Figure 8 is a block diagram of a channel access unit of the channel access subrack;

Figure 9 is a block diagram of an alarm control unit of the subracks;

Figure 10 is a block diagram of the interconnections between the subracks;

Figure 11 is a schematic diagram illustrating the signalling architecture of the distribution system;

Figures 12, 13, 14, 15 and 16 are message flow diagrams for the system;

Figure 17 is a block diagram of an alternative dual ring architecture for providing bus protection for the distribution switch;

Figure 18 is a block diagram of a second preferred embodiment of a distribution system;

Figure 19 is a block diagram of an enhanced channel distribution subrack of the distribution switch of Figure 18;

Figure 20 is a block diagram of a synchronous termination processor (STP) of the channel distribution subrack of Figure 19;

Figure 21 is a block diagram of a synchronous interface unit of the STP;

Figure 22 is a block diagram of the arrangement of circuit cards in an STP;

Figure 23 is a block diagram of an asynchronous transfer mode termination processor (ATP)of the channel distribution subrack of Figure 19;

Figure 24 is a block diagram of a circuit processing module of the ATP;

Figure 25 is a block diagram of a channel access subrack of the distribution switch of Figure 19;

Figure 26 is a block diagram of an integrated gateway unit of the channel access subrack of Figure 25;

Figure 27 is a block diagram of an ADSL exchange unit of the channel access subrack of Figure 25;

Figure 28 is a block diagram of an ADSL customer unit of the distribution system of Figure 18;

Figure 29 is a block diagram of a third preferred embodiment of a distribution system;

Figure 30 is a block diagram of a fibre to the curb (FTTC) channel access subrack of the distribution system of Figure 29;

Figure 31 is a block diagram of a remote optical channel access unit of the FTTC channel access subrack;

Figure 32 is a block diagram of a curb access subrack of the distribution system of Figure 29;

Figure 33 is a block diagram of the curb access subrack with an ISDN unit;

Figure 34 is a block diagram of the curb access subrack with a POTS unit;

Figure 35 is a block diagram of the fibre line unit (FLU) of the curb access subrack;

Figure 36 is a schematic diagram of components interconnected for transmission of Internet traffic on the distribution system of Figure 18;

Figure 37 is a block diagram of an ADSL customer unit of the distribution system of Figure 18 connected to a customer's PC; and

Figure 38 is a block diagram of an ADSL customer unit of the distribution system of Figure 18 connected to a customer's LAN.

A video signal distribution system 2, as shown in Figure 1, uses an existing PSTN that includes a transmission network 4 which is able to transmit digital data at a high bit rate, such as, but not limited to, 1.5 Mb/s, 2 Mb/s or 6 Mb/s. The PSTN includes a number of local switching exchanges which are used to switch telephone calls to and from customer terminals connected thereto. The customer terminals and the telecommunications lines used to connect the terminals to the respective local exchanges form the customer access network (CAN) of the PSTN. The telecommunications lines of the CAN may be pairs of copper conductors or optical fibres to respective customers. For lines which use copper conductors 8, the system 2 terminates a copper pair with ADSL customer equipment 10 at the customer premises and an ADSL exchange unit 12 at the local exchange for the customer. The local exchange includes a distribution switch 14 which has a plurality of the exchange units 12 for respective customers which can be connected to the local exchange. The distribution switch 14 is an integrated gateway and video switch which establishes communications channels between video information provider (VIP) equipment 16 and customers over the PSTN and switches video signals from the equipment 16 to the customer. The distribution switch 14 is also connected to the telephone

switch circuitry 18 of the local exchange for the POTS and allows the POTS telephone signals to be transmitted over the copper conductors 8 using the exchange units 12 and customer equipment 10.

The ADSL customer equipment 10 is connected to a customer's telephone 20 to receive and transmit POTS signals. The ADSL customer equipment 10 is also connected to a set top unit (STU) 22. The customer equipment 10 is able to transmit video signals to the set top unit 22 for display on a television 24 connected to the STU 22. The STU 22 generates control signals in response to signals received from a remote control unit 26 and the control signals are transmitted to the ADSL customer equipment 10 for further transmission on a copper conductor 8 to an exchange unit 12 of the distribution switch 14. The customer equipment 10 and the STU 22 can be integrated into one unit at the customer's premises, if desired.

The video signal distribution system 2 includes a plurality of the distribution switches 14 located at respective local exchanges. The distribution switches 14 are able to connect to VIP equipment 16 of the system 2 using terminal equipment 28 which are telecommunications multiplexer/demultiplexers that allow a digital communication channel to be established between the VIP equipment 16 and a distribution switch 14 using the transmission network 4.

The VIP equipment 16 may include a video server 30, a management and billing system 32, an authoring system 34 and real-time encoders 36. The real-time encoders 36 are used to digitise and compress analogue video programs using a standard compression technology, such as MPEG. The compressed digital video signals for live programs, such as those on Pay TV channels, can be broadcast directly from the encoders 36 on communication channels established with distribution switches 14. The video signals can then be multicast to customer equipment 10 via the distribution switches 14 for customers which are authorised to receive the video signals. The real-time encoders 36 can also be used to provide compressed digital video data for storage in the video server 30. The video server 30 is able to communicate with distribution switches 14 via the terminal equipment 28 so as to access and provide stored video programs when requested.

The distribution switch 14 of a local exchange communicates with an STU 22 and the VIP equipment 16 to establish a communication channel therethrough between the VIP equipment 16 and the STU 22. Once the channel is established, the STU 22 and the VIP equipment 16 communicate with one another directly, with the STU 22 providing control signals to the VIP equipment 16 and the VIP equipment 16 providing compressed digital video signals in response thereto, the video signals being decoded by the STU 22 for display on the television 24. Depending on the communication channels established, the distribution switch 14 is able to multicast video signals to a number of selected STUs 22. This is particularly advantageous for Pay TV, PPV and live to air channel services which may need to be sent to a number of customers simultaneously. Both live and prerecorded video signals can be sent to customers, and the distribution switch 14 also allows for fast switching between Pay TV and live channels at the local exchange. The distribution switch 14 is also able to provide point to point communication channels for services such as VOD.

An example of the video signal distribution system 2, as shown in Figure 2, is configured to support 300 customers, 100 each at three different local exchanges 40, 42 and 44. The first and third local exchanges 40 and 44 support customers which use DMT modulation and the second local exchange 42 supports customers which use CAP modulation. The VIP equipment 16 is able to provide simultaneously 63 2 Mb/s channels from the video server 30 and seven 2 Mb/s and seven 6 Mb/s channels from the real-time encoders 36 are for live video programs. All of the channels are provided to synchronous digital hierarchy (SDH) terminal equipment 28 for transmission on an SDH transmission network 4 of the PSTN. The seven 6 Mb/s channels are multiplexed before transmission into one 45 Mb/s channel. The 2 Mb/s channels provided by the video server 30 may be divided into 50 VOD simultaneous channels, nine PPV channels, three control channels for signalling and alarm transport to each of the distribution switches 14 of the local exchanges 40 to 44, and one channel for downloading application control software to a connected STU 22. The VIP equipment 16 includes an alarm monitoring unit (AMU) 46 which collects, stores and reports on errors and conditions associated with the system 2. The alarm monitoring unit 46 monitors the distribution switches 14 of the local exchanges 40 to 44, the ADSL equipment 10 and 12, and the STUs 22.

The distribution switch 14 of each local exchange 40 to 44 includes at least one channel distribution subrack 50 which establishes a dual bus system for connection to ADSL access subracks 52, which each include ADSL interfaces 54. The DMT interfaces can be drawn schematically in the same manner as the CAP interfaces for the second local exchange 42 where the POTS exchange lines are split off directly from the interfaces 54, as opposed to the separate DMT POTS splitter 55. The ADSL interfaces 54 form the ADSL exchange units 12. In the example shown in Figure 2, for CAP and DMT there are ten ADSL access subracks 52 each including ten ADSL interfaces 54, which can be increased as desired.

The channel distribution subrack 50 establishes two high data rate buses which have opposite data flow directions and allow data to be time division multiplex thereon to provide data to the access subracks 52. The subracks 50 and 52 are controlled by an alarm control units (ACUs) 56 which can receive and transmit control signals via the terminal equipment 28 using a router 70. The channel distribution subrack 50 is connected to the terminal equipment 28 to receive the 2 Mb/s channels and the 6 Mb/s channels, the latter being via a demultiplexer 60.

The distribution switch 14 is able to broadcast or multicast video signals to the ADSL interfaces 54 from the dual bus established by the channel distribution subrack 50. Channel switching signals received from the STU 22 can be processed and executed by the distribution switch 14 which enables fast response times for channel changing. The broadcast or multicast capability of the switch enables many users to be connected to a single video channel received by the distribution switch 14 simultaneously. This provides significant savings in network capacity as a dedicated connection for each customer to the VIP equipment 16 is not required for all services.

The distribution switch 14 provides a gateway, referred to as a level one (L1) gateway, which is used to establish communication between the video signal provider equipment 16 and the STU 22, and to control the switching of video channels to the customer. A control signal information pipe is established between the VIP equipment 16 and the STU 22 after a menu selection provided by the L1 gateway. The distribution switch 14 is an asymmetric switch in that it switches high bit rate video data signals in one direction and low bit rate control signals in both

directions.

The distribution switch 14, as shown in Figure 3, includes a number of interconnected channel distribution subracks 50 and access subracks 52 which transfer received video signals or data using high speed parallel buses 64 and 66. Control data is transferred using twisted pair Ethernet lines from the subracks 50 and 52 to a 10 baseT hub 68 and then to a multi-protocol router 70 which connects to the terminal equipment 28. The MPEG video data received by the channel distribution subracks 50 is time division multiplexed onto the parallel bus 64 and 66, the first bus 64 travelling in a counter clockwise direction through the access subracks 52 and the second bus 66 travelling in a clockwise direction through the access subracks 52 so as to form a ring structure. The access subracks 52 compare the video data from both directions and choose the higher quality signal for reception. The access subracks 52 regenerate the signals on both parallel buses 64 and 66 and selectively demultiplex the received video data for transmission using the ADSL interfaces 54. The ring structure provides a backup path in the event of a subrack failure.

A channel distribution subrack 50, as shown in Figure 4, includes a plurality of channel interface units (CIUs) 72 for respective 2 or 6 Mb/s video data lines from the terminal equipment 28, and a channel distribution unit (CDU) 74 which multiplexes data from the channel interface units 72 onto the first and second parallel buses 64 and 66 for distribution to the access subracks 52. An ACU 56 is included to control the CIUs 72 and the CDU 74 using a Motorola serial peripheral interface (SPI) bus 76. The ACU 56, as discussed hereinafter, is able to receive control data from and for a customer, and transfer it to the hub 68.

A 2 Mb/s CIU 72, as shown in Figure 5, has 21 channel interfaces 80 for 21 2.048 Mb/s channels. Data received on the channels is decoded by decoders 82, stored in elastic stores 84 and then held in 16 bit shift registers 86 before being multiplexed by multiplexers 88. The 21 channels are synchronised to a 2.1125 MHz clock using bit-stuffing and are then multiplexed into a 32 bit parallel format at a word rate of 33.7 MHz by the multiplexers 88. To each 32 bit word parity and stuffing bits are added so as to produce a 34 bit word output on a 34 bit output bus 90 to the CDU 74. The parity bits are provided by parity generators 87. A monitor channel

output 92 can be provided for analysis purposes using a channel selector 94. Control of the monitor channel output 92 and the timing for the CIU 72 is provided by a microprocessor 96 of the CIU which can communicate with the ACU 56 using the SPI bus 76 and can also monitor channel alarms held by an alarm unit 98 connected to the channel interfaces 80. The CDU 74 selects data from the CIU units as blocks of 21 channels. The base address of these blocks is configurable by the ACU via the SPI bus 76. The monitor channel output 92 can be used to provide a 2.048 MHz reference clock for the rest of the distribution switch 14.

The CDU 74, as shown in Figure 6, multiplexes the video data received on the output bus 90 from the CIUs 72 onto the buses 64 and 66. The buses 64 and 66 are each 18 bit data buses operating at 135 Mwords/s, the 18 bits including 16 bits of video data, one parity bit and one sync bit. Data received on the buses 64 and 66 by the CDU 74 is demultiplexed by demultiplexers from 18 bit words into 36 bit words on two 36 bit buses, which are checked using two parity bits. Under control from the ACU 56 of distribution subrack 50, a multiplexer 102 selects one of the buses for multiplexing with incoming data on the output bus 90 from the CIUs 72. The received data on the output bus 90 is multiplexed with that on an internal bus 104 from the multiplexer 102 by multiplexers 106 at twice the data rate so as to produce the buses 64 and 66. A locally generated framing signal and clock signal are provided by an internal oscillator 108 which runs at 67.4 MHz and is provided also to the CIUs 72 by a clock driver 110. A control processor 112 of the CDU 74 controls the timing of the CDU 74 and uses a timing gate array 114 to provide select signals to the CIUs 72 using a driver 116. The control processor 112 is connected to the SPI bus 76 to receive and transmit control signals between the ACU 56.

An access subrack 52, as shown in Figure 7, includes an ACU 56, ten CAP ADSL interfaces or ten DMT ADSL interfaces 54 and a channel access unit (CAU) 120 which connects to the parallel buses 64 and 66, and the ADSL interfaces 54. Each ADSL interface 54 is able to provide a digital subscriber line 8 to a customer. The CAU 120 acts as a switch which is able to access video data on one of the buses 64 or 66 and provide it to a selected ADSL interface 54 for a customer. Control data provided from the STU 22 of a customer is received by an ADSL interface 54, via customer equipment 10, and passed to the ACU 56 together with any operations alarm monitoring and provisioning (OAM&P) data. The data can then be provided to the VIP

equipment 16 using the router 70. The ACU 56 controls the switching performed by the CAU 120 by the SPI bus 76. The ACU 56 is also able to pass STU data to the STUs 22 using a selected ADSL interface 54.

The CAU 120 is illustrated in Figure 8 for one of the buses 64 for simplicity. The video data on the first bus 64 is regenerated and retimed using a jitter reduction circuit 124 and a retiming circuit 125 is used to account for delay, frequency doubling and jitter based on a clock signal obtained from the bus 64. The retimed and regenerated video data is placed back on the bus 64. The data on the bus 64 is demultiplexed by a demultiplexer 122 into a 32 bit data word with a further parity bit and stuffing flag and is checked for parity by a parity checker 125. The demultiplexed video data from both buses 64 and 66 is compared and the data of the bus having the highest quality is passed on an output 32 bit bus 123 to a gate array 126. The gate array 126 and the other circuitry of the CAU 120 is controlled by a microprocessor 130 in response to instructions received on the SPI bus 76 from the ACU 56.

The gate array 126 includes an ADSL channel unit 128 for each ADSL interface 54. The ADSL channel units 128 each include a timeslot assignor 132 which is connected to a framing output of the demultiplexer 122 for the demultiplexed video data. The timeslot assignors 132 are all programmable by the microprocessor 130 to access specific timeslots or channels of the demultiplexed video data and pass it to a respective ADSL interface 54. When set by the microprocessor 130, a timeslot assignor 132 ensures video data of a timeslot is read into one of three shift registers 134 of the ADSL channel unit 128. Video data stored in the shift registers 134 are multiplexed by a multiplexer 136 of the ADSL channel unit 128 and passed to the respective ADSL interface 54 for transmission on the ADSL line 8 to a customer. The CAU 120 therefore selectively passes video data to an ADSL interface 54 by selecting the respective ADSL channel unit 128. The video channel passed to the customer is selected by the timeslot assignor 132 accessing the corresponding timeslot of the video data relative to the frames received by the gate array 126, in response to control signals received by the processor 130 which in turn is instructed by the ACU 56 concerning the channel required. Video data is provided to gate array 126 in frames of 1024 timeslots, with each timeslot being available for a respective video channel and including a synchronising signal to distinguish from other timeslots. The selective use of the

timeslot assignors 132 allows the gate array 126 to pass the same video channels to the ADSL interfaces or a mixture of different channels to the ADSL interfaces, including a different video channel for each interface.

The ACU 56, as shown in Figure 9, is resident in both the channel distribution subracks 50 and the access subracks 52, as described previously. A single ACU 56 is required in each of the subracks 50 and 52 to control information flow between the various components of the distribution switch 14. The core component of the ACU 56 is a Motorola MC68360 communications controller 150. All data transfers involving the ADSL interfaces 54, memory accesses and alarm operations are supervised by the controller 150. A boot ROM 154 is provided to execute startup procedures after reset, which includes data download routines and various other operating system or monitor program tasks. The flash ROM 156 is used to store executable code for the ACU 56 which can be downloaded thereto. A RAM 158 is used for data buffers and other system read/write requirements, and an EEPROM 160 is used to store customer related information, such as customer video channel or facility access. Local storage of this data by the ACU 56 allows the CDUs 74 and CAUs 120 to take immediate action on some commands from the STU 22 without having to communicate with the VIP equipment 16. The controller 150 also establishes the SPI bus 76 which is used, as discussed previously, to control the channel switching of the CAUs 120 and the CDUs 74. The SPI bus 76 is also used to collect alarm information from the channel access units 120, CDUs 74 and CIUs 72. Two 74HC138 decoders 162 are connected to input/output ports of the controller 150 so as to provide 16 SPI slave selection lines 164 for selecting the units 120, 74 and 72. Control signals are passed between the ACU 56 and the STUs 22 using ten synchronous interface channels 166 connected to the ten ADSL interfaces 54. The data is transmitted/received serially at 16 Kb/s on the interfaces 166. The synchronous interfaces may be implemented using five Zilog 85230 serial communication controllers 168. An internal crystal oscillator/PLL circuit allows the controller 150 to operate with 25 MHz system-clock 152.

To provide an orderly system of information exchange between the distribution switch 14 and the VIP equipment 16, one ACU 56 in each local exchange 40 to 44 can be designated a 'master' with the remaining ACUs 56 in the distribution switch 14 becoming 'slaves'. Apart from

maintaining its own subrack functions, the master ACU 56 has the additional task of gathering and distributing set top and OAM&P data to the slave ACUs. When configured as the master, the ACU 56 operates two reserve interfaces which are not used in the slave mode. The two interfaces are a communications channel 170 to the terminal equipment 28 and an OAM&P RS232 link 172. The ACUs 56 can also all be operated using the same configuration without the master/slave relationship.

The communications channel to the terminal equipment 28 for an ACU 56 may be the Ethernet link 171 described previously to the hub 68 and router 58, or alternatively the ACU 56 can provide an SDH 2 Mb/s G.703 interface 170, as shown in Figure 9, which can be connected directly to the terminal equipment 28. The communication channel 170 sends data received from the STUs 22 to the transmission network 4 and is also used to receive response data for the STUs 22 which can be distributed, as required, to the slave ACUs 56. The RS232 link 172 conveys gathered OAM&P information to and from the AMU 46. A second 2 Mb/s G.703 interface 172 is provided to convey all set top data and OAM&P information between the slave ACUs and the master ACU. A third link 174, which is the same as the second link, is also provided as a backup should a failure occur on the second link 172. Data is conveyed over the links 170 and 172 using a HDLC protocol. The controller 150 includes an internal HDB3 encoder to encode and decode data packets transmitted on the links 170 to 174. The controller 150 provides an RS485 link 176 to transmit all OAM&P information between the ACU 56 and the ADSL interfaces 54. The controller 150 is able to display alarm conditions using a plurality of alarm LEDs 178 and is able to drive a number of alarm relays 180 to activate other devices when certain alarm conditions occur, such as a non-urgent (NU) condition, an urgent (U) condition or an alarm receiving attention (ARA) condition. The ACU 56 can further be used to download software to a CDU 74 or CAU 120 using a local RS232 terminal 173.

The arrangement of the ACUs 56 in the distribution subracks 50 and access subracks 52 is shown in Figure 10 which illustrates the connection of the links 172 between the ACUs 56 and the 2 Mb/s link 170 to the VIP equipment 16. The 2 or 6 Mb/s video data inputs from the terminal equipment 28 are shown as links 182 into the distribution subracks 50. The ACU 56, as described previously, is able to provide instructions to a CAU 120 to connect a customer to

a particular video channel. Once placed on the buses 64 and 66 by the CDU 74, the CAU 120 may switch the customer to that channel by selecting the appropriate ADSL channel unit 128 for the correct timeslots, as a result of messages received from the VIP equipment 16 or as a result of video dial tone (VDT) messages received from the STU 22 in response to a customer selecting a channel. The customer will only be able to switch between channels using the distribution switch 14 for channels the customer subscribes to and are broadcast to the distribution switches 14. A customer may also use the distribution switch 14 to switch between free-to-air broadcast channels which are broadcast to all of the customers connected to a distribution switch 14.

The ACU 56 is configured to provide applications, which can include menus and application software, to selected customers. The video signal provider equipment cyclically broadcasts to the local exchanges 40 to 44, the applications which can then be switched by the distribution switches 14 to the STUs 22 in response to requests from a customer. If required, the ACU 56 stores and generates a menu of available video signal/information providers from which a customer can select a video service. On selecting a video information provider, the ACU 56 establishes a session with the VIP 16 using VDT signalling. The VIP equipment 16, using VDT messages to the ACU 56, can control the switching of channels as per the requirements of an interactive session. The messages are also used to switch the broadcast applications to the STU 22. This is particularly advantageous as customers do not need to establish a dedicated high speed communication channel with the VIP equipment 16 in order to receive an application. The configuration of the channel distribution and access subracks 50 and 52 also enables more than one STU to receive simultaneously the requested applications which have been broadcast to the local exchanges 40 to 44 by the VIP equipment 16.

Signalling between the VIP equipment 16, a distribution switch 14 and a STU 22 is illustrated in Figure 11 which also shows signalling to the alarm monitoring unit 46 of the VIP equipment 16. The physical and link layout protocols used are:

Manchester:	Form of line encoding including a clock.
G.703:	An electrical interface specification (including coding) defined by the international standards body ITU.

ISO 8802.3:	Ethernet electrical interface specification (including coding).
RFC 894:	Ethernet II encapsulation of IP.
PPP:	An IP transport protocol for point to point connections.
LAP-B:	Link Access Protocol - Balanced (includes HDLC framing).

The signalling protocols used are:

IP:	Part of the TCP/IP protocol suite.
UDP:	Part of the TCP/IP protocol suite.
VDT:	Video Dial Tone. Generic term for video control signalling.
ACUP:	Alarm Control Unit Protocol used for monitoring the distribution switch.
VT-100:	Display control codes.

ACUP signalling 201 occurs exclusively between the distribution switch 14 and the VIP equipment 16, VDT signalling 203 and 205 is supported between the VIP equipment 16, the distribution switch 14 and the STU 22, and the same applies for application signalling 207 and 209 between the VIP equipment 16 and the STU 22. The application signalling 207 and 209 is transparent to the distribution switch 14 once an interactive session and video data communication channel has been established between the VIP equipment 16 and the STU 22. A video data channel 211 is effectively transparent to the distribution switch 14 once established between the VIP equipment 16 and the STU 22 so as to download video data to the STU 22.

When a STU 22 is switched on it connects to the distribution switch 14 and provides a message establishing a connection to the distribution switch 14, as shown in Figure 12, which allows the STU to begin local channel selection and causes the distribution switch 14 to provide the last used video channel to the STU 22. The STU 22 is then able to select other video channels, associated with the free-to-air and authorised broadcast services, such as Pay TV, which can be switched by the distribution switch 14. The distribution switch on receiving a channel select signal, as shown in Figure 13, provides a video characteristic signal to the STU 22 informing the STU 22 of the characteristics of the video channel if the customer is authorised to receive the channel. The distribution switch 14 then provides a display signal to display the

channel number for a brief period which appears over the video signal provided on the broadcast channel. If the user is not authorised, the distribution switch is not switched to the selected channel and instead causes display of a message indicating that the customer is not authorised.

The remote control unit 26 for the STU 22 is provided with a VIP button which when depressed, initiates an interactive session with the VIP equipment 16. The distribution switch 14 provides a VIP and service selection menu from which the user can select the VIP equipment 16, and the STU 22 sends a select VIP signal to the distribution switch 14, as shown in Figure 14. The distribution switch 14 then sends a session request signal to the VIP periodically until the VIP sends a session acknowledge message. The VIP equipment 16 may reject the session request by replying with an appropriate error code in the session acknowledge message. If after a number of attempts the session request is not acknowledged, the distribution switch 14 then tears down any resources associated with the request. Once the session acknowledge message is received, the distribution switch 14 then establishes a VIP to STU control channel. The distribution switch 14 then connects the appropriate video data channel to the customer and provides a video setup acknowledge signal to the VIP to advise that the channel is available for transmission. The VIP 16 informs the STU 22 of the connection by providing a VIP connected message to the STU 22, which prompts the STU 22 to prepare for an application boot sequence. All signalling then occurs between the VIP equipment 16 and the STU 22 so as to begin an application boot process. Once the boot session has been established between the VIP and the STU, the applications are downloaded from the VIP equipment 16 to the STU 22 on the video data channel. As discussed previously, application software and menus are broadcast to the distribution switch 14 so these applications can be downloaded on the video channel directly from the switch 14 to the STU 22. After the boot session has been completed and the application downloaded, the VIP and the STU 22 enter the interactive session where the VIP can provide video data as requested by the STU 22. During the interactive session, the VIP can change the video port to which the STU is connected by sending video setup request signals to the distribution switch 14. The distribution switch 14 provides the VIP with a video setup acknowledge message once the video port change has been completed. During the interactive session, the application signalling and video data streams are transparent to the distribution switch 14. The interactive session can be terminated on a request issued by the video server or

the STU 22 and the resources associated with the session are then torn down by the distribution switch 14.

For an application boot process, where the application is broadcast to the switch 14, as shown in Figure 15, once a boot session has been established between the VIP 16, the distribution switch 14 and the STU 22, the VIP 16 initiates the boot sequence, as described previously, by sending the connected message to notify the STU 22 to also begin the boot sequence. The connected message, which is a layer 2 (L2) message, nominates that the boot method is broadcast as opposed to pointcast. The STU 22 responds with a boot message identifying the type and configuration of the STU 22. The VIP 16 then responds with a size message indicating the size of the application to be downloaded. The size message is sent either as a specific message on the low speed bidirectional channel or by embedding the size message periodically in packets of the broadcast application such that the STU 22 can access the packet via the high speed video channel without receiving the application at that time. The STU 22 will forward a ready message if the size indicated by the size message is acceptable or an error message, which results in the session being torn down. After sending the ready message, the STU 22 monitors its video channel port for the application. In this instance, the application is one which is cyclically broadcast by the VIP 16, as described previously. The STU 22 receives the application in memory, determines if it is an executable application for that STU and then responds with an acknowledgement signal if successful. The STU 22 will continue to attempt to receive the application if errors occur, but after a number of attempts, an error message will be sent to end the session. After sending an acknowledgement message, the STU 22 executes the downloaded application and the VIP 16 and the STU 22 enter into an interactive session.

For a pointcast boot sequence, as shown in Figure 16, an STU 22 downloads an application only for itself. On receiving the connected message from the VIP 16, the STU 22 responds with a boot message which, in addition to identifying its configuration and type, specifies that the boot sequence is to be pointcast. The VIP 16 responds with a size message, then the STU 22 will respond with a ready or error message, as described previously. The STU monitors its video report after sending a ready message for data packets. After receipt of each valid data packet, the STU sends an acknowledgement message. The VIP 16 resends data

packets if an acknowledgement message is not received. After receipt of the last data packet, the STU 22 builds an application from the payload of data packets received and checks that the application is valid and executable. If the latter is true, the STU 22 responds with an acknowledgement for the last data packet. After sending the final acknowledgement message, the STU 22 executes the downloaded application and the VIP 16 and the STU 22 enter into an interactive session.

Alternatively, signalling protocols such as the MPEG standard DSM-CC (Digital Storage Media - Command and Control) as described in ISO Standard ISO CD 13818-6 can be employed.

Efficiency is achieved by enabling multicast video signals to be provided to a plurality of customers. Also control signals are processed by a distributed network of processing units, which alleviates congestion normally experienced by centralised systems during peak demand periods. Furthermore, efficient processing of channel switching commands is performed locally at the exchange units to provide fast response times from the customer's perspective.

Instead of establishing the parallel buses 64 and 66 using one distribution subrack 50, as shown in Figure 3, the buses 64 and 66 can to some extent be protected by providing two distribution subracks 50 to establish the buses 60 and 64, as shown in Figure 17. One bus 64 is established using one distribution subrack 50, whereas the bus 66 travelling in the opposite direction is established using the other distribution subrack 50. This provides some redundancy in the distribution switch 14 which would allow the buses 64 and 66 to still be maintained if one of the two distribution subracks 50 fails.

A second distribution system 200, as shown in Figure 18, is based on the provision of distribution switches 202 which are an enhanced form of the previously described distribution switch 14. The distribution switch 202 has the same architecture and features as the distribution switch 14 but includes enhanced distribution subracks 250 and enhanced access subracks 252 to provide additional interfaces and services. A distribution subrack 250 is able to connect to more than one transmission network 4 in that it can connect to a 155 Mb/s link from an SDH network

or an asynchronous transfer mode (ATM) network. The access subrack 252 is enhanced, together with the customer units 210, to support more than one set top box 22 per customer unit 210 and to provide computer services for a personal computer connected to the customer unit 210. For instance, the access subrack 252 is able to support Internet traffic for a customer unit 210 at a rate of at least 640 Kb/s. Examples of the services which the distribution system 200 can provide include:

(i) Broadcast TV (Free-to-air, subscription and PPV)

(ii) Direct Internet Access (via customer's personal computer)

(iii) NVOD (Near video on demand)

(iv) VOD (Video on Demand)

(v) Interactive Home Shopping

(vi) Home Banking

(vii) On-line Games

(viii) Indirect Internet Access (e.g. World Wide Web Browsing using a display screen or TV connected to a STU 22)

Billing for access is undertaken by external traffic monitoring devices, or based on the rates of access provided to the customer premises (i.e. subscription levels based on nominated bandwidth available). Alternatively, a level of traffic metering can be provided in the system 200 for monitoring traffic.

The distribution subrack 250 of the distribution switch 202, as shown in Figure 19, is the same as the distribution subrack 50 of Figure 4, except it further includes an ATM termination processor (ATP) 260 and/or a synchronous termination processor (STP) 262 for receiving video data bit streams in a synchronous transfer mode one (STM-1) format on an optical link 264. The ATP 260 handles data streams encapsulated by the ATM protocol, whereas the STP 262 handles streams encapsulated by the SDH protocol. The ATP and STP 260 and 262 handle video data streams received at 155 Mb/s. An ATP 260 can terminate up to 60 ATM adaption layer one (AAL-1) video channels. The data received on the optical link 264 is multiplexed by the ATP 260 and the STP 262, in the same manner as for the G.703/G.704 data handled by the CIUs 72, and output to the CDU 74 for transport on the buses 64 and 66.

The STP 262 includes a synchronous processor module (SPM) 266 and a plurality of synchronous interface units (SIUs) 268 and 270 for different data rates. The SIUs 268 and 270 are similar to the channel interface units 72. An STP 262, as shown in Figure 20, receives a 155 Mb/s video data bit stream encapsulated by the SDH protocol in the STM-1 format. A fibre optic interface module 272 of the SPM 266 recovers clock and data from the 155 Mb/s serial data stream. The serial data is then processed by a line interface unit (LIU) 274 which converts the data and clock information to byte data and clock signals and detects the frame of the incoming signal. The line interface unit 274 also descrambles the received data and scrambles the transmitted data and provides process monitoring via an interface 276 to a microprocessor 277 of the SPM 266. Parallel byte information is passed over to an SDH transmitter/receiver 278 where it is framed or deframed according to the SDH specifications. Octet alignment is also provided for all data rates up to 155 Mb/s, and idle octets are generated or screened as required. Statistical data is monitored continuously, and an interface 280 allows the microprocessor 277 to access control registers for insertion of selected header fields by the transmitter 278. An E1 framer 284 is used for both receive and transmit operations and is solely dedicated for ETHERNET STM-1 framing of control and management systems for both upstream and downstream data transfers.

A STM-1 signal is output by the SDH transceiver 278 and is demultiplexed into three tributary unit groups (TUG-3) signals by a TUG-3 demultiplexer 282. Each of the TUG-3 signals are further demultiplexed to DS2 (6.312 Mbit/s) and E1 (2.048 Mbit/s) data streams by selecting appropriate SIU modules 268 or 270.

The TUG-3, DS2, E1, DS3, STM-1, SDH and ATM formats are all defined by International Telecommunications Union (ITU) specifications, as is the G.703 and G.704 formats.

The SIUs 268 and 270 are used to process DS2 6 Mbit/s and E1 2 Mbit/s data streams, respectively. The SIUs 268 and 270, as shown in Figure 21, have the same components and architecture as a CIU 72, as shown in Figure 5, except the interface 80 and HDB3 decoder 82 of the CIU 72 are replaced by a DS2 demultiplexer 286 or E1 demultiplexer 288, respectively.

The DS2 (6.312 Mbit/s) demultiplexing is done using a DS3 (44.736 Mbit/s) multiplexing structure. Each of the demultiplexed E1/DS2 data streams is converted to NRZ (Non-Return Zero) 34 bit parallel words for output to the CDU 74 on the output bus 90.

The distribution subrack 250 operates by multiplexing up to 1024 MPEG TV channels (each 2.048 Mb/s) onto the 34 bit dual buses 64 and 66, and a 2M or 6M channel can be multiplexed onto the buses 64 and 66 by selecting a DS2 SIU 268 or an E1 SIU 270. The 2M and 6M can be mixed on the buses 64 and 66 allowing for multiple combinations. An STP 262 includes a number of combinations of SIU cards (2M/6M) 268 and 270, as shown in Figure 22. The STP 262 allows the following combinations to be achieved by demultiplexing using the TUG-3 signals and the DS3 format, such as:

(a) 63 × E1 channels

(b) 21 × E1 + 14 × DS2 channels

(c) 42 × E1 + 7 × DS2 channels

(d) 21 × DS2 channels

The maximum throughput per E1 card 270 is 21 × 2M channels and per DS2 card 268 is 7 × 6M channels. Each of the channels is converted into a 32 bit parallel format, and multiplexed onto the output bus 90 at a word rate of 33.7 MHz, with parity and stuffing bits added to the 32 bit word, giving a total of 34 bits. Once per frame, each E1 SIU 270 in turn outputs twenty-one 32 bit parallel data words. Although all SIU units 368 and 370 operate off a 33.7 MHz system-clock, the clocks to pairs of units are staggered by 180°. The CDU 74 reads data from one SIU 368 or 370 of the pair during the first half of the 33.7 MHz cycle, and from the other SIU 370 or 368 during the second half of the cycle. In this way a word rate of 67.4 MHz is obtained at the CDU 74, while each SIU operates at 33.7 MHz.

Provision has been made to allow any channel to be tested without disturbing normal operation on the other channels. The E1 slots 270 are bidirectional, and a 2M or 6M signal can be switched into any channel in the upstream direction and looped back inside the E1 SIU 270. A test signal 92 is then produced by the E1 SIU 270.

The ATP 260, as shown in Figure 23, has a similar structure to the STP 262 in that it

includes an ATM processor module (APM) 290 for performing initial demultiplexing of the received 155 Mbit/s data stream, and two circuit processing modules (CPM) 292 which can both process 2 Mbit and/or 6 Mbit channels. The structure of the CPMs 292 are based on that of the CIU 72, as shown in Figure 24.

An ATP 260 receives a 155 Mb/s video data bit stream encapsulated by the ATM protocol in the STM-1 format. A fibre optic interface module 296 of the APM recovers clock and data from the 155 Mb/s serial data stream. The serial data is then processed by a LIU 290 which converts the data and clock information to byte data and clock signals and detects the frame of the incoming signal. The LIU 298 also descrambles the received data and scrambles the transmitted data and provides process monitoring via an interface 299 to a microprocessor 300 of the APM. Parallel byte information is passed to an ATM transmitter/receiver 302 where it is framed or deframed according to the ATM forum specifications. Cell alignment is also provided for all data rates up to 155 Mb/s, and idle cells are generated or screened as required. Statistical data is monitored continuously, and the microprocessor 300 via an interface 304 can access control registers for insertion of selected header fields by the transmitter 302. A UTOPIA interface, as specified by ATM Forum Level 1, Version 2.0, 1994, is implemented for the physical layer interface at the output 306 of the transceiver 302 which is connected to a UTOPIA demultiplexer 308. The UTOPIA demultiplexer 308 receives cells and passes them to appropriate ATM adaptation layers (AAL-1/5). There are fifteen AAL-1 layers and one AAL-5 layer. Each of the fifteen AAL-1 layers implement four channels with all the functions needed for circuit emulation over ATM. The AAL-1 devices reside on the two circuit processing modules (CPM) 292 and are connected to the output of the UTOPIA demultiplexer 308. The CPM cards 292 can process up to thirty 2 Mb/s streams or ten 6 Mb/s. The line outputs from the AAL-1 layer devices are a positive/negative rail NRZ signals which are converted to 34 bit parallel words for the CDU bus 90. The one AAL-5 layer device 310 is used for both receive and transmit operations. It is solely dedicated for ETHERNET ATM framing of control and management signals for both upstream and downstream data transfers.

A CPM 292, as shown in Figure 24, includes ATM decoders 312 and channel switches 314 instead of the interface 80, HDB3 decoder 82 and elastic store 84 of the CIU 72. The

remaining components and architecture of the CPM 292 are the same as that for the CIU 72 described previously. By combining groups of two or three 2 Mb/s channels, 4096 and 6.312 Mb/s MPEG channels can be mixed onto the output bus 90, and selection of 2M, 4M or 6M is on a per-channel basis. The decoders 312 are based on COBRA chips, produced by Transwitch Corporation of Shelton, Connecticut, USA, such as CBR-AAL 1 TXC-05427. The decoders 312 decode received ATM cells into four channels of data, which can be individually chosen to be either 2.048 Mb/s (E1), 4.096 Mb/s or 6.312 Mb/s (T2). Each 4.096 or 6.312 Mb/s channel is split into two or three 2.048 Mb/s channels, using the switches 314, which also synchronise the channels onto a common 2.10625 MHz clock, using bit-stuffing. The maximum throughput per CPM card is 30 × 2M channels or equivalent, for example 10 × 6M or 4 × 6M + 9 × 4M or 5 × 6M + 7 × 4M + 1 × 2M, etc. The combinations are formed by the switches 314.

The 30-channel CPM card 292 is divided into two 15-channel halves, one handling channels 1-15 and the other handling channels 16-30. Each incoming 2M channel (which might form part of a 4M or 6M channel) can be routed to any vacant position in the same half of the CPM. This allows isolated 2M channels (in the same half) to be used to make up 4M or 6M channels, and minimises waste of resources when handling a varying mix of 2, 4 and 6M video programs.

Each of the resulting 2.10625 Mb/s channels is converted into a 32 bit parallel format, and the thirty 2M channels are then multiplexed onto the 34 bit bus 90 at a word rate of 33.7 MHz, with parity and stuffing bits added. Once per frame, each CPM in turn outputs thirty 32 bit parallel data words, one from each of its thirty input channels. Although all CPM units operate off a 33.7 MHz system-clock, the clocks to pairs of CPMs 292 are staggered by 180°. The CDU 74 reads data from one CPM 242 of the pair during the first half of the 33.7 MHz cycle, and from the other subrack during the second half of the cycle. In this way a word rate of 67.4 MHz is obtained at the CDU 74, while each CPM 292 operates at 33.7 MHz.

Provision has been made to allow any channel to be tested without disturbing normal operation of the other channels. The CPM decoders 312 and switches 314 are bidirectional, and a 2M, 4M or 6M signal can be switched into any channel in the upstream direction and looped

back inside the CPM 292. A test signal 92 then comes out of the CPM 292.

The distribution subrack 250 can also include a range of other optional input units, such as:

(i) a CIU-45 unit, which receives video data streams at 45 Mbit/s, G.703 based on a PDH hierarchy of 7 × 6.312 Mbit/s steams.

(ii) a CIU-34/DVB unit, which accepts 34 Mbit/s Digital Video Broadcasting (DVB) feeds and splits the content of this feed into a maximum of 16 steams.

An access subrack 252 of the distribution system 200, as shown in Figure 25, differs from the access subrack 52 of Figure 7 in that the ACU 56 is replaced by an integrated gateway unit (IGU) 256, which incorporates all of the functions of the ACU 56, and the ADSL interfaces 54 are replaced by ADSL exchange units (EU) 254, which incorporate the features of the interfaces 54. The new units 256 and 254 are included to provide for a bidirectional channel to customers of 640 Kbit/s instead of 16 Kbit/s, to support two set top units (STUs) at the customer premises, and to provide TCP/IP network (i.e. Internet) and ISDN Basic Rate Access for customers. The CAU 120 is the same but has its capacity expanded to support 20 ADSL channels, instead of 10, by providing additional ADSL channel units 128. The access subrack 252 includes ten 6 Mb/s ADSL EUs 254 which each support two ADSL customer units 210.

The IGU 256, as shown in Figure 26, includes a master Motorola MC68EN360 communications controller 340 and two slave communications controllers 342 and 344, which are controlled by the master controller 340 using a common CPU bus 348. The slave controllers 342 and 344 are also Motorola MC68EN360 controllers. The IGU 256 supports essentially the same functions as the ACU 56 of the access subrack of Figure 7. The IGU includes the boot PROM 154, the flash ROM 156 and RAM 158, in addition to non-volatile RAM 159, connected to the 33 MHz controller 340 by the CPU bus 348, and which are used to store and execute control software for the controllers 340, 342 and 344. The controllers each include communications ports 360, 361 and 363 to send and receive STU and OAM&P control data on the bidirectional ADSL channels established by the ADSL EUs 254. The ports 360 of the master controller 340 are connected to the first four ADSL EUs 254, the ports 360 of the first slave

controller 342 are connected to the fifth, sixth and seventh ADSL EUs 254 and the communications ports 363 of the second slave 344 are connected to the eighth, ninth and tenth ADSL EUs 254, respectively. Each port 360, 361 and 363 is able to transmit and receive data to and from a respective ADSL EU 254 at a rate of 1.28 Mb/s, being the data for two 640 Kb/s bidirectional channels established by an ADSL EU 254 for two respective customer units 210. An ethernet communications port 328 of the first slave controller 342 and a serial line interface adaptor (SIA) 330 connected to the port 328 provide the terminal 171 for receiving and transmitting the STU and OAM&P data to and from the terminal equipment 28 at the head end of the distribution switch 202. The master controller 340 establishes the SPI bus 76 which is linked to the CAU 120, and a UART port of the master controller 340 provides the local terminal 173 for the download of applications.

The IGU 256 of the access subrack 252 is able to receive traffic from a TCP/IP network, such as the Internet, and pass it to the ADSL EUs 254 using a shared ethernet bus 368 of the subrack 252, as shown in Figure 25. The IGU includes a second serial interface adaptor 356 providing an ethernet terminal 354 which can handle TCP/IP traffic direct from a transmission network 4. The traffic is placed on the shared ethernet bus 368 by a collision detector 357 of the IGU 256. An ADSL EU 254 collects traffic designated for the EU 254 on the basis of addressing information contained in the packets on the shared bus 368.

An ADSL EU 254, as shown in Figure 27 supports two customer units 210 and therefore includes two ADSL transceiver modems 370 and 372 for the units 210, respectively. Each transceivers 370 and 372 is connected via a POTS splitter 374 to a copper line 8 for connection to the respective customer unit 210. The POTS splitter 374 is connected to the local exchange, via a line 375, for POTS signals for the customer. An ADSL transceivers 370 and 372 establishes a download channel of up to 6 Mb/s and a bidirectional channel of 640 Kb/s over the copper line 8 to a customer unit 210. The ADSL transceivers 370 and 372 are preferably AT&T Paradyne CAP ADSL transceivers. The ADSL EU 254 includes two video interfaces 376 for receiving video data from the CAU 120 for each customer. The video interfaces 376 each split the video data into video channels 378 for two set top units and the channels are passed to switches 380, which are connected to downstream inputs for the transceivers 370 and 372, and a bidirectional

channel input transceivers 370 and 372.

The ADSL EU 254 has a Motorola 68EN360 communications controller 382 for handling control data on a 1.28 Mb/s control channel 362, 364 or 368 and network data on the shared ethernet bus 368 connected to the IGU 256. The shared ethernet bus 368 is connected to one SCC port 384 of the controller 382 and the 1.28 Mb/s control channel 362, 364 or 368 for the EU 254 is connected to a second SCC port 386 of the controller 382. A third SCC port of the controller 382 supports a first 6 Mb/s to 640 kb/s downstream line 388 to the first switch 380 and a 640 kb/s upstream line 390 from the first transceiver 370. A fourth SCC port 392 supports a second 6 Mb/s to 640 K downstream line 394 to the second switch 380 and a 640 K downstream line 396 from the second transceiver 372.

The controller 382 controls how the downstream and bidirectional channels established by the transceivers 370 and 372 are used. Control software for the controller 382 is held and executed using a flash PROM 398 and RAM 401 connected to the controller 382 by a CPU bus 403 which is also connected to the transceivers 370 and 372. The high bit rate downstream channels are used to transmit video data on the channels 378 when video data is present for the set top units. STU and OAM&P control data on the 1.28 Mb/s control channel 362, 364 or 368 for the EU 254 has priority to the two 640 K bidirectional channels. Internet traffic on the bus 368 for the ADSL EU 254 is transmitted on the 640 K bidirectional channels, but can be transmitted at rates of up 6 Mb/s on the downstream channels if the downstream channels are not being used to transmit video data. The speed at which the internet traffic for the ADSL EU 254 is transmitted depends on the speed at which it can be transmitted on the shared 10 Mb/s ethernet bus 368 and the level of usage of the downloaded bidirectional channels on the lines 8 for the transmission of video programs. As an alternative, Internet traffic can be routed directly to an ADSL EU 254 on a 10 base T line 403 and 405 connected to the first SCC port 384 of the controller 382.

The ADSL EU 254 can further include two ISDN interfaces 407 for the two customers supported by the unit 254, which are provided by two ISDN basic access boards 409 connected to the controller 382 by the CPU bus 403. The boards 409 support two ISDN channels 411

connected to second bidirectional channel ports of the first and second transceivers 370 and 372, respectively. The ISDN channels 411 run at the ISDN basic rate of 160 Kb/s and any ISDN traffic on the channels 411 use the 640 kb/s bidirectional channels on the lines 8.

An ADSL customer unit 210, as shown in Figure 28, has a similar structure to an ADSL EU 254 in that it includes a Motorola MC68EN360 communications controller 600, flash PROM 602, RAM 604, an ADSL CAP transceiver 606, and, if desired, an ISDN basic access board 608 all connected by a CPU bus 610. The ADSL transceiver 606 is connected to a copper line 8 by a POTS splitter 612. The splitter 612 splits and combines POTS signals on a line 613 for the customer's telephone. With an ADSL transceiver 370 or 372 of an ADSL EU 254, the ADSL transceiver 606 is able to complete a downstream channel of up to 6 Mb/s and a bidirectional channel of up to 640 Kb/s over a copper line 8 to a local exchange.

The microcontroller 600 has a first SCC port 614 with a 640 kb/s upstream channel 616 connected to a bidirectional port of the transceiver 606, and a 6 Mb/s to 640 kb/s downstream channel 618 which can be connected to the same bidirectional channel port or to a downstream channel port using a switch 620, depending on the data rate for which TCP/IP traffic is forwarded to the transceiver 606. The switch 620 is also able to switch the video data streams from downstream channel ports of the transceiver 606 to codec and RS422 interface units 622 for two set top units connected to the customer unit 210. The RS422 interfaces 622 are connected to respective ports 624 for each set top unit. The STU port 624 in addition to receiving respective video data streams are connected to respective 640 K bidirectional control channels 626 via respective second codec and RS422 interface units 628. The controller 600 has a second SCC port 630 connected to one bidirectional channel 626 for the first STU port 624 and a second SCC port 632 for the second bidirectional channel 626 for the second STU port 624. The microcontroller 600 has a fourth SCC port 634 which is connected to a driver circuit 636 to provide a bidirectional ethernet port 638 which can be connected to an ethernet port of a customer's computer for receipt and transmission of TCP/IP traffic. An ISDN port 640 is supported by the ISDN board 608 to provide ISDN Basic Rate Access. A second bidirectional port of the transceiver 606 is connected to the ISDN board 608 by a line 642 for ISDN traffic.

The ISDN board 608 in the ADSL customer unit 210 can be replaced by an auxiliary POTS interface unit in order to provide an additional one or two POTS circuits at 1 × 64 kbit/s or 2 × 64 kbit/s operating over an ADSL bidirectional channel on a line 8. In order to support this function, an auxiliary POTS concentrator unit is included in the access subrack 252. The concentrator unit is connected to the IGU 256 of the access subrack 252 in order to concentrate the multiple POTS 64 kbit/s circuits, carried on the bidirectional channels connected to the IGU 256, into a 2 Mbit/s channel for connection to the PSTN using the ETSI V5.2 protocol.

ADSL channels currently have a maximum travel distance which may be anywhere between 2.7 to 3.6 km. Whilst 80 or 90% of the population in an urban area may be within 2 or 3 km of a local exchange which holds a distribution switch 14 or 202, in order to reach customers outside of the distance limitation a fibre to the curb (FTTC) distribution system 400, as shown in Figure 29, is required. The system 400 includes an FTTC distribution switch 401 which is the same as the distribution switch 202, except that it has at least one FTTC access subrack 452 which can be connected by optical fibre links 456 to up to ten respective curb units 410 which may be located near customers, i.e. within 2 km of customer's premises. The curb units 454 connect to customer units 210 over copper pairs 8. The FTTC access subrack 452 includes a CDU 74 and a modified form of the CAU 120. The curb units 454 include up to eight ADSL EUs 254 and therefore each support up to 16 customer units 210.

An FTTC access subrack 452, as shown in Figure 30, includes an IGU 256, a CDU 74 and 10 remote channel access units (CAU-Rs) 420 connected to respective curb units 454 by respective optical fibre pairs 456. The CDU 74 is connected to the dual distribution buses 64 and 66 and transfers video signals on the buses 64 and 66 to the CAU-Rs 420 via an internal 34 bit subrack bus 458. The IGU 256 is connected to the hub 68 and to each of the CAU-Rs 420 for the transmission of STU and OAM&P data on the bidirectional control channels 362, 364 and 368 of the IGU 256. The IGU 256 is also connected to the CDU 74 by the SPI bus 76. Internet (TCP/IP) traffic and ISDN traffic is routed directly from the transmission network 4 to the CAU-Rs 420 via respective 10 Mb/s Ethernet lines 464 for the Internet traffic and 2 Mb/s lines 464 for the ISDN traffic.

The CAU-R 420, as shown in Figure 31, includes the components of the CAU 120 to demultiplex video data on the internal bus 458 and passes it to the timeslot assignors 132 of 16 ADSL channel units 128. The timeslot video channels selected by a unit 128 are multiplexed onto a download ADSL channel by an optical multiplexer 422 for transmission on an optical link. The optical multiplexer 422 receives the multiplexed ADSL channels from each of the units 128. Control of the CAU-R 420 is provided by a Motorola 68360 microcontroller 424 which receives control signals from the IGU 256 via the SPI bus 76. The microcontroller 424 has a first SCC port connected to an Ethernet line 464 to receive and transmit Internet traffic. The Internet traffic is transmitted by the microcontroller 424 via a second SCC port to the optical multiplexer 422 on 10 Mb/s downstream line 426, and received from a curb unit 454 by the second SCC port via an optical demultiplexer 430 on a 10 Mb/s upstream line 427. A third SCC port of the microcontroller 424 is used to transmit STU and OAM&P control data between the IGU 256 to the optical multiplexer 422 and demultiplexer 430 on 1.2 Mb/s downstream and upstream lines 428 and 429, respectively. The ISDN traffic on the 2 Mb/s line 462 is passed to a 2 Mb FIFO unit 431 of the optical multiplexer 422 and demultiplexer 430 for the downstream and upstream directions, respectively. The optical multiplexer 422 multiplexes the received 10 Mb/s TCP/IP data, the 2 Mb/s ISDN data and 1.2 Mb/s control data into a TS 4 format and then multiplexes this with the multiplexed video signals from the units 128 for output to an optical transmitter. Multiplexed data received by the optical transmitter is transmitted on an optical link 456 to a curb unit 454. TCP/IP, ISDN and control data received by an optical receiver connected to the optical link 456 is demultiplexed by the demultiplexer 430 and outputted to the respective lines 427, 462 and 429.

A curb unit, or subrack, 454, as shown in Figure 32 includes a fibre line unit (FLU) 470 connected to an optical fibre pair 456 from the local exchange, an IGU 256 and eight CAP ADSL EUs 254 which each support two customers and each have a tap connection to two copper lines 8 of the PSTN. The copper lines 8 are connected to respective customer units 210. The FLU 470, as shown in Figure 35, is used to multiplex and demultiplex data for the 134.8 Mbit/s optical link 456. The FLU 470 includes an optical demultiplexer 480 for demultiplexing the 134.8 Mbit/s stream received from a CAU-R 420 at an optical receiver into a video data stream 482 for the ADSL EUs 254, a 10 Mbit/s stream 484 for internet traffic and a 1.2 Mbit/s

data stream 486 for the STU and OAM&P control data. The 10 Mbit/s and control data streams 484 and 486 are passed via drivers 488 to the shared Ethernet bus 368 of the IGU 256. The IGU 256 uses the ethernet communications port of the second slave controller 344 to extract the STU and OAM&P control data from the shared ethernet bus 368 for the control channels 362, 364 and 368 connected to the ADSL EUs 254. The ADSL EUs 254 of the curb unit 454 are able to transmit and receive control data on respective control channels 362, 364 and 368 of the IGU 256, and transmit and receive TCP/IP traffic on the shared ethernet bus 368, as described previously. The optical demultiplexer 480 of the FLU 470 also demultiplexes a 2 Mbit/s stream 492 and buffers it in a FIFO unit 494 for ISDN and POTS traffic, as discussed hereinafter. The FLU 470 includes an optical multiplexer 482 for multiplexing on the return path a 10 Mbit/s ethernet stream 496 and 1.2 Mbit/s control data stream 498 from the IGU 256. A return 2 Mb/s stream 500 is also multiplexed by the optical multiplexer 482. The multiplexed data is fed to an optical transceiver for transmission on the optical link 456.

When the curb unit 454 supports ISDN services, as shown in Figure 33, ISDN BMUX equipment 502 is connected to the FLU 470 to convert between Primary Rate Access at 2 Mbit/s on the lines 492 and 500 of the FLU 470 and Basic Rate Access provided on lines 404 to each ADSL unit 254 with an ISDN Basic Rate Access interface 407. Alternatively, the 2 Mbit/s lines 492 and 500 of the FLU 40 can be used to support POTS services, as shown in Figure 34. Instead of allowing the POTS services on the 16 copper lines 8 to continue to be passed directly back to the local exchange on the lines 8, the lines 8 can be terminated at the curb unit 454 and connected to a POTS multiplexer 510. The POTS multiplexer 510 multiplexes all of the traffic on the 16 lines 8 so that traffic can be transmitted on the 2 Mb/s channels 492 and 500, and then connected to the exchange by the FLU 470 on the optical link 456. Use of the POTS multiplexer 510 and the curb unit 454, as shown in Figure 34, is advantageous for new installations or situations where the lines 8 from the exchange to the location of the curb unit 454 are inadequate.

The signalling protocol used by the distribution switch 202 for video signal applications is the same as that described for the distribution switch 14 with reference to Figures 11 to 16, where the VIP is the service provider 16.

For Internet traffic, as described previously and as shown in Figure 36, the traffic is passed directly from the network 4 to the IGUs 256 of the access subracks 252 via a signal 10 Mbit/s Ethernet line 354, passed by the router 70 and the hub 68, for each subrack 252. The customers connected to a subrack 252 share the bandwidth provided by the line 354. Alternatively a 10 Mbit/s Ethernet line 355 can be fed directly into an ADSL EU 254 to provide this bandwidth to two ADSL customer units 210. Other options exist which include the use of a standard Ethernet hub for further levels of concentration, i.e. sharing a number of subracks 252 on one 10 Mbit/s line, on using the switching hubs to provide a high dedicated bandwidth for each subrack which may include using 100 Mbit/s ports on the router 70.

Internet traffic is multiplexed onto a low speed upstream ADSL channel using addresses in the HDLC framing protocol. This keeps the Internet traffic logically separate from the VDT control signals sharing the channel. In the downstream direction, the Internet traffic is either:

1. Multiplexed onto the low speed channel as for upstream traffic when no bandwidth is available on the high speed downstream ADSL channel; or
2. Sent using any bandwidth available on the high speed downstream channel.

Customers may subscribe to different levels of access rate.

Table 1 below lists the protocol specifications used for the respective layers of the interfaces between the customer's PC and the customer unit 210, and between the router 70, hub 68 and the distribution switch 202.

TABLE 1

Layer	Specification(s)
Network	Internet IP protocol Version 4 reference RFC 791 as amended by RFC 950, 919 and 922 ARP : RFC 826
Link	RFC 894 (Ethernet II encapsulation of IP)
Physical (electrical)	ISO 8802.3 (10 baseT)

RFC is an acronym for Request For Comment, and refers to Internet standards for TCP/IP networks established by the Internet Engineering Task Force (IETF). ARP is an acronym for Address Resolution Protocol. The distribution system is transparent for all other layers not described in Table 1. The ADSL customer unit 210 proxies ARP on behalf of all the elements that supply the Internet traffic on the network 4, which requires only one Ethernet interface to exist at the customer premises. The Ethernet interface at the customer premises can be connected to one computer 520, as shown in Figure 37, or to a sub-network, such as a LAN 522, where more than one address is required. For the latter a router 524 with a firewall is connected to the Ethernet interface of the customer premises of the ADSL customer unit 210, as shown in Figure 38. The ADSL EU 254 proxies ARP on behalf of all of the elements at the customer premises. The distribution switch 202 provides security by discarding upstream packets with source addresses which do not match an expected address (or range). This prevents IP address "spoofing". Only IP and Internet Control Message Protocol (ICMP) traffic is allowed to pass. The ADSL EU 254 also blocks all packets where the destination is a broadcast address.

CLAIMS:

1. A distribution system, including:

a channel distribution system for receiving content signals from a telecommunications transmission network; and

an access system for accessing the content signals received by said channel distribution system and multicasting said content signals to customer units on telecommunications lines.

2. A distribution system as claimed in claim 1, wherein said access system includes modulating units for modulating said content signals for transmission on said telecommunications lines for said customer units, and a channel access unit for accessing and multicasting said content signals to said modulating units.

3. A distribution system as claimed in claim 2, wherein said channel distribution system includes a data bus connected to said access system on which said channel distribution system places said content signals for selective access by said channel access unit.

4. A distribution system as claimed in claim 3, including a plurality of said access system connected to said data bus.

5. A distribution system as claimed in claim 3 or 4, including a distribution switch comprising said channel distribution system and said access system.

6. A distribution system as claimed in claim 5, including a local telecommunications exchange having said distribution switch.

7. A distribution system as claimed in claim 2, wherein said modulating units establish a bidirectional data channel and a downstream content channel with said customer units.

8. A distribution system as claimed in claim 7, wherein said content signals are provided on service channels and said channel access unit is adapted to switch the service channels provided

to said modulating units in response to switch control signals received on said bidirectional data channel.

9. A distribution system as claimed in claim 8, wherein service provider equipment broadcasts said content signals to a plurality of said channel distribution system.

10. A distribution system as claimed in claim 9, wherein said content signals are Pay TV, PPV or free-to-air TV signals.

11. A distribution system as claimed in claim 7, wherein said channel distribution system and said access system are adapted to establish said bidirectional data channel and said downstream content channel between service provider equipment and at least one of said customer units.

12. A distribution system as claimed in claim 11, wherein said content signals are VOD signals.

13. A distribution system as claimed in claim 7, wherein said access system is adapted to receive and transmit TCP/IP network signals on said bidirectional data channel.

14. A distribution system as claimed in claim 13, wherein said access system is adapted to transmit TCP/IP network signals on said downstream content channel.

15. A distribution system as claimed in claims 10, 12 or 14, wherein said modulating units and said customer units are ADSL units.

16. A distribution system as claimed in claim 3 or 4, including:

a local telecommunications exchange having said channel distribution system and said channel access unit; and

a curb unit including said modulating units, said curb unit being connected to said exchange by an optical telecommunications link.

17. A distribution system as claimed in claim 15, wherein said channel distribution system includes:

a channel interface unit for receiving said content signals on service channels from said telecommunications transmission network and for time division multiplexing the service channels into time division multiplexed data words; and

a channel distribution unit for placing said data words on a bus connected to said access system.

18. A distribution system as claimed in claim 17, wherein said channel distribution system includes means for receiving said content signals on PDH, SDH, ATM or DVB data streams and multiplexing said content signals into said data words for output to said channel distribution unit.

19. A distribution system as claimed in claim 17, wherein said channel access unit includes a gate array for receiving said data words and for selecting time slots in said data words for said modulating units, a selected one of said time slots corresponding to a selected one of said service channels, the selected service channel thereby being transmitted on said downstream content channel for one of said customer units.

20. A distribution system as claimed in claim 19, wherein said access system includes a control unit connected to said bidirectional data channel for controlling said channel access unit in response to control signals received on said bidirectional data channel.

21. A distribution system as claimed in claim 20, wherein said control unit is adapted to establish said bidirectional data channel between service provider equipment connected to said transmission network and said customer units.

22. A distribution system as claimed in claim 21, wherein said modulating units include:

at least one ADSL transceiver for establishing said bidirectional data channel and said downstream content channel on said telecommunications lines; and

a communications controller adapted to connect said selected service channel to said downstream content channel, and connect said bidirectional data channel to said control unit.

23. A distribution system as claimed in claim 22, wherein said communications controller is adapted to selectively connect a TCP/IP network channel to said bidirectional data channel or said downstream content channel.

24. A distribution system as claimed in claim 22, wherein said ADSL units include ISDN units and said communication controller is adapted to connect an ISDN communications channel to said bidirectional data channel.

25. A distribution system as claimed in claim 22, wherein said customer units and said access system include auxiliary POTS interface units and said communication controller is adapted to connect at least one POTS communications channel to said bidirectional data channel.

26. A distribution system as claimed in claim 16, wherein said curb unit includes a POTS multiplexer coupled to said optical link for handling all POTS signals between said customer units and said exchange.

27. A distribution system, including:

content signal provider equipment having first telecommunications means for providing content signals to at least one local exchange of a telecommunications network; and

a distribution switch of said at least one local exchange, said distribution switch having means for receiving said content signals, a plurality of exchange units for transmitting content signals to a plurality of respective customer units, and being adapted to multicast the received content signals to said plurality of exchange units for transmission to said customer units.

28. A distribution system as claimed in claim 27, wherein said content signals are Pay TV, PPV or free-to-air TV signals

29. A distribution system as claimed in claim 28, wherein said content signals are broadcast to said local exchange equipment.

30. A distribution system as claimed in claim 29, said exchange units and said customer units

are ADSL units.

31. A distribution switch for a telecommunications exchange, including:

means for receiving content signals;

means for multicasting said content signals; and

a plurality of exchange units for transmitting the multicast content signals to a plurality of respective customer units.

32. A distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider; and

means for multicasting content signals provided by said content signal provider on said telecommunications channel to said exchange units.

33. A distribution switch as claimed in claim 32, adapted to establish a telecommunications channel with said customer units to provide applications cyclically broadcast by said content signal provider to said customer units.

34. An asymmetric distribution switch for a telecommunications exchange, including:

a plurality of exchange units for receiving low bit rate data from respective customer units and for sending high bit rate data to said customer units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between said at least one of said exchange units and said high bit rate data provider.

35. A distribution switch as claimed in claim 34, wherein said exchange units are adapted to send low bit rate data to said respective customer units and said low bit rate telecommunications channel is bidirectional.

36. A distribution switch as claimed in claim 35, adapted to multicast data received on said high bit rate telecommunications channel from said high bit rate data provider to said customer units.

37. A distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider to receive applications cyclically broadcast by said video signal provider; and

means for establishing a telecommunications channel with at least one of said customer units to provide said applications thereto when requested.

38. A distribution switch as claimed in any one of claims 31 to 37, wherein said exchange units and said customer units are adapted to receive and transmit TCP/IP network, ISDN data and/or a plurality of POTS circuits signals therebetween.

39. A distribution switch as claimed in any one of claim 38, wherein said exchange units and customer units are ADSL units.

40. A distribution system, including:

means for establishing a telecommunications channel with a content signal provider; and

a plurality of exchange units for communicating with a respective plurality of curb units over optical links, said curb units communicating with respective customer units;

said exchange units including means for multicasting content signals provided by said content signal provider on said telecommunications channel to said curb units.

41. A distribution system as claimed in claim 40, wherein said curb units and customer units are ADSL units.

42. A distribution system, including:

a plurality of exchange units for receiving low bit rate data from respective remote units

and for sending high bit rate data to said remote units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between at least one of said exchange units and said high bit rate data provider.

43. A distribution system as claimed in claim 42, wherein said exchange units are adapted to send low bit rate data to said respective remote units, and said low bit rate telecommunications channel is bidirectional.

44. A distribution system as claimed in claim 43, adapted to multicast data received on said high bit rate telecommunications channel from said high bit rate data provider to said customer units.

45. A distribution system as claimed in claim 44, wherein said remote units are connected to said exchange units using optical links and said remote units communicate with respective customer units to establish a low bit rate telecommunications channel therebetween and to send said high bit rate data to said customer units.

46. A distribution system as claimed in claim 45, wherein said remote units and customer units are ADSL units.

AMENDED CLAIMS

[received by the International Bureau on 10 February 1997 (10.02.97); original claim 3 cancelled; original claims 1, 4, 15-17, 19, 23, 27, 30-32, 34, 37, 38, 40, 42 and 45 amended; new claims 47-55 added; remaining claims unchanged (9 pages)]

1. (Amended) A distribution system, including:

a channel distribution system for receiving content signals from a telecommunications transmission network and placing said content signals on a data path; and

an access system connected to said data path and for selectively accessing the content signals on said data path and multicasting said content signals to customer units on telecommunications lines.

2. A distribution system as claimed in claim 1, wherein said access system includes modulating units for modulating said content signals for transmission on said telecommunications lines for said customer units, and a channel access unit for accessing and multicasting said content signals to said modulating units.

3. (Deleted)

4. (Amended) A distribution system as claimed in claim 2, including a plurality of said access system connected to said data path.

5. A distribution system as claimed in claim 4, including a distribution switch comprising said channel distribution system and said access system.

6. A distribution system as claimed in claim 5, including a local telecommunications exchange having said distribution switch.

7. A distribution system as claimed in claim 2, wherein said modulating units establish a bidirectional data channel and a downstream content channel with said customer units.

8. A distribution system as claimed in claim 7, wherein said content signals are provided on service channels and said channel access unit is adapted to switch the service channels provided to said modulating units in response to switch control signals received on said bidirectional data

channel.

9. A distribution system as claimed in claim 8, wherein service provider equipment broadcasts said content signals to a plurality of said channel distribution system.

10. A distribution system as claimed in claim 9, wherein said content signals are Pay TV, PPV or free-to-air TV signals.

11. A distribution system as claimed in claim 7, wherein said channel distribution system and said access system are adapted to establish said bidirectional data channel and said downstream content channel between service provider equipment and at least one of said customer units.

12. A distribution system as claimed in claim 11, wherein said content signals are VOD signals.

13. A distribution system as claimed in claim 7, wherein said access system is adapted to receive and transmit TCP/IP network signals on said bidirectional data channel.

14. A distribution system as claimed in claim 13, wherein said access system is adapted to transmit TCP/IP network signals on said downstream content channel.

15. (Amended) A distribution system as claimed in claims 10, 12, 13, 14 or 16, wherein said modulating units and said customer units are ADSL units.

16. (Amended) A distribution system as claimed in claim 4, including:

a local telecommunications exchange having said channel distribution system and said channel access unit; and

a curb unit including said modulating units, said curb unit being connected to said exchange by an optical telecommunications link.

17. (Amended) A distribution system as claimed in claim 15, wherein said channel

distribution system includes:

a channel interface unit for receiving said content signals on service channels from said telecommunications transmission network and for time division multiplexing the service channels into time division multiplexed data words; and

a channel distribution unit for placing said data words on said data path connected to said access system.

18. A distribution system as claimed in claim 17, wherein said channel distribution system includes means for receiving said content signals on PDH, SDH, ATM or DVB data streams and multiplexing said content signals into said data words for output to said channel distribution unit.

19. (Amended) A distribution system as claimed in claim 17, wherein said channel access unit includes a selection unit for receiving said data words and for selecting time slots in said data words for said modulating units, a selected one of said time slots corresponding to a selected one of said service channels, the selected service channel thereby being transmitted on said downstream content channel for one of said customer units.

20. A distribution system as claimed in claim 19, wherein said access system includes a control unit connected to said bidirectional data channel for controlling said channel access unit in response to control signals received on said bidirectional data channel.

21. A distribution system as claimed in claim 20, wherein said control unit is adapted to establish said bidirectional data channel between service provider equipment connected to said transmission network and said customer units.

22. A distribution system as claimed in claim 21, wherein said modulating units include:

at least one ADSL transceiver for establishing said bidirectional data channel and said downstream content channel on said telecommunications lines; and

a communications controller adapted to connect said selected service channel to said downstream content channel, and connect said bidirectional data channel to said control unit.

23. (Amended) A distribution system as claimed in claim 22, wherein said communications controller is adapted to selectively connect a TCP/IP network channel to said bidirectional data channel and/or said downstream content channel.

24. A distribution system as claimed in claim 22, wherein said ADSL units include ISDN units and said communication controller is adapted to connect an ISDN communications channel to said bidirectional data channel.

25. A distribution system as claimed in claim 22, wherein said customer units and said access system include auxiliary POTS interface units and said communication controller is adapted to connect at least one POTS communications channel to said bidirectional data channel.

26. A distribution system as claimed in claim 16, wherein said curb unit includes a POTS multiplexer coupled to said optical link for handling all POTS signals between said customer units and said exchange.

27. (Amended) A distribution system, including:

content signal provider equipment having first telecommunications means for providing content signals to at least one local exchange of a telecommunications network; and

a distribution switch of said at least one local exchange, said distribution switch having means for receiving and placing said content signals on a data path, a plurality of exchange units for transmitting content signals to a plurality of respective customer units, and being adapted to selectively access and multicast the received content signals on said data path to said plurality of exchange units for transmission to said customer units.

28. A distribution system as claimed in claim 27, wherein said content signals are Pay TV, PPV or free-to-air TV signals.

29. A distribution system as claimed in claim 28, wherein said content signals are broadcast to said local exchange equipment.

30. (Amended) A distribution system as claimed in claim 29, wherein said exchange units and said customer units are ADSL units.

31. (Amended) A distribution switch for a telecommunications exchange, including:

means for receiving and placing said content signals on a data path;

means for selectively accessing and multicasting said content signals on said data path; and

a plurality of exchange units for transmitting the multicast content signals to a plurality of respective customer units.

32. (Amended) A distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider;

means for placing content signals provided by said content signal provider on said telecommunications channel on a data path; and

means for selectively accessing and multicasting content signals on said data path to said exchange units.

33. A distribution switch as claimed in claim 32, adapted to establish a telecommunications channel with said customer units to provide applications cyclically broadcast by said content signal provider to said customer units.

34. (Amended) An asymmetric distribution switch for a telecommunications exchange, including:

a plurality of exchange units for receiving low bit rate data from respective customer units and for sending high bit rate data to said customer units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between said at least one of said exchange units and said high bit rate data provider;

said switch being adapted to selectively access data received on said high bit rate telecommunications channel from said high bit rate data provider for said exchange units.

35. A distribution switch as claimed in claim 34, wherein said exchange units are adapted to send low bit rate data to said respective customer units and said low bit rate telecommunications channel is bidirectional.

36. A distribution switch as claimed in claim 35, adapted to multicast data received on said high bit rate telecommunications channel from said high bit rate data provider to said customer units.

37. (Amended) A distribution switch, including:

a plurality of exchange units for communicating with respective customer units and for sending content signals to said customer units;

means for establishing a telecommunications channel with a content signal provider to receive applications cyclically broadcast by said content signal provider; and

means for establishing a telecommunications channel with at least one of said customer units to provide said applications thereto when requested.

38. (Amended) A distribution switch as claimed in any one of claims 27 to 37, wherein said exchange units and said customer units are adapted to receive and transmit TCP/IP network, ISDN data and/or a plurality of POTS circuits signals therebetween.

39. A distribution switch as claimed in any one of claim 38, wherein said exchange units and customer units are ADSL units.

40. (Amended) A distribution system, including:

means for establishing a telecommunications channel with a content signal provider;

means for placing content signals provided by said content signal provider on said telecommunications channel on a data path;

a plurality of exchange units for communicating with a respective plurality of curb units

over optical links, said curb units communicating with respective customer units; and

said exchange units including means for selectively accessing and multicasting content signals on said data path to said curb units.

41. A distribution system as claimed in claim 40, wherein said curb units and customer units are ADSL units.

42. (Amended) A distribution system, including:

a plurality of exchange units for receiving low bit rate data from respective remote units and for sending high bit rate data to said remote units;

means for establishing a high bit rate telecommunications channel between a high bit rate data provider and at least one of said exchange units; and

means for establishing a low bit rate telecommunications channel between at least one of said exchange units and said high bit rate data provider;

said system being adapted to selectively access data received on said high bit rate telecommunications channel from said high bit rate data provider for said exchange units.

43. A distribution system as claimed in claim 42, wherein said exchange units are adapted to send low bit rate data to said respective remote units, and said low bit rate telecommunications channel is bidirectional.

44. A distribution system as claimed in claim 43, adapted to multicast data received on said high bit rate telecommunications channel from said high bit rate data provider to said customer units

45. (Amended) A distribution system as claimed in claim 43 or 44, wherein said remote units are connected to said exchange units using optical links and said remote units communicate with respective customer units to establish a low bit rate telecommunications channel therebetween and to send said high bit rate data to said customer units.

46. A distribution system as claimed in claim 45, wherein said remote units and customer

units are ADSL units.

47. (New) A distribution system as claimed in claim 13 or 14, wherein said TCP/IP network signals are Internet signals.

48. (New) A distribution system as claimed in claim 7, wherein said access system is adapted to receive and transmit data service signals on said bidirectional data channel.

49. (New) A distribution system as claimed in claim 48, wherein said access system is adapted to receive and transmit data service signals on said downstream content channel.

50. (New) A distribution system as claimed in claim 23, wherein said TCP/IP network channel is an Internet service channel.

51. (New) A distribution system as claimed in claim 22, wherein said communications controller is adapted to selectively connect a data service channel to said bidirectional data channel and/or said downstream content channel.

52. (New) A distribution switch as claimed in any one of claims 27 and 31 to 37, wherein said content signals are Pay TV, PPV, free-to-air TV, VOD or Internet signals.

53. (New) A distribution system as claimed in any one of claims 16 and 40 to 46, wherein said content signals are Pay TV, PPV, free-to-air TV, VOD or Internet signals.

54. (New) A distribution system, including:

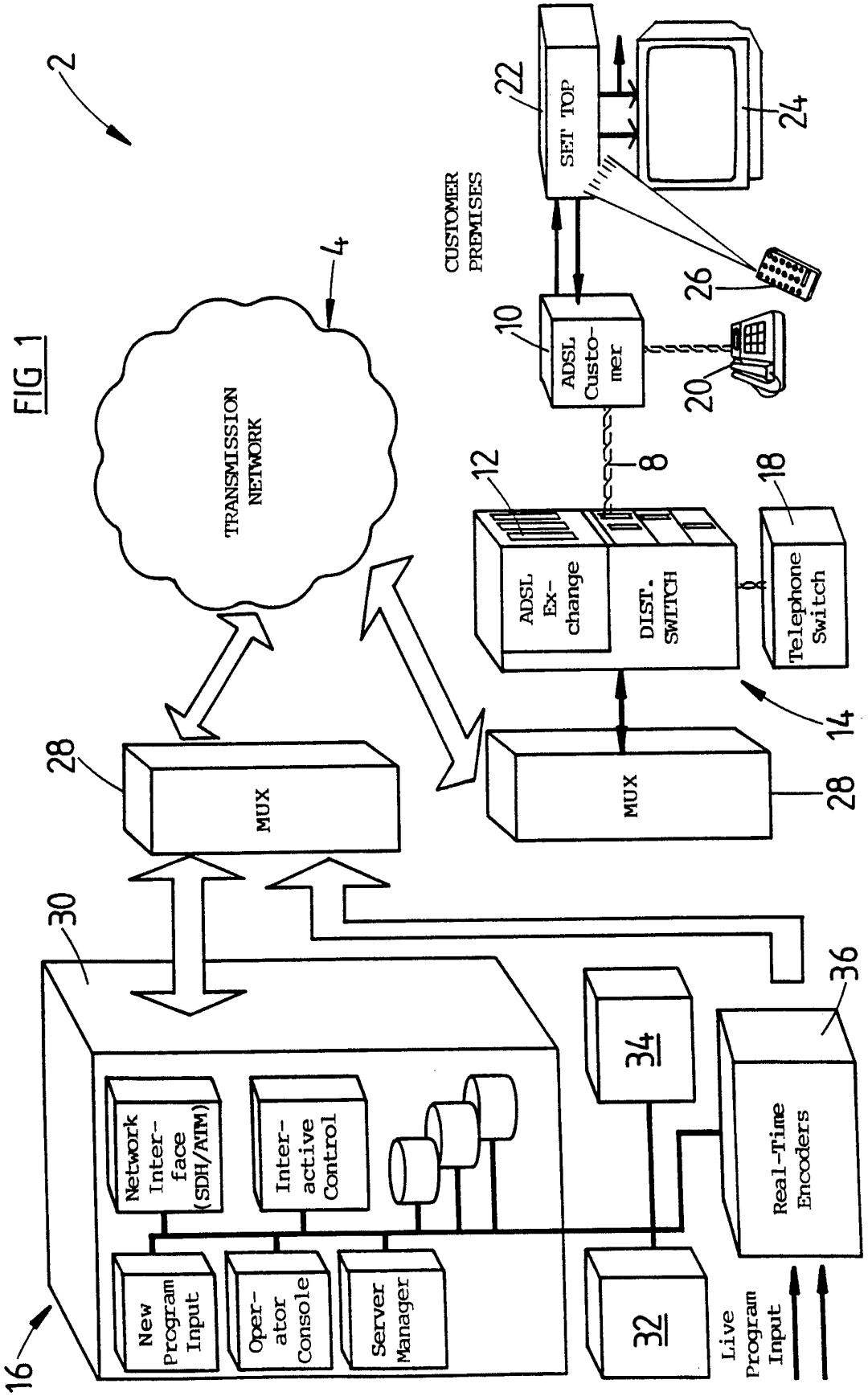
a channel distribution system for receiving content signals from a telecommunications transmission network and placing said content signals on a data path; and

an access system connected to said data path and for selectively accessing the content signals on said data path and transmitting the selected content signals to customer units on telecommunications lines.

55. (New) A distribution system as claimed in claim 54, wherein said access system includes modulating units for modulating the content signals for transmission on said telecommunications lines for said customer units, and a channel access unit for accessing said content signals for the modulating units.

5

FIG 1


2
4
TRANSMISSION NETWORK
CUSTOMER PREMISES
22
SET TOP
24
26
10
ADSL Custo-mer
20
12
8
18
ADSL Ex-change
DIST. SWITCH
Telephone Switch
14
28
MUX
28
MUX
30
34
36
Network Inter-face (SDH/ATM)
Inter-active Control
Real-Time Encoders
New Program Input
Oper-ator Console
Server Manager
32
Live Program Input
16

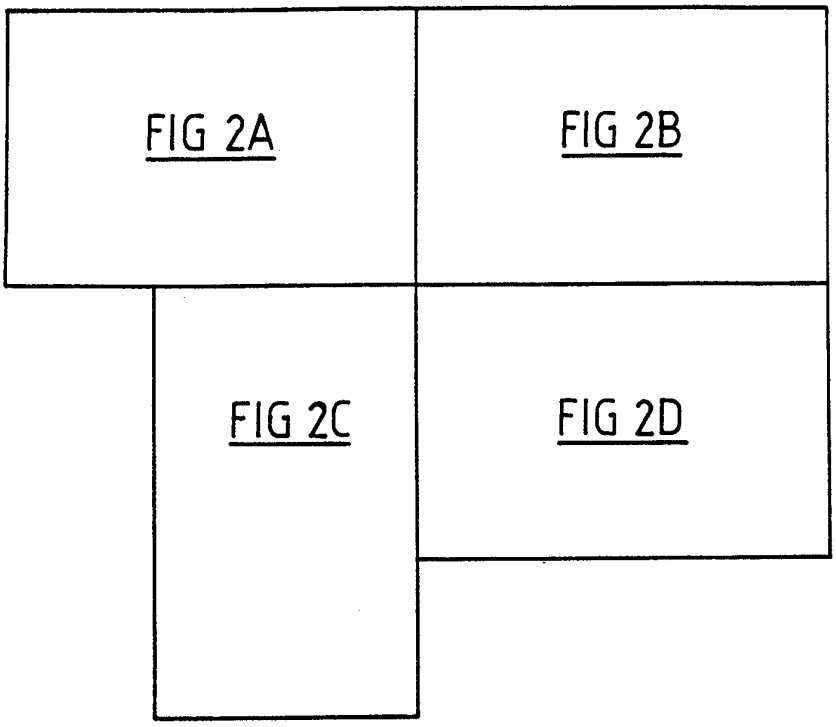


FIG 2

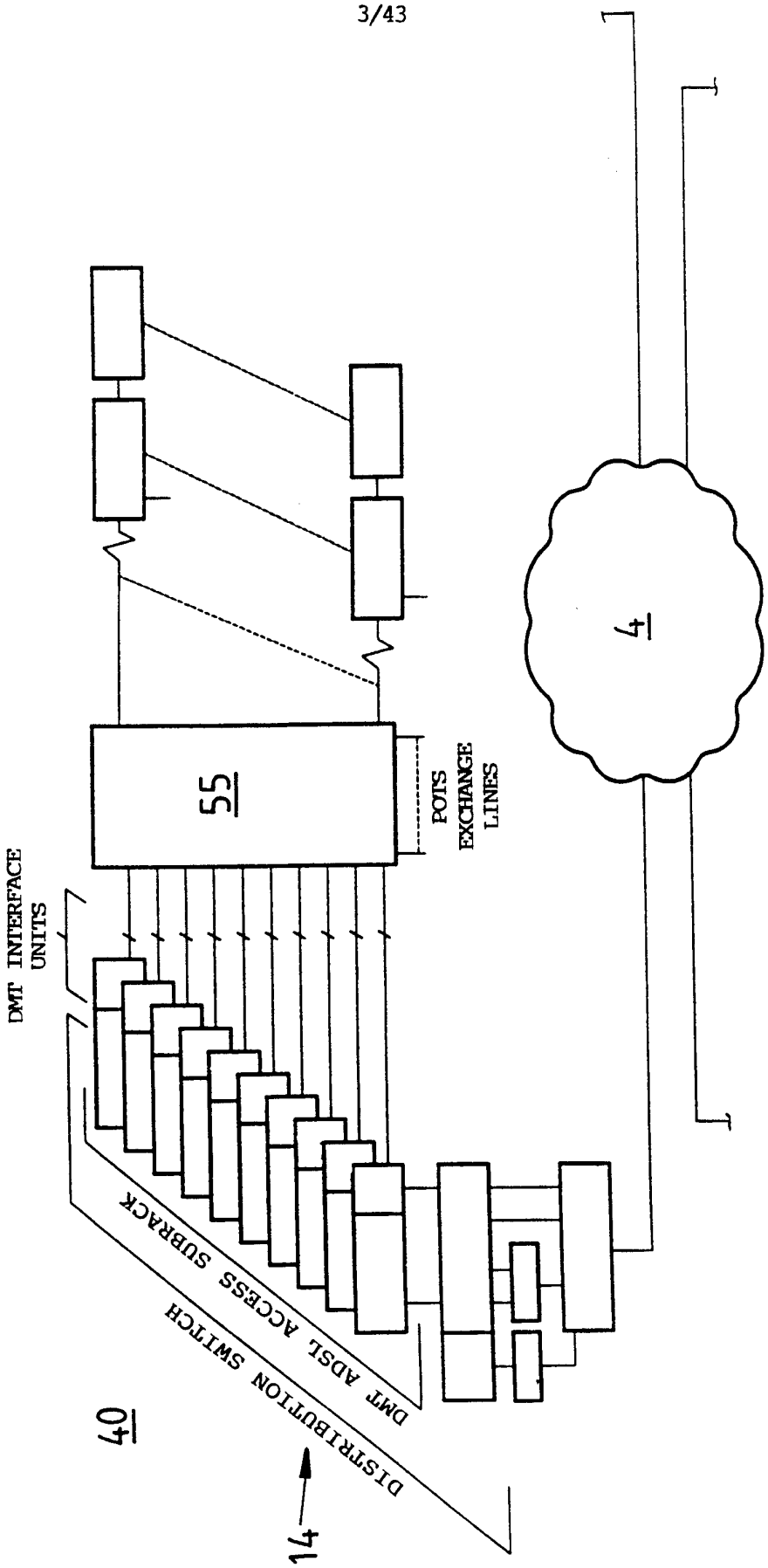

4
55
POTS EXCHANGE LINES
DMT INTERFACE UNITS
DMT ADSL ACCESS SUBRACK
DISTRIBUTION SWITCH
40
14

FIG 2A

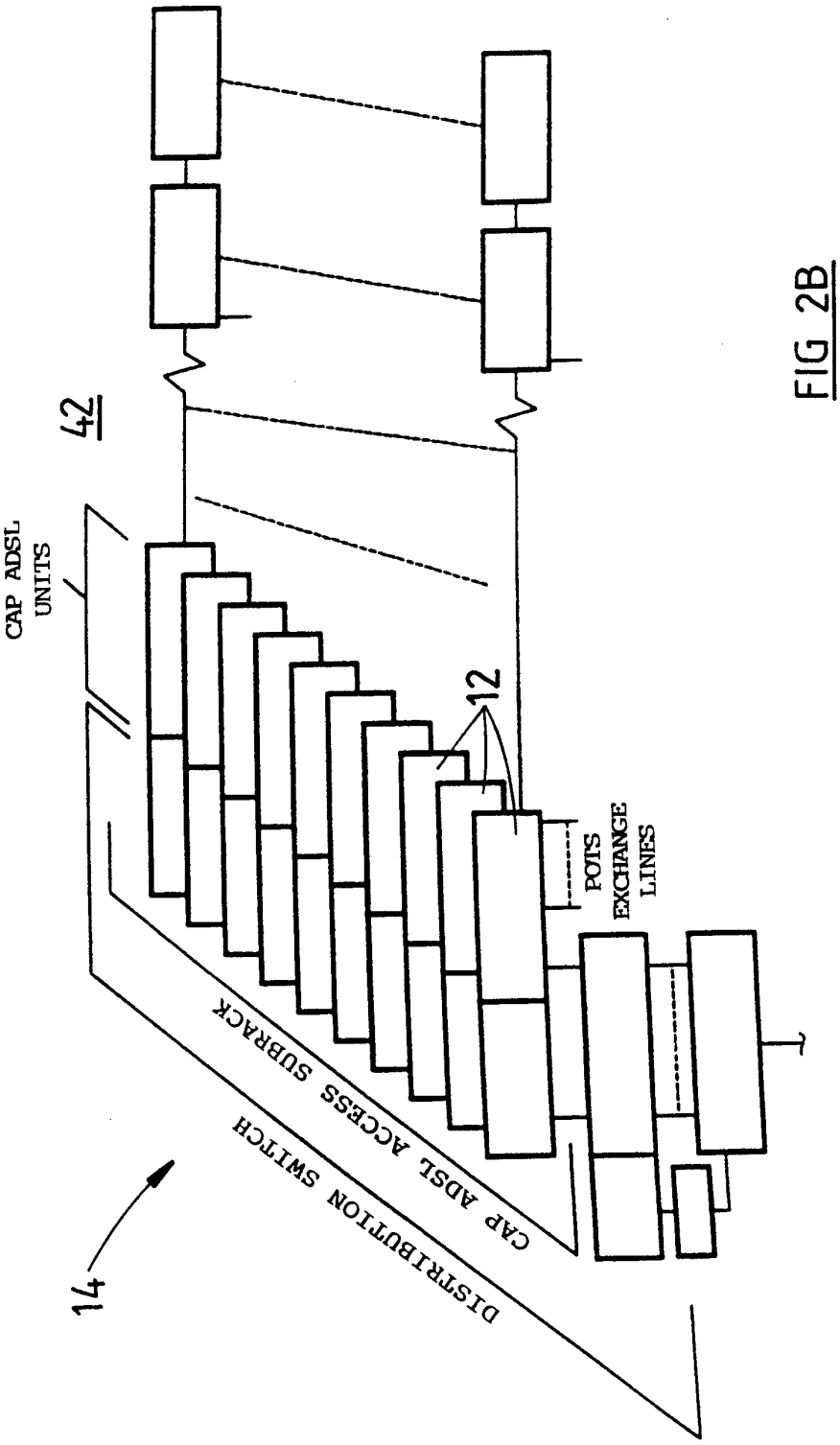

42
CAP ADSL UNITS
12
POTS EXCHANGE LINES
CAP ADSL ACCESS SUBRACK
DISTRIBUTION SWITCH
14

FIG 2B

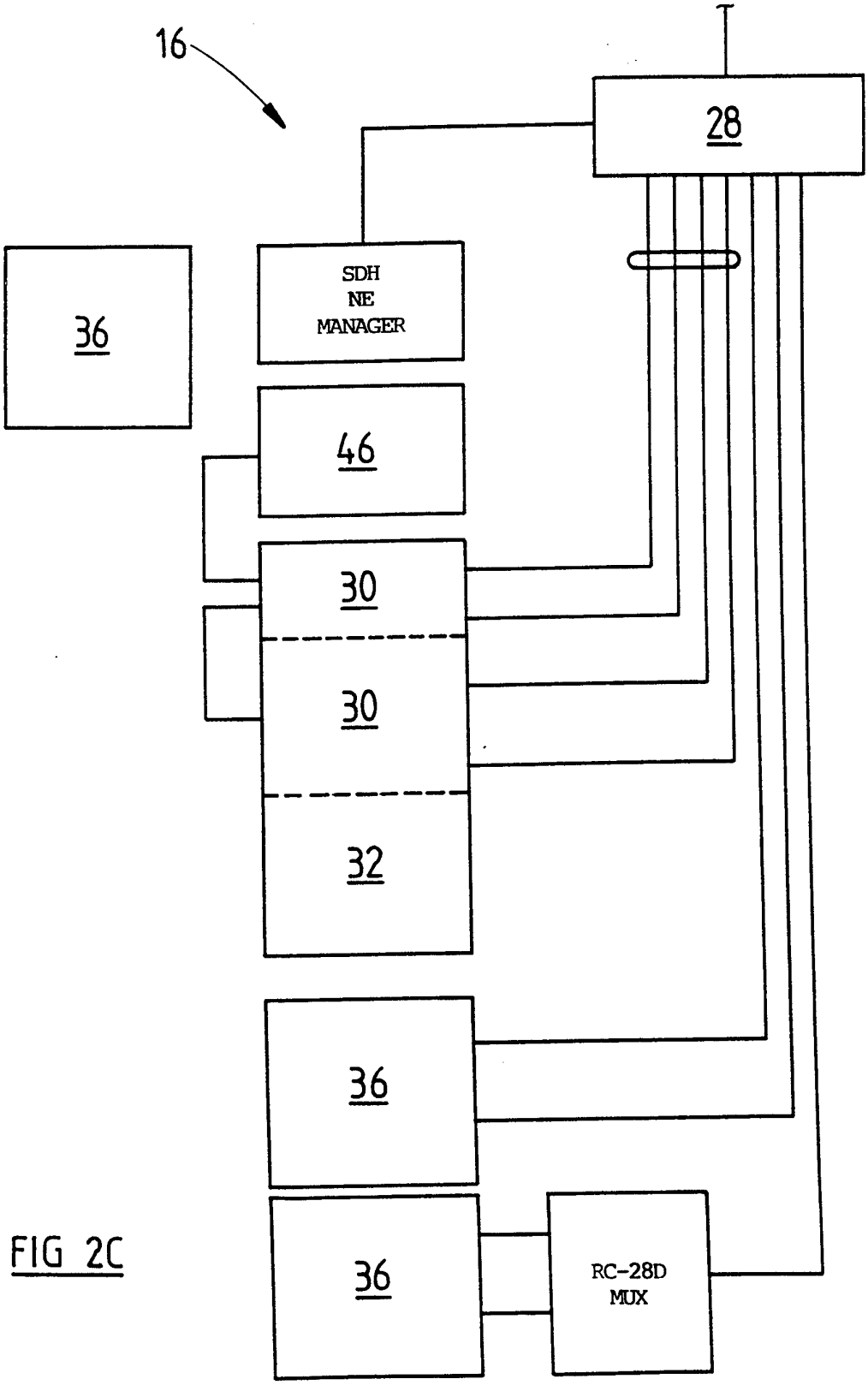


FIG 2C

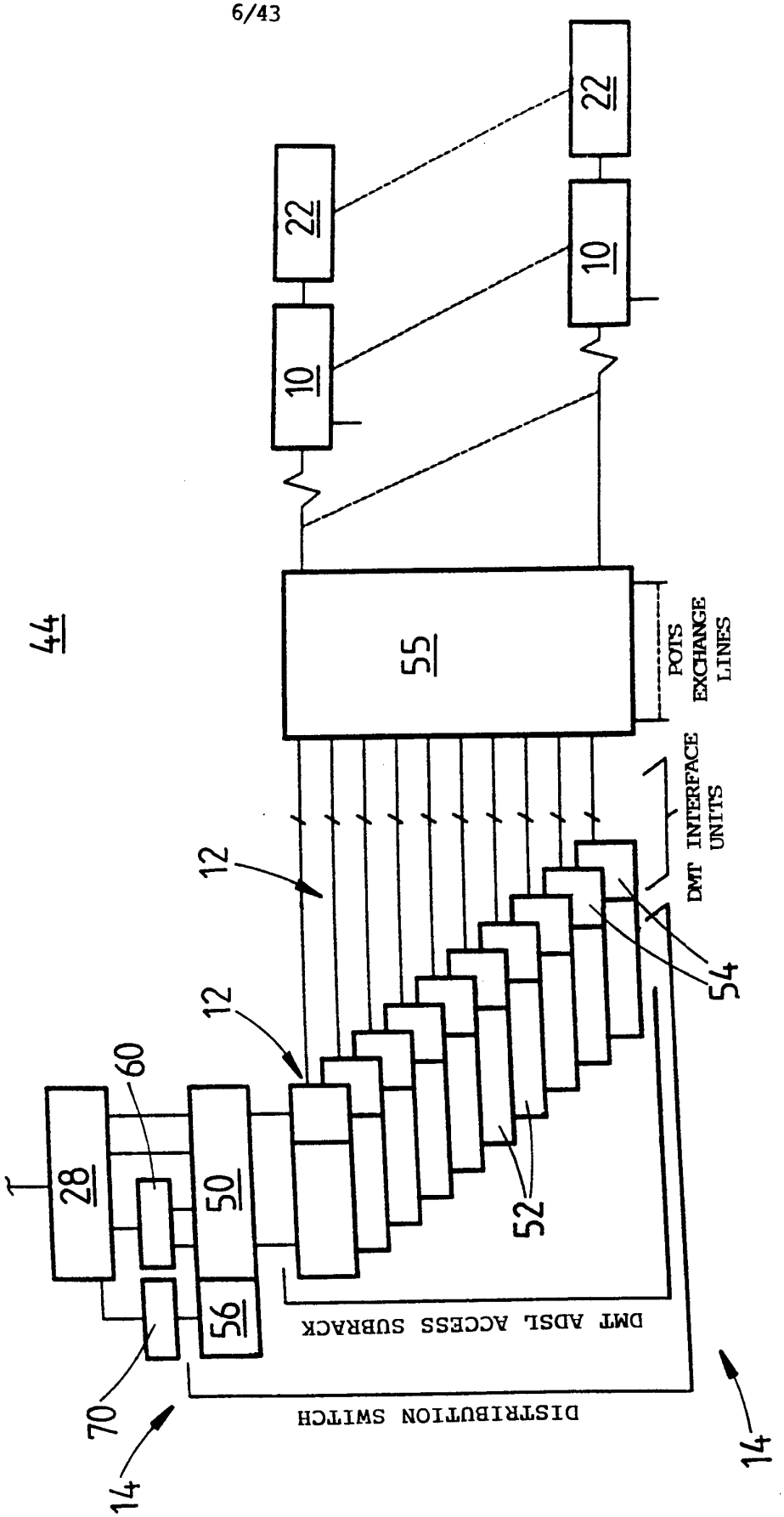

22
22
10
10
44
55
POTS EXCHANGE LINES
DMT INTERFACE UNITS
12
12
54
60
28
50
52
56
DMT ADSL ACCESS SUBRACK
DISTRIBUTION SWITCH
70
14
14

FIG 2D

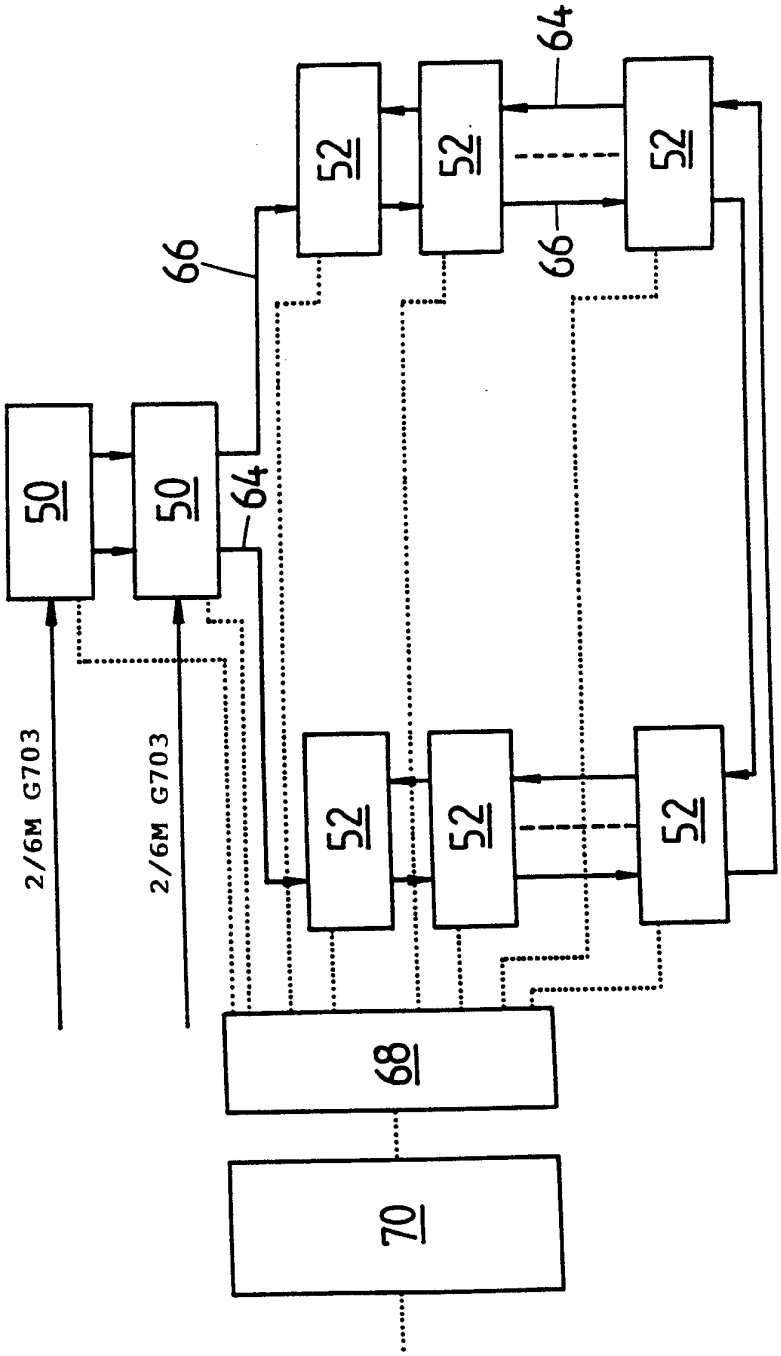


FIG 3

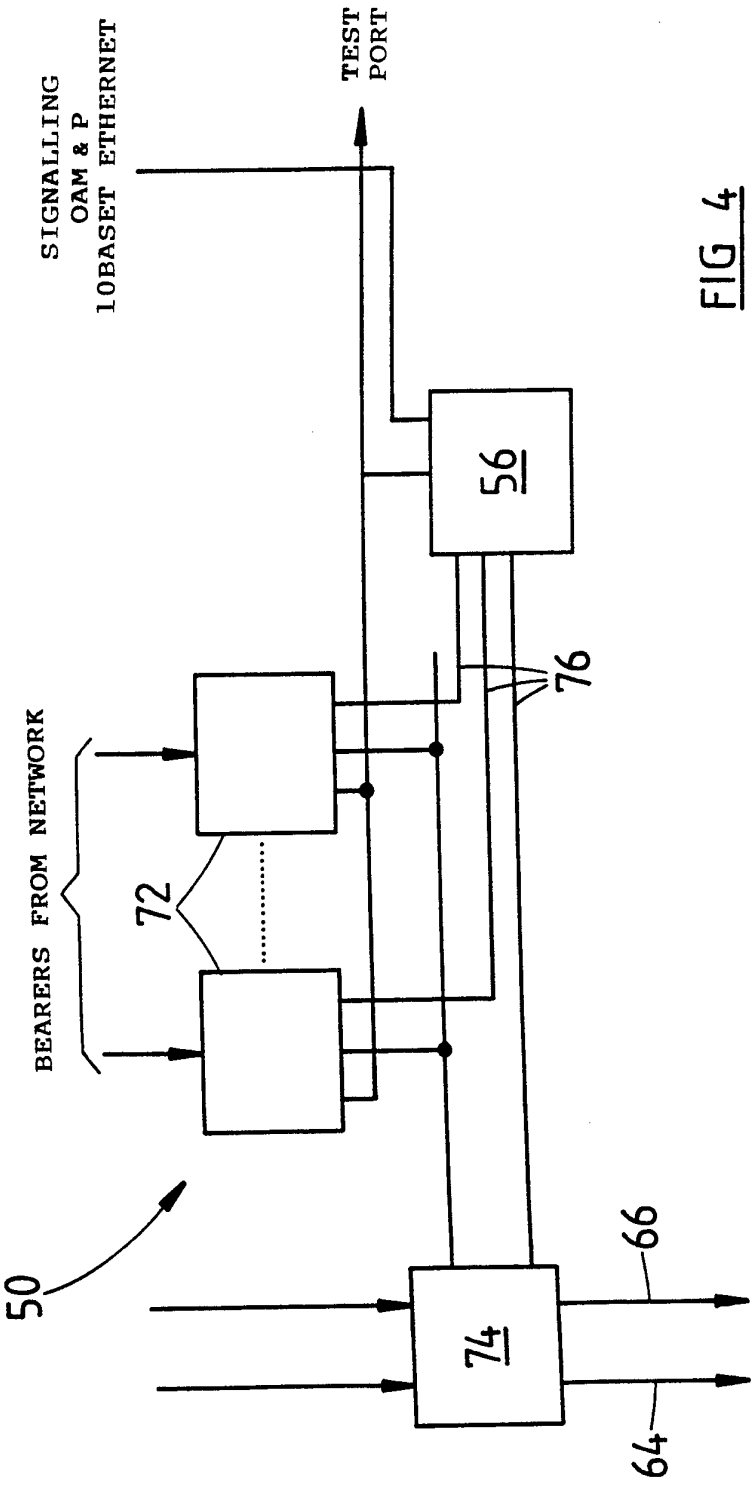

SIGNALLING
OAM & P
10BASET ETHERNET
TEST
PORT
56
76
BEARERS FROM NETWORK
72
50
74
66
64

FIG 4

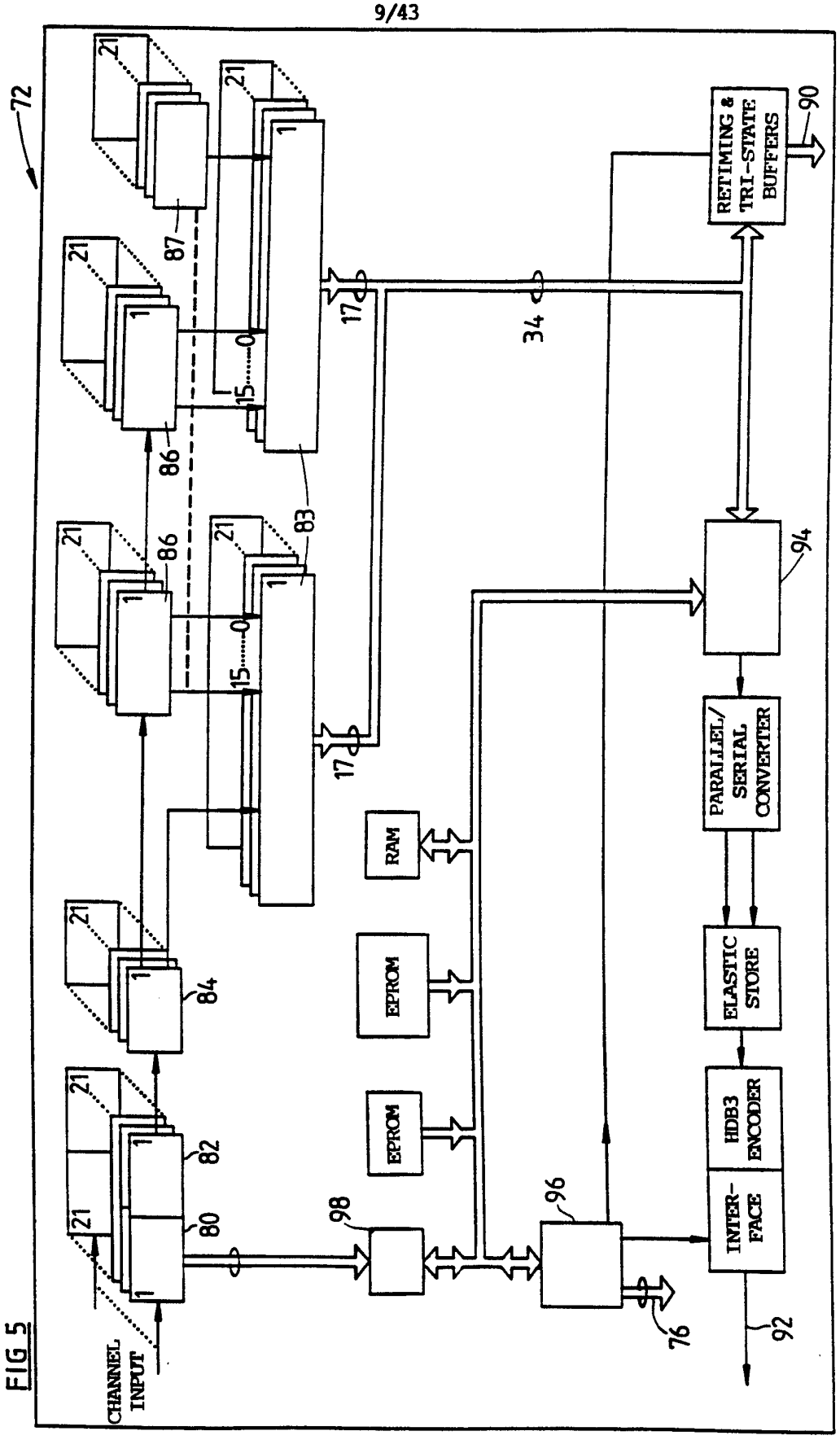

72
RETIMING & TRI-STATE BUFFERS
90
PARALLEL/ SERIAL CONVERTER
ELASTIC STORE
HDB3 ENCODER
INTER-FACE
92
94
96
98
76
RAM
EPROM
EPROM
CHANNEL INPUT
21
1
0
15
17
34
80
82
84
86
87
83

FIG 5

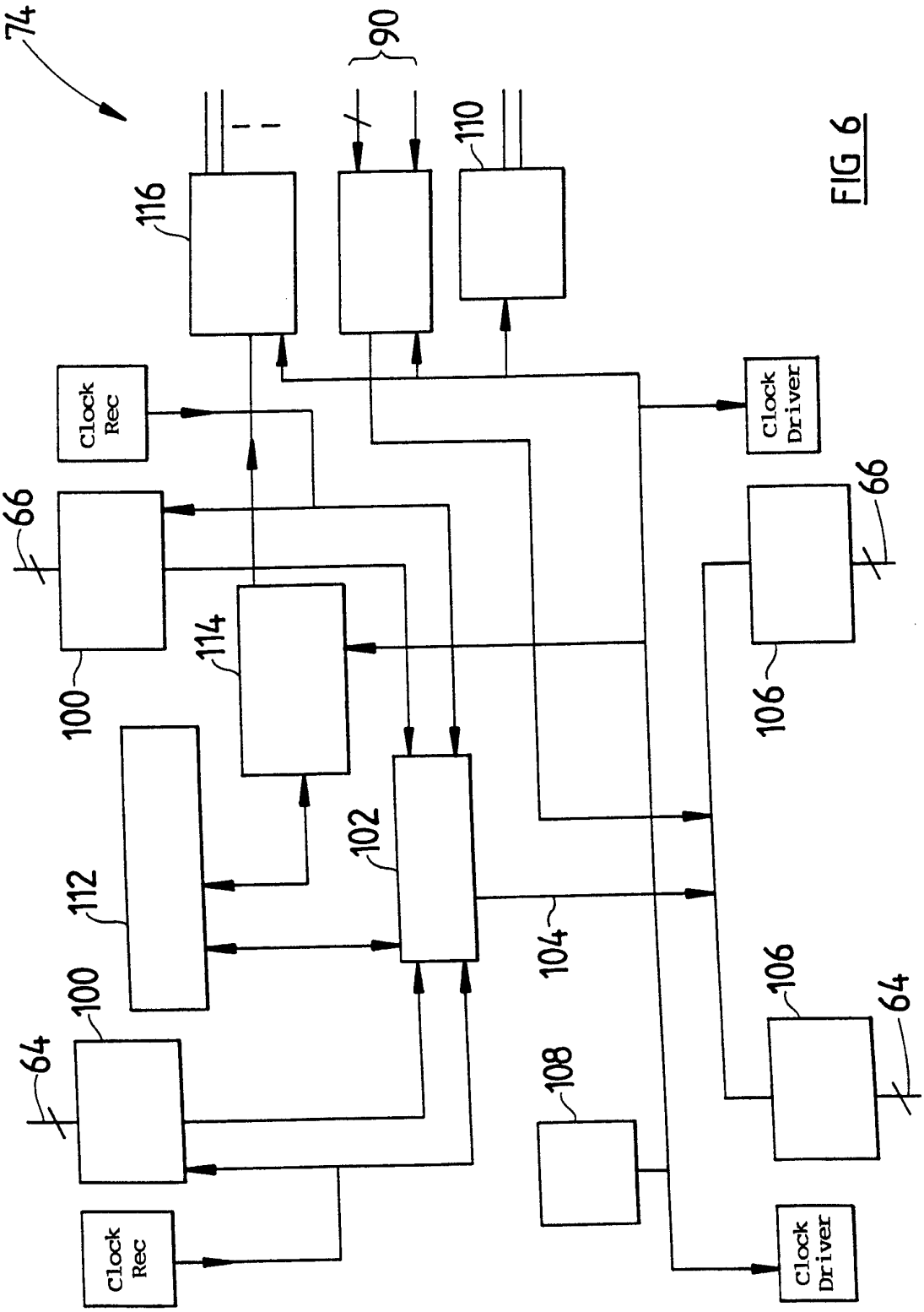

74
90
110
116
Clock Rec
Clock Driver
66
66
114
100
106
102
112
104
100
106
64
64
108
Clock Rec
Clock Driver

FIG 6

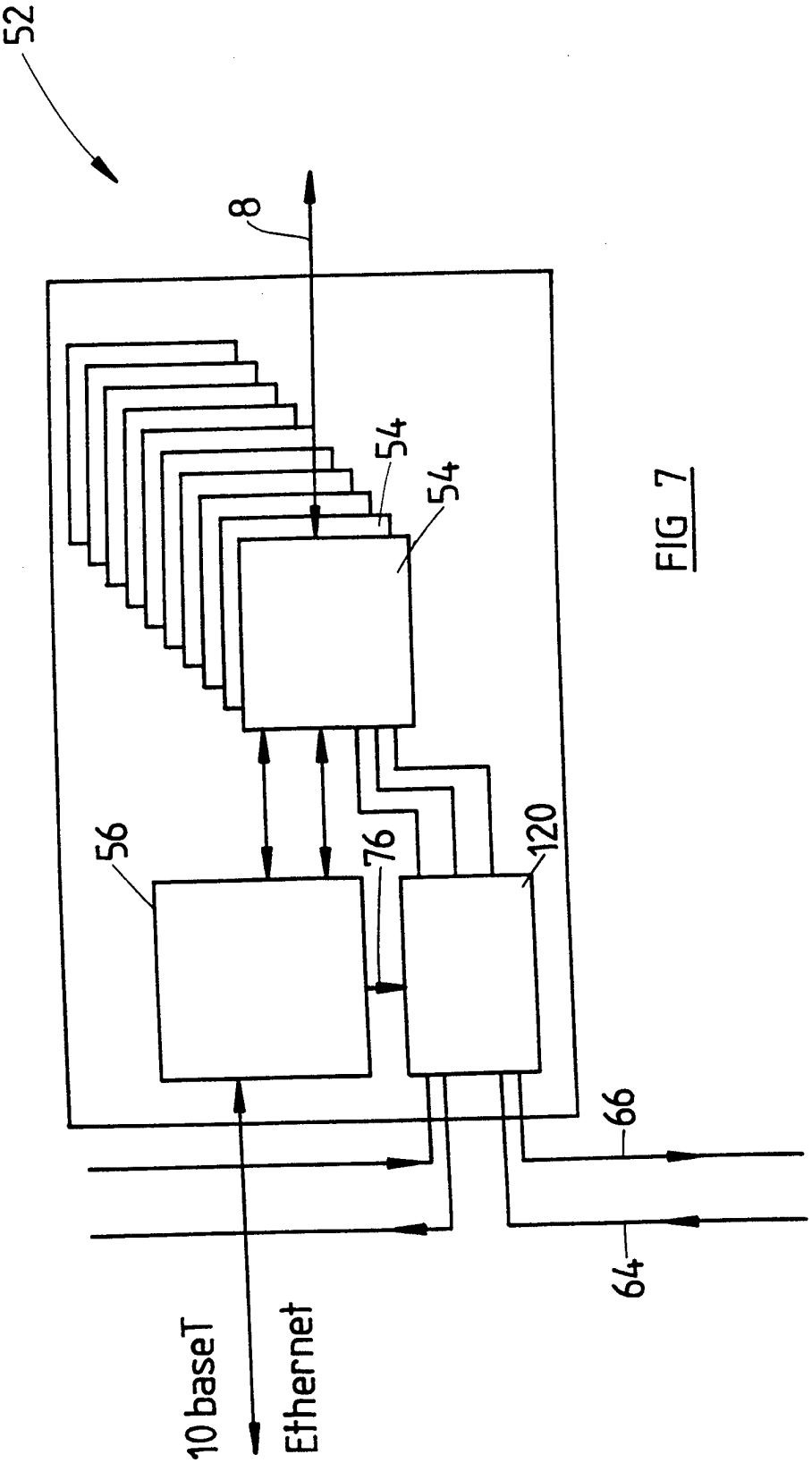


FIG 7

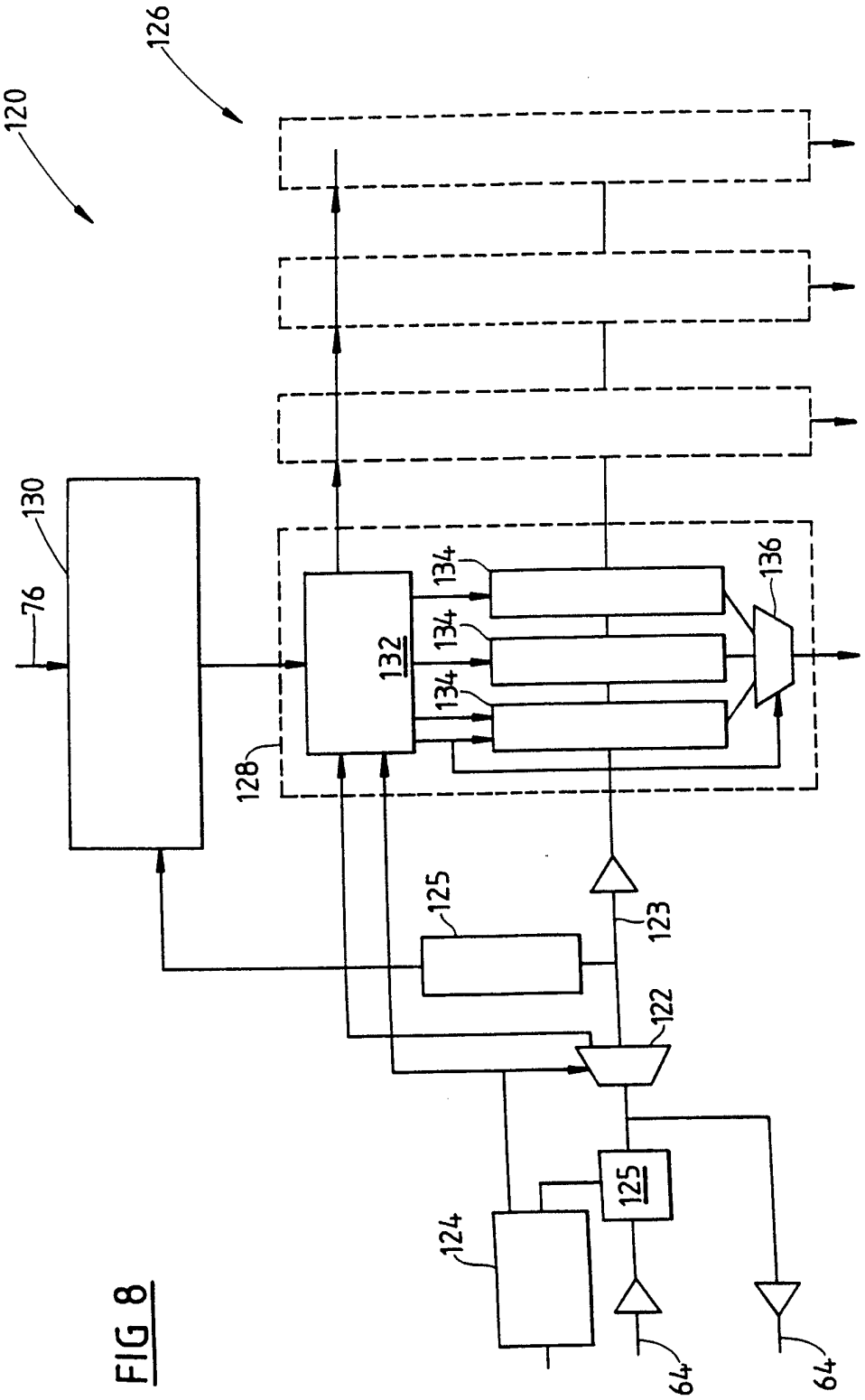


FIG 8

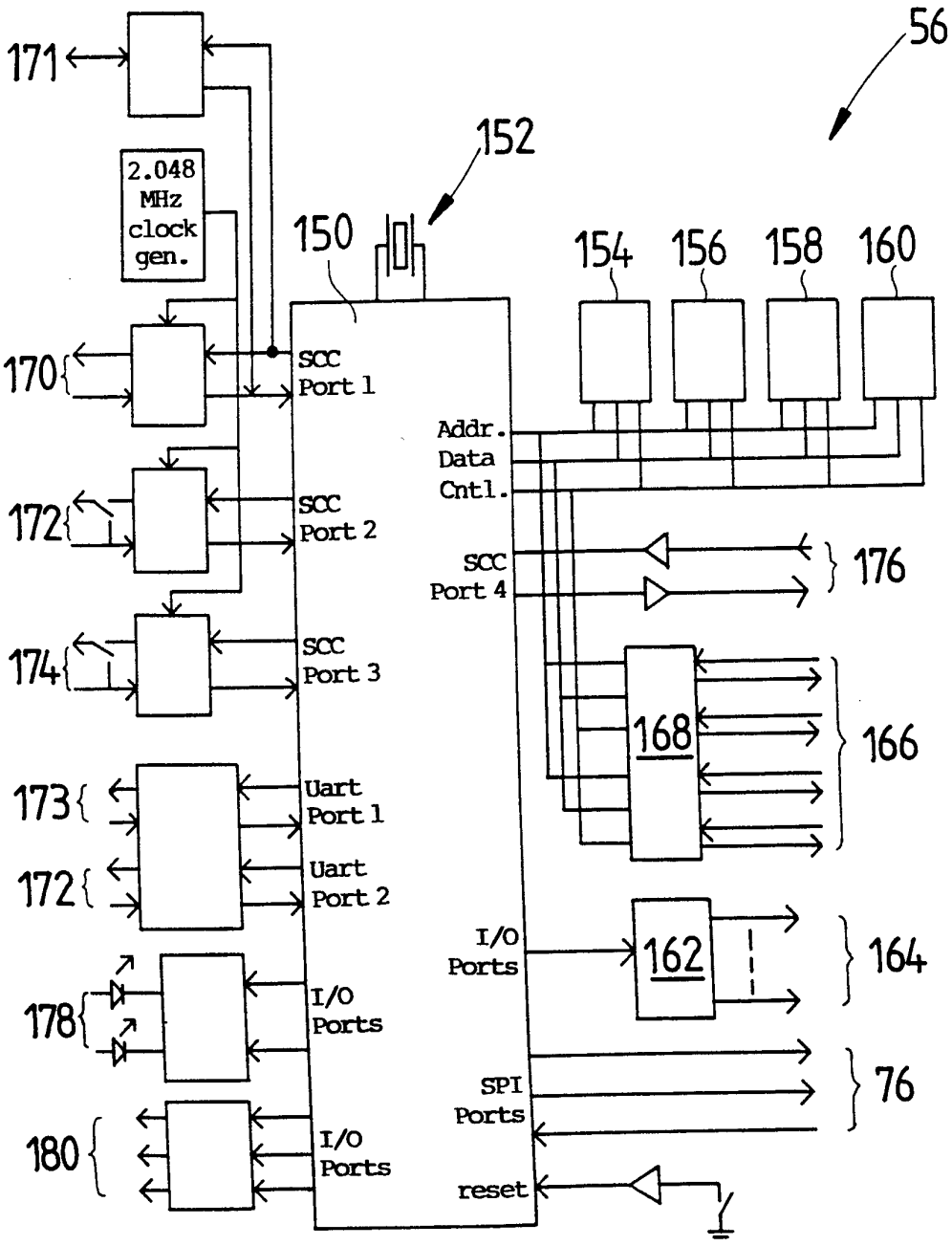

171
2.048 MHz clock gen.
152
150
56
154
156
158
160
170
SCC Port 1
172
SCC Port 2
174
SCC Port 3
Addr.
Data
Cntl.
SCC Port 4
176
168
166
173
Uart Port 1
172
Uart Port 2
I/O Ports
162
164
178
I/O Ports
SPI Ports
76
180
I/O Ports
reset

FIG 9

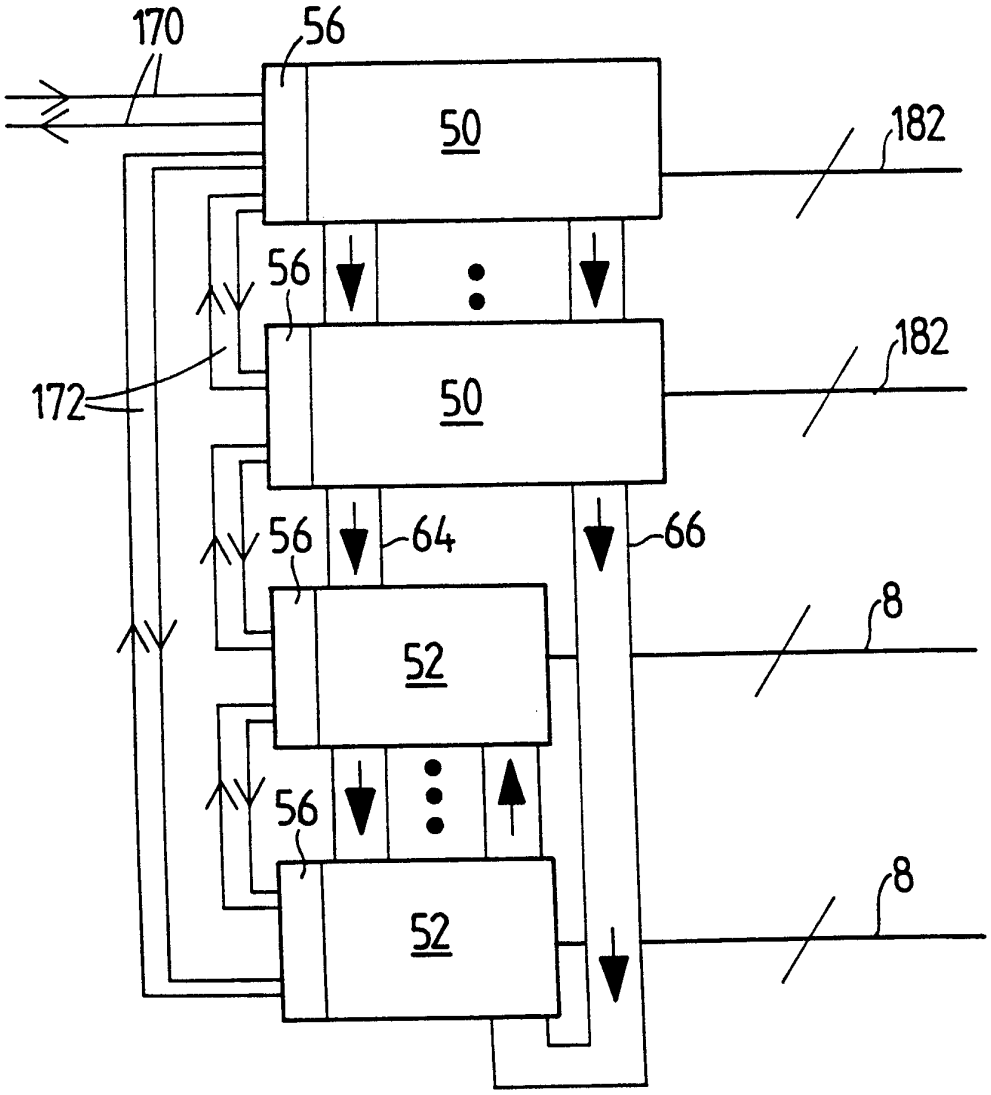
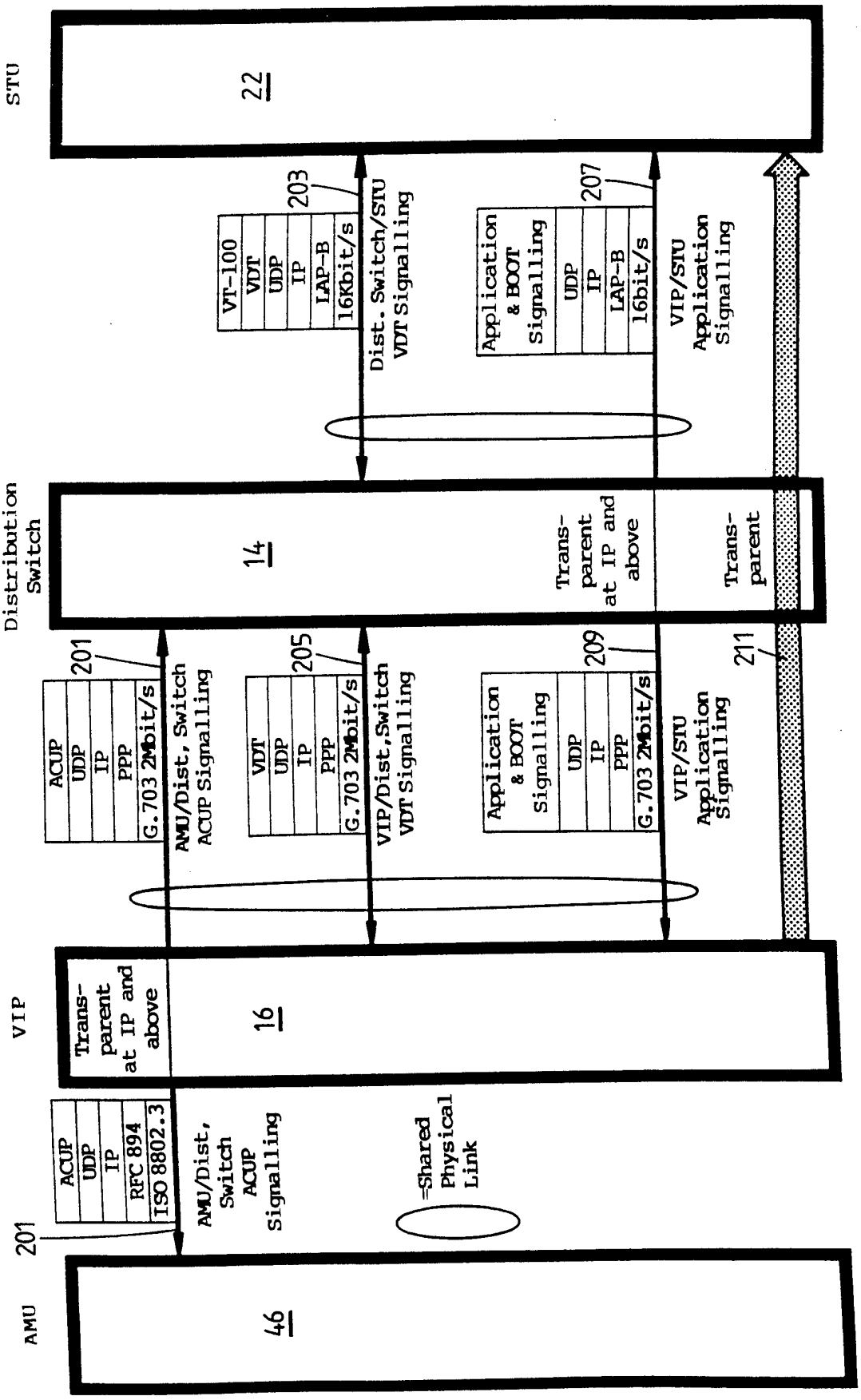


FIG 10


STU
22
VT-100
VDT
UDP
IP
LAP-B
16Kbit/s
203
Dist. Switch/STU
VDT Signalling
Application
& BOOT
Signalling
UDP
IP
LAP-B
16bit/s
207
VIP/STU
Application
Signalling
Distribution
Switch
14
Trans-
parent
at IP and
above
Trans-
parent
ACUP
UDP
IP
PPP
G.703 2Mbit/s
201
AMU/Dist, Switch
ACUP Signalling
VDT
UDP
IP
PPP
G.703 2Mbit/s
205
VIP/Dist,Switch
VDT Signalling
Application
& BOOT
Signalling
UDP
IP
PPP
G.703 2Mbit/s
209
VIP/STU
Application
Signalling
211
VIP
Trans-
parent
at IP and
above
16
ACUP
UDP
IP
RFC 894
ISO 8802.3
201
AMU/Dist,
Switch
ACUP
Signalling
=Shared
Physical
Link
AMU
46

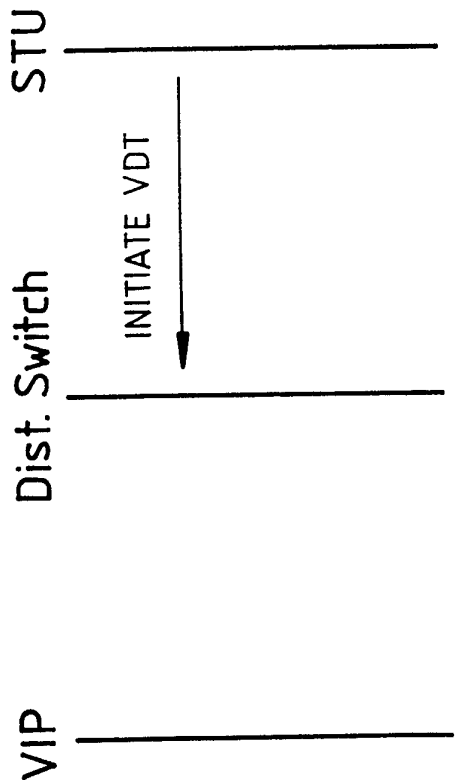


FIG 12

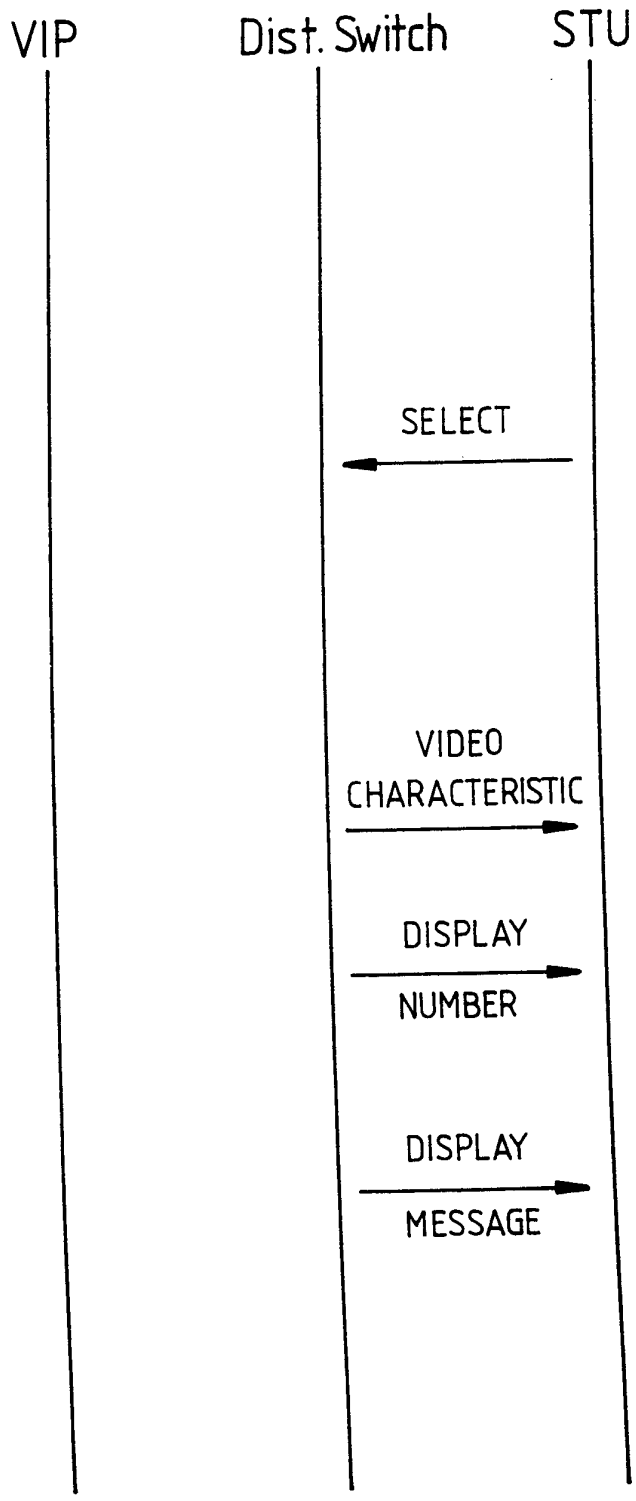

VIP
Dist. Switch
STU
SELECT
VIDEO
CHARACTERISTIC
DISPLAY
NUMBER
DISPLAY
MESSAGE

FIG 13

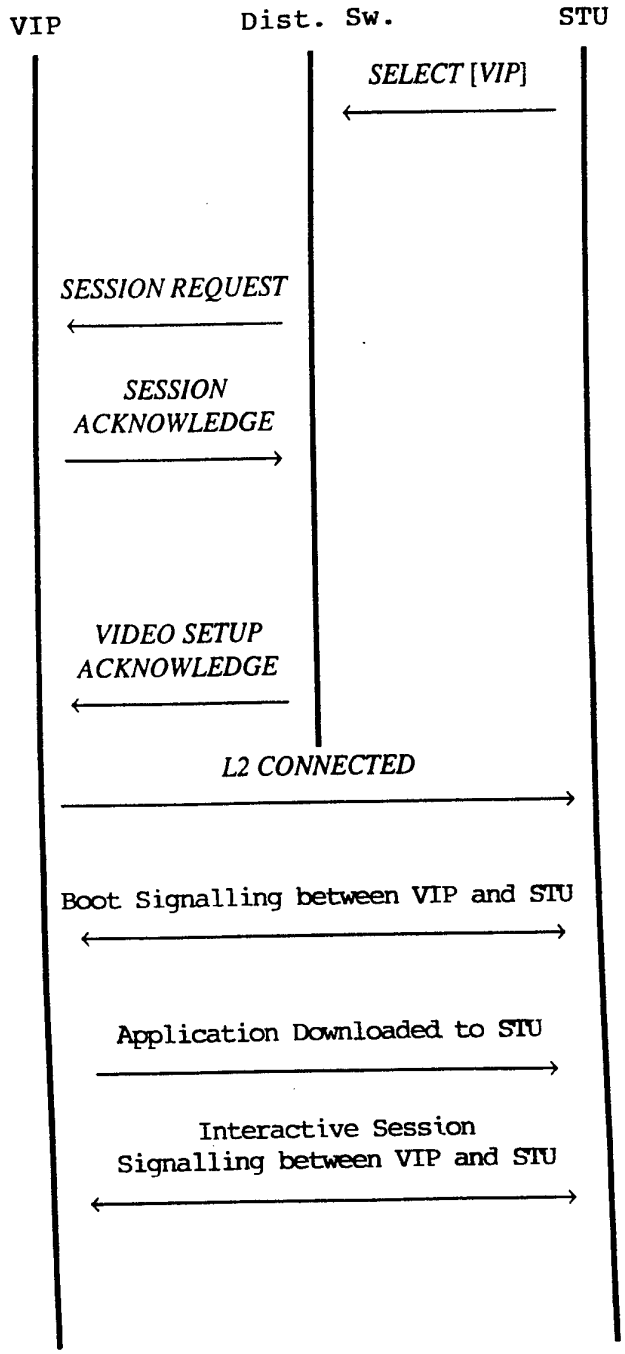

VIP
Dist. Sw.
STU
SELECT [VIP]
SESSION REQUEST
SESSION ACKNOWLEDGE
VIDEO SETUP ACKNOWLEDGE
L2 CONNECTED
Boot Signalling between VIP and STU
Application Downloaded to STU
Interactive Session Signalling between VIP and STU

FIG. 14

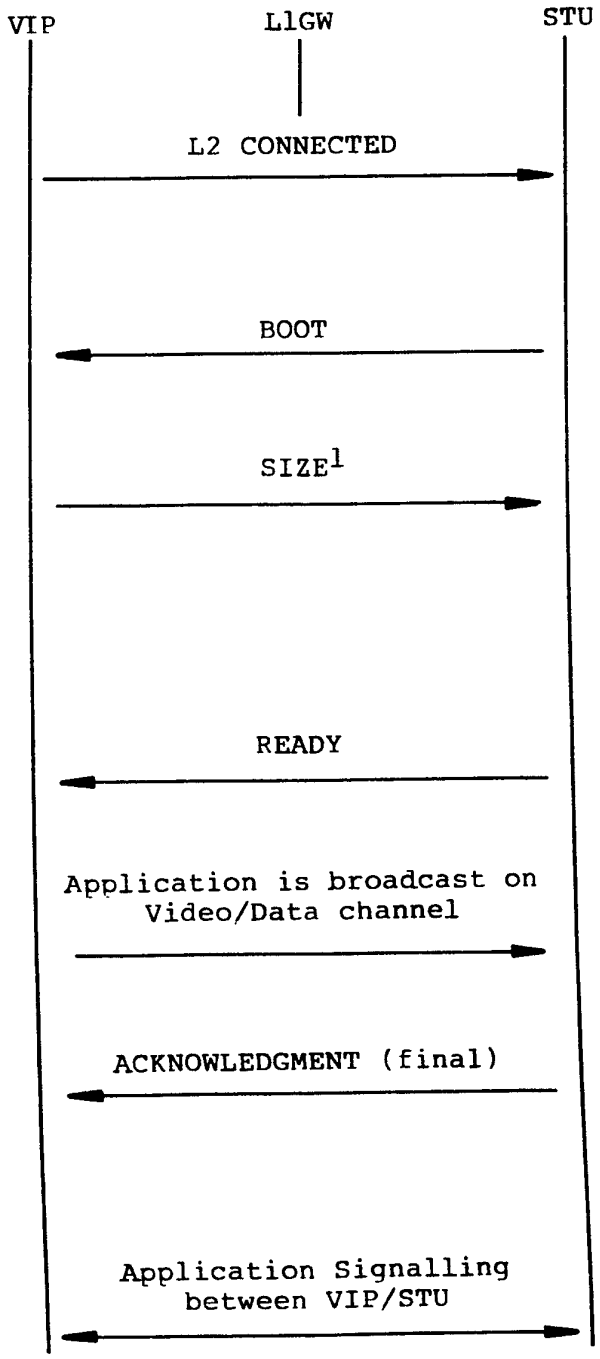

VIP
L1GW
STU
L2 CONNECTED
BOOT
SIZE1
READY
Application is broadcast on Video/Data channel
ACKNOWLEDGMENT (final)
Application Signalling between VIP/STU

FIG. 15

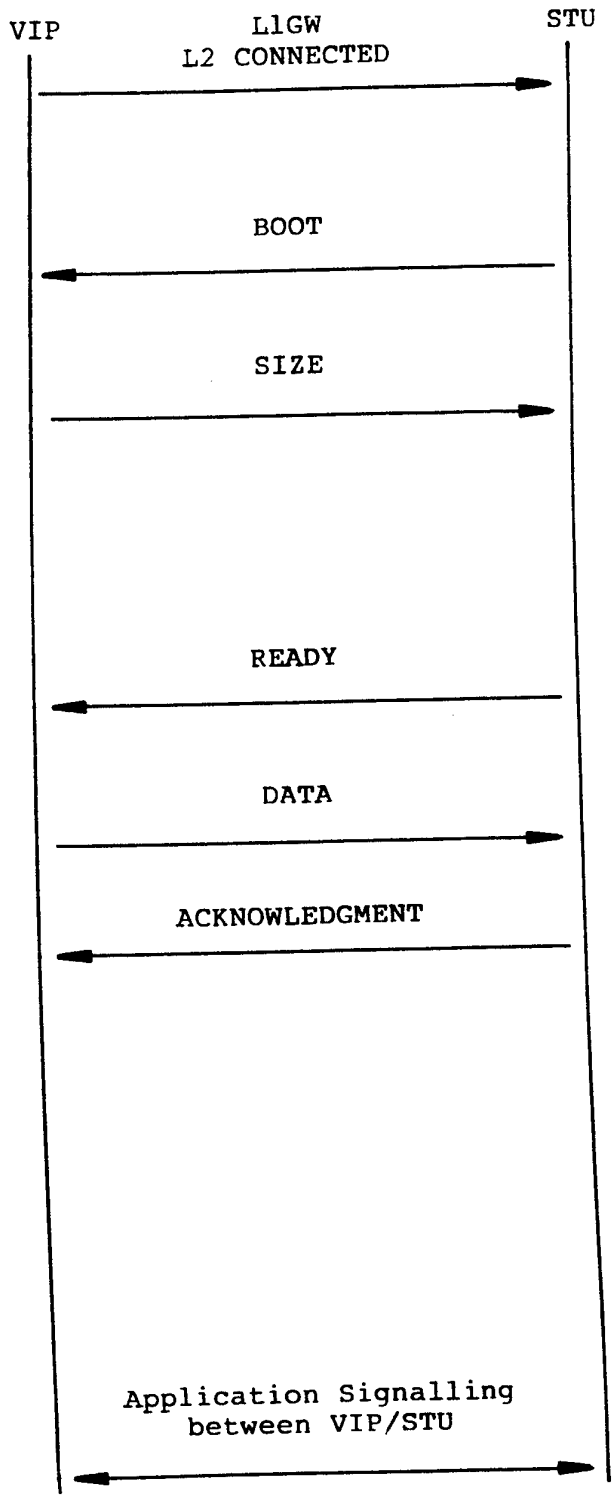

VIP
L1GW
L2 CONNECTED
STU
BOOT
SIZE
READY
DATA
ACKNOWLEDGMENT
Application Signalling
between VIP/STU

FIG. 16

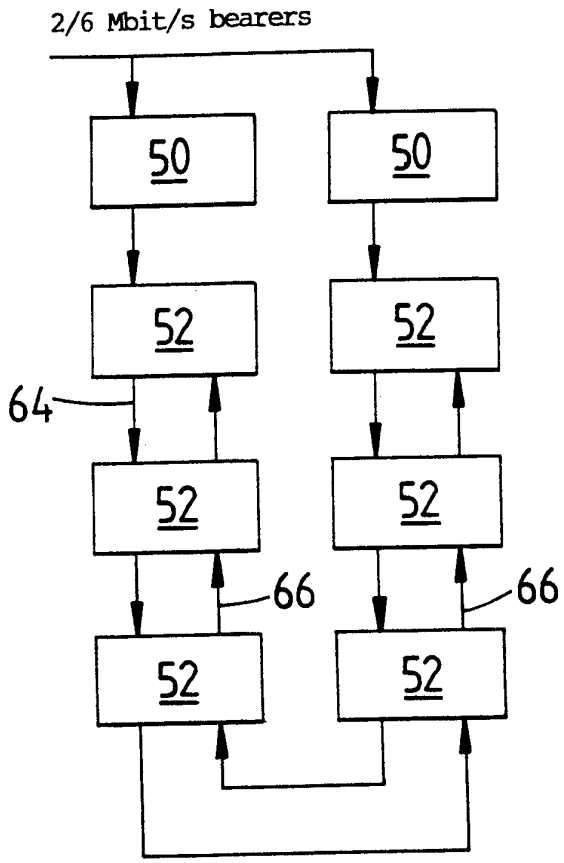


FIG 17

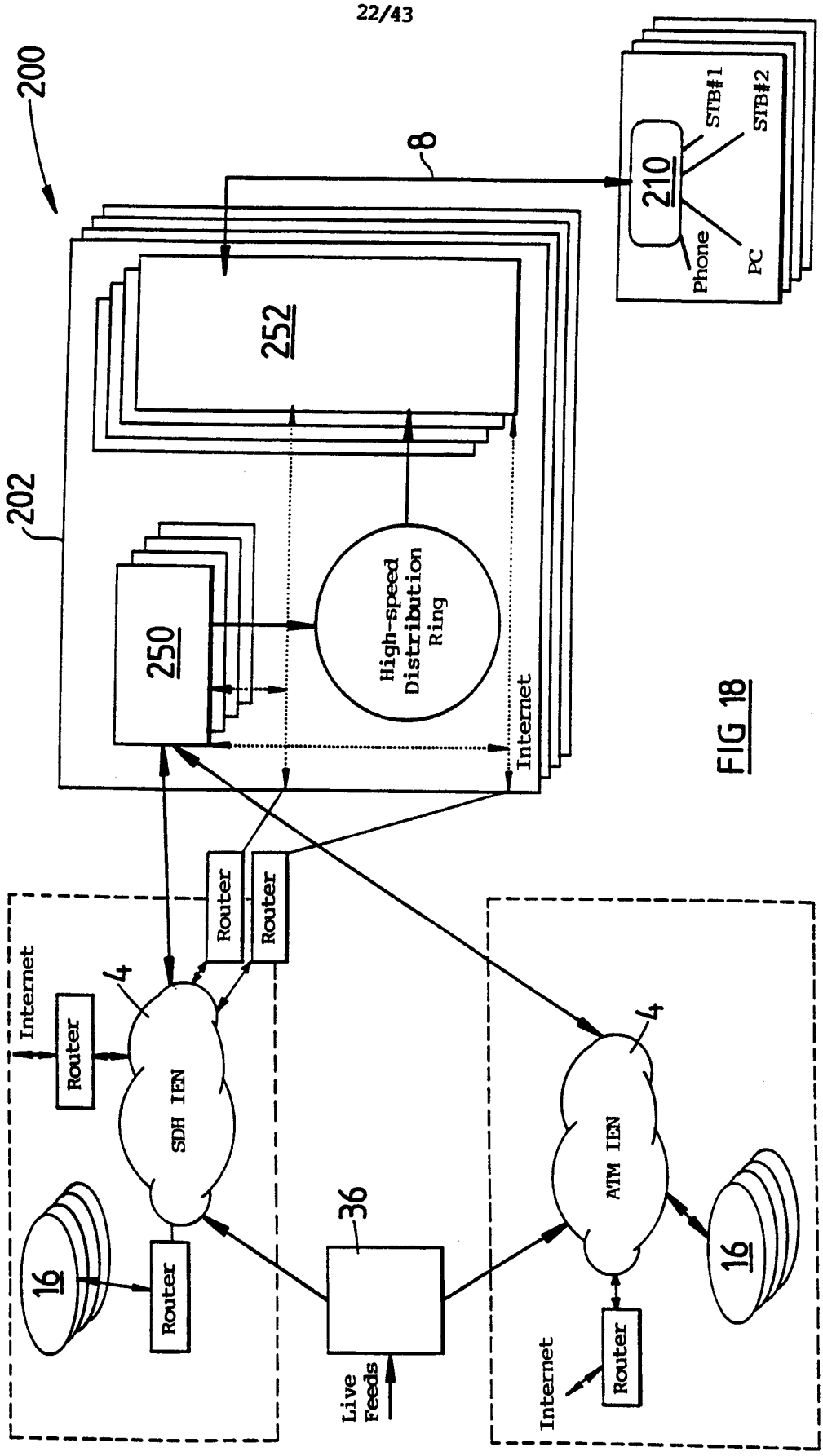

200
8
210
STB#1
STB#2
Phone
PC
252
202
250
High-speed Distribution Ring
Internet
Router
Router
Router
Internet
4
SDH IEN
16
Router
36
Live Feeds
4
ATM IEN
16
Internet
Router

FIG 18

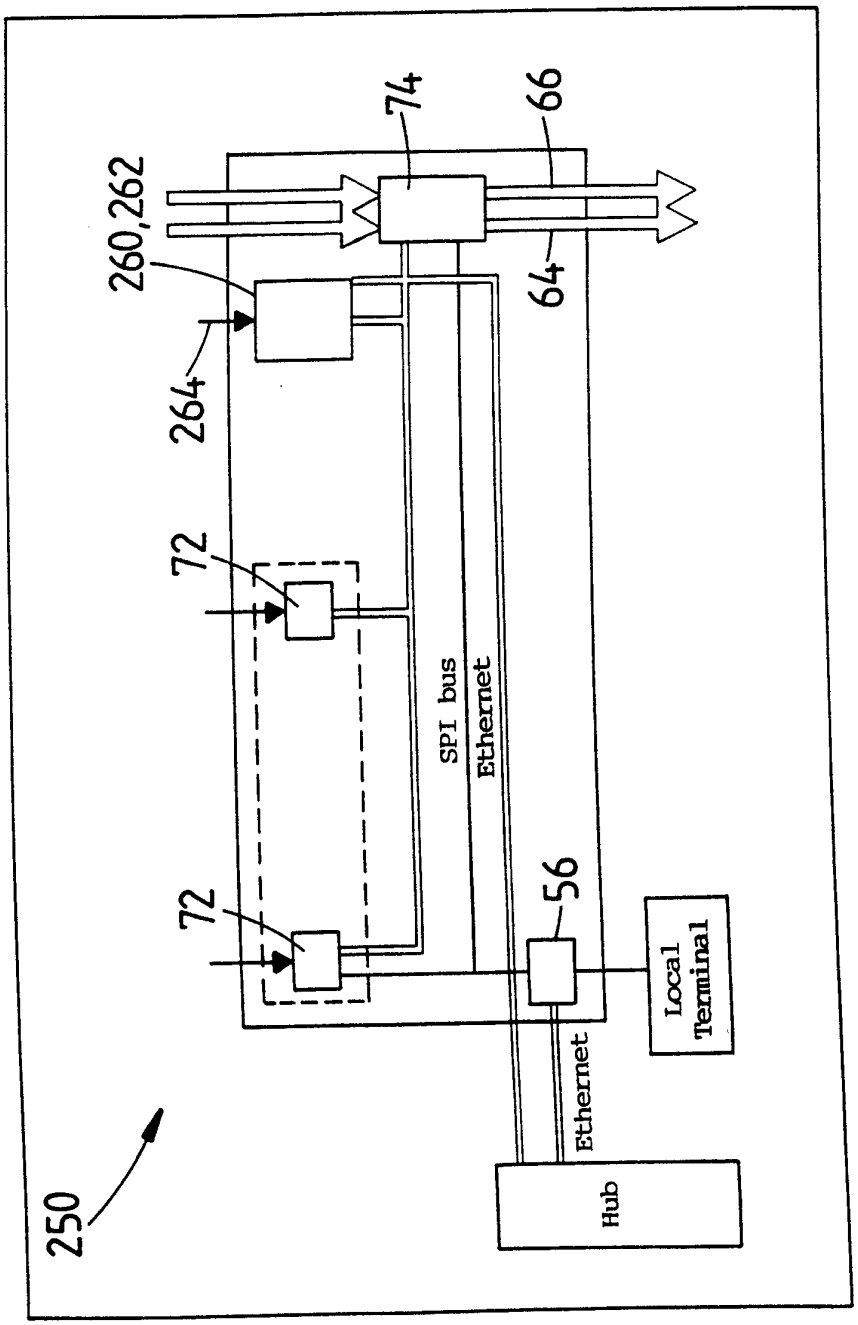
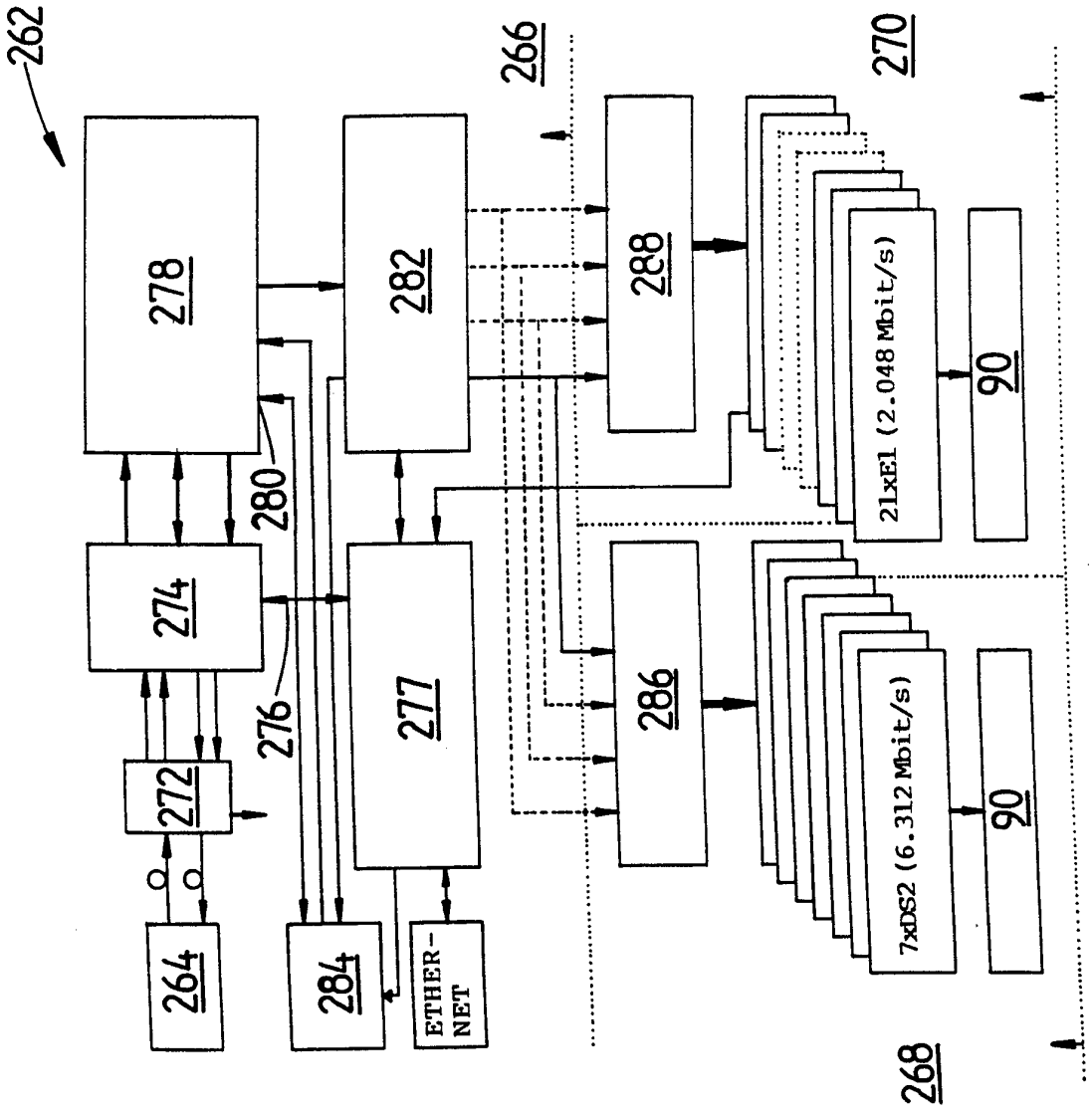

74
66
260,262
64
264
72
72
SPI bus
Ethernet
56
Local Terminal
Ethernet
Hub
250

FIG 19

FIG 20


262
278
282
288
266
270
21xE1 (2.048 Mbit/s)
90
280
274
277
276
286
7xDS2 (6.312 Mbit/s)
90
272
264
284
ETHER-NET
268

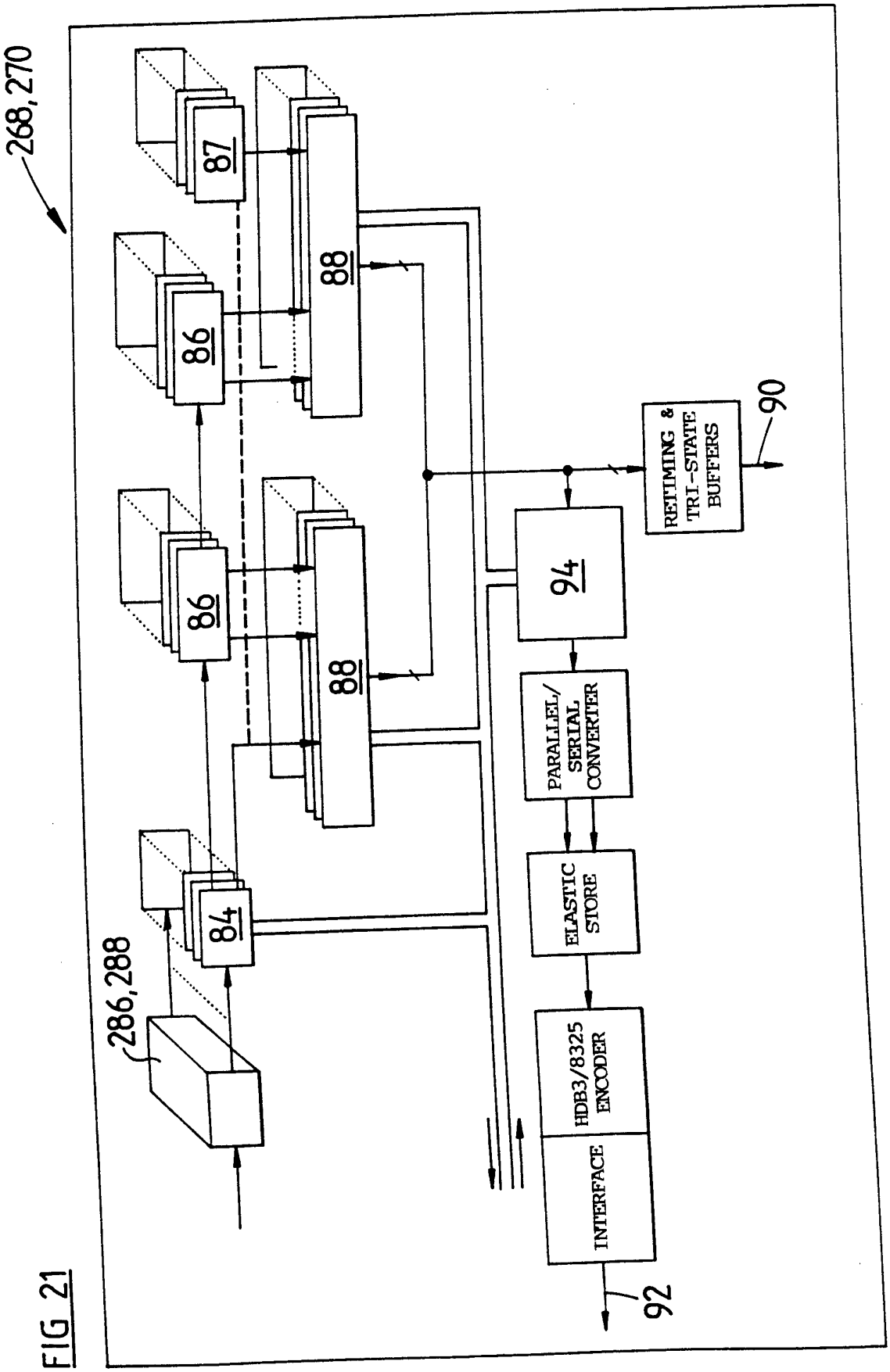
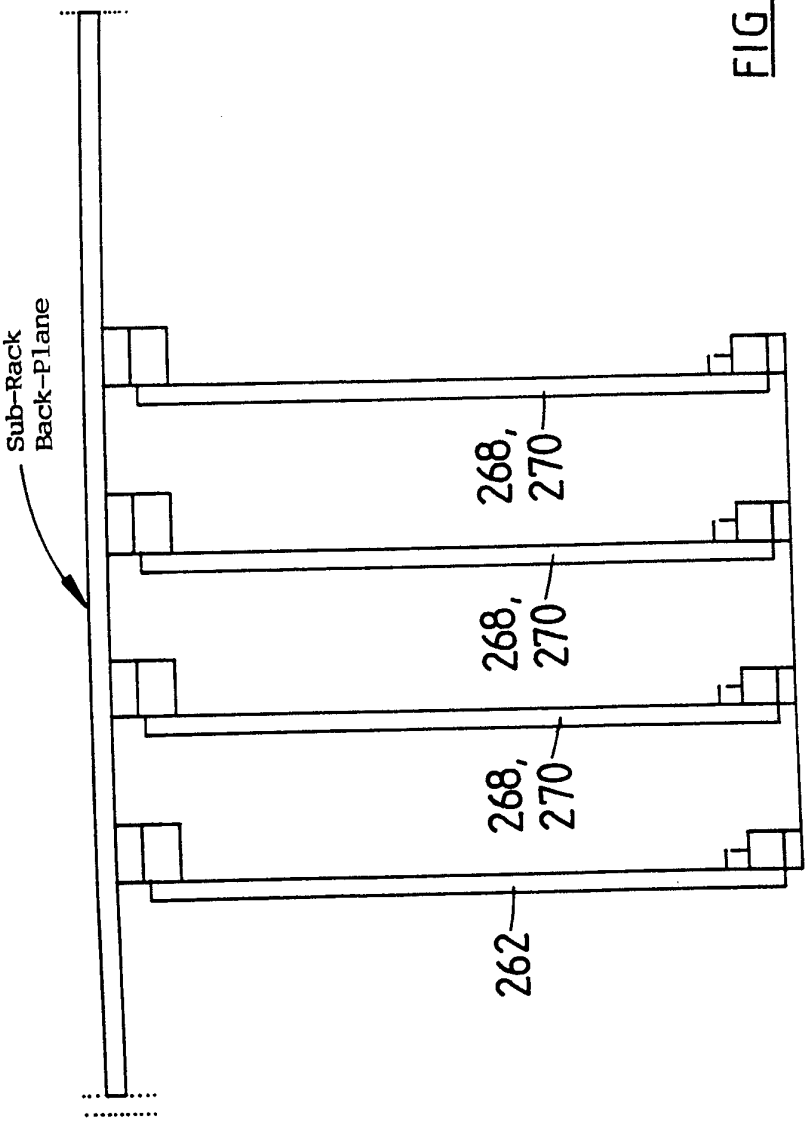

268,270
87
88
86
86
88
84
286,288
94
RETIMING & TRI-STATE BUFFERS
90
PARALLEL/ SERIAL CONVERTER
ELASTIC STORE
HDB3/8325 ENCODER
INTERFACE
92

FIG 21

FIG 22



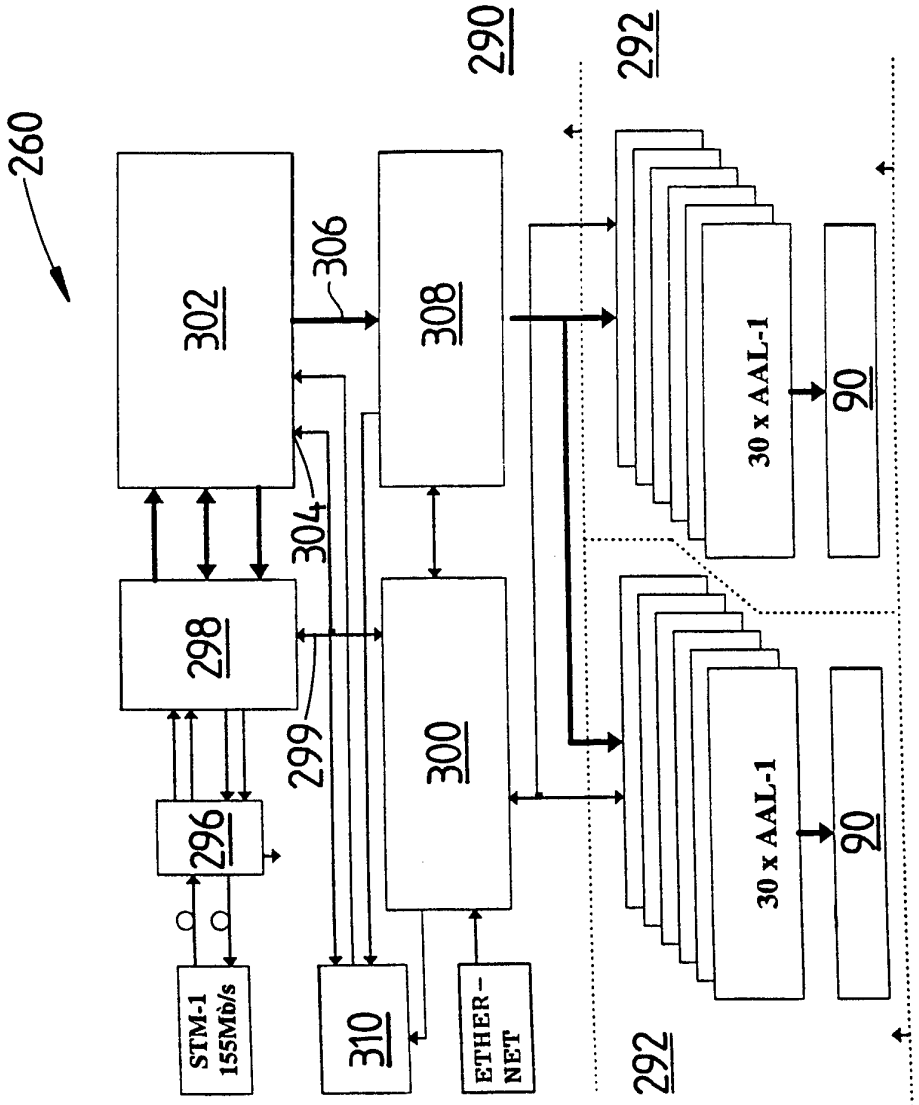

260
290
292
302
306
308
304
298
299
300
296
STM-1
155Mb/s
310
ETHER-
NET
30 x AAL-1
90
30 x AAL-1
90
292

FIG 23

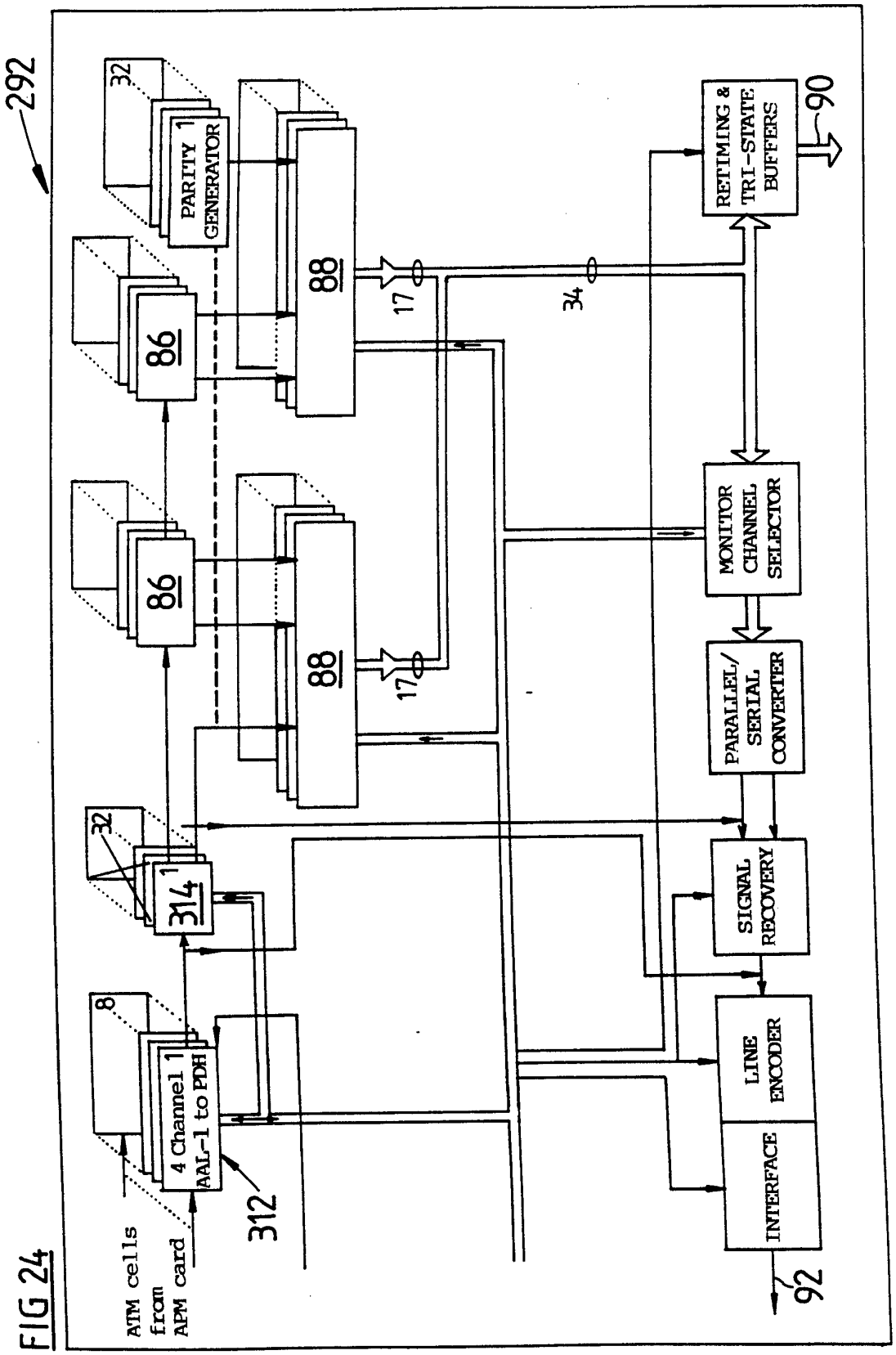

292
32
PARITY 1 GENERATOR
86
88
17
34
RETIMING & TRI-STATE BUFFERS
90
MONITOR CHANNEL SELECTOR
PARALLEL/ SERIAL CONVERTER
SIGNAL RECOVERY
LINE ENCODER
INTERFACE
92
314
8
4 Channel 1 AAL-1 to PDH
312
ATM cells from APM card

FIG 24

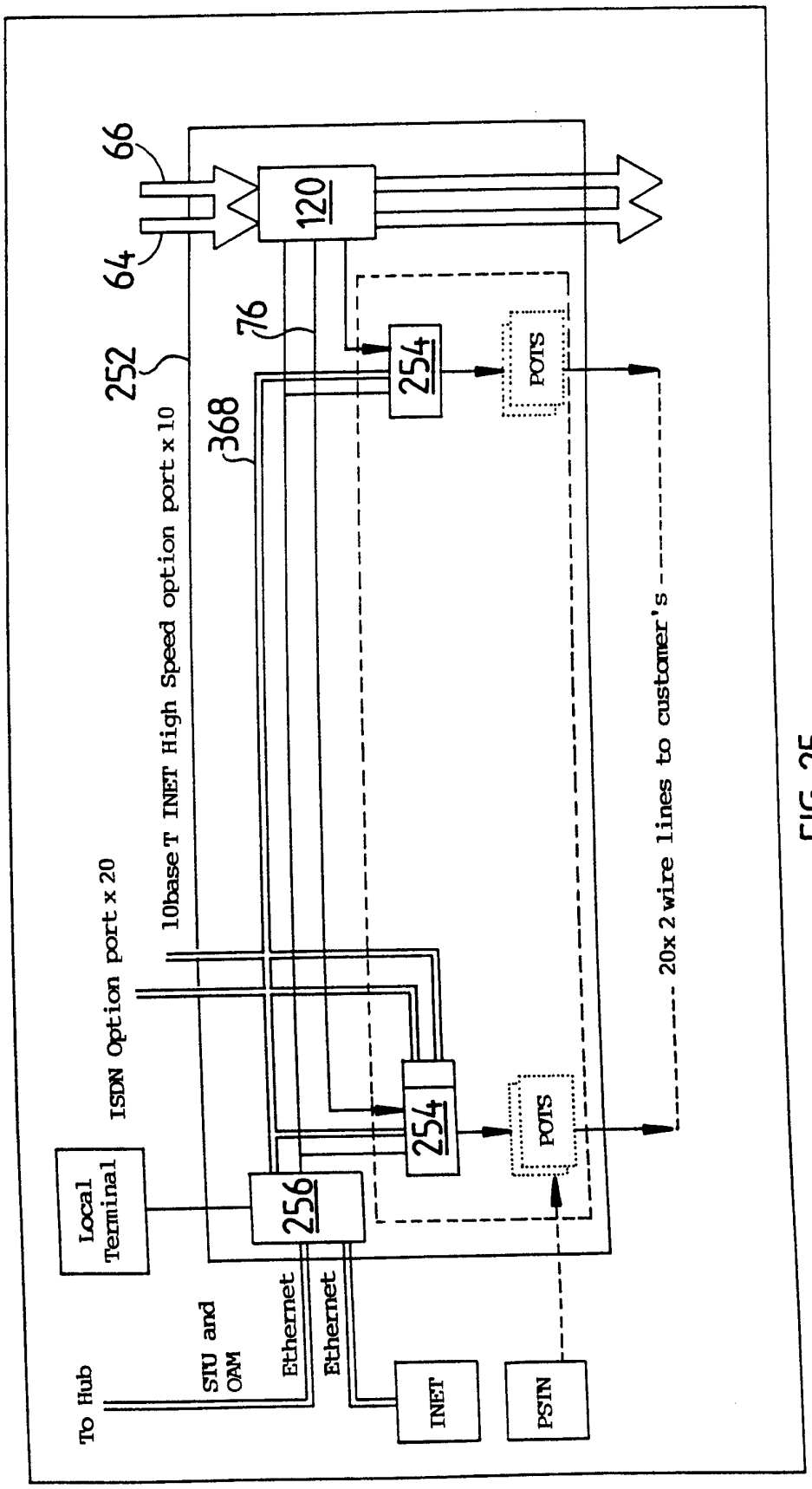

66
64
120
76
252
368
254
POTS
10base T INET High Speed option port x 10
ISDN Option port x 20
20x 2 wire lines to customer's
Local Terminal
256
254
POTS
To Hub
STU and OAM
Ethernet
Ethernet
INET
PSTN

FIG 25

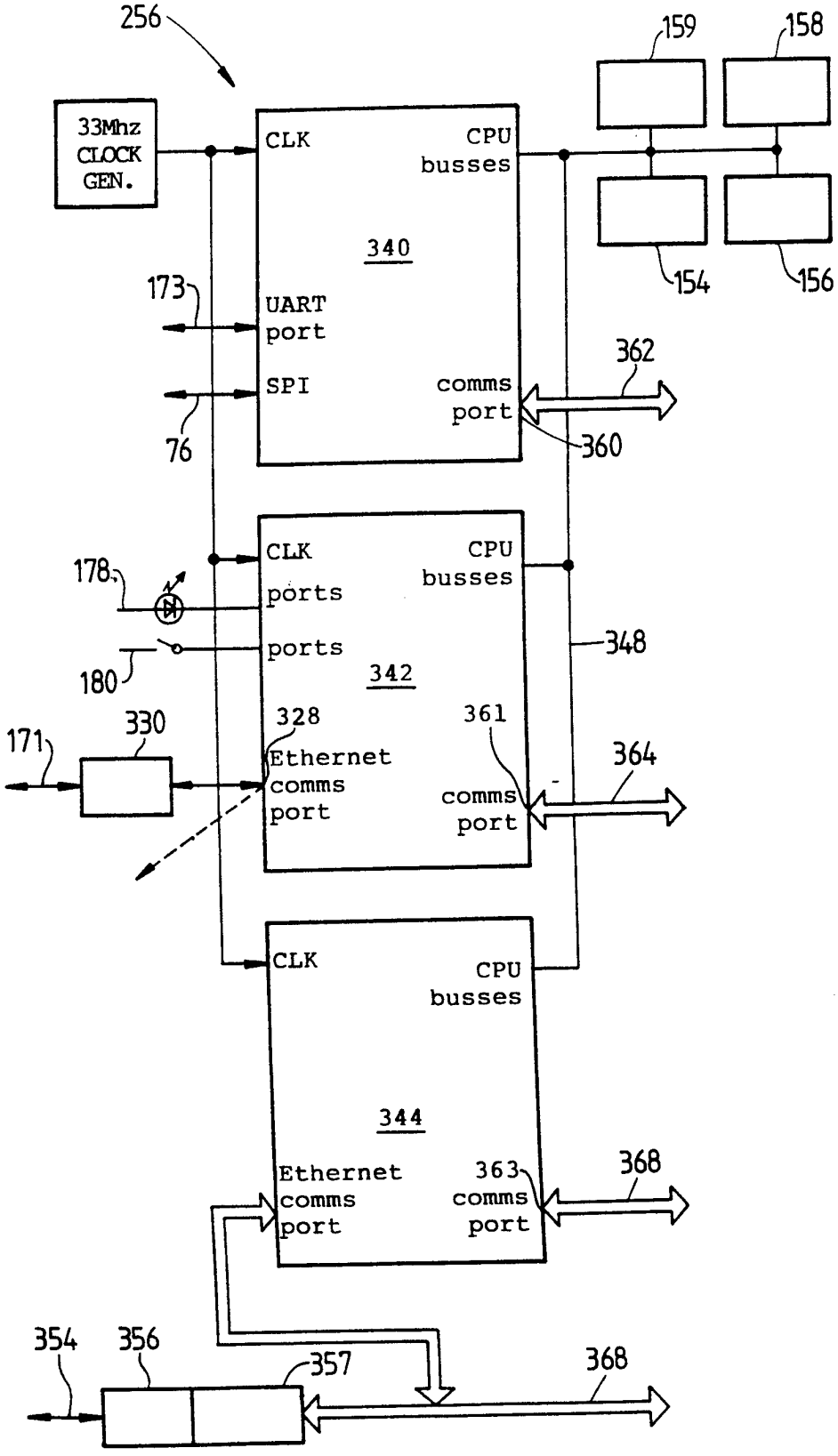

256
159
158
33Mhz CLOCK GEN.
CLK
CPU busses
340
154
156
173
UART port
362
SPI
comms port
76
360
CLK
CPU busses
178
ports
348
ports
342
180
330
328
361
171
Ethernet comms port
364
comms port
CLK
CPU busses
344
Ethernet comms port
363
comms port
368
354
356
357
368

FIG. 26

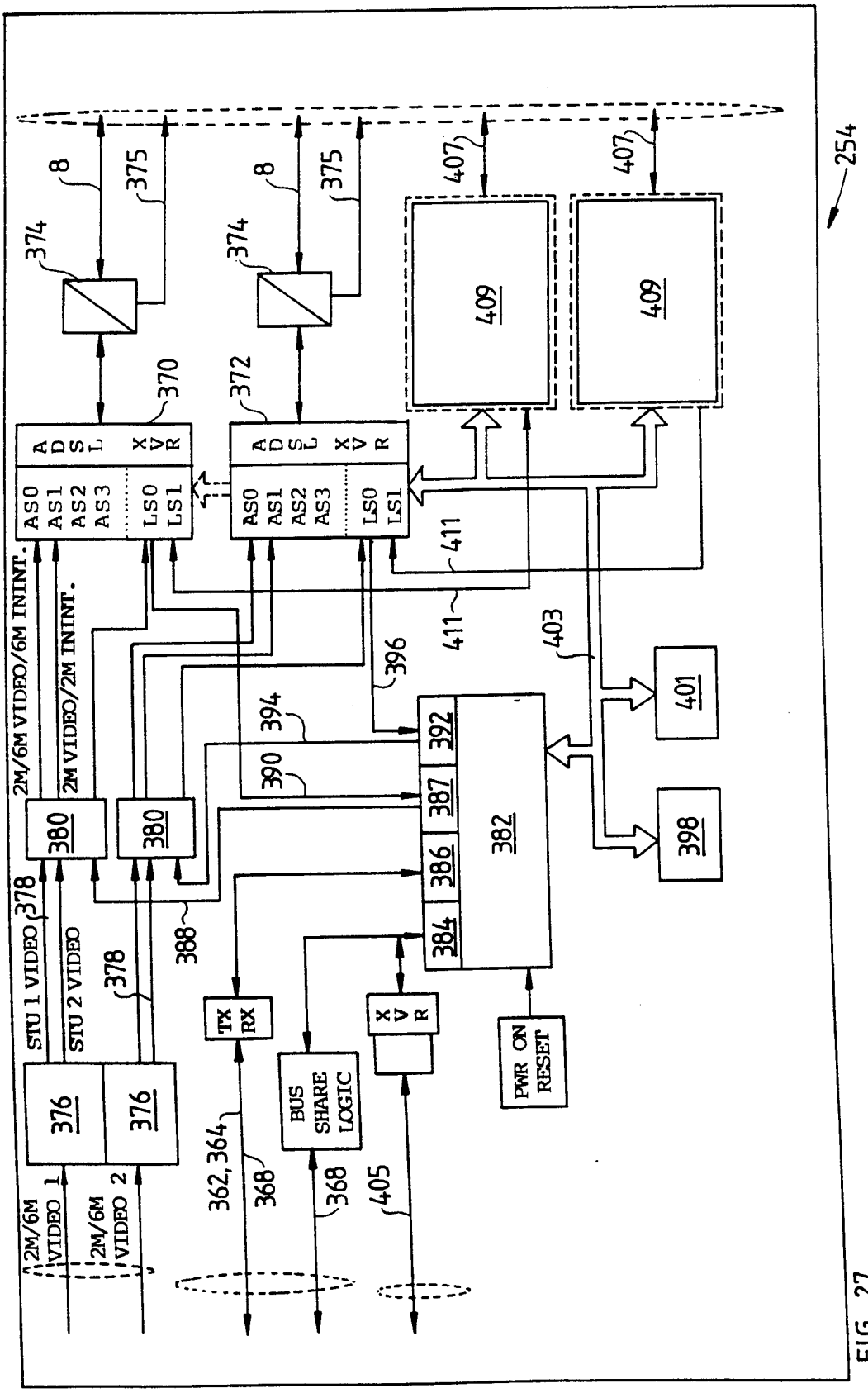

254
8
375
374
370
372
407
409
ADSL
XVR
AS0
AS1
AS2
AS3
LS0
LS1
411
403
396
394
390
392
387
386
384
382
401
398
380
388
378
2M/6M VIDEO/6M ININT.
2M VIDEO/2M ININT.
STU 1 VIDEO
STU 2 VIDEO
376
2M/6M VIDEO 1
2M/6M VIDEO 2
TX RX
XVR
BUS SHARE LOGIC
PWR ON RESET
362, 364
368
405

FIG 27

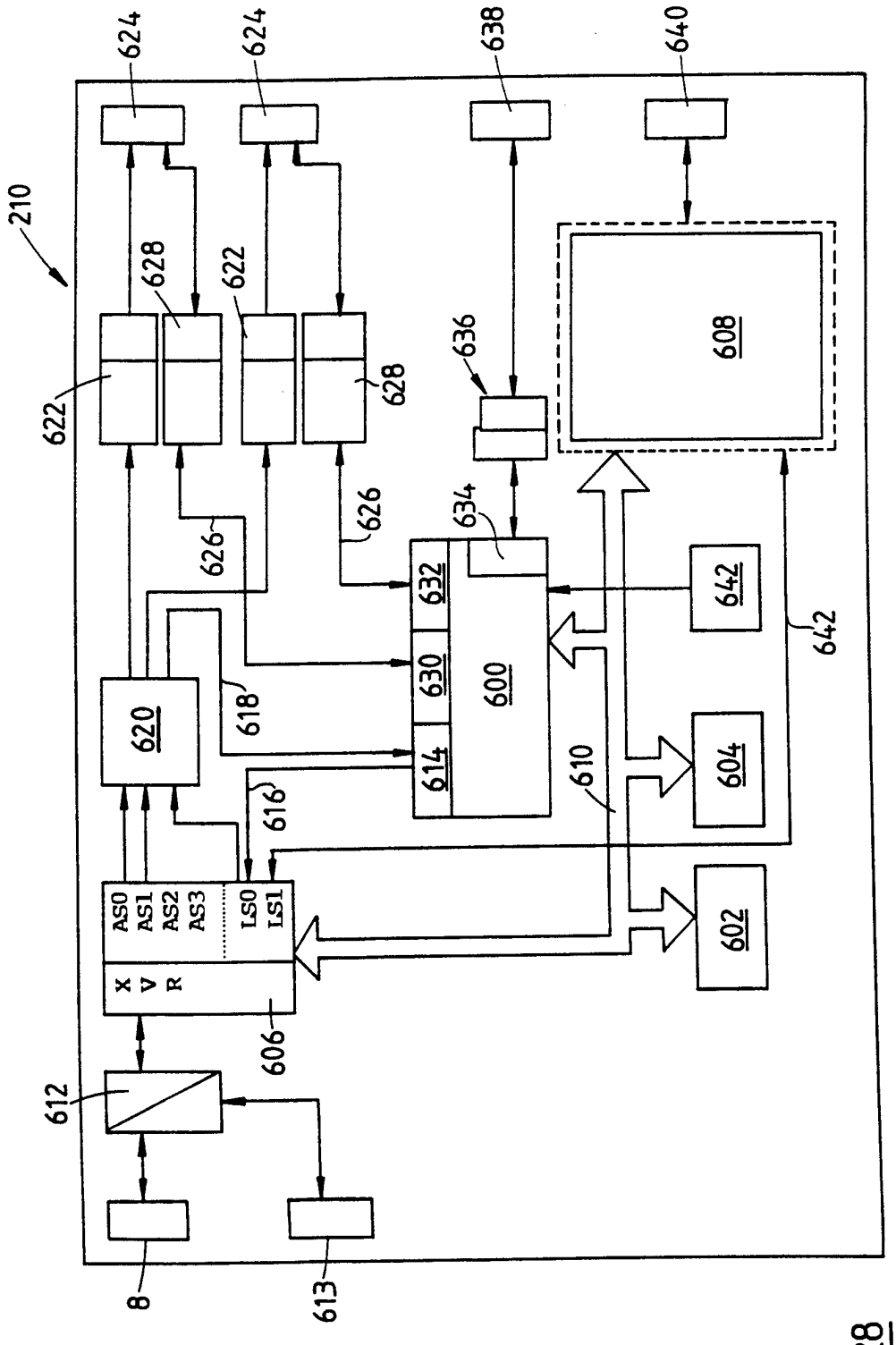

210
624
624
638
640
628
622
622
628
636
608
626
626
634
632
630
600
614
642
642
620
618
604
610
616
AS0
AS1
AS2
AS3
LS0
LS1
X
V
R
602
606
612
8
613

FIG 28

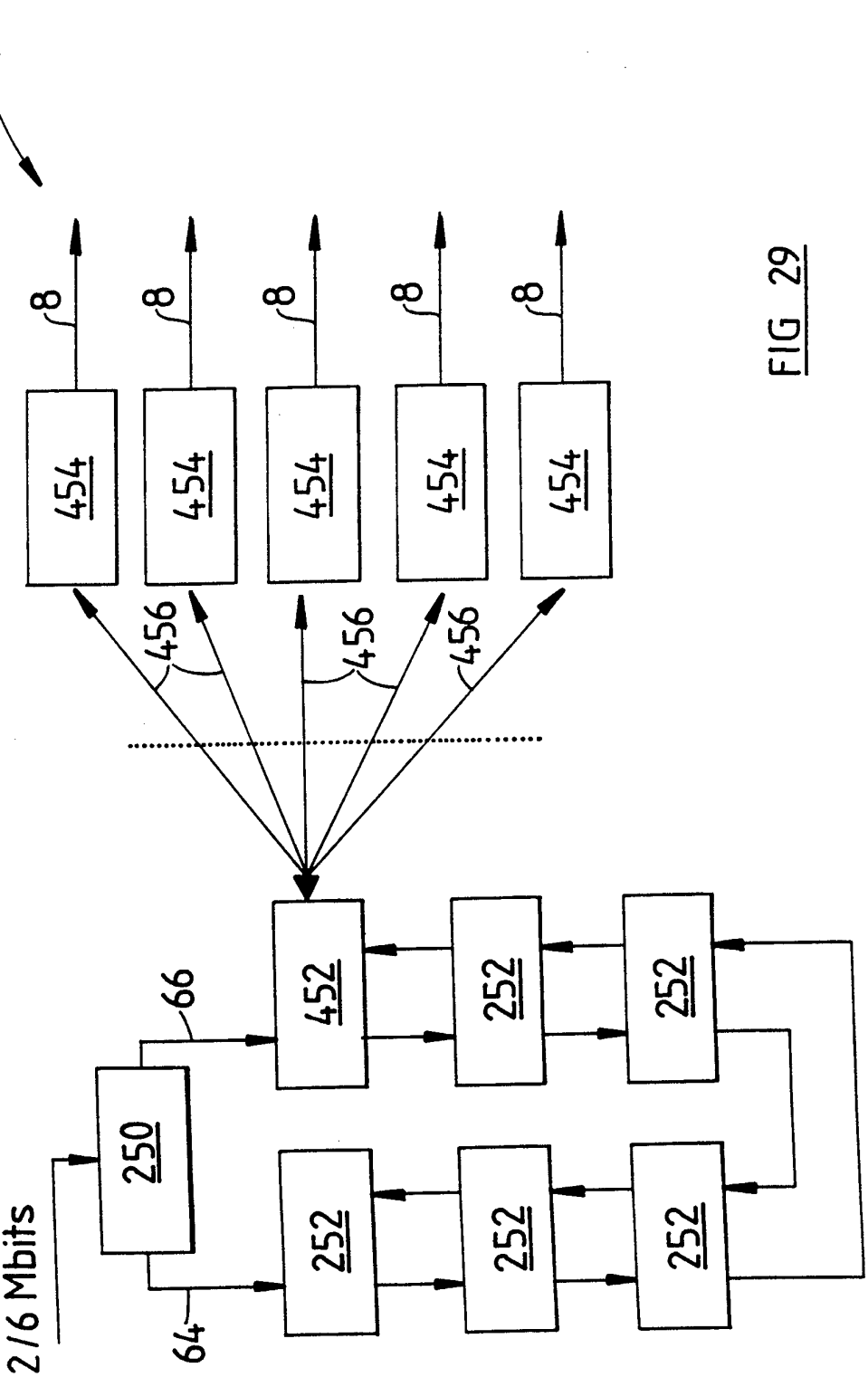


FIG 29

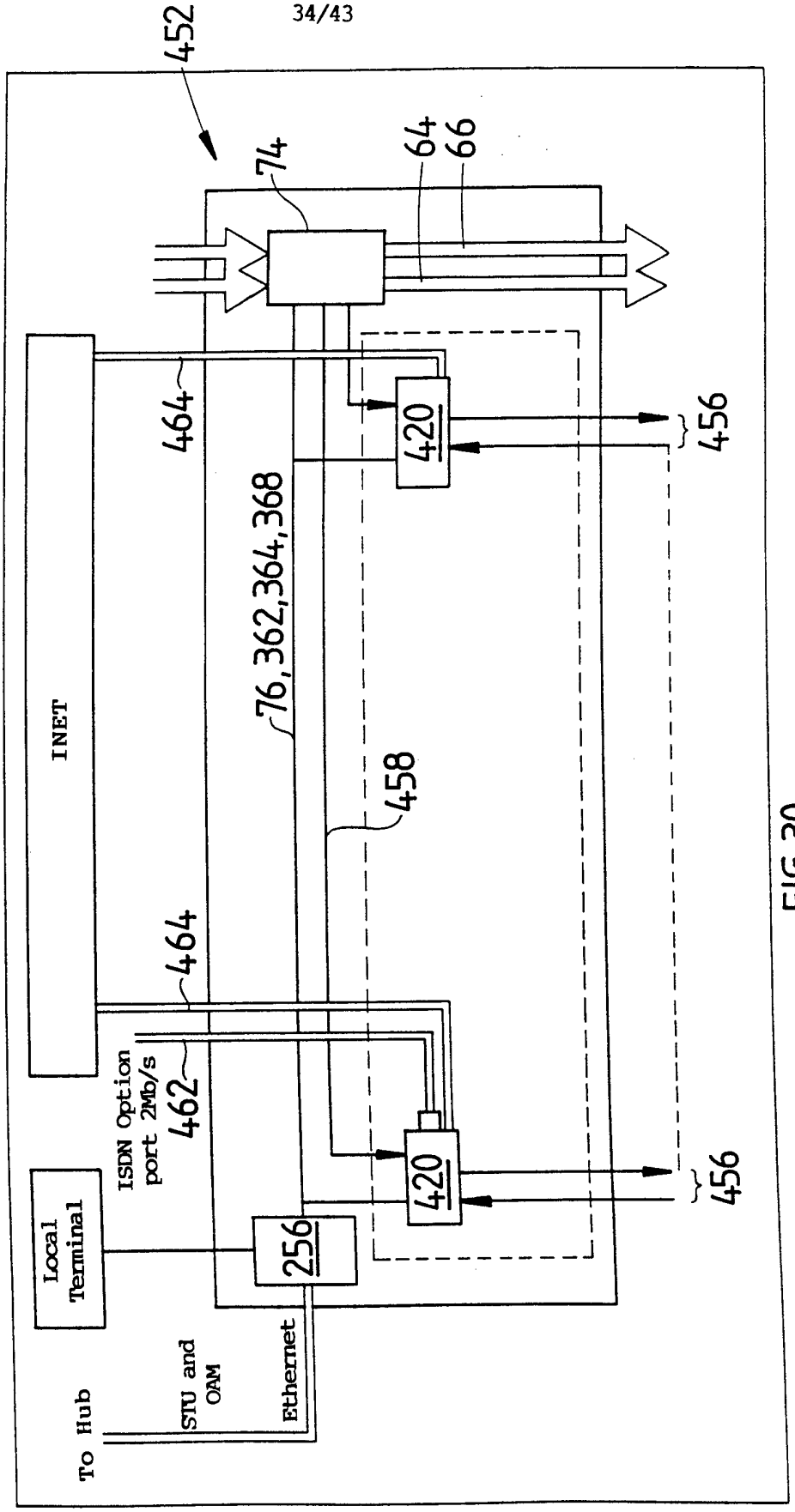

452
74
64
66
464
420
456
76,362,364,368
458
INET
464
ISDN Option
port 2Mb/s
462
420
456
Local
Terminal
256
To Hub
STU and
OAM
Ethernet

FIG 30

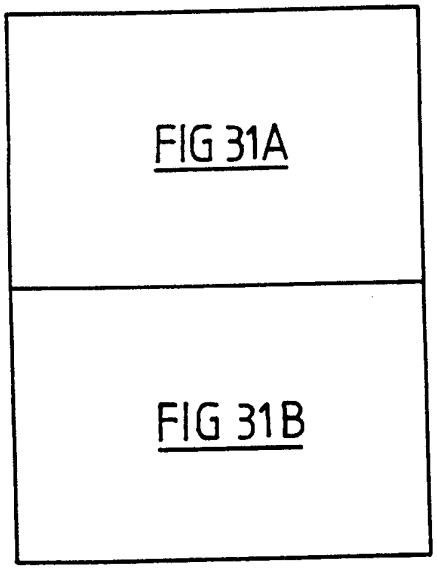


FIG 31

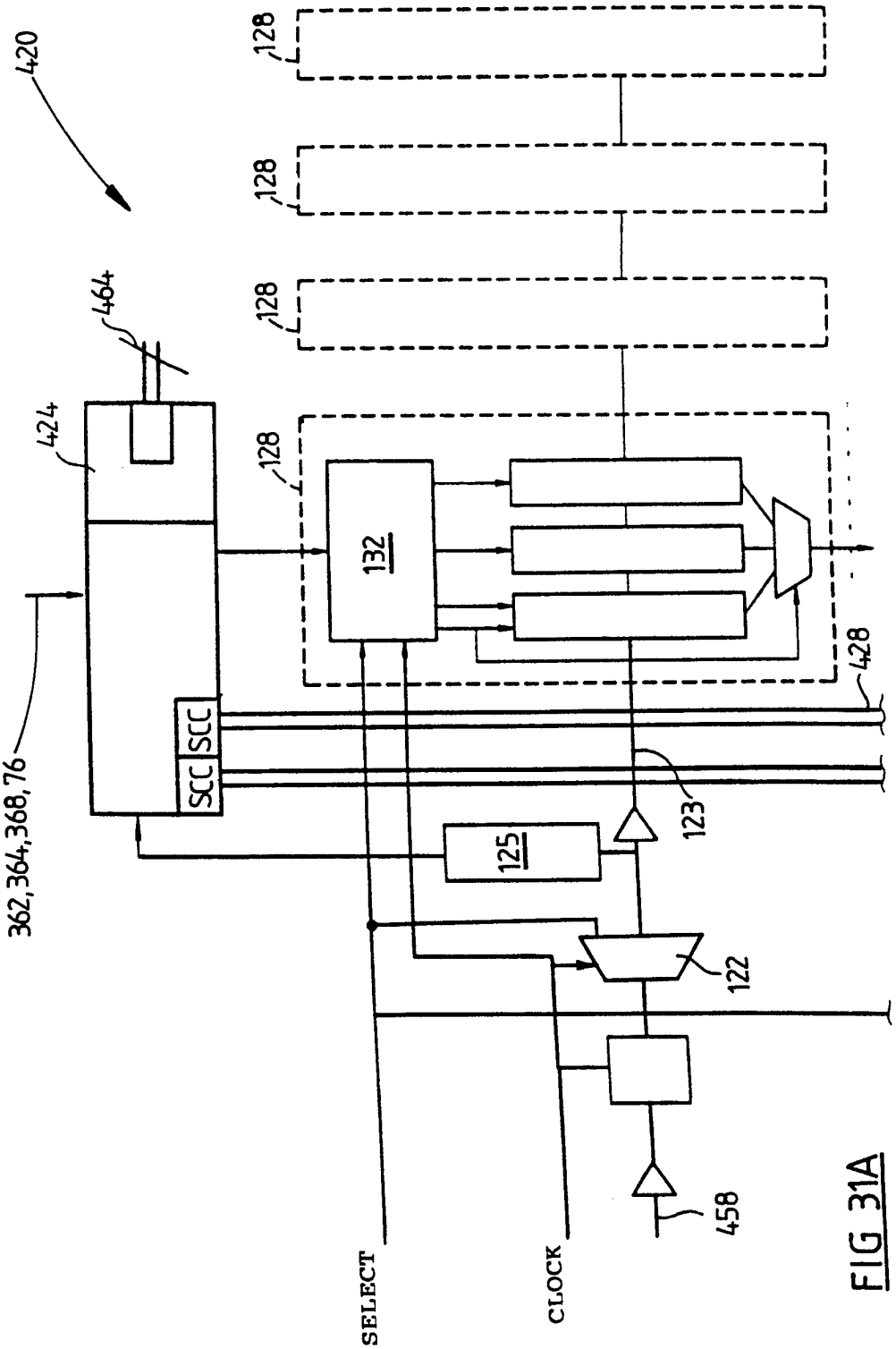

420
128
128
128
464
424
128
132
428
SCC
SCC
362, 364, 368, 76
123
125
122
458
SELECT
CLOCK

FIG 31A

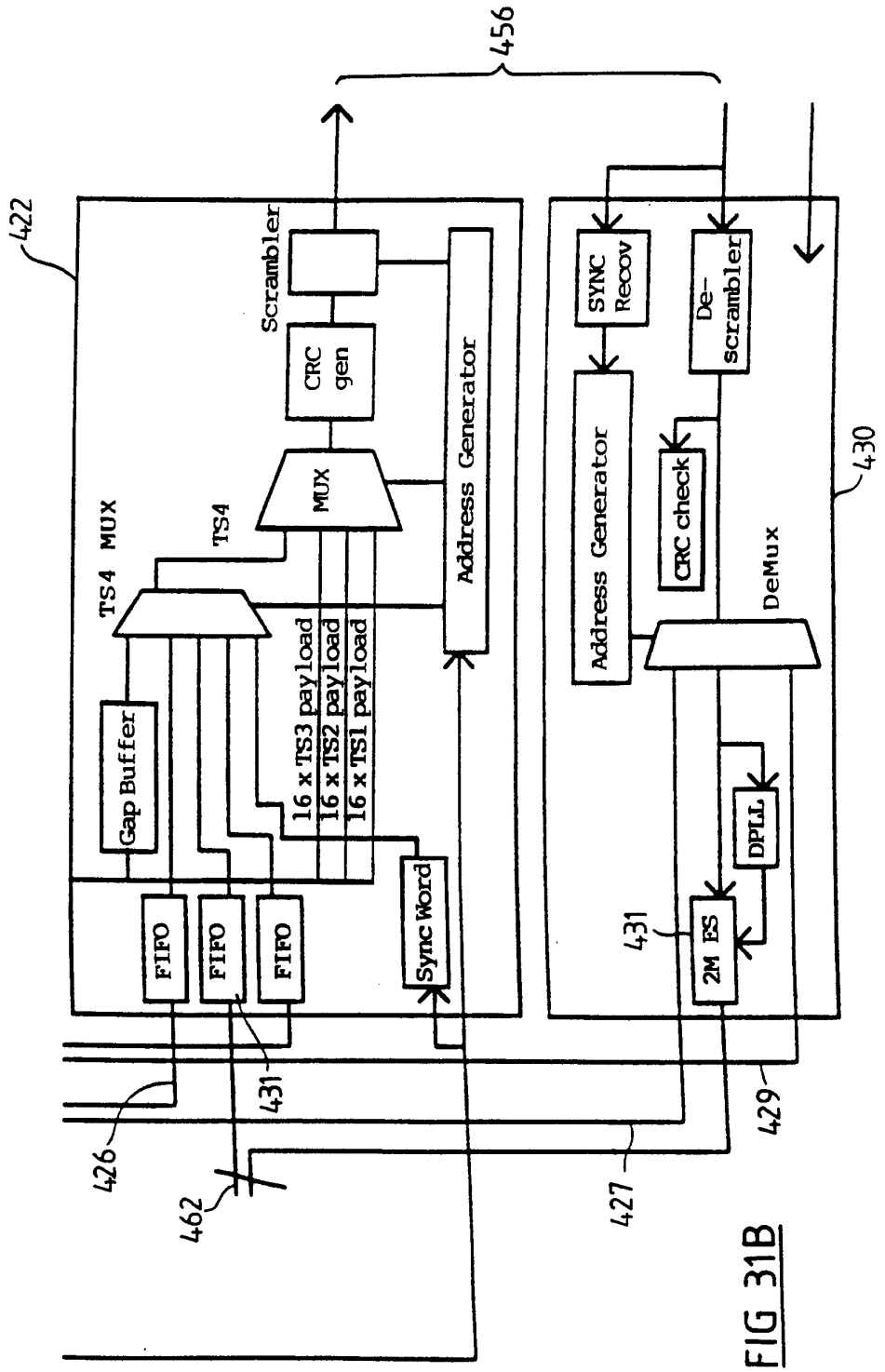

456
422
Scrambler
CRC gen
MUX
Address Generator
TS4
TS4 MUX
Gap Buffer
16 x TS3 payload
16 x TS2 payload
16 x TS1 payload
FIFO
FIFO
FIFO
Sync Word
431
426
462
SYNC Recov
De-scrambler
Address Generator
CRC check
DeMux
430
DPLL
2M ES
431
429
427

FIG 31B

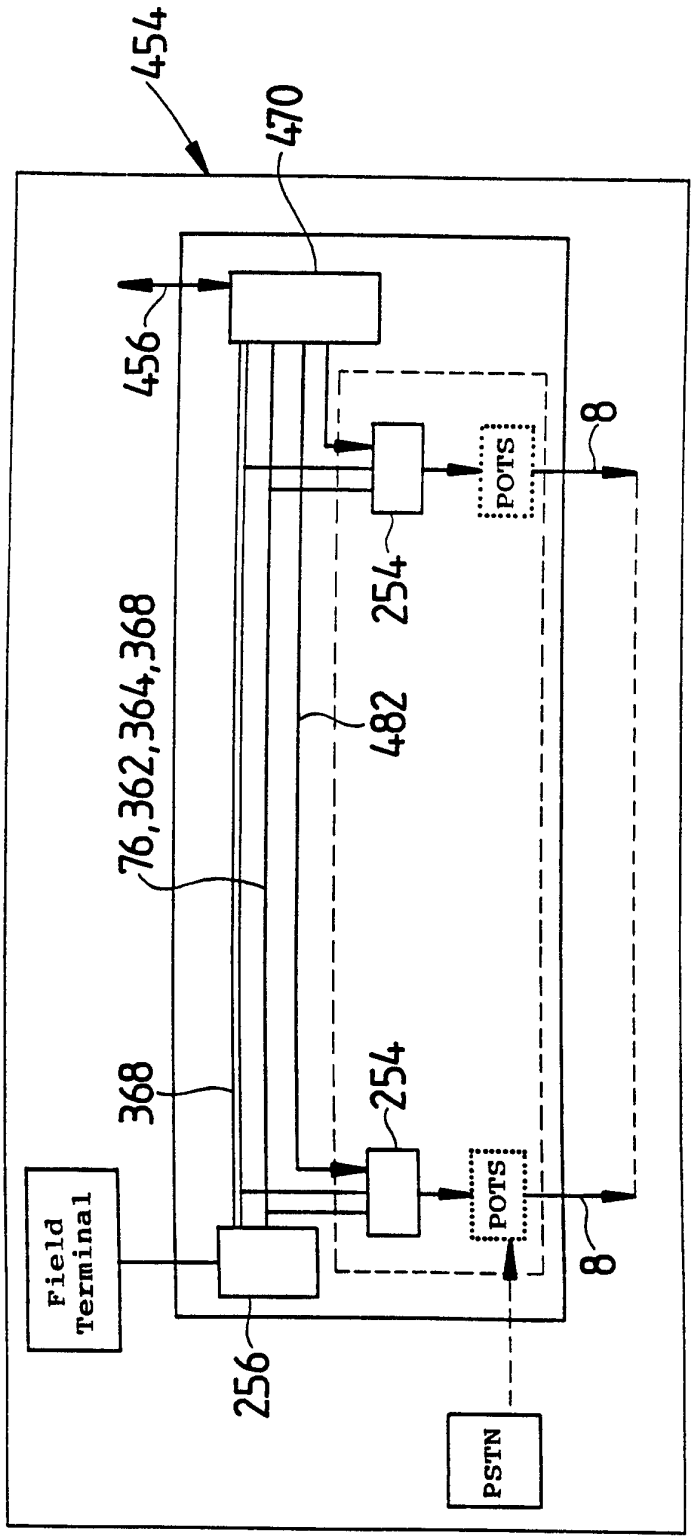

454
470
456
POTS
8
254
482
76,362,364,368
368
254
POTS
8
Field Terminal
256
PSTN

FIG 32

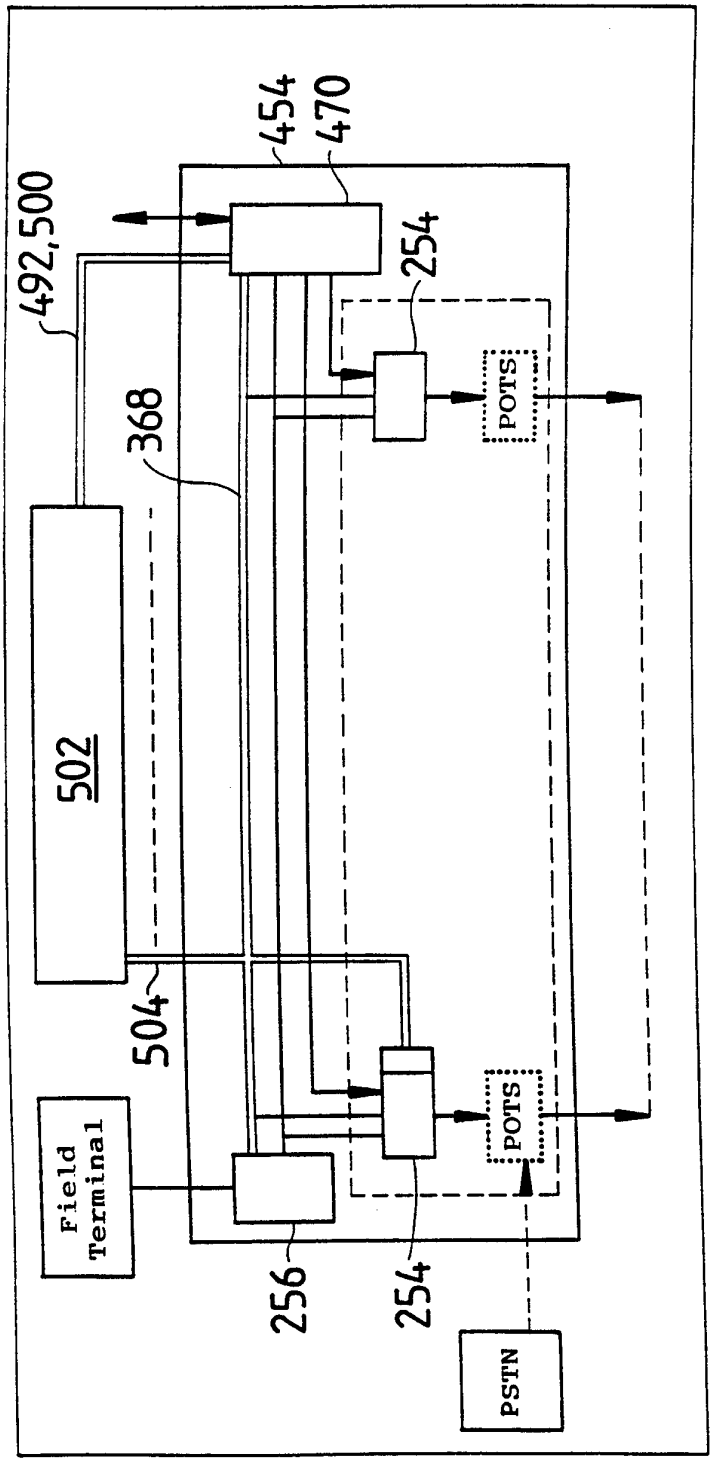

454
470
492,500
254
POTS
368
502
504
Field Terminal
POTS
256
254
PSTN

FIG 33

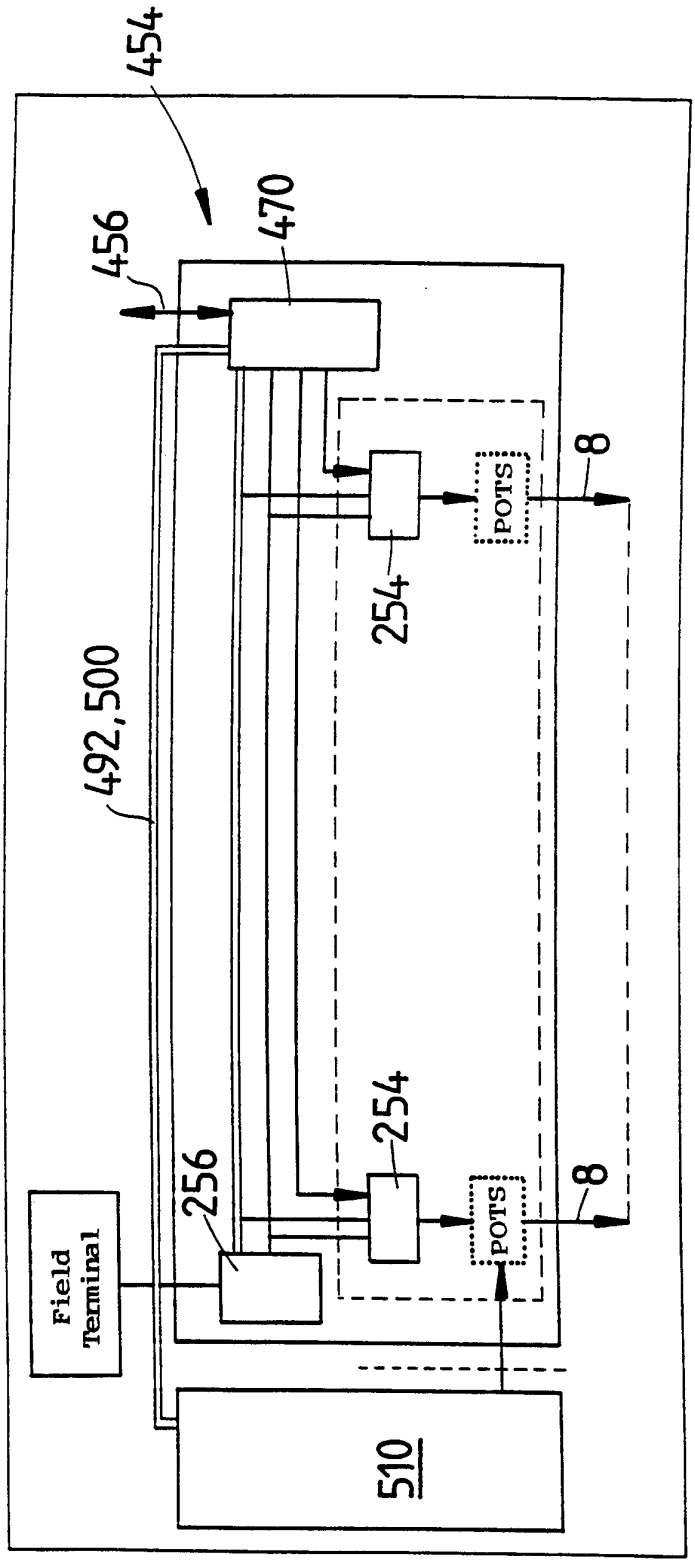

454
456
470
492,500
254
POTS
8
254
POTS
8
256
Field Terminal
510

FIG 34

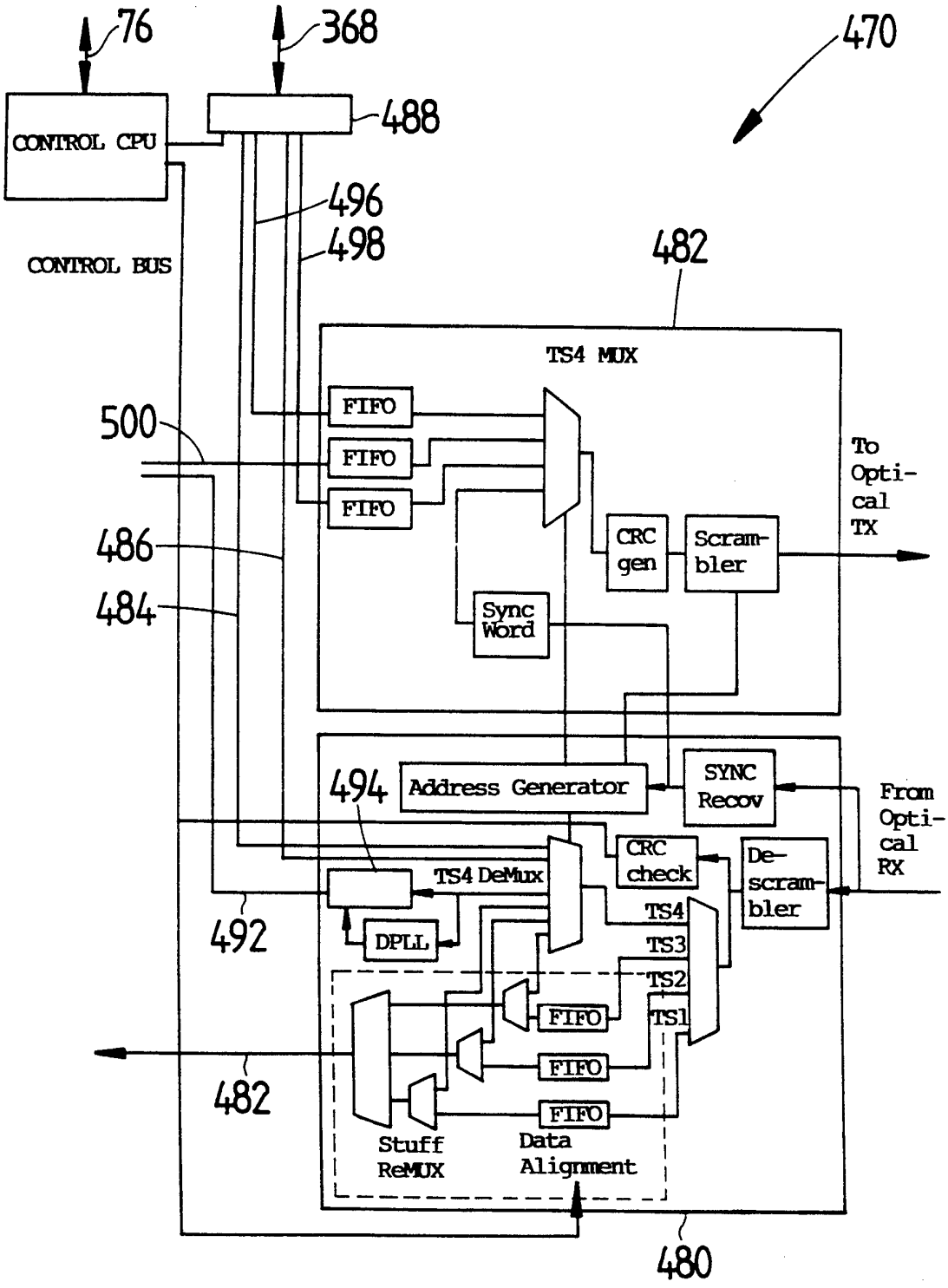

76
368
470
CONTROL CPU
488
496
498
CONTROL BUS
482
TS4 MUX
500
FIFO
FIFO
FIFO
To Optical TX
CRC gen
Scrambler
486
484
Sync Word
494
Address Generator
SYNC Recov
From Optical RX
CRC check
De-scrambler
TS4 DeMux
TS4
TS3
TS2
TS1
492
DPLL
FIFO
FIFO
FIFO
482
Stuff ReMUX
Data Alignment
480

FIG 35

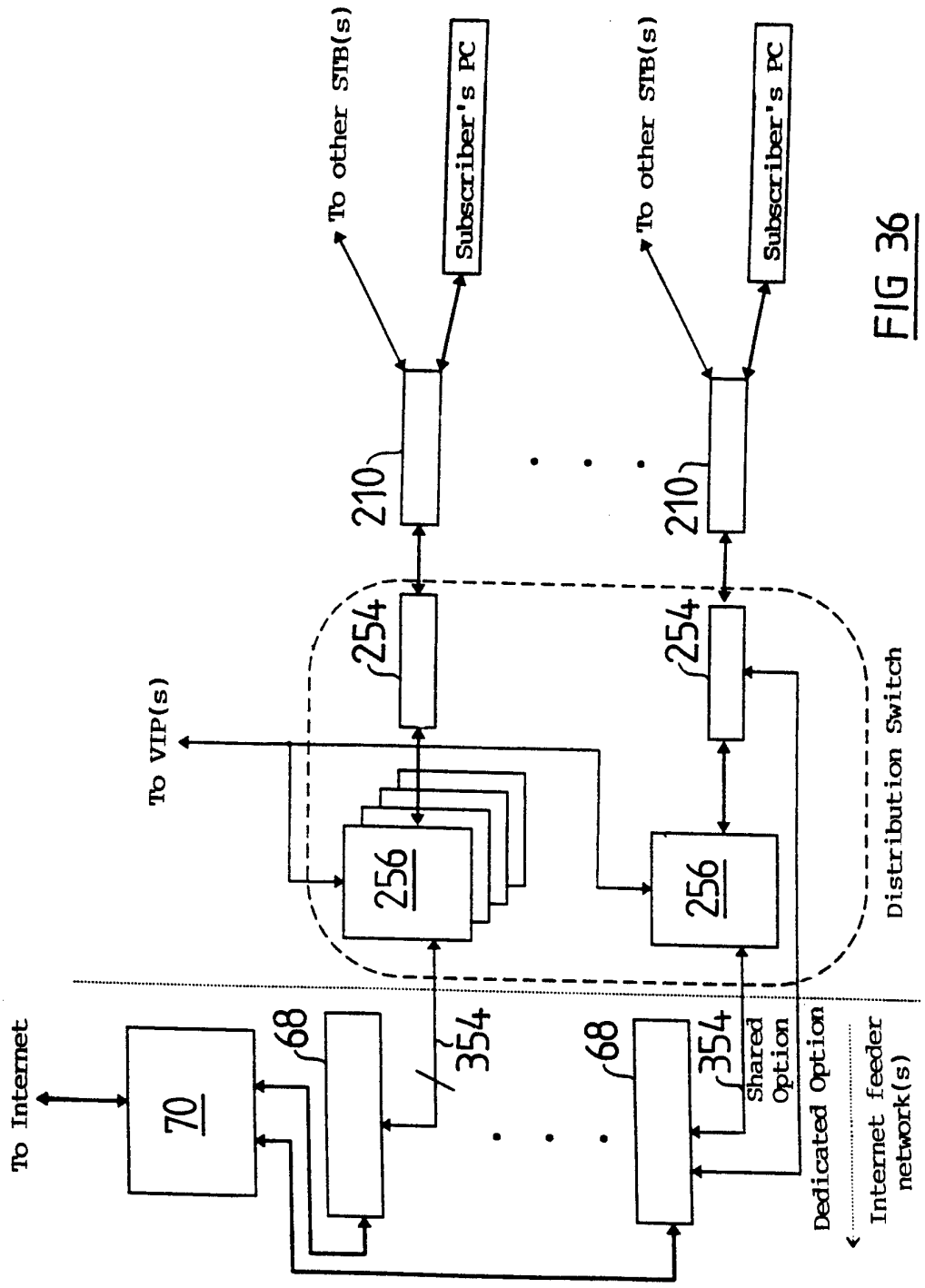

To other STB(s)
Subscriber's PC
To other STB(s)
Subscriber's PC
210
210
254
254
To VIP(s)
256
256
Distribution Switch
To Internet
70
68
354
68
354
Shared Option
Dedicated Option
Internet feeder network(s)

FIG 36

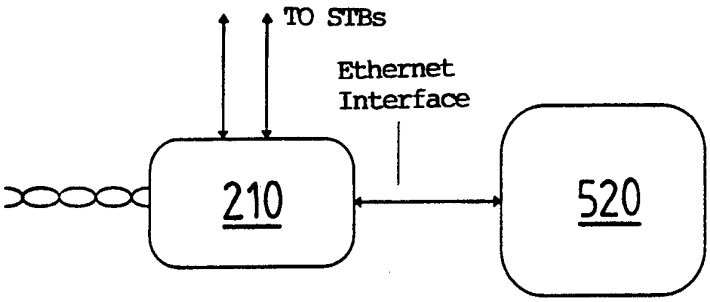


FIGURE 37

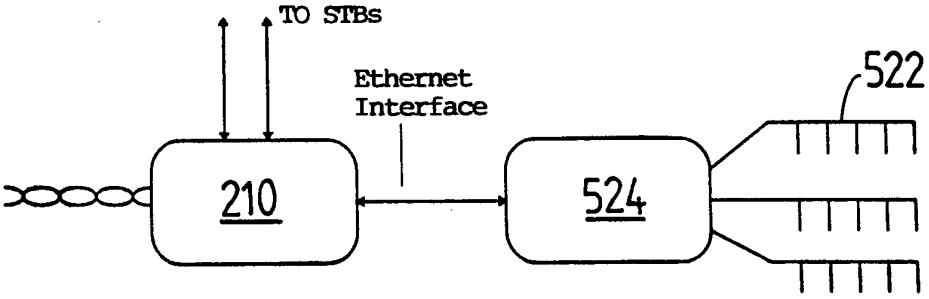


FIGURE 38

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00561

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: H04N 7/173, H04H 1/04, 1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC H04N 7/173, 7/17, H04H 1/04, 1/08, H04L 12/16, 12/18, 11/18 H04M 11/08, 3/42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT: SWITCH or DISTRIBUTION
JAPIO : SWITCH or DISTRIBUTION

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Proceedings IEEE INFOCOM '90, Conference on Computer Communications, ninth annual joint conference of the IEEE Computer and Communications Societies, Los Alamitos, IEEE Computer society Press. 1990. T. S. YUM, "Hierarchical Distribution of Video with dynamic Port Allocation", pages 321-328 Page 321, column 2, lines 12-39, Fig. 1	1,27-29,31-33 40
Y	Communication & Transmission, Vol. 17 No. 4, 1995 SOTELEC, Paris. B. PILLET, "Optical Access Network", pages 67-76 Pages 67-69, page 70, column 3, page 74, columns 1-2	31-33, 40

[X] Further documents are listed in the continuation of Box C

[X] 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 document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 November 1996	9 DEC 1996
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer J. LAW Telephone No.: (06) 283 2179

Form PCT/ISA/210 (second sheet) (July 1992) copjhw

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00561

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	IEEE Transaction on Networking, Vol. 2 No. 6, December 1994. IEEE Computer Society, New York, NY. Y. W. LEUNG, et al., "A Modular Multirate Video Distribution System - Design and Dimensioning", pages 549-557 Pages 549-552, figs. 1-8 Pages 555, column 2 - pages 556, column 1, Fig. 9.	1,27-29,31-33, 40
X Y	AU 61924/94 A (ALCATEL N.V.) 24 November 1994 Page 8 line 24 - page 11 line 19, fig. 1	1,27-29,31-38, 40, 42-45
P,X Y	WO 95/34169 A (UNISYS CORPORATION) 14 December 1995 The Abstract, pages 11-17, Fig. 1.	1, 27-29 31-38, 40 42-45
X Y	Martin de Prycker, "Asynchronous Transfer Mode, Solution for Broadband ISDN", ELLIS HORWOOD, 1991, England. Pages 156-157.	1 27-29, 31-33, 40
X,Y	Patent Abstract of Japan, E839, page 34, JP 1-190150 A, (NIPPON TELEGR & TELEPH CORP) 31 July 1989 Abstract	1, 27-29, 31-33, 40
X	W.W. Hodge, "Interactive Television A Comprehensive Guide for Multimedia Technologists". McGraw-Hill, USA, 1995 Pages 48-50	34,35,37-39 42-43
X	EP 431816 A (CABLETIME LIMITED) 12 June 1991 Column 2, line 41 - column 6 line 4	34,35,37,42,43
X	EP 653884 A (BELL TELEPHONE MANUFACTURING COMPANY) 17 May 1995 Column 9 line - column 10 line 37, Fig. 1	34,35,37-39 42, 43
X	EP 653885 A (BELL TELEPHONE MANUFACTURING COMPANY) 17 May 1995 Column 7 line 11 - column 8 line 17	34,35,37-39 42,43
X	EP 660605 A (HITACHI LTD.) 28 June 1995 Column 8 line 36 - column 9 line 40, Fig. 1.	34,35,37,38 42,43
X	WO 94/23537 A (BELL ATLANTIC SERVICES INC.) 13 October 1994 Page 6 line 25 - page 19 line 13	34,35, 37-39, 42, 43
X	WO 93/06692 A (BELL ATLANTIC NETWORK SERVICES, INC.) 1 April 1993 Abstract, page 8 line 10 - page 13 line 16	34,35,42,43

AUSTRALIAN PATENT OFFICE
SEARCH REPORT

Application No.
AU 96/00561

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5130792 A (TINDELL et al.) 14 July 1992 Column 2, line 44 - column 7 line 8	34,35,42,43
X	WO 95/17055 A (BRITISH TELECOMMUNICATIONS PLC) 22 June 1995 Page 12 line 37 - page 13 line 25, Fig. 7 page 14 line 10 - page 15 line 1, Fig. 8	34,35,37,38 42,43
X	EP 513763 A (FUJITSU LIMITED) 19 November 1992 Column 3 line 39 - column 8 line 5, Fig. 1	34,35,37,38 42, 43
X	AU 59339/94 A (AMERICAN TELEPHONE AND TELEGRAPH COMPANY) 10 November 1994 Page 3 line 21 - page 9 line 2	34,35,37,38 42, 43
X	AU 20649/92 A (ALCATEL N.V.) 4 February 1993 Page 11 line 10 - page 15 line 3 page 18 lines 17-33	34,35,37,38 42, 43
X	GB 2124059 A (THE GENERAL ELECTRIC COMPANY plc) 8 February 1984 The whole document	34,35,37,38 42, 43
X	Patent Abstracts of Japan JP, 6-205414 A (NIPPON TELEGR & TELEPH CORP) 22 July 1994 Abstract	34,35,42,43
X	Patent Abstracts of Japan E-862, page 92, JP, 1-238392 A (FUJITSU LTD) 22 September 1989 Abstract	34,35,37,38 42,43
P,X	US 5488411 A (LEWIS) 30 January 1996 Column 4 line 64 - column 8 line 48	34,35,37,38 42, 43
P,X	AU 30428/95 (ALCATEL N.V.) 21 March 1996 Abstract, page 10 line 21 - page 14 line 10	34,35,37,38 42,43
P,X	US 5541927 (KRISTOL et al) 30 July 1996 The claims	32

AUSTRALIAN PATENT OFFICE SEARCH REPORT	Application No. AU 96/00561

C (Continuation)	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 95/34168 (PHILIPS ELECTRONICS N.V.) 14 December 1995 Page 4 line 15 - page 5 line 20, Fig. 1	34,35,42,43
P,X	EP 698999 A (HEWLETT PACKARD COMPANY) 28 February 1996 Column 5 line 52 - column 8 line 5	34,35,42,43
P,X	US 5541757 A (FUSE et al) 30 July 1996 Column 4 line 37 - column 5 line 6	37
P,X	US 5534913 A (MAJETI et al) 9 July 1996 Column 8 line 39 - column 11 line 55	34,35,42,43

INTERNATIONAL SEARCH REPORT

...ernational Application No.
PCT/AU 96/00561

Box 1 Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-33, 37-41 directed to a distribution switch/system where content signal is received and is then multicasted. It is considered that the reception and multicast of the content signal comprises a first "special technical feature".
2. Claims 34-36, 42-46 directed to an asymmetric distribution switch where high/low bit rate communication channels are established in between the content provider, the exchange units and the customer units. The establishment of communication channels characterised by the respective high or low bit rates is considered to comprise a second "special technical feature".

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/AU 96/00561

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

AU 96/00561 Patent Document Cited in Search Report		Patent Family Member					
AU	61924/94	AU	670189	EP	625855	NZ	260222
WO	9534169						
EP	431816	GB	8927344				
EP	653884	AU	77742/94	CA	2135990	CN	1110456
		EP	653884	JP	7203418		
EP	653885	AU	77743/94	CA	2135991	US	5539448
EP	660605	JP	7236132				
WO	9423537	AU	66999/94	US	5528281	AU	24894/92
		AU	660710	EP	605454	JP	7502629
		NZ	244083	US	5247347	WO	9306692
		US	5410343	US	5528281	EP	605454
		JP	7502629	JP	6505728	WO	9216494
		AU	13720/92	FI	933828	NO	933272
		CA	2106068	FI	933828	GB	9105489
		HU	9302596				
WO	9306692	AU	24894/92	AU	660710	EP	605454
		JP	7502629	NZ	244083	US	5247347
		US	5410343	US	5528281	AU	66999/94
		WO	9423537	WO	9216494	AU	13720/92
		FI	933828JP	JP	6505728	NO	933273
		CA	2106068	GB	9105489	HU	9302596
US	5130792						
							END OF ANNEX

Patent Document Cited in Search Report		Patent Family Member					
WO	9517055	AU	12477/95	EP	734623	GB	9325697
		US	5572349	WO	9517055		
EP	513763	CA	2068387	DE	69213317	EP	513763
		EP	715470	JP	4336830	US	5513180
AU	59339	AU	660387	CA	2116801	EP	624039
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		EP	701762	FI	955479	NO	954578
		US	5488411	WO	9525403		
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JP	205414						
JP	238392	DE	69021307	EP	419139	FR	2652170
		JP	3101779	US	5481347		
US	5541927	CA	2151072	EP	698975	JP	8088633
		US	5541927				
WO	9534168	WO	9534168				
EP	698999	JP	8018947				
US	5541757	JP	7183870				
US	5534913	WO	9527347				

END OF ANNEX