Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2381304 C 2006/11/21

(11)(21) 2 381 304

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2000/08/03
(87) Date publication PCT/PCT Publication Date: 2001/02/15
(45) Date de délivrance/Issue Date: 2006/11/21
(85) Entrée phase nationale/National Entry: 2002/02/05
(86) N° demande PCT/PCT Application No.: KR 2000/000856
(87) N° publication PCT/PCT Publication No.: 2001/011897
(30) Priorité/Priority: 1999/08/05 (KR1999/32187)

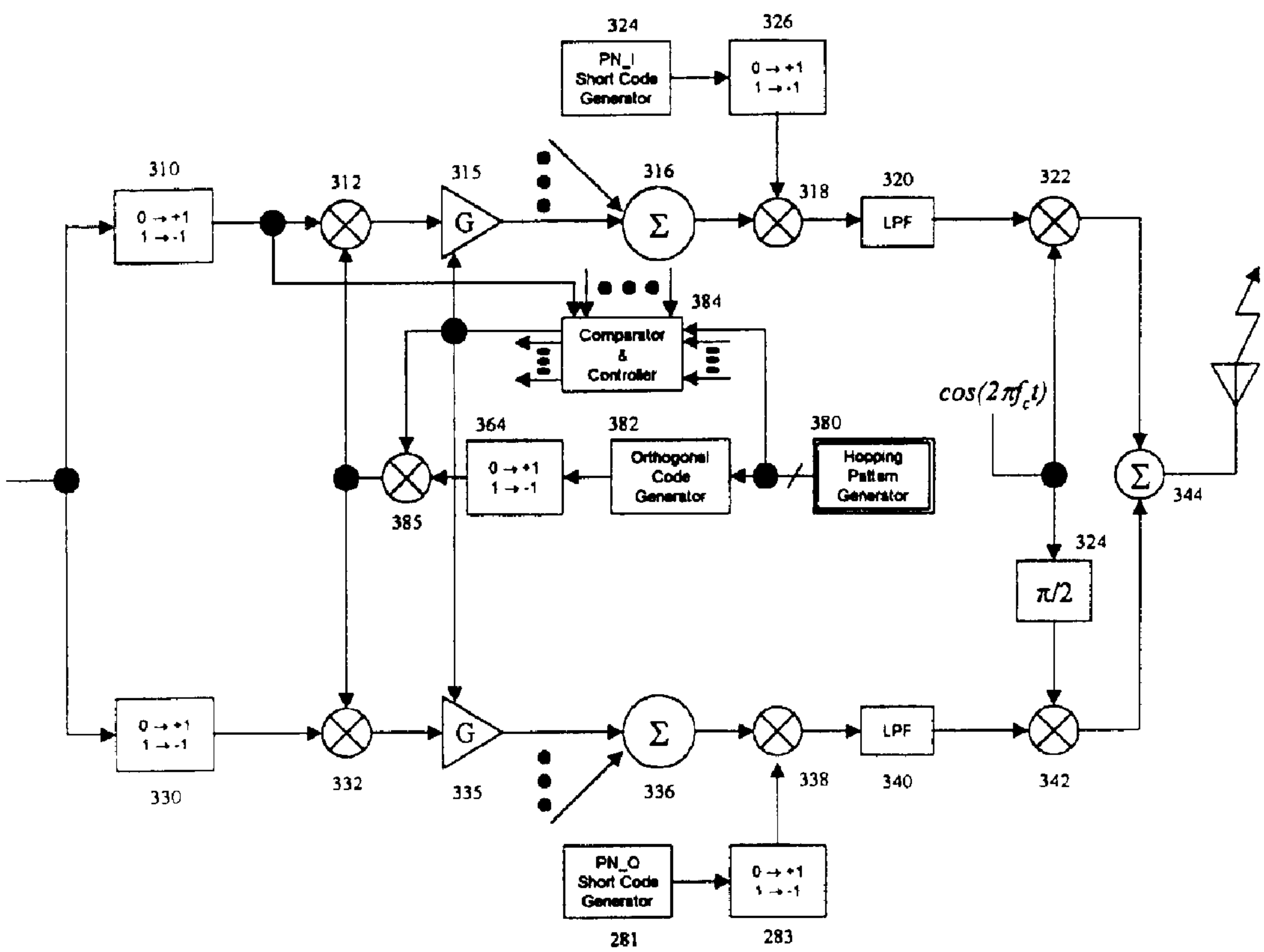
(51) Cl.Int./Int.Cl. *H04J 13/06* (2006.01), *H04B 1/69* (2006.01), *H04B 1/713* (2006.01), *H04J 11/00* (2006.01), *H04J 13/02* (2006.01), *H04J 13/00* (2006.01)

(72) Inventeurs/Inventors:
SUNG, DAN-KEUN, KR;
PARK, SU-WON, KR

(73) Propriétaires/Owners:
KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY, KR;
ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE, KR

(74) Agent: SMART & BIGGAR

(54) Titre : PROCEDE ET APPAREIL DE MULTIPLEXAGE DE CANAUX DE COMMUNICATION PAR SAUTS DE CODES ORTHOGONAUX
(54) Title: METHOD AND APPARATUS FOR ORTHOGONAL CODE HOPPING MULTIPLEXING COMMUNICATIONS



(57) Abrégé/Abstract:
This invention is concerned with a method and apparatus for statistically multiplexing based on orthogonal code hopping multiplexing according to orthogonal code hopping patterns in wired/wireless communication systems in which a plurality of

(11)(21) 2 381 304

(13) C

(57) Abrégé(suite)/Abstract(continued):
synchronized communication channels coexist through one media. The system comparing a primary communication station and a plurality of second communications includes an orthogonal code hopping pattern generator, a spreader for selecting a corresponding orthogonal codeword in the orthogonal code and data symbols, a comparator & controller for monitoring whether the orthogonal codewords collide and determining whether all the transmitting data symbols to the secondary communication stations are the same in the collision interval, a transmission controller for perforation (transmission 'OFF') in case that all the corresponding data symbols with the same orthogonal codeword for spreading are not the same, and a transmission power controller for compensating for the loss of average reception energy due to perforation.

79837-1

ABSTRACT

This invention is concerned with a method and apparatus for statistically multiplexing based on orthogonal code hopping multiplexing according to orthogonal code hopping patterns in wired/wireless communication systems in which a plurality of synchronized communication channels coexist through one media.

The system comparing a primary communication station and a plurality of second communications includes an orthogonal code hopping pattern generator, a spreader for selecting a corresponding orthogonal codeword in the orthogonal code and data symbols, a comparator & controller for monitoring whether the orthogonal codewords collide and determining whether all the transmitting data symbols to the secondary communication stations are the same in the collision interval, a transmission controller for perforation (transmission 'OFF') in case that all the corresponding data symbols with the same orthogonal codeword for spreading are not the same, and a transmission power controller for compensating for the loss of average reception energy due to perforation.

FIG. 10a

79837-1

METHOD AND APPARATUS FOR ORTHOGONAL CODE HOPPING MULTIPLEXING COMMUNICATIONS

TECHNICAL FIELD

The present invention relates to an apparatus and a method for statistically multiplexing channels by using orthogonal code hopping multiplexing in wired/wireless communication systems where a plurality of channels synchronized through a single medium and low data channel activity coexist. More particularly, the present invention relates to an apparatus and a method in which, in a system consisting of a primary communication station and a plurality of secondary communication stations synchronized with the primary communication station, the primary communication station identifies a channel toward each secondary communication station with an orthogonal code hopping pattern, the orthogonal code hopping pattern of a secondary communication station is determined at random, and orthogonal codewords (or code symbols) in the hopping patterns of different channels may coincide at an instance (hereinafter, the above coincidence of the orthogonal codewords is called "hopping pattern collision"). The system checks the discordance of transmitting data symbols for all channels related to the hopping pattern collision from the primary communication station and makes a corresponding data symbol interval 'OFF' if any channel intends to transmit a data symbol not coincident with other channels. Transmission power of all related channels after transmission 'OFF' of the data symbol can be increased by an amount specified in a communication protocol during a specified interval in order to supplement the average bit energy of lost data symbol in all relevant channels.

79837-1

BACKGROUND ART

Descriptions in this application are based on wireless communication systems, however the statistical multiplexing suggested in the application may be applied to wired communication systems as well as the wireless communication systems without any change.

In order to point out clearly which parts or concepts are developed or improved in the present invention in comparison with the prior art, the prior art is described on basis of a spread spectrum communication system of IS-95, which has already been in service.

The primary communication station and the second communication stations in this application are corresponding to a base station and mobile stations in a conventional system. One primary communication station communicates with a plurality of secondary communication stations and the present invention suggests a statistical multiplexing scheme, which may be applied to a synchronized orthogonal channel group from the primary communication station toward the secondary communication stations. For systems which maintain the orthogonality only for each channel group, such as Quasi-Orthogonal Code (QOC) for cdma2000® and Multi-Scrambling Code (MSC) for W-CDMA, which are two candidate techniques for the next generation mobile communication system "IMT-2000 (International Mobile Telecommunications-2000)", the present invention may be independently implemented for each channel group. Moreover, when classifying channels of the primary communication station such as sectored or smart antenna systems into channel groups having the same transmitter antenna beam, the present invention may be independently implemented in each channel group.

In the communication systems based on OCDM (Orthogonal Code Division Multiplexing) such as IS-95 system, the primary communication station allocates orthogonal codewords (or codewords), which have not been allocated among the orthogonal code (or set of orthogonal codewords) when establishing physical communication channels, to one of the secondary communication stations and the secondary communication station returns the allocated orthogonal codeword(s) to the primary communication station when releasing the physical channel such that other secondary communication stations may use the orthogonal codewords.

In the description of the prior art, the same reference number is used for a component having the same function as that of the present invention.

FIG. 1 shows a system according to both the prior art and the present invention. As shown in the figure, each communication channel 121, 122, 123 from the primary communication station 101 to the secondary communication stations 111, 112, 113 is synchronized with maintaining orthogonality.

FIG. 2a shows a configuration of a transmitter of the primary communication station, which corresponds to a common element of the prior art and embodiments of the present invention. FIG. 2b shows a configuration of the transmitter of the primary communication station for a traffic channel of the prior art.

A pilot channel 200 is used as a reference signal for initial acquisition, tracking and coherent detection in the secondary communication station of FIG. 1. The pilot channel 200 is commonly used in all secondary communication stations within a cell area covered by the primary communication station. The pilot channel 200 provides a phase reference for coherent detection by transmitting symbols having a known phase without passing through channel coding and channel interleaving, as shown in FIG. 2a.

A synchronization channel 210 is a broadcast channel which is uni-directionally transmitted to all secondary communication stations in a cell area covered by the primary communication station, like the pilot channel 200. The primary communication station transmits information (e.g. timing information, an identifier of the primary communication station, etc.), which the secondary communication stations commonly require, to the second synchronization channel 210 through the synchronization channel 210. The data from the synchronization channel 210 pass through a convolutional encoder 214, a repeater 216 for adjusting symbol rates, a block interleaver 218 for correcting burst errors, a repeater 219 for matching transmission data symbol rates, and a spreading and modulation unit, shown in FIG. 3 and described below.

A paging channel 220 is a common channel used for paging the corresponding secondary communication station in case of an incoming message or for responding to a request from a secondary communication station. Several paging channels 220 can exist. The data transmitted by the paging channel pass through a convolutional encoder 224, a symbol repeater 226 and a block interleaver 228, and are symbol-level scrambled by an exclusive OR gate 236 with a decimated output of a long code generator 232 generated by a long code mask 230. The data through the exclusive OR gate 236 is then passed to the spreading and modulation unit of FIG. 3.

A traffic channel 240 in FIG. 2b is a channel dedicatedly allocated to each secondary communication station for use until a call is completed. When there are data to be transmitted to each secondary communication station, the primary communication station transmits the data through the traffic channel 240. The data from the traffic channel 240 pass through a cyclic redundancy check (CRC) 241 for detecting an error in a specific time unit, or frame, (e.g. 20 ms in IS-95). For ensuring the channel is encoded independently in a frame unit, tail bits 242 are inserted into the traffic channel, all of which are "0", and the data through the CRC 241 pass through a convolutional encoder 244. The data then pass through a symbol repeater 246 for matching transmission data symbol rate according to a transmission data rate. After passing through the symbol repeater 246, the data pass through a block interleaver 248 for changing burst errors into random errors. The data passing through the block interleaver 248 are symbol-level scrambled in a scrambler 256 using a decimated pseudo-noise (PN) sequence, which are generated by decimating an output of a long code generator 232 using a long code mask 250 generated by an electronic serial number (ESN) allocated to each secondary communication station. A PCB (power control bit) position extractor 258 extracts a position where a command for controlling transmission power from the secondary communication station is inserted based on the decimated PN sequence from the decimator 234. A puncturing and insertion block 260 punctures a data symbol corresponding to the insertion position of the power control command determined by the PCB position extractor 258 among the data symbols scrambled in the scrambler 256 and inserts the power control command, then transmits the power control command to the spreading and modulation unit in FIG. 3.

FIGs. 3a, 3b and 3c show an embodiment of a spreading and modulation unit according to the prior art.

FIG. 3a corresponds to the data modulation of a conventional IS-95 system employing BPSK (Binary Phase Shift Keying). FIG. 3b shows the spreading and modulation unit employing QPSK (Quadrature Phase Shift Keying) as a data modulation.

FIG. 3b is adopted for the cdma2000® system, which is one of candidate techniques for the IMT-2000. FIG. 3c shows a spreading and modulation unit, which employs QOC (Quasi-Orthogonal Code) used in cdma2000®. In FIG. 3, signal converters 310, 326, 330, 346, 364 convert logical values "0" and "1" into physical values "+1" and "-1" to be really transmitted. The signal from each channel of FIG. 2 passes through the signal converters and is then spread in spreaders 312, 332 by an output of a Walsh code generator 362. Transmission power of each channel is adjusted in amplifiers 314, 334. All channel signals of the primary communication station are spread in spreaders 312, 332 by an orthogonal Walsh function of the Walsh code generator 362 allocated to each channel fixedly. The channel signals are then amplified in the amplifiers 314, 334 and then pass through QPSK spreading and modulation units 318, 338. The spread and data-modulated signals filtered by low-pass filters (LPF) 320, 340 are multiplied by a carrier in multipliers 322, 342. The signal multiplied by the carrier passes through a RF (radio frequency) unit and is then transmitted through an antenna, not shown in the figure.

FIG. 3b is identical to FIG. 3a except the fact that, in order to transmit the signal generated in FIG. 2 to QPSK instead of BPSK, different information data are carried in an in-phase channel and a quadrature phase channel through a demultiplexer 390. Using the demultiplexer 390 and the signal converters 310, 330 enables QAM (Quadrature Amplitude Modulation) as well as QPSK.

FIG. 3c shows the case that a QOC mask is used for distinguishing channels from the primary communication station to the secondary communication stations. Orthogonality is not maintained in a codeword group using different QOC masks but is maintained in a codeword group using the same QOC mask. Therefore, the present invention is applied to the orthogonal codeword group using the same QOC mask, which may maintain the orthogonality.

FIGs. 4a, 4b and 4c show signals used in the code division multiplexing, which spreads the signal generated in FIG. 2 and FIG. 3 into the orthogonal codeword fixedly allocated to each channel, according to the prior art. A pilot channel 410 is spread by a fixedly allocated orthogonal Walsh codeword W#0 in a spreader 412. Other channels are also spread by orthogonal Walsh codewords W#1, W#2, …. W#29, W#30, …. W#63 fixedly allocated regardless of activities of the corresponding channels. If an orthogonal codeword is fixedly allocated to a channel such as channels 440, 450, 460 having relatively low transmission data activity, utilization of the orthogonal code, which is a limited source, is much less than 100%.

FIG. 4b shows how a despreading data symbol is spread by the orthogonal code. In reference numbers 471 to 477, white areas mean "logically, 0 [physically, +1]" and black areas mean "logically, 1 [phycially, -1]", for the Walsh code as an example of the orthogonal code.

FIG. 4c shows that different orthogonal codewords are dedicatedly allocated to channels in OCDM.

FIG. 5 briefly shows a configuration of a receiver of the secondary communication station. As shown in the figure, the signal received through the antenna passes through multipliers 510, 530 for multiplying the signal with a carrier, low pass filters (LPFs) 512, 532 for generating a baseband signal, and short code generators 520, 540 which are synchronized with sequences used in the transmitter. The baseband signal then passes through multipliers 514, 534 for multiplying the signal by the generated short code sequences and then despreaders 516, 536 for accumulating the signals during a transmission data symbol interval. A channel estimator 550 estimates a propagation channel by extracting only pilot channel components from the baseband signal with the orthogonal codeword allocated to the pilot channel. A phase recovery 560 compensates for phase distortion of the baseband signal by using an estimated phase distortion value.

FIG. 6 shows a configuration of a receiver for channels, such as paging channels, in which a control command for controlling transmission power from the secondary communication station to the primary communication station is not inserted. Referring to the figure, maximal ratio combiners 610, 612 combine signals passing through the phase compensation, with a maximal ratio. If the transmitter performs QPSK data modulation as shown in FIG. 3b, the receiver performs descrambling after multiplexing the signal in a multiplexer 614. The descrambling is done by multiplying the signal through soft decision by the decimated output 624 of a long code generator 622 generated by a long code mask 620. In the present invention, the configuration of a receiver in the secondary communication station for the orthogonal code hopping multiplexing is similar to the configuration in

FIG. 6. For the synchronization channel, the descrambling processes 620, 622, 624, 626, 618 using the long code may be skipped.

FIG. 7 shows a receiver structure of channels such as traffic channels that carry a command for controlling transmission power of channels from secondary communication stations to primary communication station. As shown in the figure, the signal with the compensated phase in FIG. 5 passes through maximal ratio combiners 710, 712. In case that a receiver performs QPSK data demodulation as shown in FIG. 5, a multiplexer 714 multiplexes an in-phase component and a quadrature phase component in the signal. An extractor 740 extracts a signal component corresponding to the power control command transmitted from the primary communication station among the received signals. The signal from the extractor 740 then passes through a hard decision unit 744 and is then transmitted to a transmission power controller of the secondary communication station. Data symbols except the power control command in the received signal from the multiplexer 714 pass through a soft decision unit 742. A decimator 724 decimates an output of a long code generator 722 generated by a long code mask 720, which are generated by an identifier of the secondary communication station. A multiplier 718 descrambles the data symbols from the soft decision unit 742 using the output of the decimator 724.

FIG. 8 shows a function of recovering the received signal through the signal processes of FIG. 6 and FIG. 7 from the primary communication station, through block deinterleavers 818, 828, 838 and convolutional decoders 814, 824, 834. In a synchronization channel 810, in order to lower symbol rate, a sampler 819 performs symbol compression for the signals through the soft decision unit by accumulating the signals, which is an inverse process to the symbol repeater 219. The signal through the sampler 819 passes through a block deinterleaver 818. Then, a sampler 816 performs symbol compression again for the signal, which is an inverse process to the symbol repeater 216, before the signal passes to a convolutional decoder 814. The signal enduring the symbol compression then passes through the convolutional decoder 814, then the synchronization channel transmitted from the primary communication station is recovered.

In case of a paging channel 820, the signal enduring the soft decision passes through a block deinterleaver 828 for channel deinterleaving. The signal enduring the channel deinterleaving passes through a sampler 826 for symbol compression according to the transmission data rate, which is an inverse process of the symbol repeater 226. The signal enduring the symbol compression passes through a convolutional decoder 824 such as Viterbi decoder for channel decoding, then the paging channel data transmitted from the primary communication station is recovered.

In case of a traffic channel 830, the signal enduring soft decision passes through a block deinterleaver 838 for performing channel deinterleaving regardless of transmission data rates. The signal enduring channel deinterleaving passes through a sampler 836 for performing symbol compression according to the transmission data rate, which is an inverse process to the symbol repeater 246. A convolutional decoder 834 performs channel decoding for the signal enduring the symbol compression. A tail bit remover 832 removes tail bits of the signal used for transmitting independent data block in a frame unit. A CRC 831 generates CRC (Cyclic Redundancy Check) bits for the transmitting data portion and detects errors by comparison with recovered CRC bits after channel decoding. If the CRC bits match with the received data, the CRC 831 determines that there is no error and then the traffic channel data are received without error. If the transmitter does not include information about the transmission data rate in 20ms frame unit, the transmission data rate of the primary communication station may be estimated by channel-decoding the signals enduring the independent channel deinterleaving and comparing the CRC bits for all candidate data rates. A system, which transmits a transmission data rate independently, just further requires a channel decoding process corresponding to the data rate.

In case of spreading the encoded data symbol by fixedly using the orthogonal code allocated when establishing a call as shown in FIG. 3 in order to maintain orthogonality between channels from the primary communication station to the secondary communication stations as shown in FIG. 1, the orthogonal codewords, limited resource, may not be efficiently used for transmitting data having relatively low activity such as data indicated by reference numbers 440, 450 and 460 in FIG. 4a. In order to increase utilization of the orthogonal codewords based on fixed allocation, fast and frequent channel allocation and de-allocation are required. However, if the control signal information for channel allocation and de-allocation is exchanged more frequently, a more significant amount of limited radio resources should be used for the control information of data transmission, not for data transmission itself. Moreover, even if the channel allocation and de-allocation are required to be processed quickly, there should be a buffering process upon reception of the acknowledgement message after a channel allocation (or de-allocation) message is transmitted. As the time required for such processes becomes longer, a larger buffer size is required. Information, which requires checking whether the information is transmitted successfully, should be buffered for possible retransmission until the reception of the acknowledgement. However, in case of datagrams that do not require receiving the acknowledgement, delay should be minimized in an allowable range in order to decrease the required buffer size.

Therefore, while the prior art is to allocate the orthogonal codewords in a fixed manner so as to have a one-to-one correspondence between orthogonal codewords and channels, the present invention, with a little modification of the prior art, performs statistical multiplexing for traffic channels having low activities in consideration of activity of the transmitting data in order to increase the utilization of the orthogonal codewords, which are a limited resource, and reduces unnecessary channel allocation and de-allocation procedures in order to reduce the buffer size and the data transmission delay.

DISCLOSURE OF INVENTION

The present invention is designed to overcome the above problems of the prior art. The objectives of the invention are (1) to decrease waste of resources caused by transmission of unnecessarily many control signals, (2) to reduce the required buffer size in a primary communication station, (3) to reduce data transmission delay by means of a statistical multiplexing method, namely orthogonal code hopping multiplexing, when synchronized channels maintaining orthogonality have low activities, and (4) to reduce unnecessary channel allocation and de-allocation procedures through spreading or despreading according to a given hopping pattern of each transmitter and receiver pair.

Accordingly, in one aspect of the invention, there is provided a method for orthogonal code hopping multiplexing communications in spread spectrum communication systems, the method comprising the step of: performing statistical multiplexing for communication channels from a primary communication station to secondary communication stations by using orthogonal code hopping multiplexing and controlling the transmission of spread data symbols from the primary communication station based on the result of collision comparison done within the primary communication station.

In another aspect, the present invention provides a method for orthogonal code hopping multiplexing communications in spread spectrum communication systems, which perform statistical multiplexing for communication channels with relatively low activity from a primary communication station to secondary communication stations by orthogonal code hopping multiplexing communications.

The synchronized channels from the primary communication station to a plurality of the secondary communication stations can be distinguished by using orthogonality.

The method may include a further step of distinguishing the channels from the primary communication station to the secondary communication stations by using orthogonal code hopping patterns.

The orthogonal code may be a Hadamard code, a variable spreading factor code, an orthogonal Gold code, or so forth.

The method may include a further step of allocating the orthogonal code hopping patterns to the secondary communication stations dedicatedly.

It is preferred that the orthogonal code hopping pattern is allocated or predefined to the secondary communication stations from the primary communication station at the starting phase of communication, and the secondary communication stations release the allocated orthogonal code hopping pattern after the completion of communication.

The method may include a further step of performing the orthogonal code hopping multiplexing for a channel among the channels, which have low transmission data activity.

The method may include a further step of transmitting a command for controlling transmission power of the secondary communication stations by using separate common power control channels from a primary communication station.

The transmission power control command of each secondary communication station in the common power control channel can be time-multiplexed and may employ a collision-free hopping pattern for preventing collisions of the hopping patterns.

The collision-free hopping pattern may include a fixed orthogonal codeword allocation like a conventional orthogonal code division multiplexing.

The orthogonal code hopping patterns for the statistical multiplexing may be generated at random or by using a pseudo-noise sequence generator.

A plurality of the orthogonal code hopping patterns for the statistical multiplexing can be allocable to one of the secondary communication stations according to the transmission data rate of the primary communication station.

Each of the orthogonal code hopping patterns may hop independently in the orthogonal code hopping multiplexing communications.

The orthogonal code hopping patterns may hop so as to avoid collisions in the orthogonal code hopping multiplexing communications and may be periodically repeated in a frame unit.

The frame unit is an independent data unit based on channel encoding.

The primary communication station may detect a hopping pattern collision caused by the independent orthogonal code hopping patterns in advance in order to perforate (not to transmit) a corresponding data symbol.

The method may include a further step of comparing data symbols at the time of a hopping pattern collision caused by the independent orthogonal code hopping patterns in order to transmit (not to perforate) the data symbols in case that all of the corresponding data symbols with the same orthogonal codeword for spreading are the same even if there occurs a hopping pattern collision caused by the independent orthogonal code hopping patterns.

The method may include a further step of comparing data symbols at the time of a hopping pattern collision caused by the independent orthogonal code hopping patterns in order to perforate (not to transmit) the data symbols in case that all the corresponding data symbols with the same orthogonal codeword for spreading are not the same.

The method may include a further step of increasing transmission power of data symbols following the perforated data symbol, which are not transmitted because of discordance of the data symbols with the same orthogonal codeword for spreading at the time of the hopping pattern collision.

It is also preferred that the transmission power is increased by an amount specified by a system parameter during an interval specified by a system parameter.

The two system parameters may be a function of position of the perforated (non-transmitted) data symbols, and both parameter values are preferably at least zero.

Preferably, the above procedures for handling the hopping pattern collisions can be taken only when there is a possibility that transmitter antenna beams of the primary communication station are superposed so as to cause serious errors in a channel decoding process of the secondary communication stations.

A pilot signal can be used for initial acquisition and tracking of the channel and for coherent detection of the data channels by compensating for phase distortion.

The pilot signal may employ a collision-free hopping pattern for preventing a loss of compensation capability for phase distortions due to collisions.

The collision-free hopping pattern may include a fixed orthogonal codeword allocation as allocated in the conventional orthogonal code division multiplexing.

In order to obtain the above objectives, the present invention provides a transmitter in spread spectrum communication systems including a primary communication station and secondary communication stations, the transmitter comprising a channel encoder; an orthogonal code hopping pattern generator for generating an orthogonal code hopping pattern; an orthogonal code generator for generating an orthogonal codeword according to the hopping pattern; and an orthogonal code collision detector for detecting collisions of the hopping patterns.

The transmitter may further include a transmission controller for transmitting or perforating the encoded data symbols according to the output of an orthogonal code hopping pattern collision detector.

The orthogonal code hopping pattern collision detector may include a data symbol comparator for checking whether all data symbols of the corresponding channels with the same orthogonal codeword for spreading are the same or not at the time of a hopping pattern collision; and the controller does not transmit the encoded data symbols in case that the corresponding encoded data symbols are not the same as a result of the data symbol comparator.

In order to accomplish the above objectives, the present invention provides a receiver in spread spectrum communication systems including a primary communication station and secondary communication stations, the receiver comprising a channel decoder; an orthogonal code hopping pattern generator for generating an orthogonal code hopping patterns; and an orthogonal code generator for generating orthogonal codewords according to the hopping pattern.

In order to perform the above objectives, the present invention also provides a method for spread spectrum communications using orthogonal codes, the method comprising the step of dividing the orthogonal codes into a first orthogonal codeword group for orthogonal code division multiplexing and a second orthogonal codeword group for statistical multiplexing owing to orthogonal code hopping.

The method may include a further step of performing the orthogonal code division multiplexing by fixedly allocating the orthogonal codewords in the first orthogonal codeword group to channels having high data activity.

The method may include a further step of performing orthogonal code hopping multiplexing for channels having low channel activity according to the orthogonal code hopping pattern by using only the orthogonal codewords in the second orthogonal codeword group.

The orthogonal code may be an orthogonal variable spreading factor code.

Preferably, the first orthogonal codeword group consists of child codes generated from one parent code in a hierarchical orthogonal code generating a tree structure according to the variable spreading factors, while the second orthogonal codeword group consists of the remaining orthogonal codewords.

The first orthogonal codeword group used for the code division multiplexing may be selected to have a variable spreading gain according to the transmission data rate.

The channel for the orthogonal code hopping multiplexing may have a fixed data rate, and the method may include a further step of selecting orthogonal codewords having the same spreading factor in the second orthogonal codeword group.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of preferred embodiments of the present invention will be more fully described in the following detailed description, with reference to accompanying drawings. In the drawings:

FIG. 1 shows a concept of a system having a primary communication station and secondary communication stations according to both the prior art and the present invention;

FIG. 2a shows a configuration of a transmitter in the primary communication station, which is a common component of both the prior art and the present invention;

FIG. 2b shows a configuration of a transmitter for traffic channels in the primary communication station according to the prior art;

FIG. 3a shows a configuration of a receiver in the primary communication station using an OCDM (Orthogonal Code Division Multiplexing) method in case of BPSK data modulation according to the prior art;

FIG. 3b shows a configuration of a receiver in the primary communication station using an OCDM method in case of QPSK data modulation according to the prior art;

FIG. 3c shows a configuration of a receiver in the primary communication station using an OCDM method in case of using QOC data according to the prior art;

FIG. 4a shows a transmitting signal of the primary communication station according to the prior art;

FIG. 4b shows an orthogonal code for distinguishing channels according to the prior art;

FIG. 4c shows the OCDM according to the prior art;

FIG. 5 shows a configuration of a receiver in the secondary communication station in the OCDM method according to the prior art;

FIG. 6 shows a configuration of common components of the receiver in the secondary communication station according to both the prior art and the present invention;

FIG. 7 shows a configuration of the receiver in the secondary communication station in FIG. 4b;

FIG. 8 shows a configuration of common components of the receiver according to both the prior art and the present invention;

FIG. 9 shows a configuration for traffic channels of a transmitter in the primary communication station for orthogonal code hopping multiplexing and a configuration of a common power control channel for the traffic channels;

FIG. 10a shows a configuration of a transmitter in the primary communication station using the orthogonal code hopping multiplexing according to the present invention, corresponding to FIG. 4a;

FIG. 10b shows a configuration of a transmitter in the primary communication station using the orthogonal code hopping multiplexing according to the present invention, corresponding to FIG. 4b;

FIG. 10c shows a configuration of a transmitter in the primary communication station using the orthogonal code hopping multiplexing according to the present invention, corresponding to FIG. 4c;

FIG. 11 shows a configuration of an orthogonal code hopping pattern generator according to the present invention;

FIG. 12 shows an example of an orthogonal variable spreading factor code according to the present invention;

FIG. 13 shows a configuration of a receiver in the secondary communication station in the orthogonal code hopping multiplexing of FIG. 10b according to the present invention;

FIG. 14a shows orthogonal code division multiplexed signals for traffic channels toward the secondary communication stations having relatively high channel activity;

FIG. 14b shows orthogonal code hopping multiplexed signals for traffic channels toward the secondary communication stations having relatively low channel activity;

FIG. 14c shows an example of the orthogonal spreading code of the present invention;

FIG. 14d shows an example of the OCDM of FIG. 14a according to the present invention;

FIG. 14e shows an example of the statistical multiplexing based on the OCHM of FIG. 14b according to the present invention;

FIG. 14f shows hopping pattern collisions in case of the OCHM of FIG. 14b according to the present invention;

FIG. 14g shows the perforation (or transmission 'OFF') in the collision interval of relevant channels when the hopping patterns collide and transmitting data symbols do not match as shown in FIG. 14f;

FIG. 14h shows a scheme to increase the transmission power of the primary communication station in a certain interval after a perforated data symbol in order to compensate average reception energy or signal-to-interference ratio (SIR) required for a channel decoder for satisfying the required communication quality when there occurs a perforation in the hopping pattern collision interval in FIG. 14g; and

FIG. 15 shows that perforation caused by the hopping pattern collision and mismatch of the transmitting data symbols is independently operated for each transmitter antenna beam of the primary communication station.

BEST MODES FOR CARRYING OUT THE INVENTION

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

In this application, identical reference numbers are used for components identical to the prior art and only modified or added components in comparison with the prior art are described for the present invention in detail.

FIG. 9 is a modified configuration of the traffic channel of the prior art for performing orthogonal code hopping multiplexing for traffic channels having low channel activity, and this configuration is identical to the prior art except that a transmission power control command for the secondary communication station is not inserted. Communications are divided into bi-directional and uni-directional communications, in which the uni-directional communication does not require the transmission power control command for the secondary communication station.

However, in case of the bi-directional communication, the transmission power control command is required in order to maximize system capacity through effective power control. For fast processing, the power control commands are not channel-coded in most cases. Random (or pseudo-random) and independent orthogonal code hopping patterns inevitably cause collisions among other channels. Therefore, it is required to transmit the power control command to a channel in which a collision is not generated. From this aspect, a concept of a common power control channel adopted in cdma2000®, which is one of candidate techniques for the IMT-2000, may be introduced. The common power control channel is spread by a separate orthogonal codeword such as those used in the pilot channel and transmitted in the time division multiplexing (TDM) scheme for a plurality of the secondary communication stations. The position of power control command for each secondary communication station is allocated during a call setup procedure. FIG. 9 shows an embodiment of the common power control channel for controlling 24 secondary communication stations.

FIGs. 10a, 10b and 10c show embodiments when orthogonal code hopping features of the present invention are applied to the prior art shown in FIGs. 3a, 3b and 3c. For statistical multiplexing based on the orthogonal code hopping multiplexing proposed in the present invention, required are an orthogonal code hopping pattern generator 380 and collision comparator & controller 384, 386 for suitable control by detecting collisions of the orthogonal codewords generated by independent hopping pattern generators. An example of the orthogonal code hopping pattern generator is shown in FIG. 11, which has a configuration for generating a hopping pattern using a general PN sequence generator. Fig. 11 shows an embodiment of hopping pattern generator. That is, in a sequence generator using a general LFSR (Linear Feedback Shift Register), Fig. 11 shows a method to extract the required number of bits according to the hopping range of orthogonal codewords. For example, if the number of orthogonal codewords (or orthogonal code symbols) is 32 (= 2^5), when 5 bits are required in the sequence generator, a hopping pattern can be generated based on the index with the 5 bits in each clock. Thus, the orthogonal codewords (or orthogonal code symbols) indicated by the index may be used for despreding the data symbol in the receiver. An orthogonal code generator 382 is required for generating a spreading orthogonal codeword according to the hopping pattern generator 380. The orthogonal code generated in the orthogonal code generator 382 may be an orthogonal variable spreading factor (OVSF) code having a hierarchical structure which can be a Walsh code for a specific spreading factor as shown in FIG. 12, or an orthogonal Gold code generated by an orthogonal Gold code generator. Any orthogonal code maintaining orthogonality is possible.

When the output of an orthogonal code hopping pattern generator 380 is constant, the present invention corresponds to the orthogonal code division multiplexing (OCDM) identical to the prior art. That is, the orthogonal code division multiplexing of the prior art is a subset of the orthogonal code hopping multiplexing of the present invention. Therefore, after dividing one orthogonal code into two orthogonal codeword groups, one orthogonal code group is used for an orthogonal code division multiplexing (OCDM) based on the fixed allocation and the other orthogonal code group is used for an orthogonal code hopping multiplexing (OCHM) according to given hopping patterns.

Or else, one orthogonal codeword group among the two divided orthogonal codeword groups performs the orthogonal code hopping multiplexing based on a hopping pattern selected dependently to prevent collisions of the hopping patterns in a non-statistical multiplexing mode, while the other orthogonal codeword group performs the orthogonal code hopping multiplexing based on hopping patterns selected independently in a statistical multiplexing mode in case that collisions between the hopping patterns may happen.

In both cases, it is preferred that the former is allocated to channels having a relatively high channel activity and the latter is allocated to channels having a relatively low channel activity. In case of using a hierarchical orthogonal code supporting a variable spreading factor as a spreading code as shown in FIG. 12, it is preferred to divide the orthogonal code into orthogonal codeword groups 393, 397 consisting of all child codewords having the same parent codeword 391, 395 such as "01" or "0110" because it may support the variable spreading factor. As briefly described above, if the orthogonal code hopping pattern generator dependently generates the orthogonal code hopping patterns so as not to select different channels for the same orthogonal codeword at the same instant, no collisions generate.

However, such method has disadvantages that the hopping pattern should be allocated by the primary communication station during a call setup and that the number of the hopping patterns allocated by the primary communication station is limited by the size of the orthogonal code (i.e., the number of orthogonal codewords in a orthogonal code). In this case, since statistical multiplexing according to the channel activity of each channel is not possible, an independent and random (or pseudo-random) hopping pattern is allocated to each channel. For this reason, orthogonal code patterns, which may select the same orthogonal codeword at the same instant, cause collisions inevitably. Therefore, the present invention receives hopping pattern of each channel and data symbols to be transmitted, and determines whether the hopping patterns collide using the collision comparator & controller 384, 386 for overcoming such problems. In addition, the present invention compares whether the data symbols of all channels enduring the collisions are all the same.

In case that all data symbols match, the data symbols in the collision interval are spread and transmitted. It is because the data symbols do not cause any errors in the channel decoding process. However, even if there is one data symbol not matched, all the data symbols in the collision interval of the corresponding channels are not transmitted. That is, according to the result of the comparator & controller 384, 386, the input of the multipliers 385, 387 becomes "+1" or "0". In the interval that the input of the multiplier is "0", transmission is 'OFF'.

In order to compensate for the reduced average reception energy or SIR in the secondary communication station due to perforation of the data symbols, the gain of amplifiers 315, 335 of the corresponding channel is adjusted by an amount specified by a system parameter during an interval specified by a system parameter like the reference numbers 1072, 1074 in FIG. 14h, then the transmission power of the primary communication station is increased accordingly for the specified interval after the perforation (transmission 'OFF'). Regardless of the above process, the transmission power control for the primary communication station is performed according to the method of the prior art.

FIGs. 14a to 14h show concepts of transmitting signals of the primary communication station according to the present invention. FIG. 14a shows transmitting signals in case of performing the code division multiplexing by fixedly allocating the orthogonal codewords to channels with relatively high activity. FIG. 14b shows transmitting signals in case of performing the orthogonal code hopping multiplexing by spreading with orthogonal codeword according to hopping patterns $H_1[n]$, $H_2[n]$, $H_3[n]$, ..., $H_M[n]$ for channels with relatively low activity. The number of the hopping patterns may be larger than that of orthogonal codewords in an orthogonal code. Since the hopping patterns generated independently may cause collisions, it is preferred that the orthogonal codewords are fixedly allocated as designated by reference number 912 to a pilot channel 910 used as a phase reference for coherent demodulation and a channel not enduring channel coding like the common power control channel of FIG. 9, while the orthogonal code hopping multiplexing is performed using remaining orthogonal codewords.

It is also preferred to use the statistical multiplexing based on the orthogonal code hopping multiplexing during data interval and not to use the orthogonal code hopping multiplexing during pilot interval, not only when the pilot channel is orthogonal code division multiplexed but also when it is time division multiplexed like the pilot signal, as applied in W-CDMA (Wideband Code Division Multiple Access), another candidate technique of the IMT-200 system. During the data interval, the orthogonal codeword used during the pilot interval may be reused.

If the transmitter antenna beams of the primary communication station are different according to the location of the secondary communication stations, as shown in smart antenna beams, a pilot signal is separately managed for each antenna beam. In addition, in a non-coherent modulation/demodulation system, which does not use the pilot signal and does not require the pilot signal, the orthogonal code hopping multiplexing can be performed using all orthogonal codewords in the orthogonal code.

FIG. 14c shows an example of the orthogonal codeword used for spreading the data symbol according to the present invention. As shown in the figure, it will be easily known that this embodiment has no difference from the prior art in FIG. 4b for a symbol duration except that different orthogonal codewords may be used.

FIG. 14d shows a case of allocating a dedicated orthogonal codeword to each channel having high channel activity similar to the prior art.

FIG. 14e shows the orthogonal code hopping multiplexing according to the present invention, in which the hopping pattern for each channel 1011, 1012, 1013, 1014, 1015, 1016, 1017 does not collide in all symbol intervals 1021, 1022, 1023, 1024, 1025, 1026, 1027, 1028. However, in case of performing the orthogonal code hopping multiplexing as shown in FIG. 14f, it can be seen that the hopping patterns collide in the symbol intervals 1041, 1043, 1046. In the data symbol interval 1041, the hopping patterns collide and the data symbols also coincide (as shown with double-line box). For symbol intervals 1043, 1046, all the data symbols with the same orthogonal codeword for spreading are not the same. In the case of a data symbol interval 1061 in FIG. 14g, since the transmitting data symbols coincide, the corresponding data symbols are spread and transmitted. However, in the case of data symbol intervals 1063, 1066, since the transmitting data symbols are not the same, transmission of all relevant channels is 'OFF' (or perforated).

Such a perforation is carried out for the channel group existing within the same transmitter antenna beam from the primary communication station. In case that a plurality of transmitter antenna beams 1120, 1130, 1140 from the primary communication station such as a smart antenna exist, transmission is not perforated for channels 1132, 1142, 1144 in non-overlapped transmitter antenna beams 1130, 1140, even though the hopping patterns collide.

FIG. 14h shows the process of increasing transmission power by a specified amount during a specified time interval in order to maintain the average reception signal energy or SIR in the secondary communication station required for communication quality after a transmission 'OFF' interval due to a collision of the hopping patterns and discordance of the data symbols as briefly described above, similar to FIG. 14g.

As described in embodiments of the present invention, if the orthogonal code hopping multiplexing is performed using independent hopping patterns, the transmitting data may be lost in data symbol intervals where the hopping patterns collide. Therefore, in order to recover the data existing in the loss interval in the receiver, the transmitters and receivers require channel encoding and channel decoding, respectively.

The orthogonal code hopping multiplexing of the present invention for statistical multiplexing may be used in combination with other multiplexing methods such as time division multiplexing, frequency division multiplexing, space division multiplexing such as smart antenna system, etc.

In addition, as an extension of the orthogonal code division multiplexing system based on a multi-code method, a plurality of channels may be allocated to one secondary communication station with use of a plurality of hopping patterns, which may be used in implementing high data rates. When the multiple hopping patterns are allocated, the hopping patterns of each channel may be generated as described above.

As described above, the present invention employs a statistical multiplexing method, namely the orthogonal code hopping multiplexing, in case that synchronized channels maintaining orthogonality have low channel activities, which may enable limited resources to be utilized more efficiently and yield less complexity than the prior art. In particular, the receiver requires no more hardware components except an orthogonal code hopping pattern generator. In addition, since the transmitter and the receiver perform spreading and despreading, respectively, according to the hopping patterns without any procedure for frequent channel allocation or de-allocation for traffic channels with low activity from the primary communication station to the secondary communication stations, the present invention may reduce waste of resources due to unnecessary control signal transmission and reduce buffer size required in the primary communication station and data transmission delay caused by scheduling of the transmitting data from the primary communication station.

Moreover, the present invention may distinguish a nearly unlimited number of channels (if the hopping pattern period is a frame unit, the number of different hopping patterns are approximately $64^{19.2ksps \times 20ms} = 64^{384}$ for IS-95 system) when random hopping patterns are adopted, compared with the fixed allocation of orthogonal codewords to the corresponding channels. Furthermore, though there occur collisions among the hopping patterns due to the independent selection of the hopping patterns, there is no need to perforate the colliding data symbols in case that there exist the secondary communication stations in the cell area where transmitter antenna beams, such as those of sectored antenna and smart antenna, are not overlapped. In addition, the data symbols, which are perforated (not transmitted) due to the hopping pattern collisions among channels within the same transmitter antenna beam, may be recovered in the channel decoding process of the secondary communication station without independently informing the corresponding secondary communication stations of the perforations.

The concept of the present invention may be applied to each carrier code group and each quasi-orthogonal code group in systems using a multiple carrier transmission method, a quasi-orthogonal code, etc. in order to realize the statistical multiplexing.

79837-1

CLAIMS:

1. A method for orthogonal code hopping multiplexing communications in spread spectrum communication systems, the method comprising the step of:

performing statistical multiplexing for communication channels from a primary communication station to secondary communication stations by using orthogonal code hopping multiplexing and controlling the transmission of spread data symbols from the primary communication station based on the result of collision comparison done within the primary communication station.

2. The method for orthogonal code hopping multiplexing communications as claimed in claim 1, wherein the channels from the primary communication station to a plurality of the secondary communication stations are synchronized and the channels are distinguished by using orthogonality.

3. The method for orthogonal code hopping multiplexing communications as claimed in claim 1, further comprising the step of:

distinguishing the channels from the primary communication station to the secondary communication stations by using orthogonal code hopping patterns.

4. The method for orthogonal code hopping multiplexing communications as claimed in one of claims 1 to 3, wherein orthogonal code of the orthogonal code multiplexing communications is a Hadamard code.

5. The method for orthogonal code hopping multiplexing communications as claimed in one of claims 1 to 3, wherein orthogonal code of the orthogonal code

multiplexing communications is an orthogonal variable spreading factor (OVSF) code.

6. The method for orthogonal code hopping multiplexing communications as claimed in one of claims 1 to 3, wherein orthogonal code of the orthogonal code multiplexing communications is an orthogonal Gold code.

7. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, further comprising the step of:

allocating the orthogonal code hopping patterns to the secondary communication stations dedicatedly.

8. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, wherein the orthogonal code hopping patterns are allocated to the secondary communication stations from the primary communication station at the starting phase of communication, and each secondary communication station releases the orthogonal code hopping pattern after the completion of communication.

9. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, further comprising the step of:

performing the orthogonal code hopping multiplexing for channels with low channel activity among the channels.

10. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, further comprising the step of:

transmitting commands for controlling transmission power of the secondary communication stations by using separate common power control channels from the primary communication station.

11. The method for orthogonal code hopping multiplexing communications as claimed in claim 10, wherein the commands for controlling transmission power of the secondary communication stations in the common power control channels are time-multiplexed and a collision-free hopping pattern is adopted for preventing collisions of the hopping patterns.

12. The method for orthogonal code hopping multiplexing communications as claimed in claim 11, wherein the collision-free hopping pattern includes an allocation of orthogonal codewords as fixedly allocated in orthogonal code division multiplexing.

13. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, wherein the orthogonal code hopping patterns for statistical multiplexing are generated independently.

14. The method for orthogonal code hopping multiplexing communications as claimed in claim 13, wherein the orthogonal code hopping patterns are generated independently from a pseudo-noise (PN) sequence generator.

15. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, wherein a plurality of the orthogonal code hopping patterns for statistical multiplexing are allocable to one of the secondary communication stations according to a transmission data rate of the primary communication station.

16. The method for orthogonal code hopping multiplexing communications as claimed in claim 15, wherein each of the orthogonal code hopping patterns hops independently in the orthogonal code hopping multiplexing communications.

17. The method for orthogonal code hopping multiplexing communications as claimed in claim 15, wherein the orthogonal code hopping patterns may hop so as not to generate collisions among hopping patterns in the orthogonal code hopping multiplexing communications.

18. The method for orthogonal code hopping multiplexing communications as claimed in claim 3, wherein the orthogonal code hopping patterns are periodically repeated in a frame unit.

19. The method for orthogonal code hopping multiplexing communications as claimed in claim 18, wherein the frame unit is an independent data unit based on channel encoding.

20. The method for orthogonal code hopping multiplexing communications as claimed in claim 13, wherein the primary communication station detects a hopping pattern collision caused by the orthogonal code hopping patterns in advance in order to perforate a corresponding data symbol.

21. The method for orthogonal code hopping multiplexing communications as claimed in claim 13, further comprising the step of:

comparing data symbols at the time of a hopping pattern collision caused by the orthogonal code hopping patterns in order to transmit the data symbols in case that all corresponding data symbols having identical orthogonal codewords for spreading are the same.

22. The method for orthogonal code hopping multiplexing communications as claimed in claim 13, further comprising the step of:

comparing data symbols at the time of a hopping pattern collision caused by the orthogonal code hopping patterns in order to perforate the data symbols in case that all corresponding data symbols having identical orthogonal codewords for spreading are not the same.

23. The method for orthogonal code hopping multiplexing communications as claimed in claim 22, further comprising the step of:

increasing transmission power of data symbols following a perforated data symbol, which is not transmitted because of discordance of the data symbols at the time of the hopping pattern collision.

24. The method for orthogonal code hopping multiplexing communications as claimed in claim 23, wherein the transmission power is increased by an amount specified by a first system parameter during an interval specified by a second system parameter.

25. The method for orthogonal code hopping multiplexing communications as claimed in claim 24, wherein the two system parameters are functions of position of the perforated data symbol.

26. The method for orthogonal code hopping multiplexing communications as claimed in claim 25, wherein the two system parameter values are at least zero.

27. The method for orthogonal code hopping multiplexing communications as claimed in one of claims 20 to 26, wherein a perforation process for reducing the effect of hopping pattern collision is done only when there is a possibility that transmitter antenna beams of the primary communication station are superposed so as to cause serious errors in a channel decoding process of any of the secondary communication stations.

28. The method for orthogonal code hopping multiplexing communications as claimed in claim 2, wherein a pilot signal is used for initial acquisition of synchronization and tracking of the channels and for coherent detection of the channels by compensating for phase distortion.

29. The method for orthogonal code hopping multiplexing communications as claimed in claim 28, wherein the pilot signal employs a collision-free hopping pattern for preventing a loss of compensation capability for phase distortion due to collisions.

30. The method for orthogonal code hopping multiplexing communications as claimed in claim 29, wherein the collision-free hopping pattern includes a fixed orthogonal codeword as allocated in orthogonal code division multiplexing.

SMART & BIGGAR
OTTAWA, CANADA

PATENT AGENTS

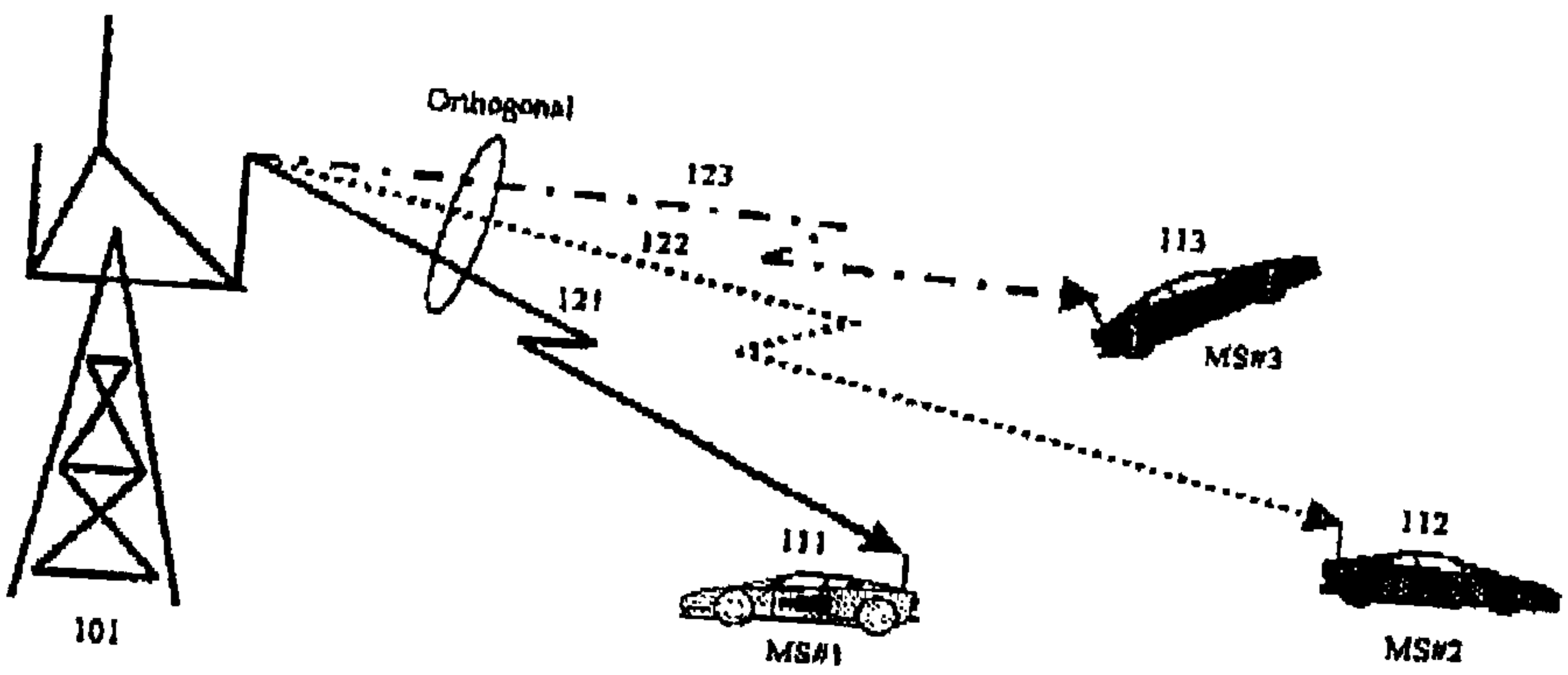


FIG. 1
(Prior Art)

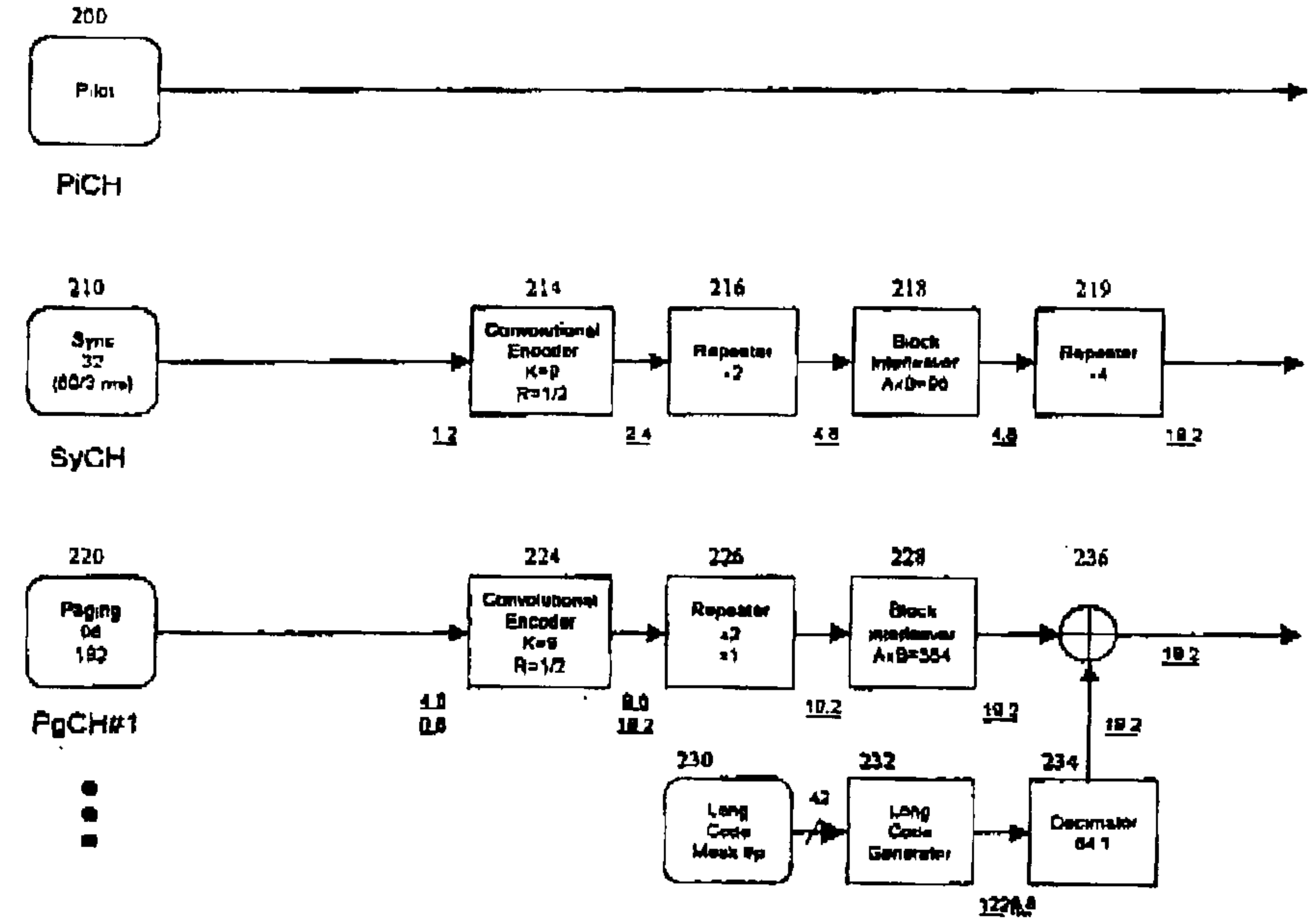


FIG. 2a
(Prior Art)

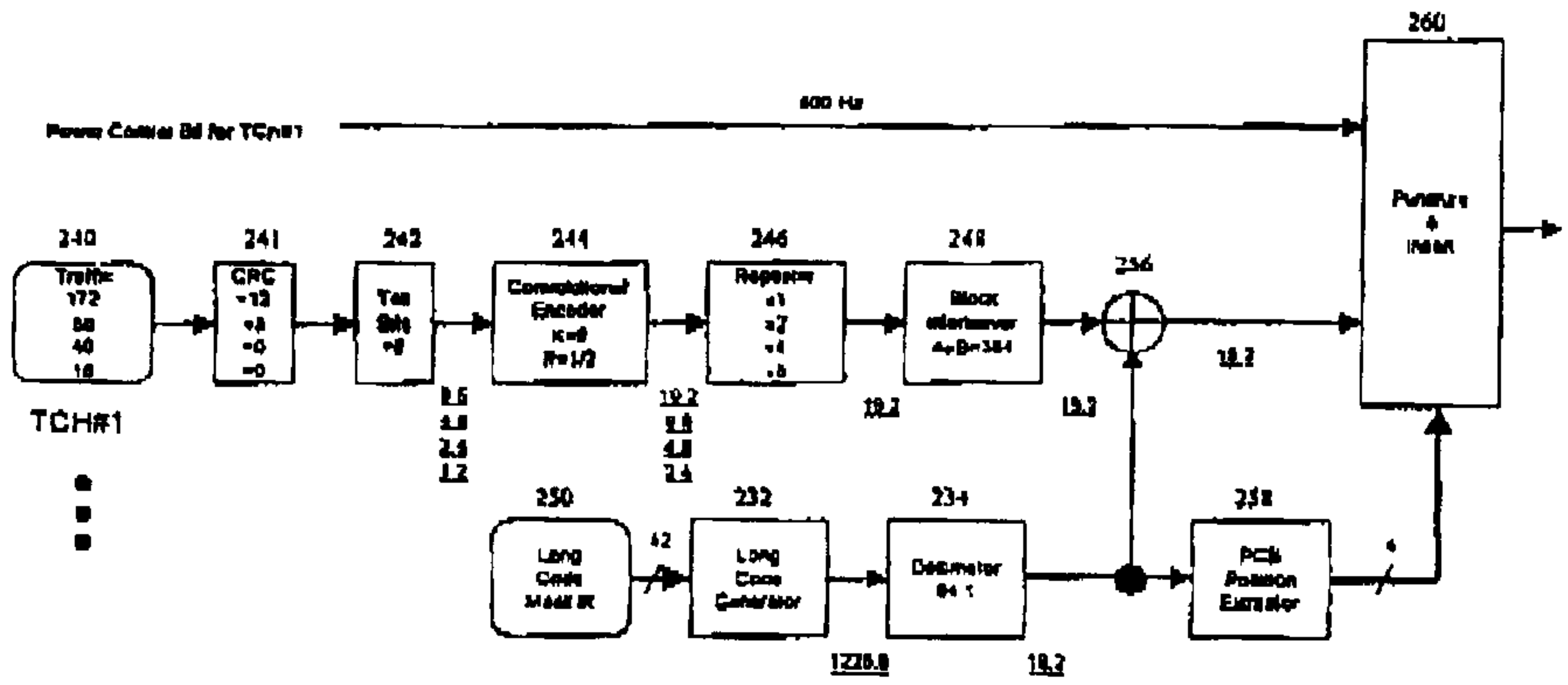


FIG. 2b
(Prior Art)

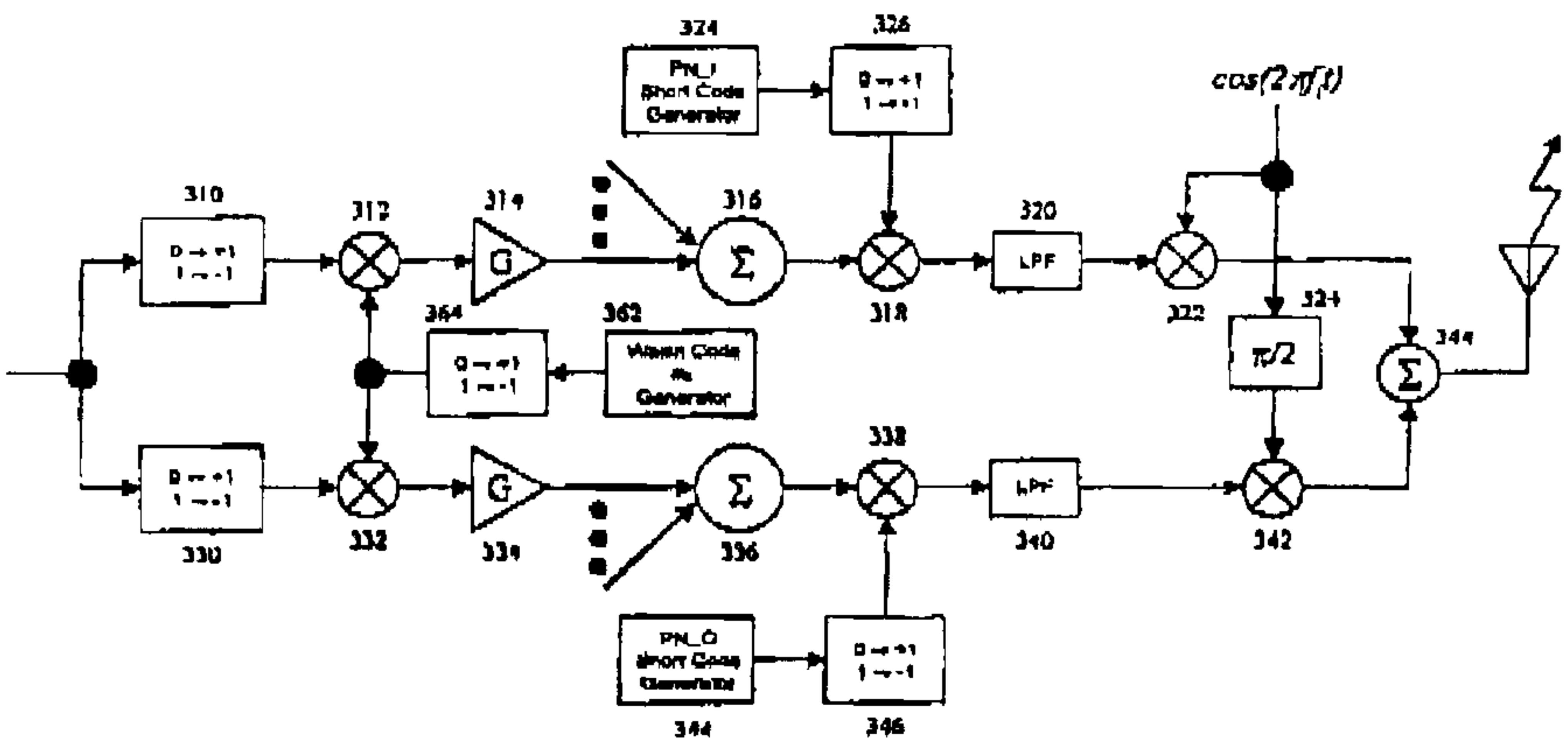


FIG. 3a
(Prior Art)

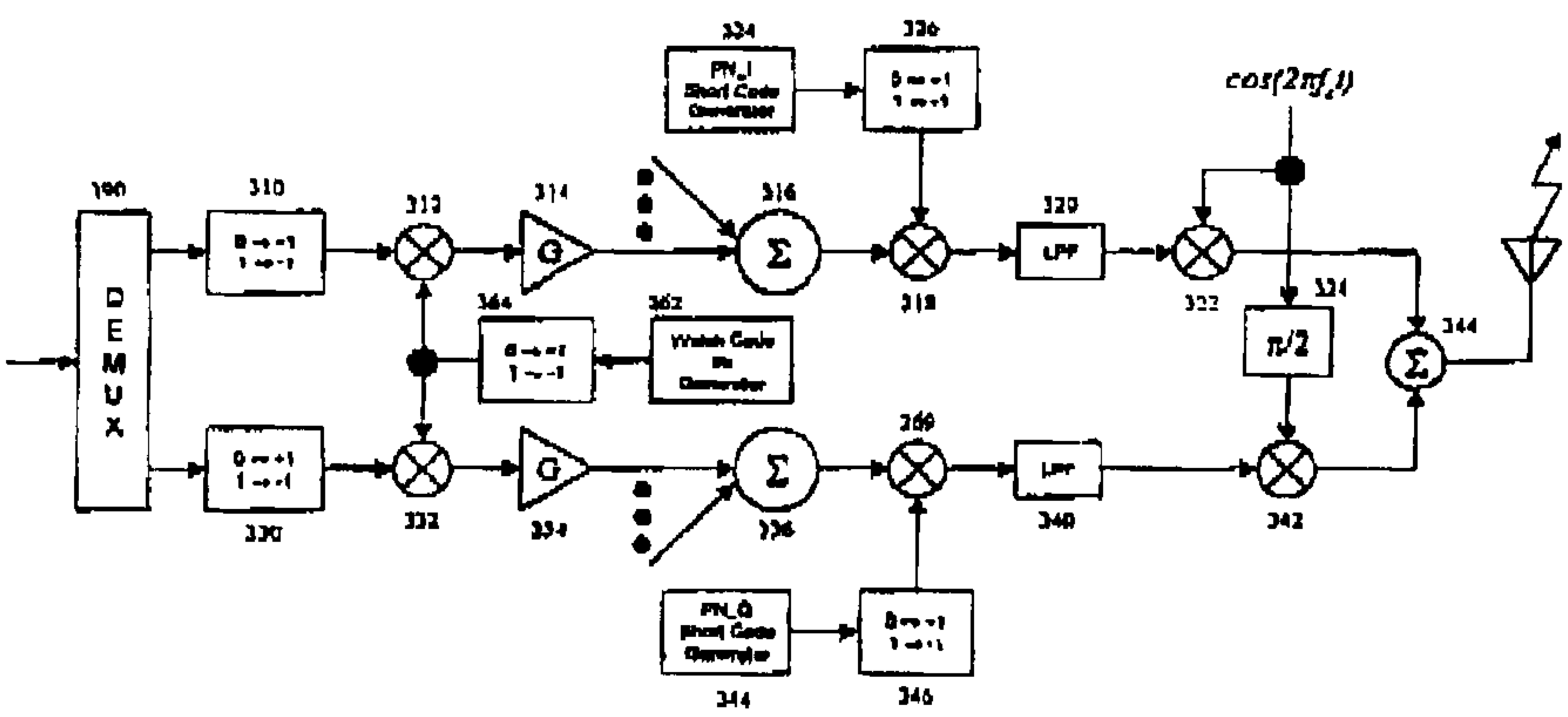


FIG. 3b
(Prior Art)

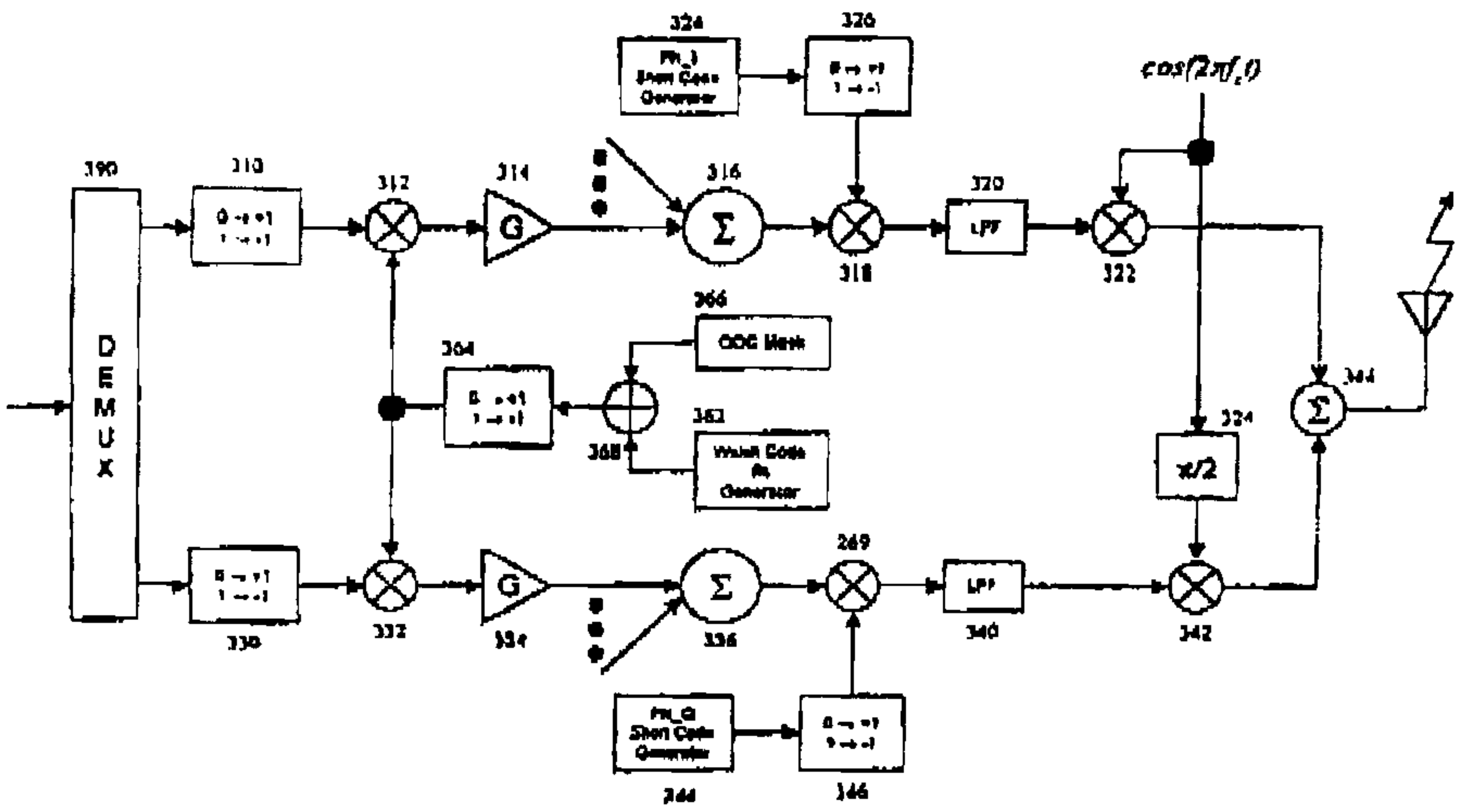


FIG. 3c
(Prior Art)

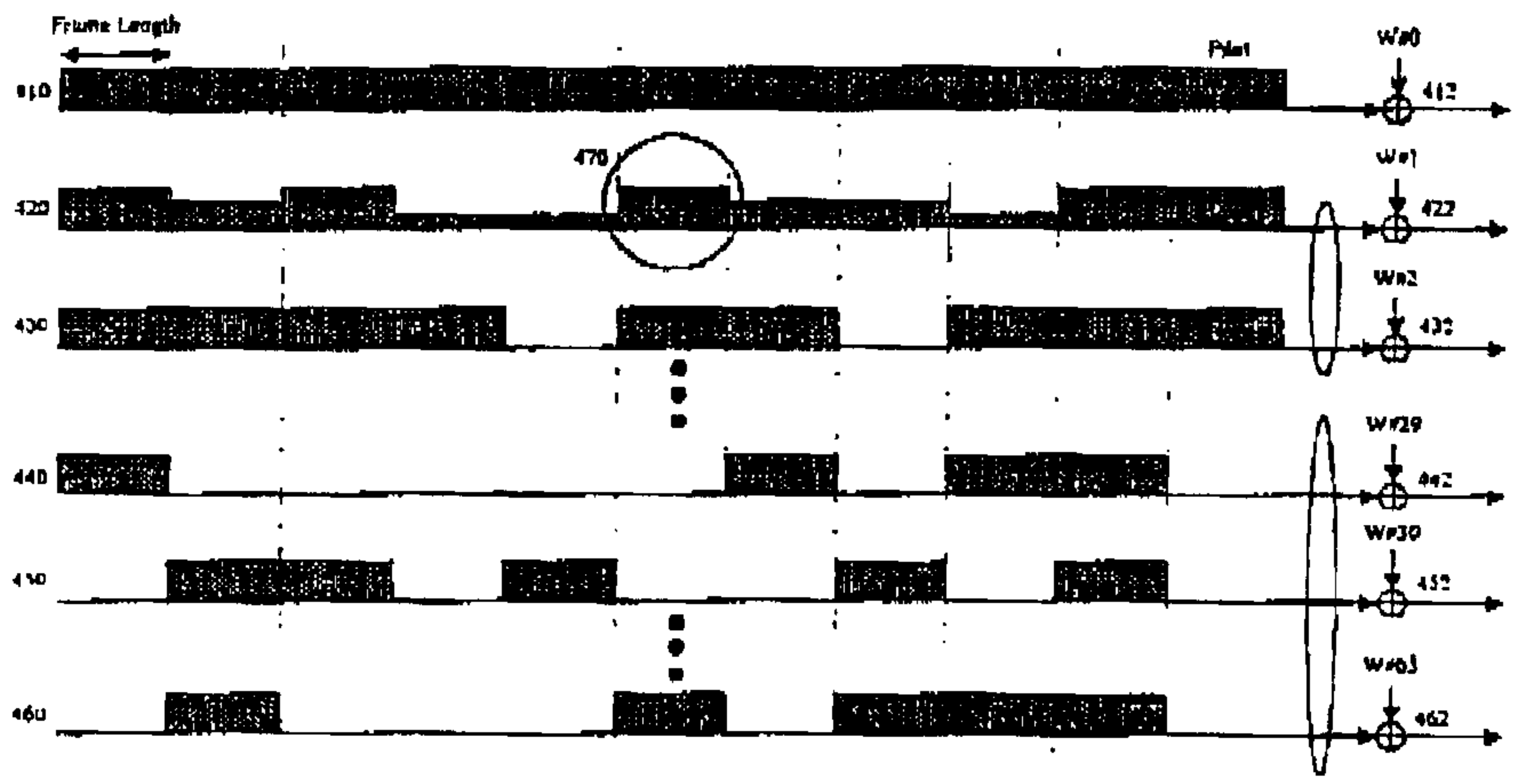


FIG. 4a
(Prior Art)

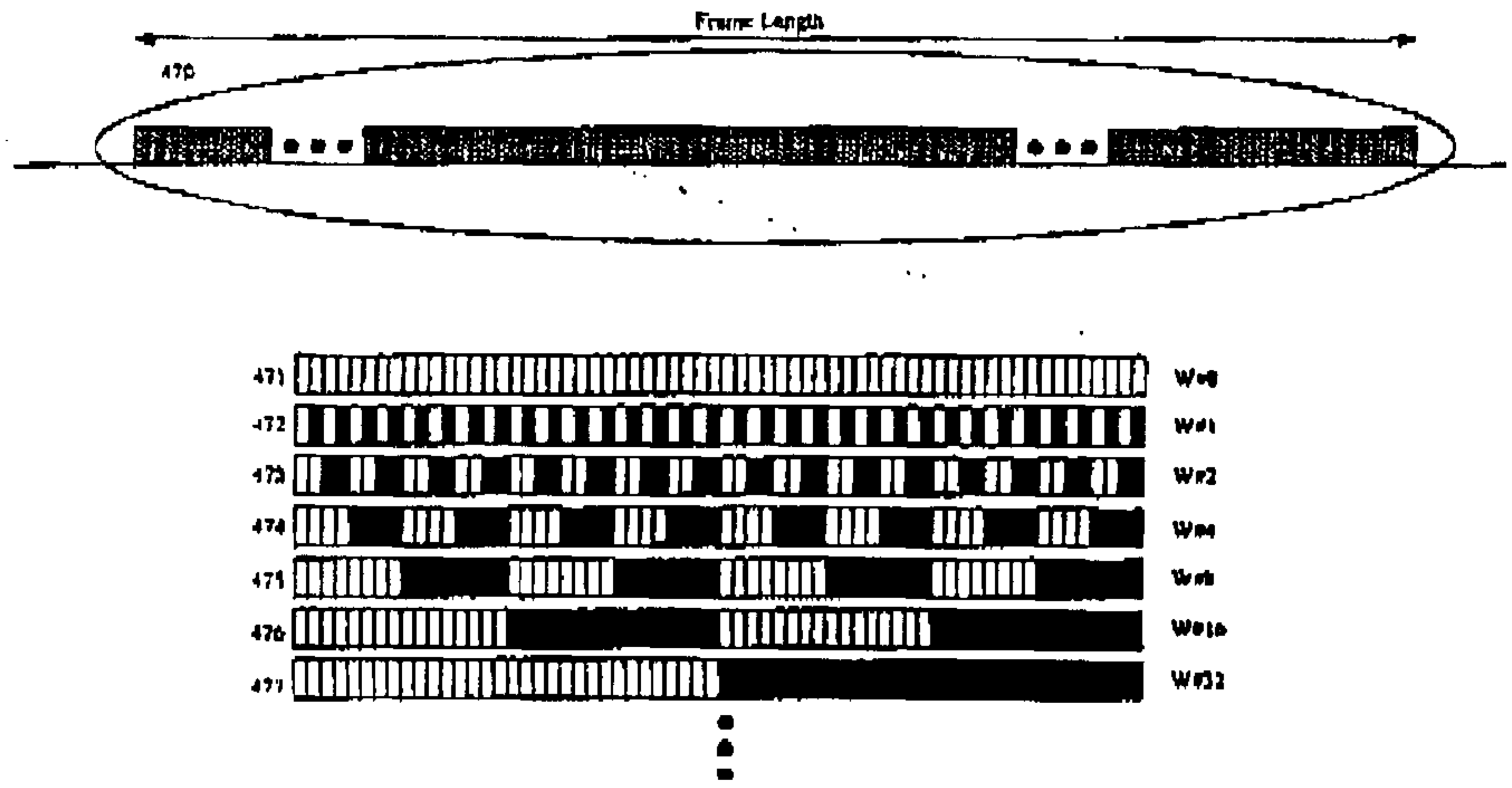


FIG. 4b
(Prior Art)

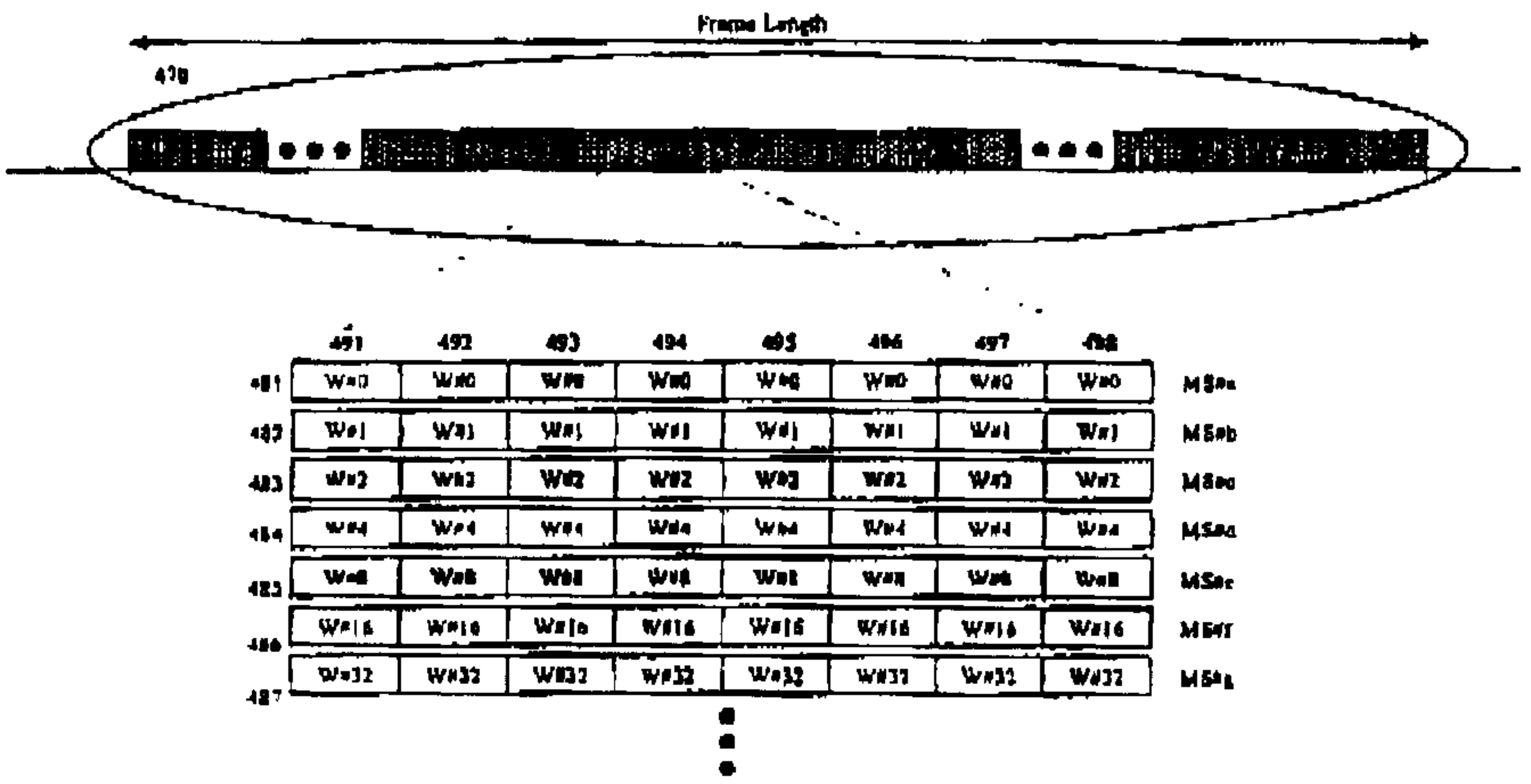


FIG. 4c
(Prior Art)

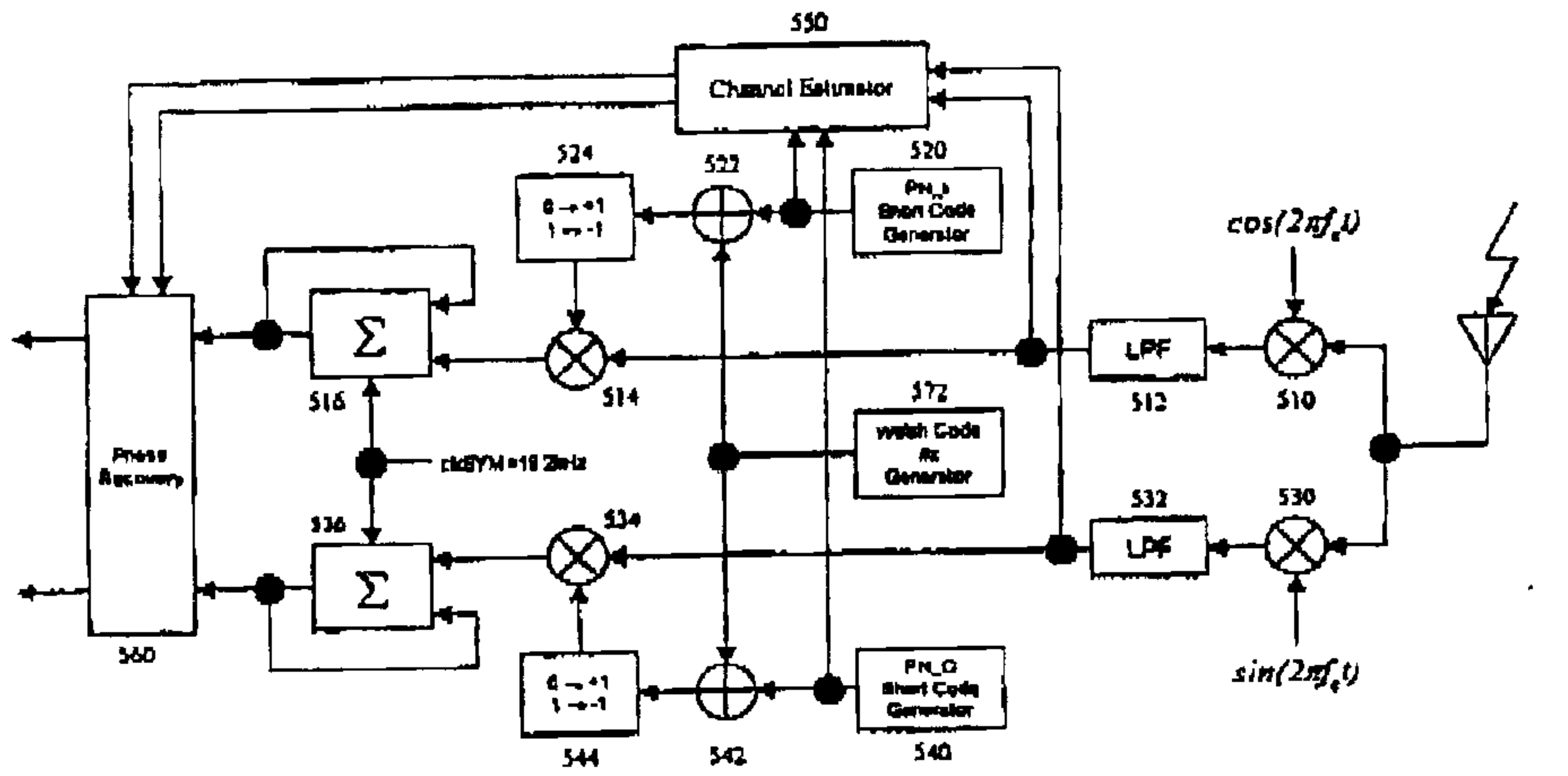


FIG. 5
(Prior Art)

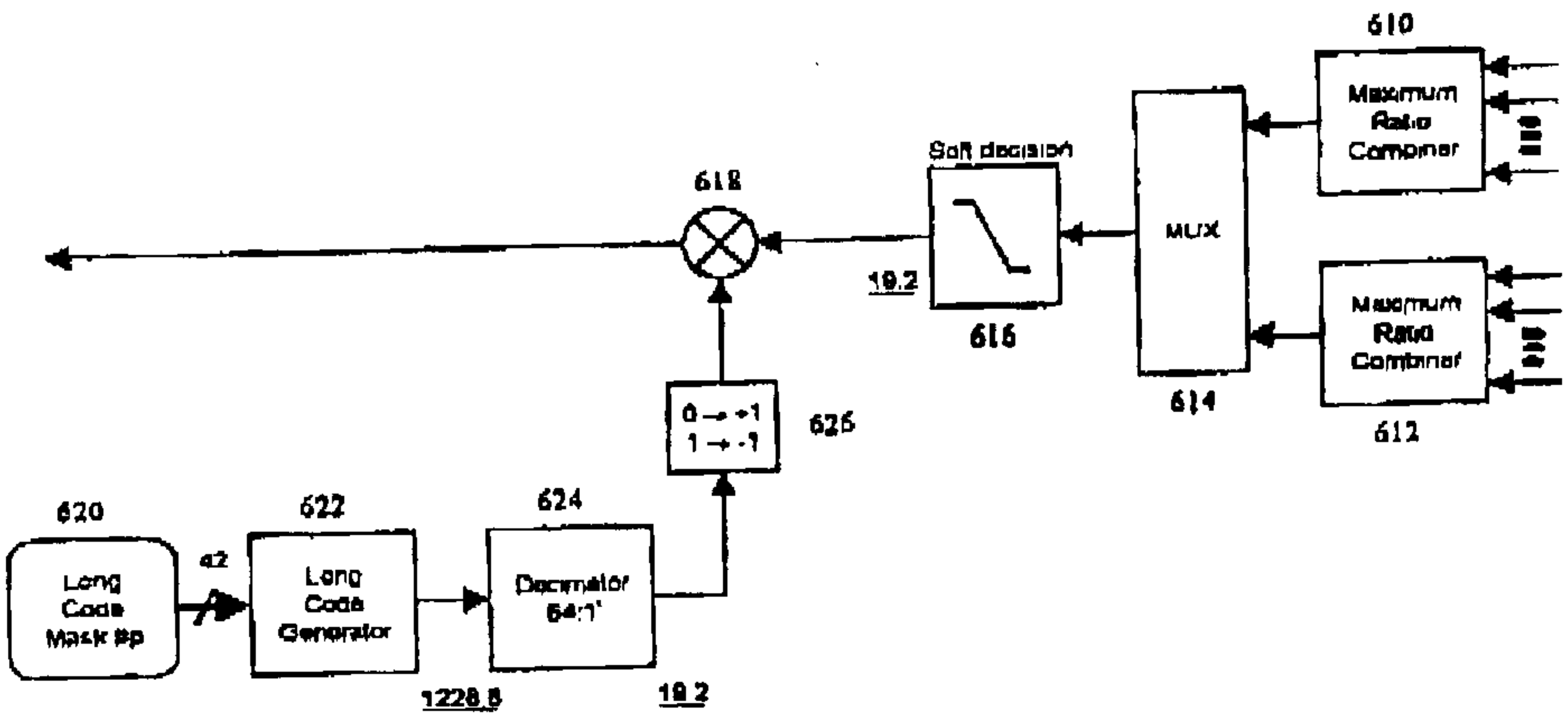


FIG. 6
(Prior Art)

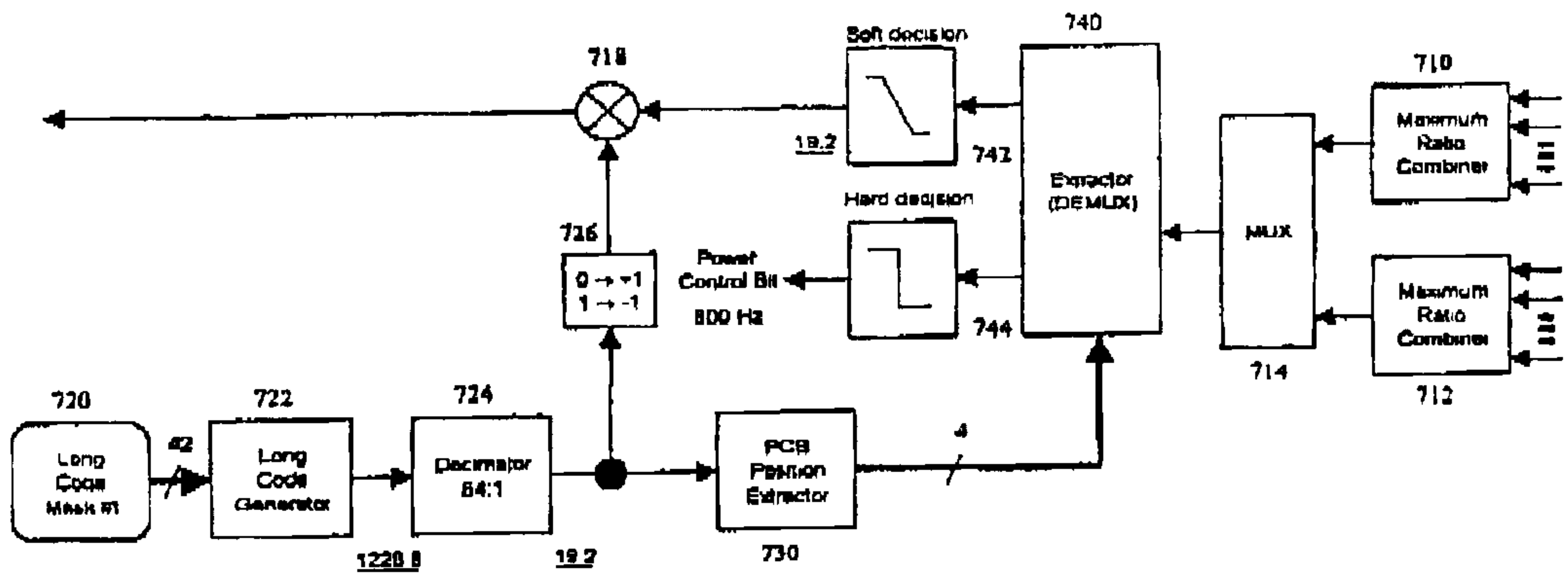


FIG. 7
(Prior Art)

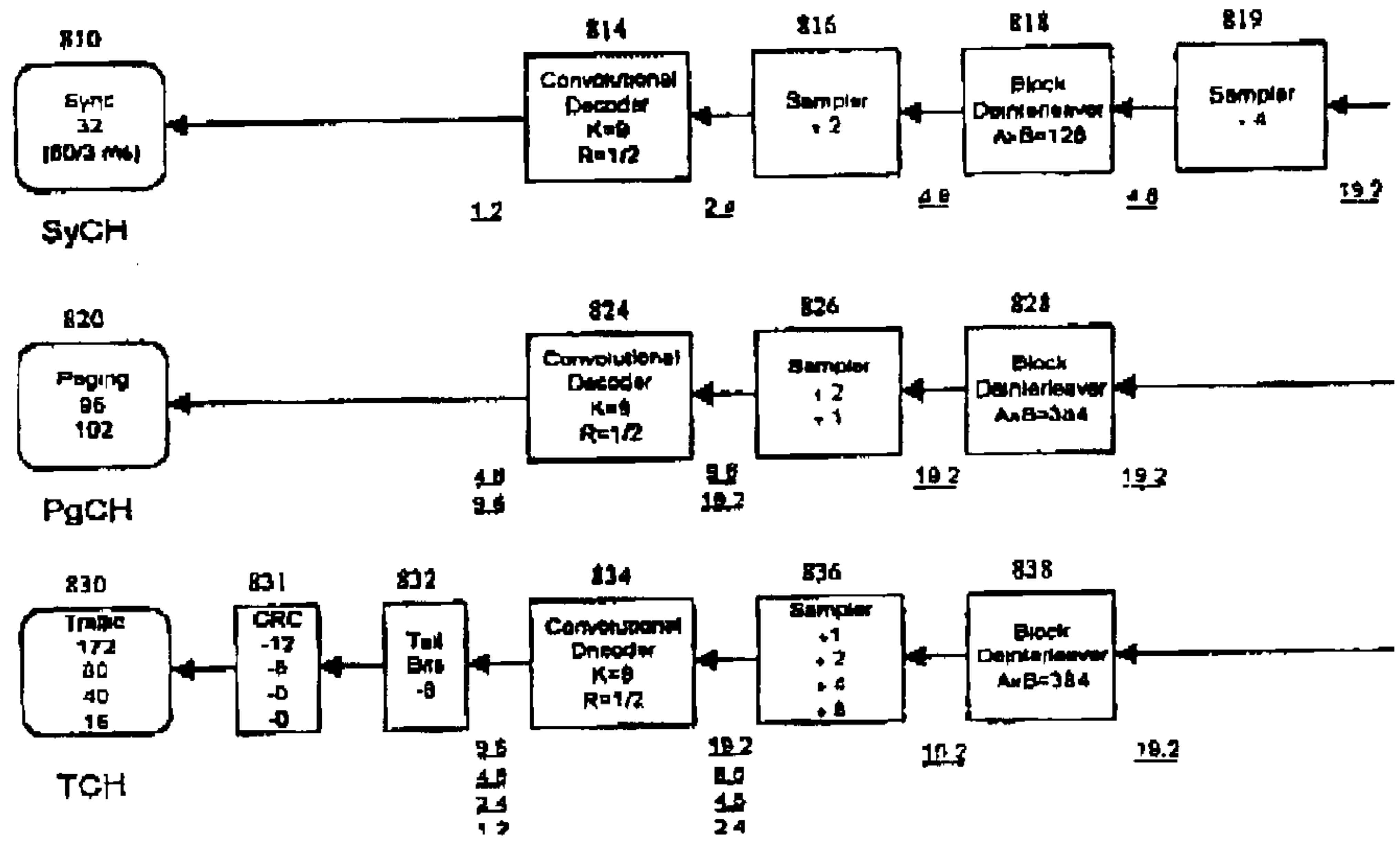


FIG. 8
(Prior Art)

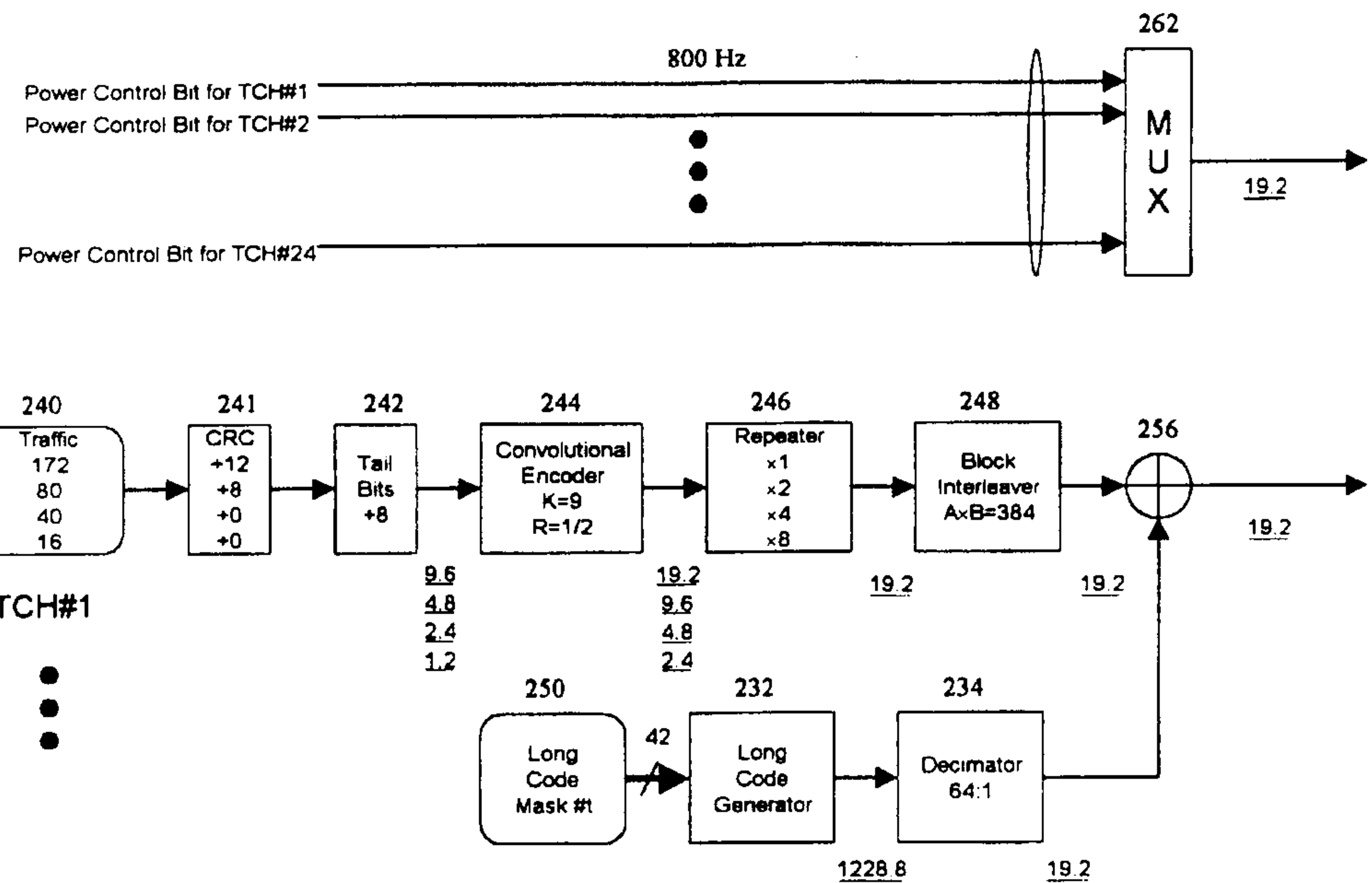

262
800 Hz
Power Control Bit for TCH#1
Power Control Bit for TCH#2
Power Control Bit for TCH#24
M U X
19.2
240
Traffic 172 80 40 16
241
CRC +12 +8 +0 +0
242
Tail Bits +8
244
Convolutional Encoder K=9 R=1/2
246
Repeater ×1 ×2 ×4 ×8
248
Block Interleaver AxB=384
256
19.2
TCH#1
9.6 4.8 2.4 1.2
19.2 9.6 4.8 2.4
19.2
19.2
250
Long Code Mask #t
42
232
Long Code Generator
234
Decimator 64:1
1228.8
19.2

FIG. 9

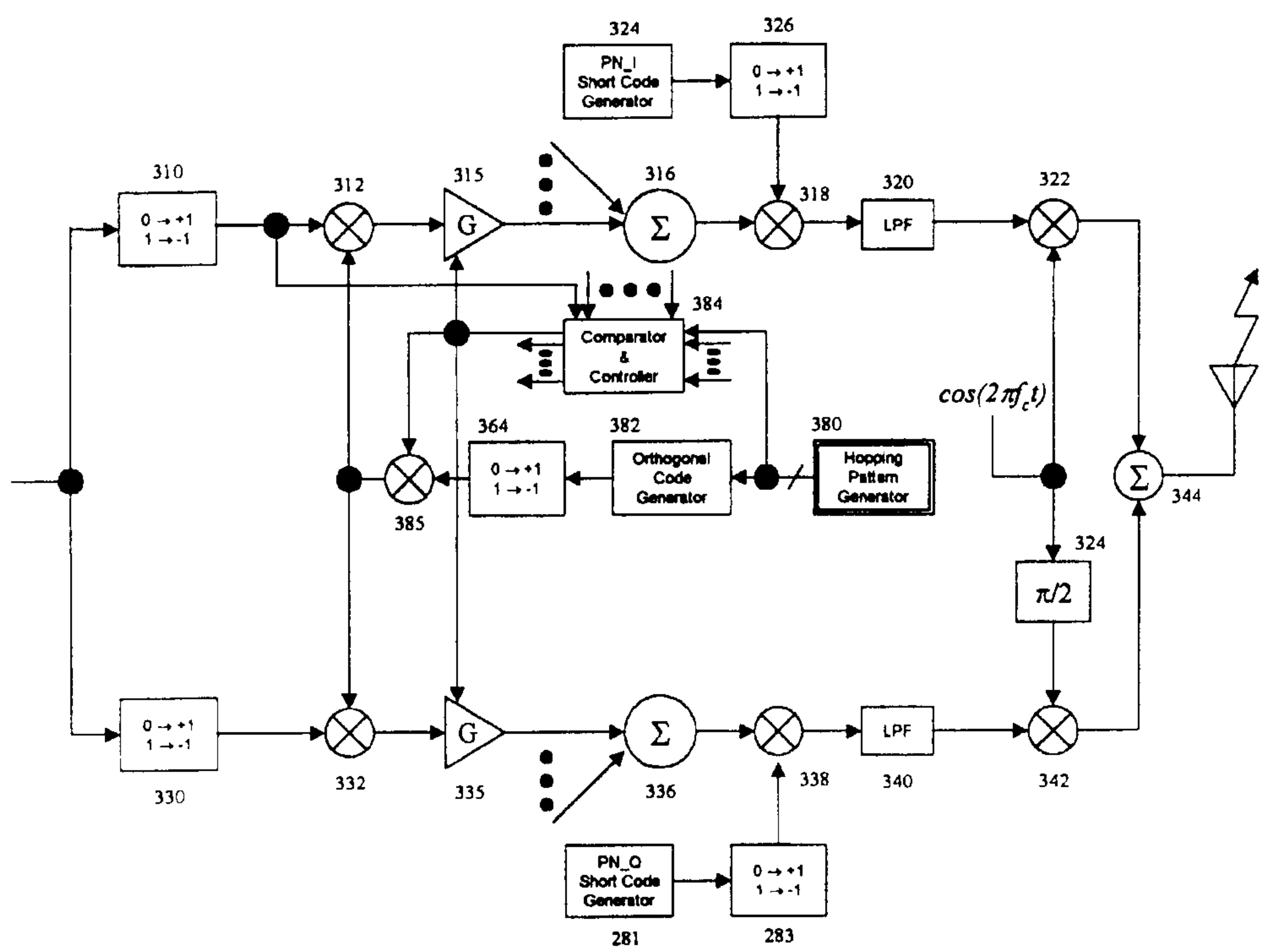

324
PN_I Short Code Generator
326
0 → +1
1 → -1
310
312
315
316
318
320
LPF
322
G
Σ
384
Comparator & Controller
cos(2πf_c t)
364
382
380
Orthogonal Code Generator
Hopping Pattern Generator
385
344
324
π/2
330
332
335
336
338
340
342
PN_Q Short Code Generator
281
283

FIG. 10a

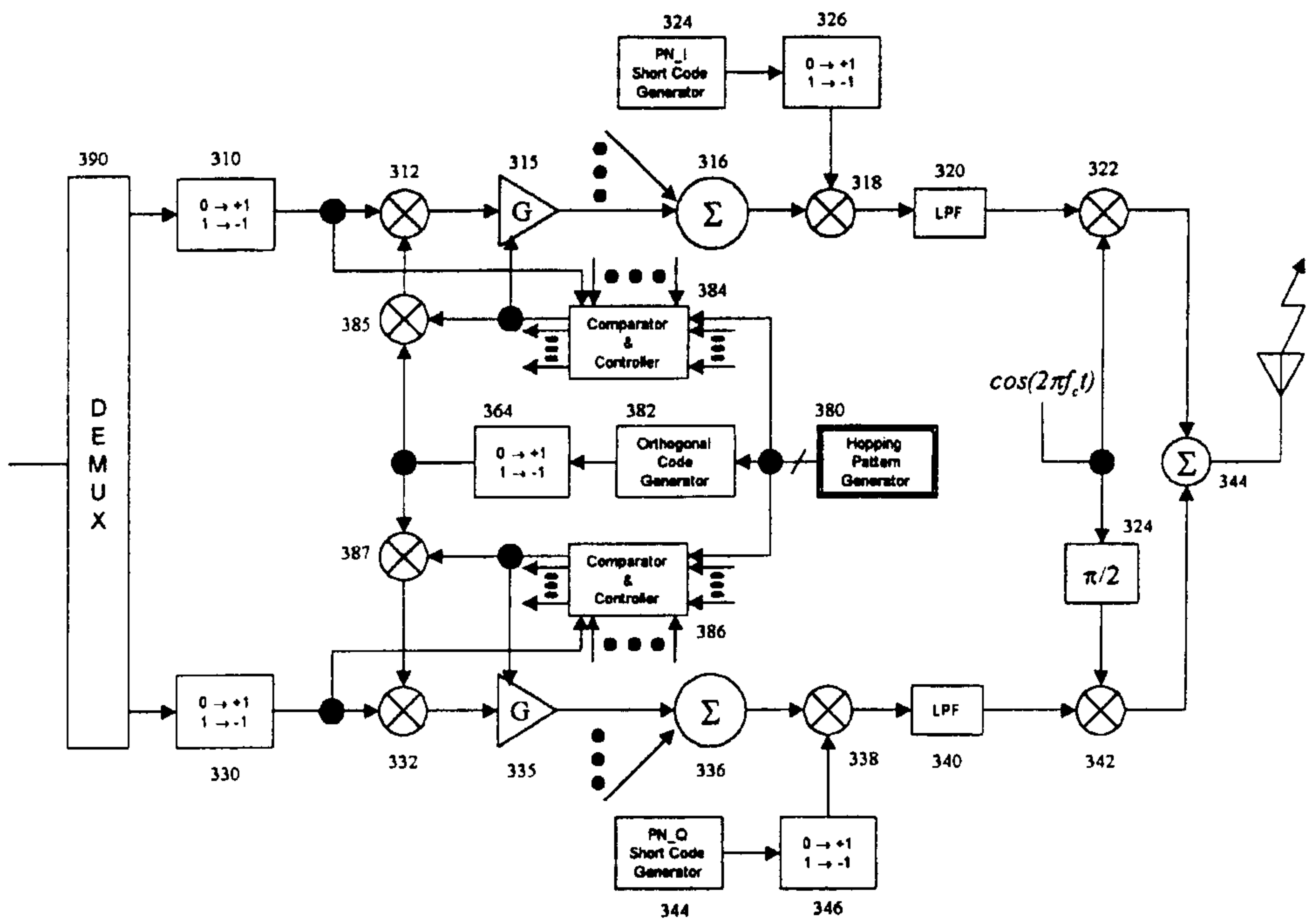


FIG. 10b

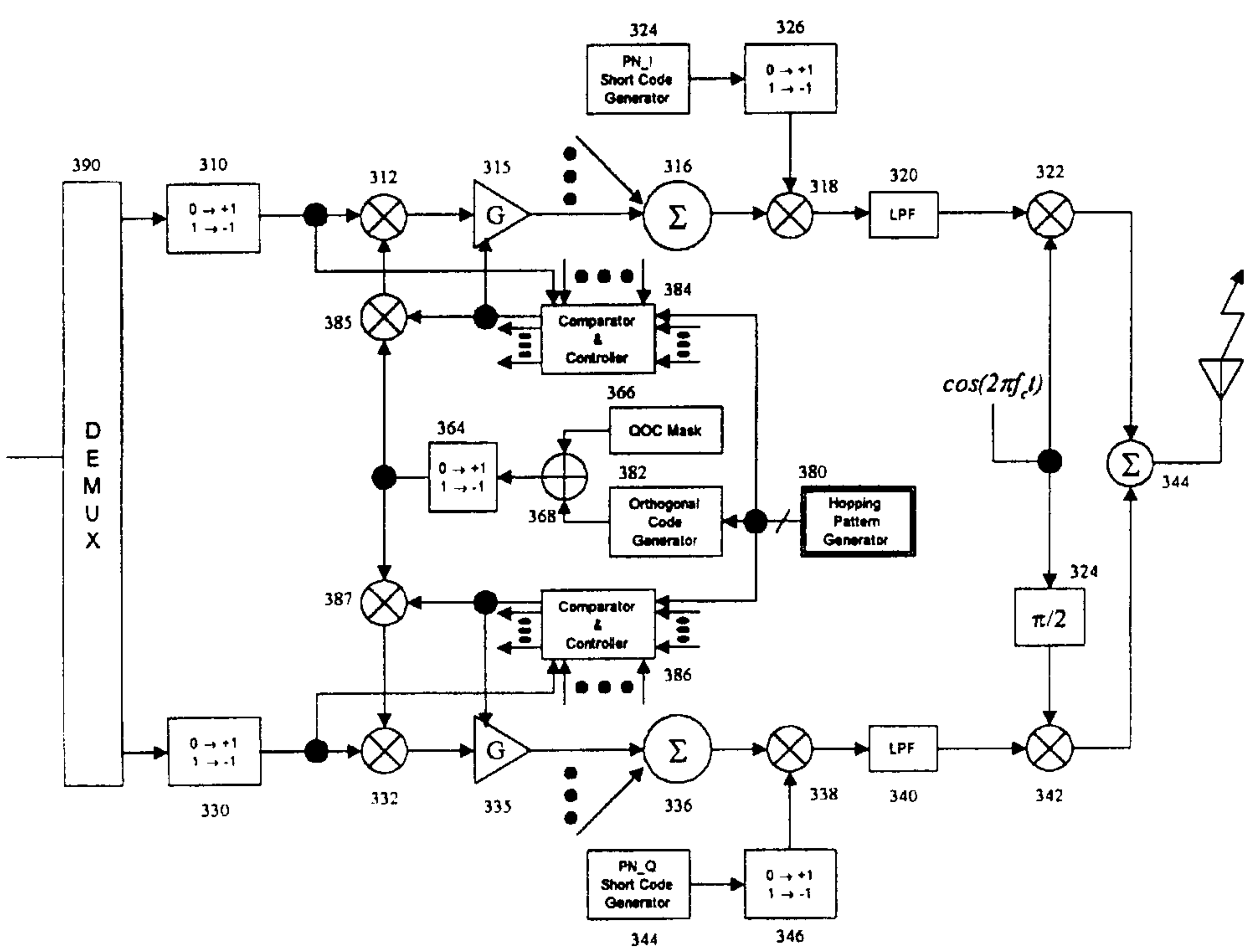


FIG. 10c

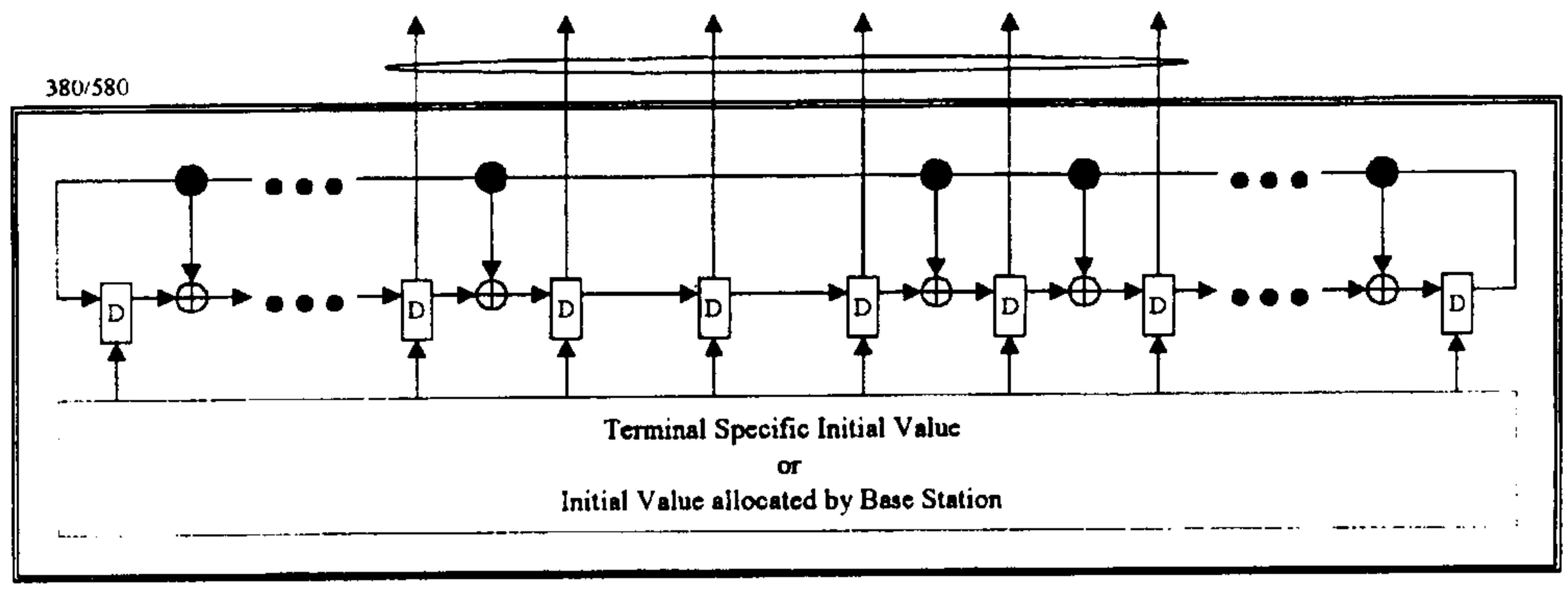

380/580
D
Terminal Specific Initial Value
or
Initial Value allocated by Base Station

FIG. 11

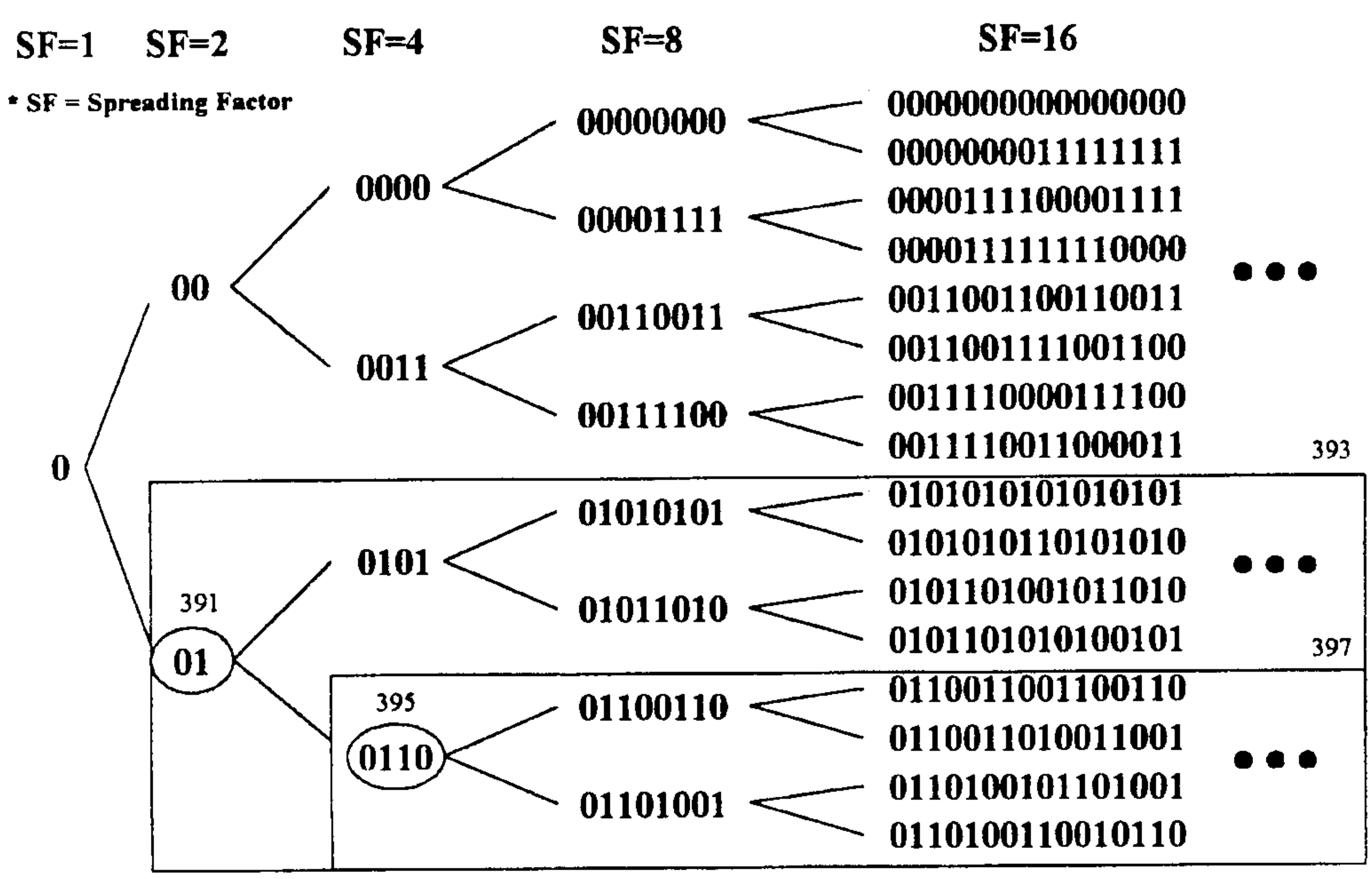

SF=1
SF=2
SF=4
SF=8
SF=16
* SF = Spreading Factor
0
00
01
391
0000
0011
0101
0110
395
00000000
00001111
00110011
00111100
01010101
01011010
01100110
01101001
0000000000000000
0000000011111111
0000111100001111
0000111111110000
0011001100110011
0011001111001100
0011110000111100
0011110011000011
0101010101010101
0101010110101010
0101101001011010
0101101010100101
0110011001100110
0110011010011001
0110100101101001
0110100110010110
393
397

FIG. 12

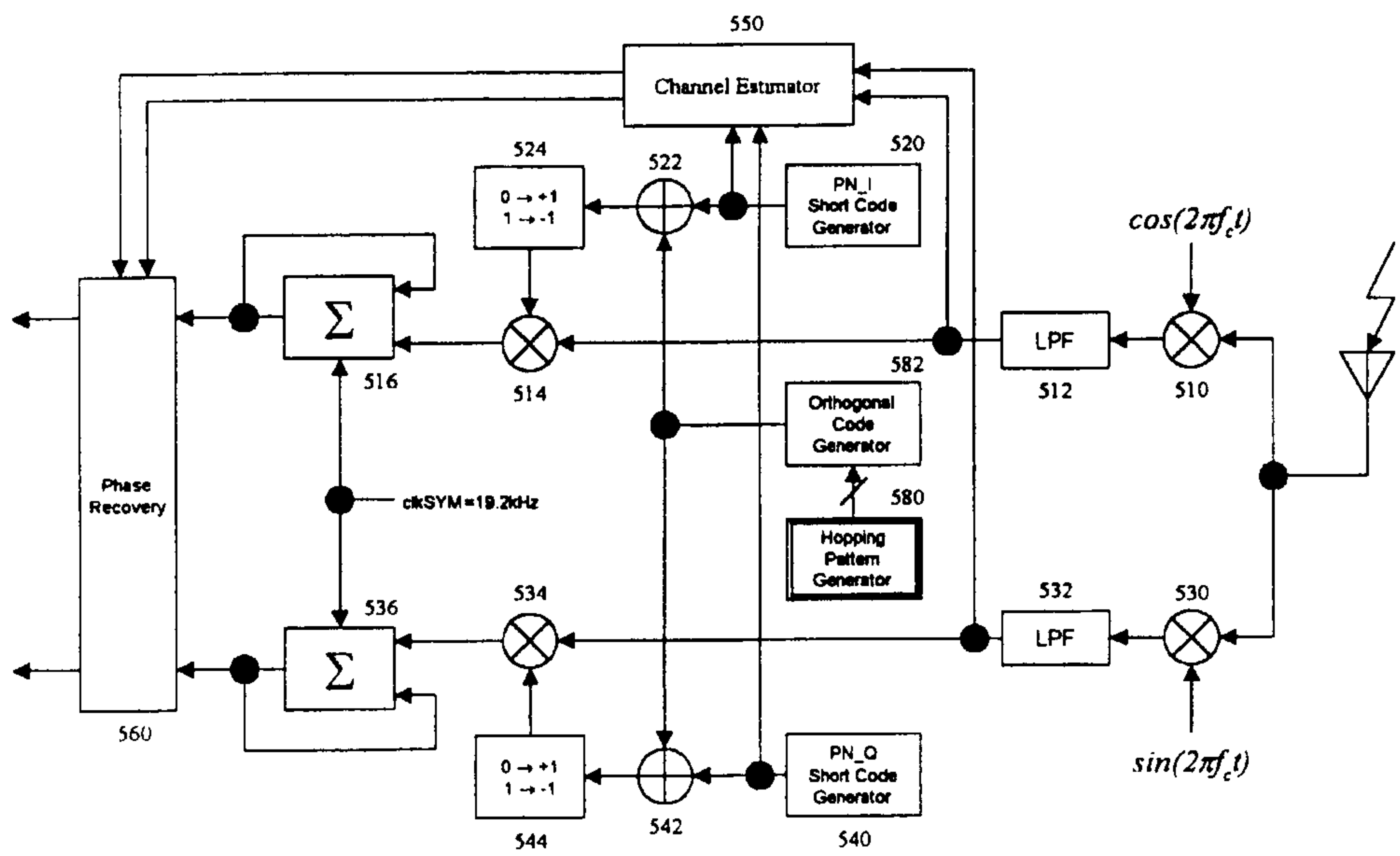


FIG. 13

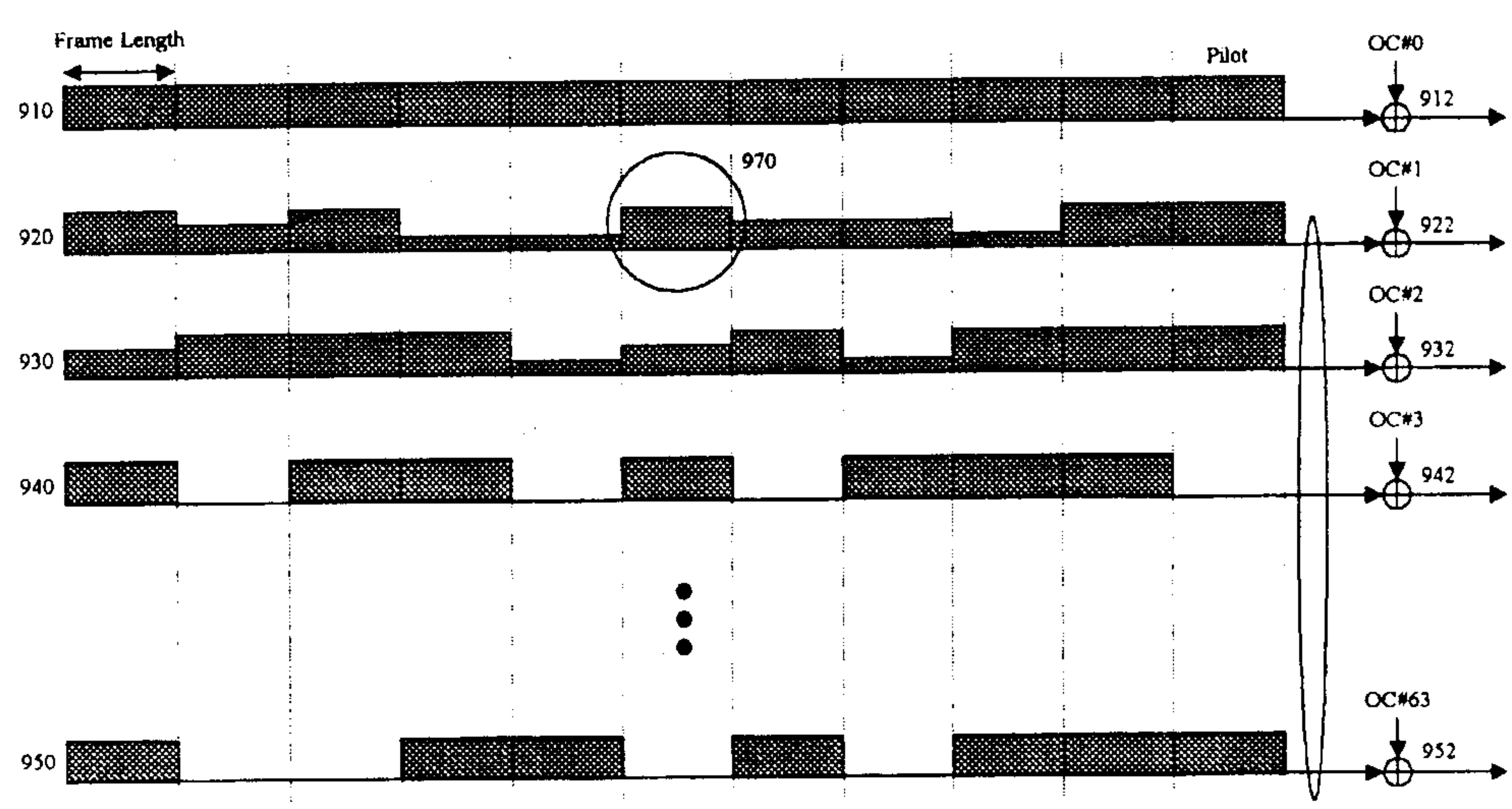


FIG. 14a

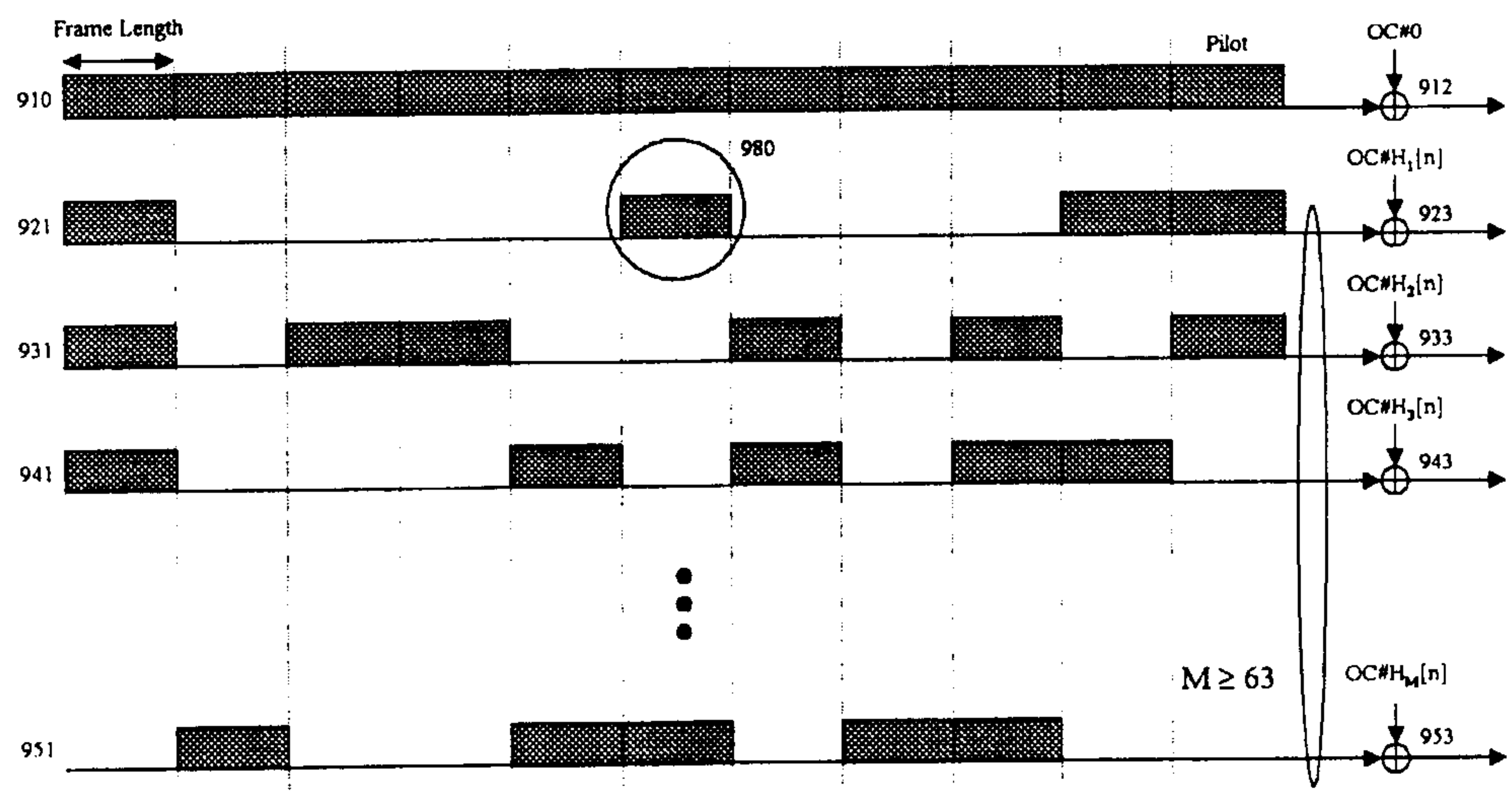


FIG. 14b

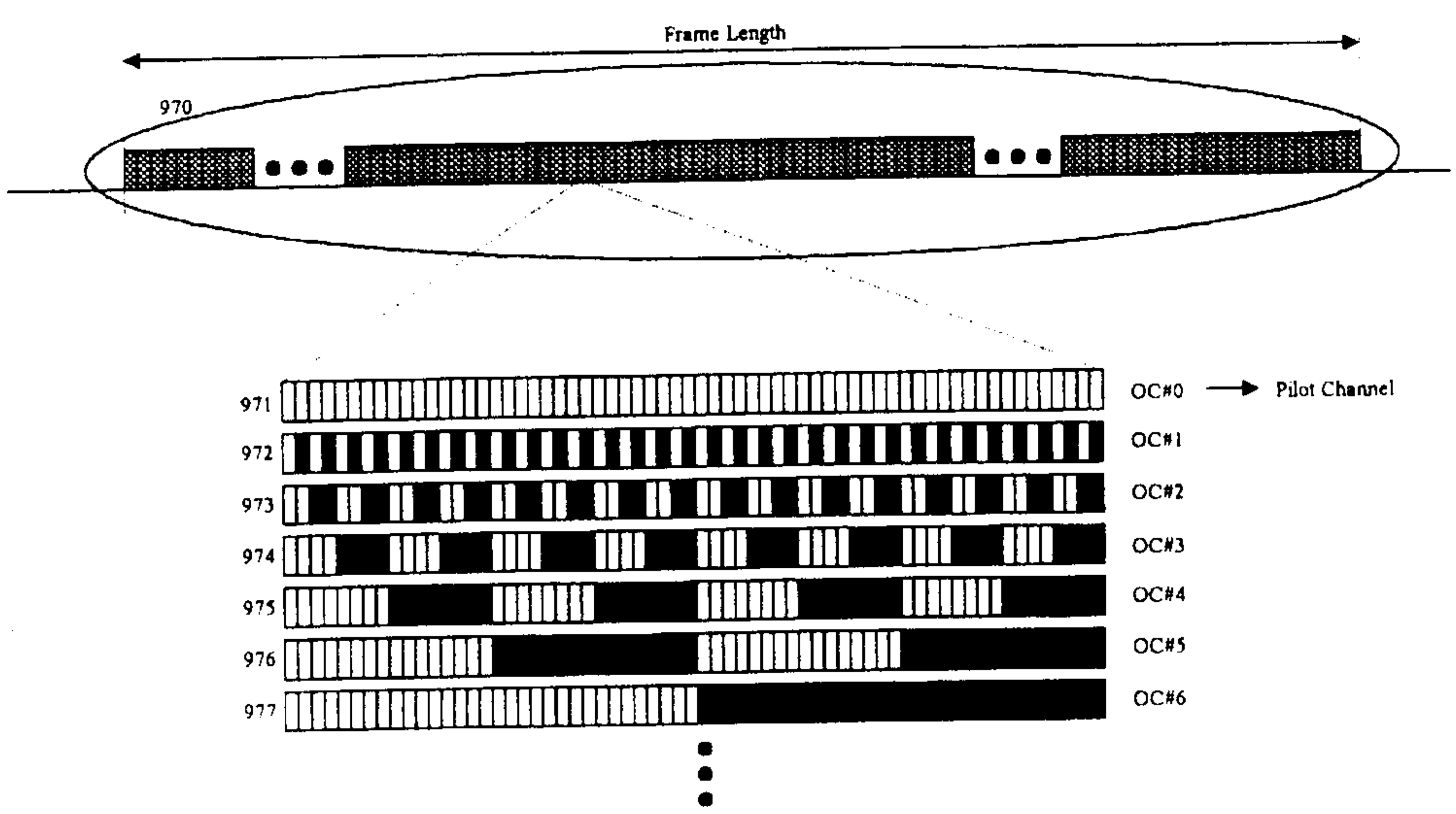


FIG. 14c

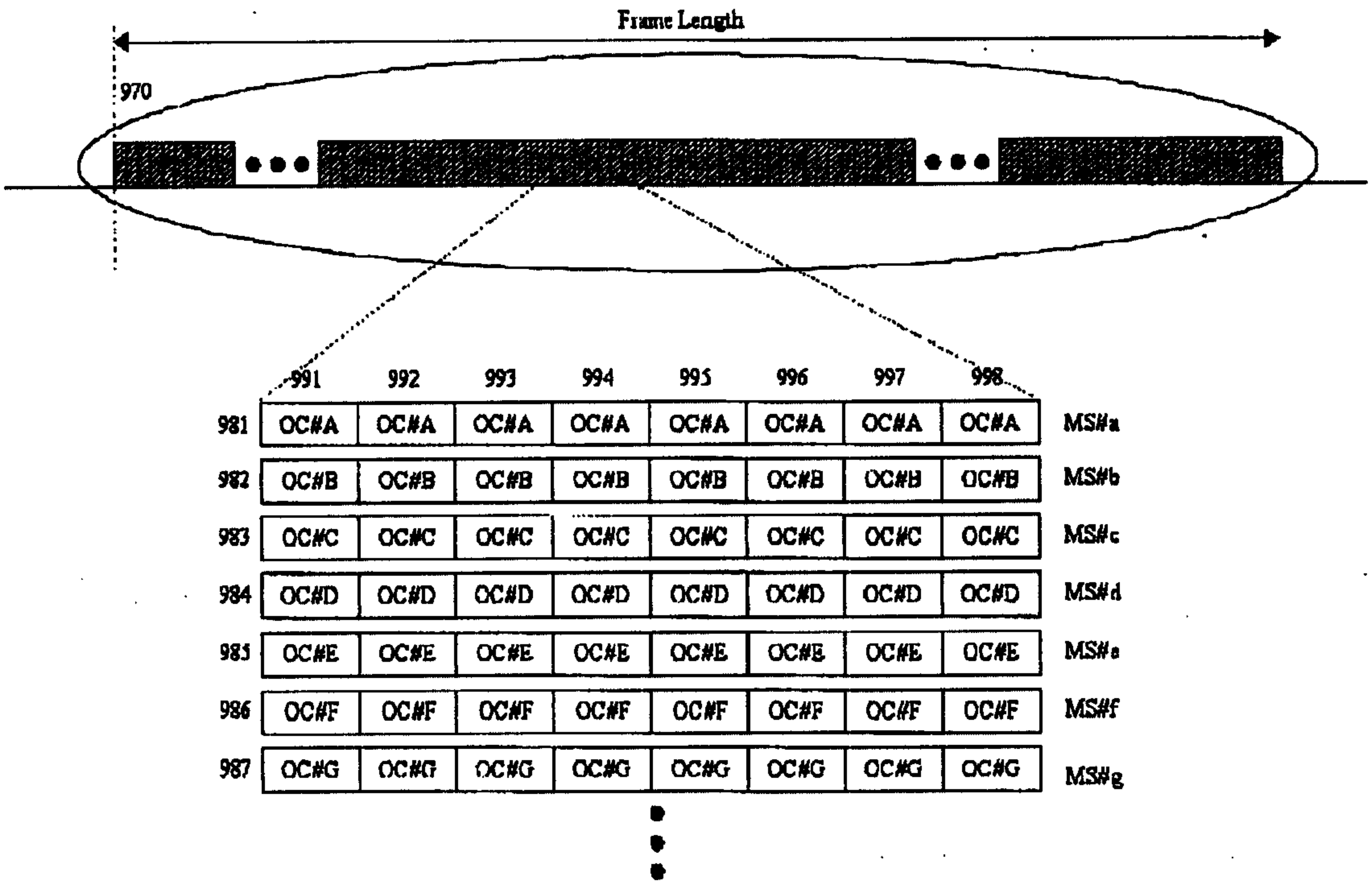
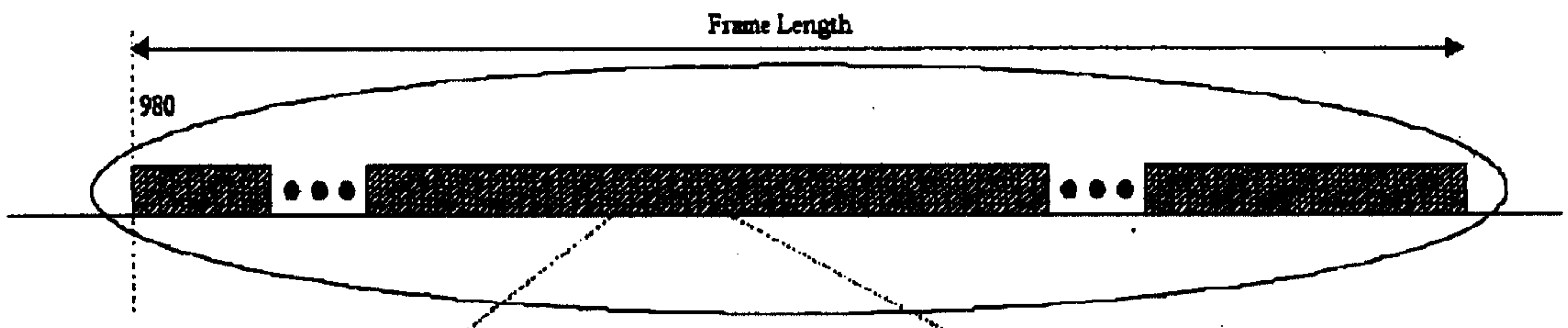

Frame Length
970
991 992 993 994 995 996 997 998
981 OC#A OC#A OC#A OC#A OC#A OC#A OC#A OC#A MS#a
982 OC#B OC#B OC#B OC#B OC#B OC#B OC#B OC#B MS#b
983 OC#C OC#C OC#C OC#C OC#C OC#C OC#C OC#C MS#c
984 OC#D OC#D OC#D OC#D OC#D OC#D OC#D OC#D MS#d
985 OC#E OC#E OC#E OC#E OC#E OC#E OC#E OC#E MS#e
986 OC#F OC#F OC#F OC#F OC#F OC#F OC#F OC#F MS#f
987 OC#G OC#G OC#G OC#G OC#G OC#G OC#G OC#G MS#g

Fig. 14d



	1021	1022	1023	1024	1025	1026	1027	1028	
1011	OC#9	OC#5	OC#35	OC#61	OC#54	OC#34	OC#23	OC#23	MS#a↔ HP#a
1012	OC#43	OC#26	OC#48	OC#33	OC#15	OC#17	OC#55	OC#60	MS#b↔ HP#b
1013	OC#45	OC#37	OC#58	OC#49	OC#7	OC#2	OC#12	OC#52	MS#c↔ HP#c
1014	OC#36	OC#38	OC#37	OC#22	OC#37	OC#32	OC#42	OC#22	MS#d↔ HP#d
1015	OC#31	OC#25	OC#29	OC#35	OC#56	OC#28	OC#19	OC#27	MS#e↔ HP#e
1016	OC#57	OC#44	OC#17	OC#2	OC#48	OC#52	OC#52	OC#11	MS#f↔ HP#f
1017	OC#48	OC#49	OC#9	OC#9	OC#50	OC#37	OC#35	OC#55	MS#g↔ HP#g

•
•
•

Fig. 14e

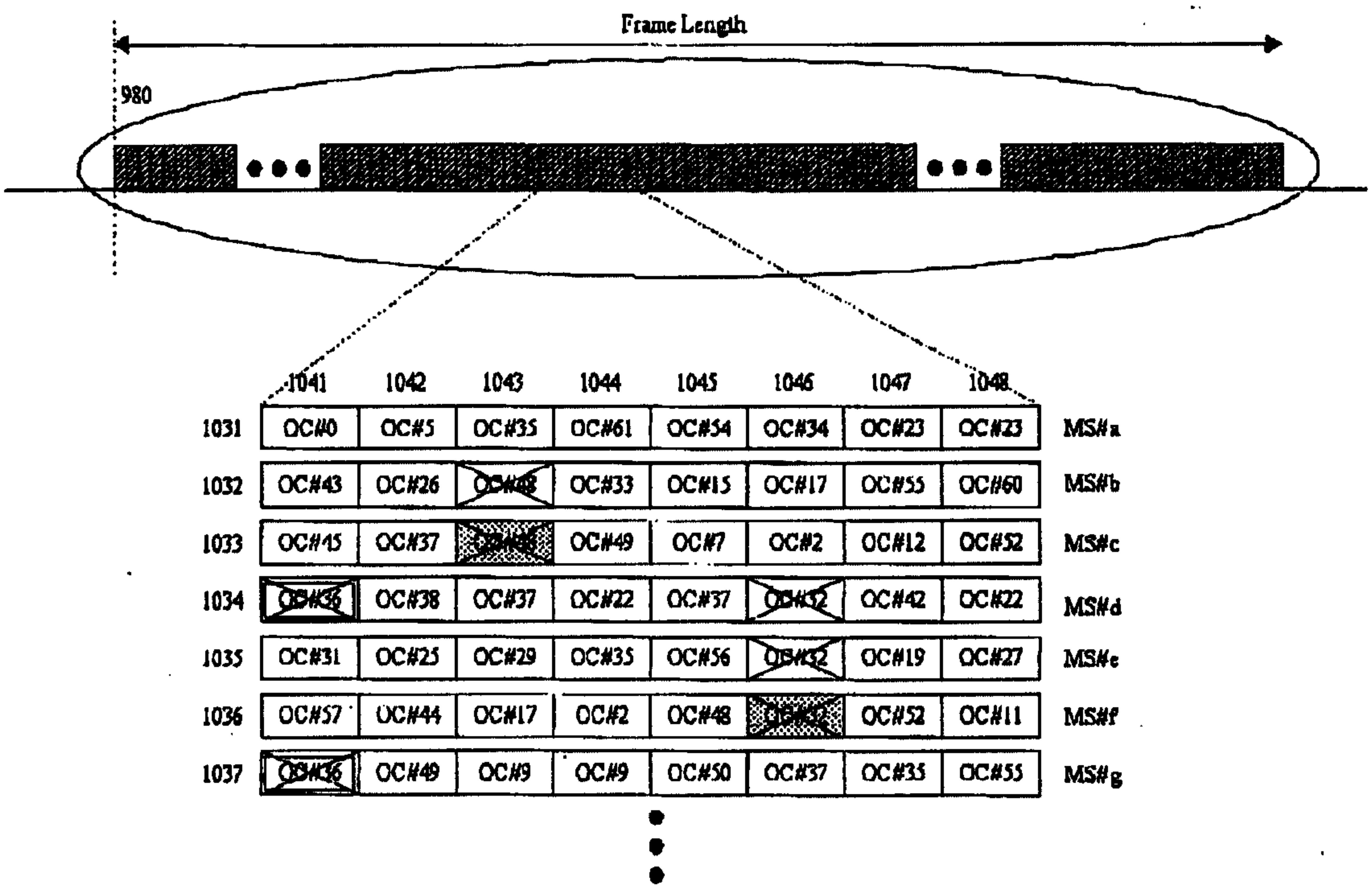

Frame Length
980
1041 1042 1043 1044 1045 1046 1047 1048
1031 OC#0 OC#5 OC#35 OC#61 OC#54 OC#34 OC#23 OC#23 MS#a
1032 OC#43 OC#26 OC#48 OC#33 OC#15 OC#17 OC#55 OC#60 MS#b
1033 OC#45 OC#37 OC#49 OC#7 OC#2 OC#12 OC#52 MS#c
1034 OC#36 OC#38 OC#37 OC#22 OC#37 OC#32 OC#42 OC#22 MS#d
1035 OC#31 OC#25 OC#29 OC#35 OC#56 OC#32 OC#19 OC#27 MS#e
1036 OC#57 OC#44 OC#17 OC#2 OC#48 OC#52 OC#11 MS#f
1037 OC#36 OC#49 OC#9 OC#9 OC#50 OC#37 OC#35 OC#55 MS#g

Fig. 14f

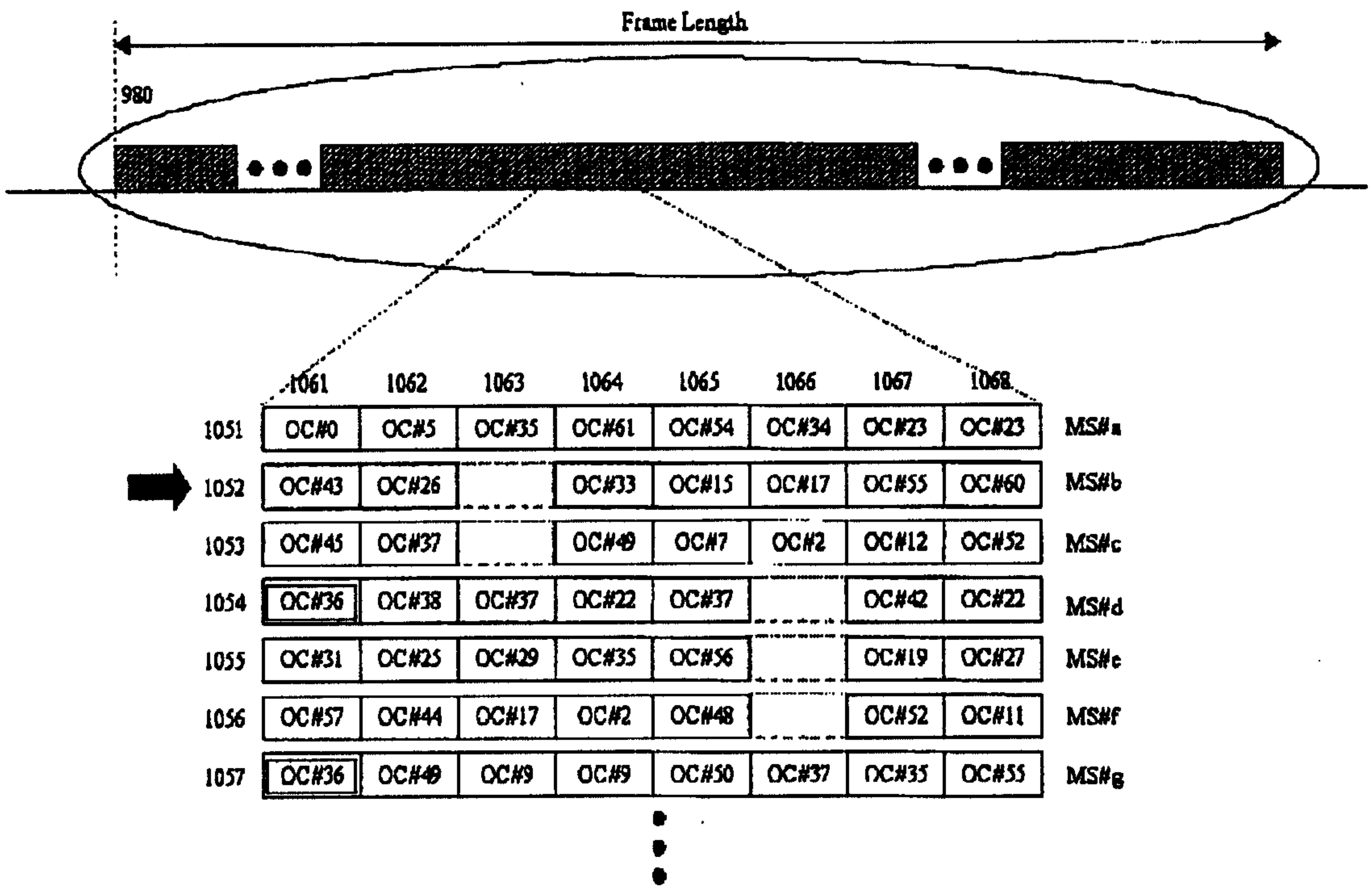

Frame Length
980
1061 1062 1063 1064 1065 1066 1067 1068
1051 OC#0 OC#5 OC#35 OC#61 OC#54 OC#34 OC#23 OC#23 MS#a
1052 OC#43 OC#26 OC#33 OC#15 OC#17 OC#55 OC#60 MS#b
1053 OC#45 OC#37 OC#49 OC#7 OC#2 OC#12 OC#52 MS#c
1054 OC#36 OC#38 OC#37 OC#22 OC#37 OC#42 OC#22 MS#d
1055 OC#31 OC#25 OC#29 OC#35 OC#56 OC#19 OC#27 MS#e
1056 OC#57 OC#44 OC#17 OC#2 OC#48 OC#52 OC#11 MS#f
1057 OC#36 OC#49 OC#9 OC#9 OC#50 OC#37 OC#35 OC#55 MS#g

Fig. 14g

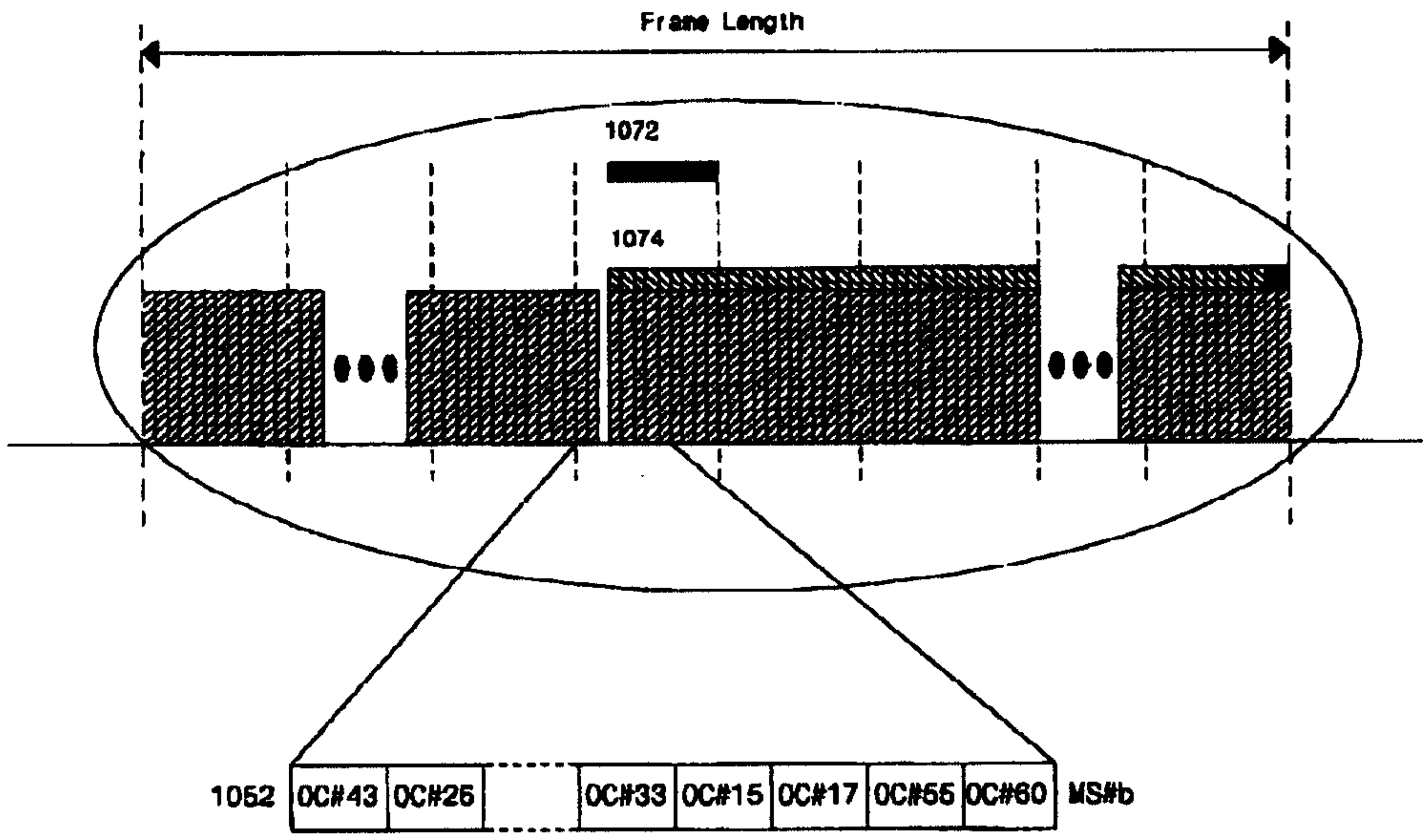

Frame Length
1072
1074
1052
0C#43
0C#25
0C#33
0C#15
0C#17
0C#55
0C#60
MS#b

Fig. 14h

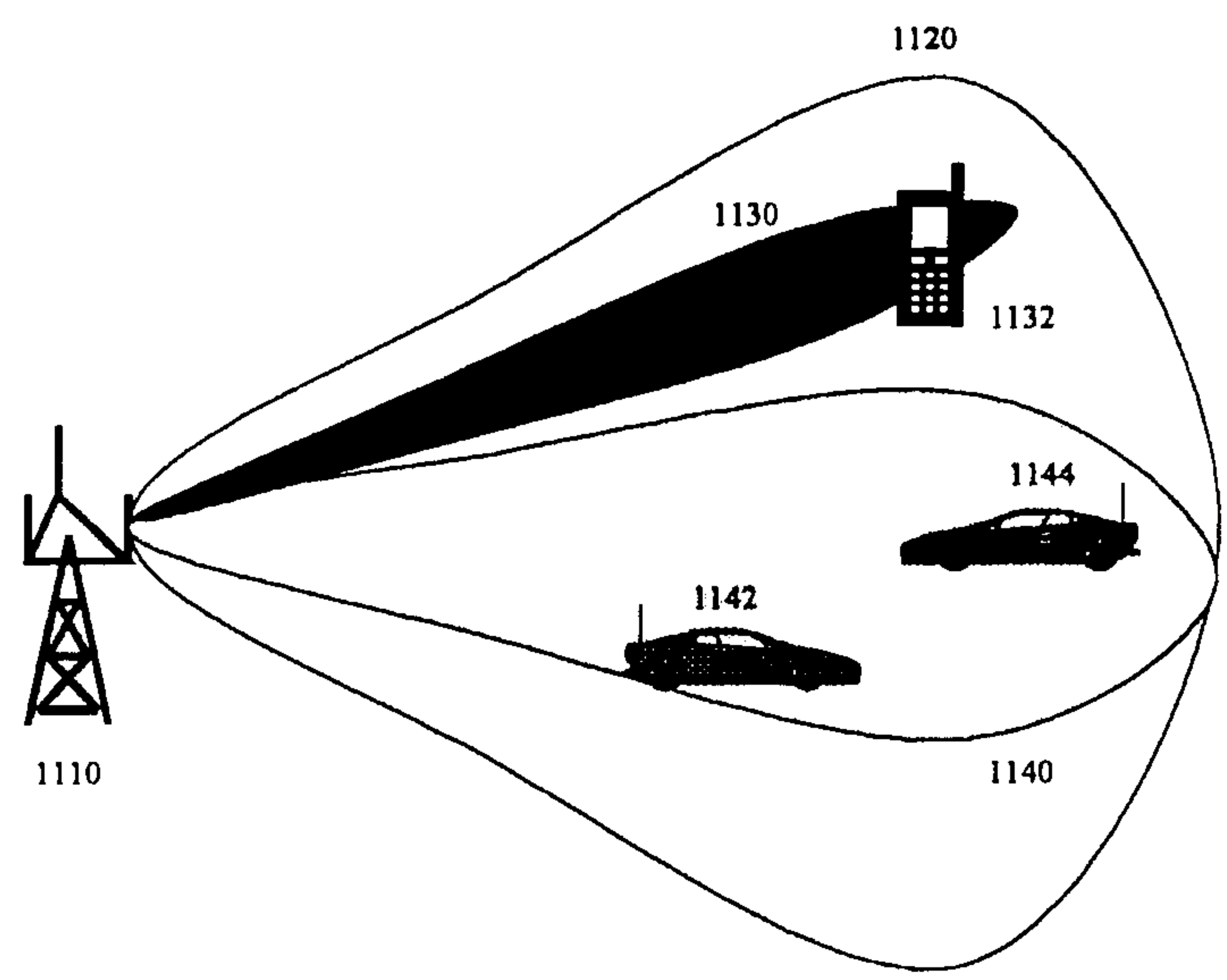
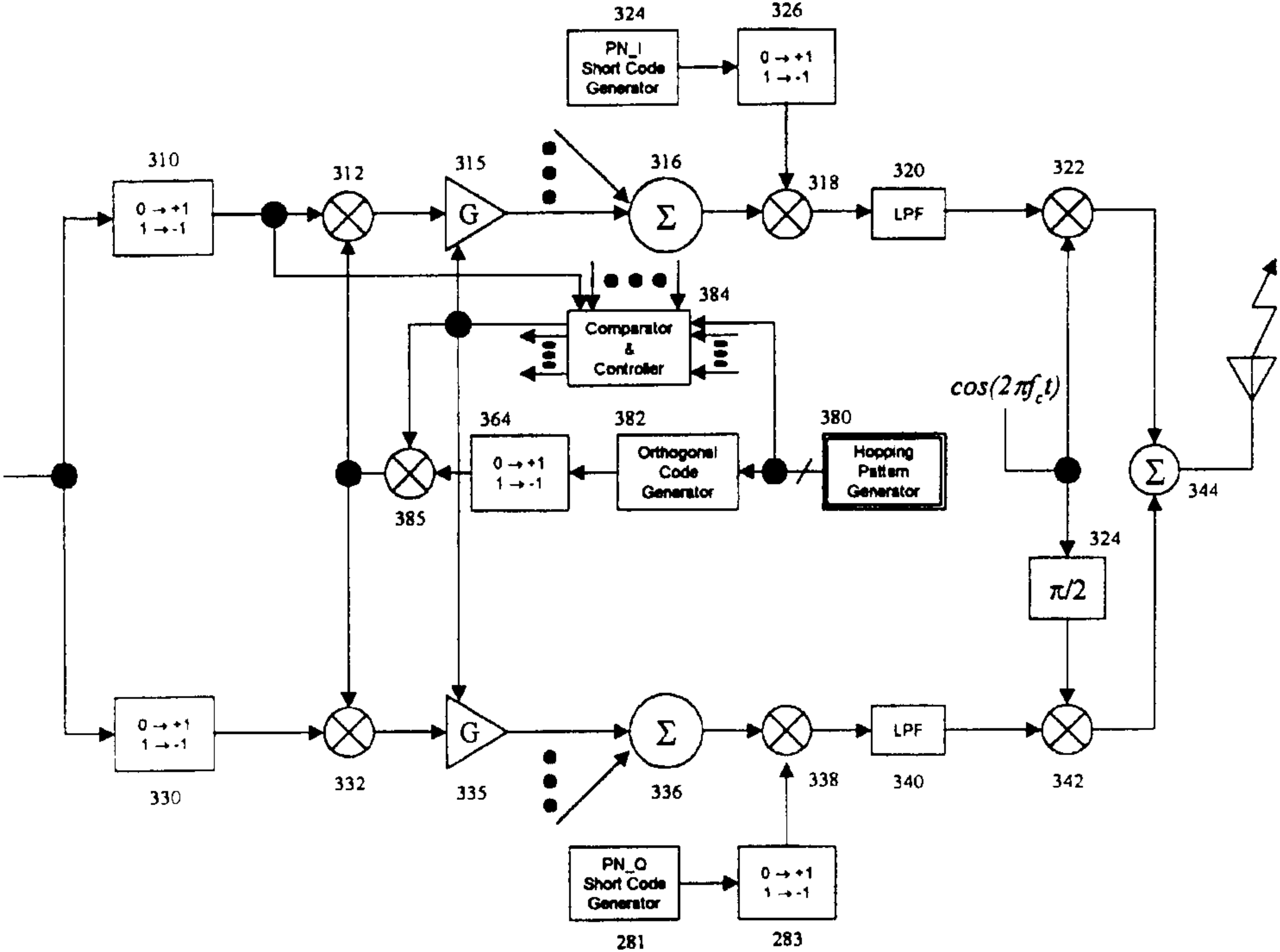


FIG. 15


324
PN_I
Short Code
Generator
326
0 → +1
1 → -1
310
0 → +1
1 → -1
312
315
G
316
Σ
318
320
LPF
322
384
Comparator
&
Controller
cos(2πf_c t)
364
0 → +1
1 → -1
382
Orthogonal
Code
Generator
380
Hopping
Pattern
Generator
385
Σ
344
324
π/2
0 → +1
1 → -1
330
332
G
335
Σ
336
338
LPF
340
342
PN_Q
Short Code
Generator
281
0 → +1
1 → -1
283