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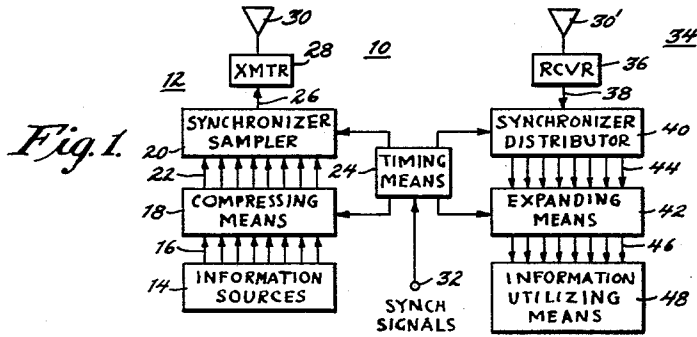
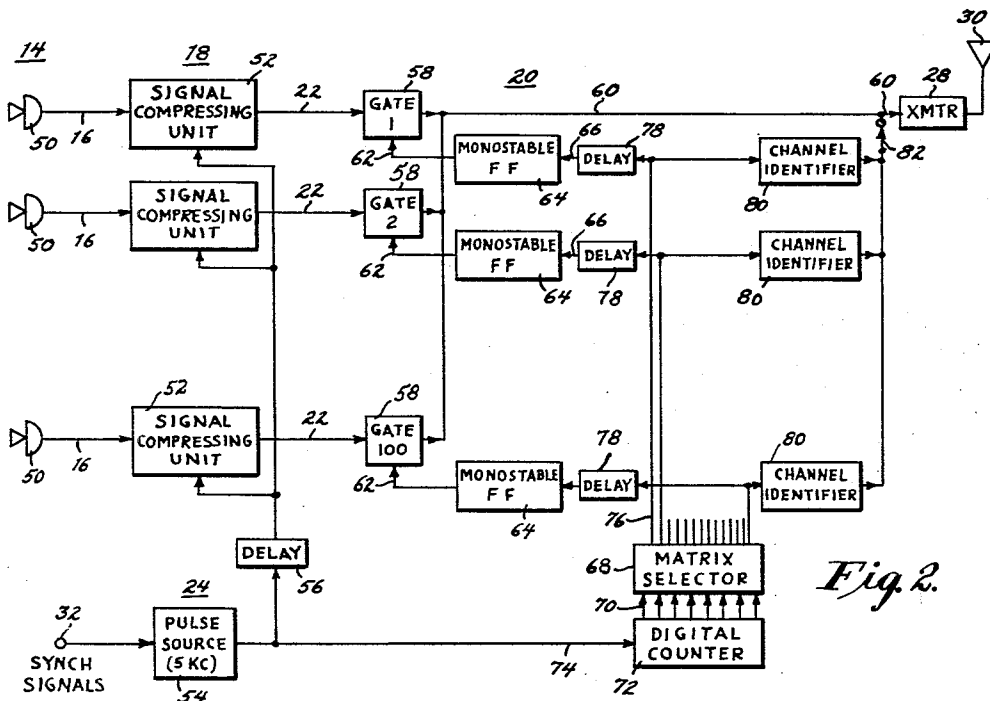
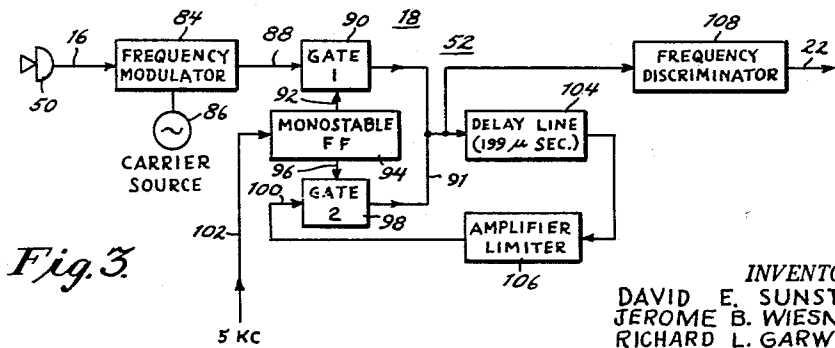
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MULTICHANNEL SIGNALING SYSTEM AND METHOD

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## MULTICHANNEL SIGNALING SYSTEM AND METHOD

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The invention relates to a signaling system and method, and more particularly to a system and method for transmitting and receiving a plurality of information signals from a plurality of various locations utilizing a single carrier frequency.

Heretofore, signaling systems have provided numerous information channels, wherein each of the channels has required a respective carrier frequency. This requirement has limited the number of available information channels due to the limited frequency spectrum and intermodulation interference.

At present, it appears that for ultra high frequency short range communications, it is possible to transmit from a given small platform such as a ship, only about 17 channels simultaneously. This is despite the fact that an ultra high frequency receiver has available about 1700 possible channels. The number of transmitters on the air simultaneously is limited by intermodulation and spurious response difficulties.

It is therefore a principal object of the invention to provide a new and useful signaling system and method requiring a single carrier frequency for providing a plurality of information channels between many different locations.

A further object and advantage of the system and method is to make possible the simultaneous transmission of a hundred or more separate information or voice sources simultaneously from a single location.

Another object of the invention is to provide a new and improved system and method in which considerable simplification takes place so that all transmissions can emanate from a single antenna used for both transmission and reception, making unnecessary the present installations requiring many transmitters and antennae, as well as separate receivers.

Another object of the invention is to provide a new and improved system and method of signaling covering a predetermined range determined by design specifications.

Another object of the invention is to provide a new and improved system and method of signaling which greatly increases the channel capacity for transmitting information over a single carrier frequency with stations at various locations.

Another object of the invention is to provide a new and improved system and method of signaling which entirely overcomes the production of intermodulation products of the prior art.

Another object of the invention is to provide a new and improved system and method of signaling which reduces the requirement for highly accurate frequency control of receivers and transmitters.

Another object of the invention is to provide a new

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and improved system and method of signaling giving much better spectrum utilization than provided by the prior art.

The above objects are achieved by providing a signaling system and method including a signal compressing means which receives a plurality of information signals from several sources extending over a period of time. The compressing means delivers an output signal which has a time duration which is a fraction of the time over which the same information signals are delivered to the compressing means. A synchronizing means receives the plurality of compressed signals and delivers then in sequential order to a transmitter. The transmitter has its carrier frequency modulated by the series of signals from the synchronizing means. The compressed signals, each representing a different information source, is delivered in time sequence within channel periods which have a duration greater than the duration of each of the compressed signals. This provides a dead time between information signals of adjacent channel periods. This dead time is of importance to accommodate variations in propagation time for signals between systems at various locations.

The compressing means and synchronizing means are provided with timing signals from a timing means to coordinate their operations. Master signals may be delivered to the timing means for synchronizing same with the timing means of all of the plurality of systems in a network.

The system also includes a receiver which delivers the series of information signals occurring in sequence and received from one or more systems which may be at different locations. A distributing means delivers the signals over a plurality of lines corresponding to the channel period of the received signals. The signals from the synchronizing means is received by an expanding means which expands the signals from their compressed form to their original duration.

Signals from the expanding means are delivered concurrently to respective information utilizing means.

Thus, the signaling system and method provides for intercommunication between a plurality of systems at various locations, wherein any number of parties may communicate over any one of the channel periods. With the provision for 100 channel periods, 100 such separate nets may be provided for intercommunication. When any one system is transmitting on one particular channel period, the other systems of the net receive such signals and may in turn transmit to the remaining systems. The dead time between signals of different channel periods prevents the receipt of information signals of one channel corresponding to one net in an adjacent channel utilized for a different communication network.

The foregoing and other objects of the invention will become more apparent as the following detailed description of the invention is read in conjunction with the drawings, in which:

FIGURE 1 is a diagrammatic representation in block form illustrating an embodiment of the invention.

FIGURE 2 diagrammatically illustrates in greater detail the transmitting portion of the system of FIGURE 1,

FIGURE 3 diagrammatically illustrates in block form the signal compressing unit of FIGURE 2,

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FIGURE 4 diagrammatically illustrates in greater detail the receiving portion of the system of FIGURE 1, and FIGURE 5 diagrammatically illustrates in block form the signal expanding unit of FIGURE 4.

Like numerals designate like parts throughout the several views.

FIGURE 1 is a diagrammatic representation in block form of a signaling system 10 embodying the invention.

The transmitting portion 12 of the signaling system is provided with a plurality of information sources 14 which deliver information over lines 16 to a signal time compressing means 18. Signals from the compressing means 18 are sampled by a synchronizing means 20 over respective lines 22. The compressing means 18 and synchronizing means 20 receive timing signals from a timing means 24 for providing a signal sampling cycle having a plurality of successive channel periods during which respective compressed information signals from the compressing means 18 are delivered by the output line 26 of the synchronizing means 20 to the transmitter 28. The transmitter provides a carrier signal with said plurality of channel periods during which respective information signals are transmitted. Sufficient dead time is provided within each channel period to accommodate the variation in propagation times for transmission of signals between various systems 10 at different locations.

Thus, a plurality of concurrent information sources 14 provide information which is respectively received and time compressed by the compressing means 18 and successively sampled by the synchronizing means 20 for serial transmission in compressed form by the transmitter 28 and radiated by its single antenna 30. With a plurality of such transmitters in different locations, the dead time within each channel period is sufficient to prevent the receipt of information signals of one channel period during other adjacent channel periods. The timing means 24 may be provided with synchronizing signals at its input terminal 32 for synchronizing the channel periods of the sampling cycle with the channel periods of the other systems 10 of a signaling network.

The signaling system 10 has a receiving portion 34 with a receiver 36 deriving signals from a single antenna 30'. The antenna 30' may be in fact the same antenna as 30, since as will be evident later, transmission from transmitter 28 into antenna 30 will not take place at those instants when it is desired to receive signals by receiver 36 in which case a conventional T-R or transmit receiver switch can alternately connect antenna 30 to transmitter 28 and receiver 36. The receiver 36 receives signals from other systems 10 of the network on a single frequency. The signals from the receiver are delivered over line 38 to a synchronizing means 40 which delivers a plurality of information signals corresponding to the several channel periods of the received signal. An expanding means 42 receives respective information signals over the lines 44 from the synchronizing means 40 and delivers respective expanded signals over the lines 46 to the information utilizing means 48. The synchronizing means 40 and expanding means 42 also receive timing signals from the timing means 24 coordinating the performance of their operations.

The antenna 30' may receive a plurality of information signals from a plurality of transmitters at different locations of the network and during respective channel periods to provide a plurality of channels each of which may have a respective information signal in compressed form. These signals are delivered by the receiver 36 in the same sequential form that they are received. The synchronizing means 40, by use of the timing signals from the timing means 24, distributes the incoming signals over respective lines 44 corresponding to the channel period of the signal. The expanding means 42 receives respective time compressed signals on lines 44 and expands same delivering the information signals over respective lines

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46 with a duration extending over the entire sampling cycle. Thus, if voice transmissions are taking place, respective audio signals are each compressed into a short fraction of time and positioned within respective channels. After being received, the serially occurring signals are distributed to appropriate lines and expanded to extend over the entire time interval corresponding to the original time interval of the information signal from the source 14.

With a plurality of signaling systems 10, a network is provided wherein information may be transmitted and received in turn by various receivers and transmitters of a net on a particular channel period. Various communicating nets may thus be provided by each channel and one hundred or more channels may readily be provided by the illustrated system and method of the invention.

The FIGURE 2 diagrammatically illustrates in greater detail the transmitting portion 12 of the signaling system 10 shown in FIGURE 1.

The information sources 14 may comprise a plurality of respective information input devices such as the microphones 50. In the illustrated embodiment 100 information sources 50 are utilized, although only three are shown. As it will appear in connection with the description given, 100 channel periods are provided to accommodate 100 separate information sources of the system 10.

The information signals from the microphones 50 are each respectively delivered over lines 16 to a signal compressing unit 52 of the compressing means 18 which will be described in detail in connection with FIGURE 3.

Each of the compressing units 52 receives a timing signal from a pulse source 54 through a delay element 56 of the timing means 24. The frequency of the pulse source appropriate for the illustrated system 10 is chosen to be 5 kilocycles, and may be derived from a multivibrator. The pulse source 54 may also receive synchronizing signals at the terminal 32 for synchronizing the pulse source with signals derived from a master timing means and delivered in common to all of the systems 10.

Output signals from each of the compressing units 52 are provided on its output line 22. The output signals on line 22, however, are time compressed with respect to the signals delivered to the input line 16. Thus, the signals on the line 22 extend over a period of time which is a fraction of the period of time during which the same signals are delivered to the input line 16 of each of the compressing units 52.

A plurality of input gates 58 of the synchronizing means 20 may each respectively receive signals from the lines 22 of respective compressing units 52. Each of the gates 58 is conditioned for transmitting signals from its input line 22 to a common output line 60 upon the occurrence of a gating pulse on its input lead 62. Each of the leads 62 of the gates 58 is normally conditioned to inhibit conduction of the gates 58 by deriving a signal from a respective monostable flip-flop circuit 64. The monostable flip-flop circuit 64, upon receipt of a triggering signal on its input line 66, assumes its set state for a predetermined period of time after which it automatically returns to its normal reset condition. When the monostable flip-flop circuit 64 is in its set condition, it delivers a gating signal to the input lead 62 of its respective gate 58 conditioning the gate 58 for transmission of output signals from its compressing unit 52 to the output line 60. The signals on line 60 are delivered to the transmitter 28 for modulating its carrier signal and delivering a signal to its antenna 30 for propagation to another system 10 of the network.

The monostable flip-flop circuits 64 respectively derive triggering pulses from a matrix selector 68 which is energized by the signals from the output leads 70 of a digital counter 72, which may provide a binary parallel coded output. The digital counter 72 counts from 1 to 100 and is driven by the timing pulses received at its

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input lead 74 from the pulse source 54 of the timing means 24. It is arranged to advance one count for each two pulses on line 74.

The matrix selector 68 may be of the diode type wherein the signals delivered over the lines 70 from the counter 72 indicate the count and result in the sequential energization of each of the 100 output lines 76 of the matrix selector 68, the advance occurring once per two input pulses on line 74. The selector 68 may be provided with capacitive coupling to the lines 76 to deliver an output pulse over the appropriate line 76 upon the switching of the digital counter 72 from one count to the next higher count.

Each of the lines 76 is respectively connected through a delay element 78 to the input line 66 of its respective monostable flip-flop 64 to provide the triggering pulse. The pulse from the output line 76 may also respectively be delivered to a channel identifier 80, which upon receiving such a pulse delivers an output signal to the output line 60 corresponding to the particular channel energized for the purpose of identification. The signal from the channel identifier 80 extends over a short period of time and precedes the signal delivered to the output line 60 through its respective gate 58. This is accomplished by the use of the delay elements 56 and 78 which allows the trigger pulse to be delivered to the channel identifier 80 an appropriate time before the gating signal is delivered to the selected gate 58. The identifying signal provided by each of the identifiers 80 may be of a digital or other appropriate form for readily distinguishing one channel period from another.

A switch 82 is provided which may be opened to prevent delivery of identification signals to the output line 60 in cases where this is desired.

For the purpose of this example 100 information channels are provided. The signal compressing unit 52 compresses the information received on its input line 16 by a factor of 200. Thus, for example, information delivered during a period of .04 second is compressed 200 times and delivered over line 22 during a period of 200 microseconds.

The pulse source 54 delivers pulses alternate ones of which define one of the 100 channel periods of the sampling cycle. Thus, the 5 kilocycle pulse rate provides a period of 400 microseconds for each channel period, while the digital counter 72 defines the particular channel which is to be sampled.

Since the compressed output signal from the compressing unit 52 has a duration of 200 micro-seconds, it only occupies one-half of the time provided for each channel period. Thus, when the synchronizing means 20 is to obtain a sample of the compressed signal from one of the compressing unit 52, the pulse from the source 54 delivers an actuating signal to the digital counter 72 energizing the selector 68 to deliver an output pulse to the selected monostable flip-flop 64 through its delay 78. The monostable flip-flop circuit 64 upon being triggered, delivers an output signal having a duration of 200 micro-seconds corresponding to the duration of the compressed signal from its compressing unit 52. The delays 56 and 78 are appropriately adjusted so that the gating signal is delivered to the gate 58 at the beginning of the compressed signal and at a time after the delivery of the signal from the pulse source 54 so that it is properly positioned within the channel period providing such dead space before and after the information signal which may be desired. The dead space is important, in that, it may be desired to transmit a channel identification signal before the information signal within the channel as well as to provide such dead time which may be necessary to prevent interference between signals of different channels due to variations in propagation time for the signals transmitted from different locations.

Since the channel identifier 80 receives the trigger signal from the selector 68 before its delivery to the flip-

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flop circuit 64, the triggered identifier 80 provides an identifying signal after the beginning of the channel period but before the delivery of the compressed information signal to the transmitter 28.

Thus, with information being delivered concurrently to the microphones 50 of the information sources 14, the occurrence of an output signal from the pulse source initiates the delivery of a signal to a channel identifier 80, which for example may be the first channel identifier. With the switch 82 closed, an identification signal is delivered to the transmitter modulating the carrier signal and being radiated by the antenna 30. Shortly after this, the first gate 58 is conditioned for delivering the 200 micro-second compressed signal to the transmitter 28 for propagation during the first channel period. The succeeding two pulses from the source 54 set the counter 72 to its second count causing the selector 68 to deliver a signal to the second identifier 80 which provides its identification signal to the transmitter 28 and is followed by the compressed information signal from the second gate. This process continues until all of the 100 information sources are sampled and sequentially transmitted by modulating the carrier of the transmitter 28. Thus, an entire sampling cycle occurs during a period of 40 milli-seconds corresponding to a frequency of 25 cycles per second. Thereby, all information which may be continuously supplied through the 100 separate channels of the transmitting portion 12 of the system 10 may be compressed and sequentially transmitted with a channel identification signal by the transmitter 24 utilizing a single carrier signal. If all of the stations are for example within a diameter of 28 miles, a dead period at the beginning of each channel period of 150 micro-seconds, provides sufficient time to prevent interference between signals of different channel periods. Should the maximum distance between any two systems 10 of a network be greater or smaller, the required dead time may be appropriately modified to correspond to these conditions.

For example, in the particular embodiment of the system 10 illustrated each channel period has a duration of 400 micro-seconds, and the compressed information signal on the output conductor 60 has a duration of 200 micro-seconds. When a channel identification signal is to be utilized it can be provided during a period of 40 micro-seconds and can be spaced to begin 50 micro-seconds before the information signal providing a separation space of 10 micro-seconds between the identification and information signals. Thus, the total time from the beginning of the identification signal to the end of the information signal is 250 micro-seconds leaving 150 micro-seconds dead space which may be utilized as explained above to provide for variations in propagation times between various system locations of the network. Of course, the above standards may be varied to accommodate the requirements of a particular communications situation.

FIGURE 3 illustrates in greater detail the signal compressing unit 18 shown in FIGURE 2.

The information signals from the microphone 50 delivered over the line 16 are received by a frequency modulator 84 which is provided with a carrier source 86 as well known to the art. The output signals from the modulator 84 are delivered to the input lead 88 of a first sampling gate 90. The gate 90 is normally inhibited and receives a gating signal for delivering signals from its input lead 88 to the output line 91. A monostable flip-flop circuit 94 has a first output lead 92 for delivering gating signals to the gate 90 and a second output line 96 for delivering gating signals to a second signal circulating gate 98 which is normally conditioned for transmitting signals from its input line 100 to the output line 91. The flip-flop circuit 94 receives triggering pulses over the line 102 from the delay element 56 of FIGURE 2 at the 5 kilocycle rate. Upon receipt of a trigger signal, the flip-flop circuit 94 which is normally in its set

condition, assumes its reset condition for a period of 0.5 micro-second. When in its set condition, the flip-flop circuit 94 conditions the gate 90 to deliver a signal sample occurring during a period of 0.5 micro-second from the frequency modulator 84 for sampling the information from the signal source 50. After the 0.5 micro-second period, the flip-flop circuit 94 automatically returns to its reset condition, inhibiting gate 90. The flip-flop circuit 94 acts to inhibit the circulating gate 98 when the gate 90 is transmitting signals while conditioning gate 98 for passing signals at all other times. The information on the output line 91 is delivered to the input of a delay line 104 which may be of the ultra-sonic quartz type. The delay line 104, for the purpose of this example, provides the delay of 199 micro-seconds and delivers its output signals, which it will be recalled are in the form of frequency modulated signals, to an amplifier limiter 106 which delivers them to the input lead 100 of the signal circulating gate 98. It is noted that each time one sample is taken by the gate 90, the information presented to the gate 98 is lost because gate 98 is inhibited at that time. However, when the sample provided by gate 90 passes through the delay line 104, it is returned to the output line 91 through the gate 98, 199 micro-seconds later, which precesses or advances it from its first original position to the second adjacent position with respect to the new signal sample. After a period of 40 milli-seconds, the information derived from the information source 50 corresponding to 200 samples taken over the period of 40 milli-seconds, is received by and passes through the delay line 104 circulating with a period of 199 micro-seconds. Since, however, the samples have a duration of 0.5 micro-second, the samples are also separated from each other in their occurrence by 0.5 micro-second. Thus, the signals presented to the frequency discriminator 108 from the input to the delay line 104 and delivered to the output line 22 of discriminator 108 provides a compressed signal having a duration of 200 micro-seconds and corresponds to the information signal from the source 50 occurring over a period of 40 milli-seconds, a compression ratio of 200 to 1.

Referring to FIGURE 2, it is noted that the signals on line 22 are sampled for 200 micro-seconds representing substantially the full capacity of the delay line 104 and that this formation is sampled at the rate of 25 cycles per second corresponding to 40 milli-seconds. All of the information in the delay line 104 is utilized since sampling takes place at the rate at which completely new information is delivered to the delay line 104. This means, however, that information delivered by the unit 52 on line 22 may be delayed for a period of 40 milli-seconds after its actual occurrence at the source 50.

The FIGURE 4 illustrates in greater detail the receiving portion 34 of the system 10 shown in FIGURE 1.

The information from one or more transmitters of the network is received by the antenna 30' of the receiver 36 which is tuned to the signal carrier frequency. The output from the receiver 36 may be delivered through a frequency modulator 110 to a distributor line 112. One hundred gates 114 of the synchronizing means 40 each corresponding to a channel period receive signals at their input leads 116 from the distributor line 112. The gates 114 respectively deliver signals over lines 118 to a respective signal expanding unit 120 of the expanding means 42. Each expanding unit 120 delivers output signals to an information utilizing device such as the ear phones 122 constituting the utilization means 48. The signal expanding units 120 also receive timing signals over the output line 124 of the pulse source 54 of the timing means 24 at the 5 kilocycle rate.

The gates 114 of the synchronizing means 40 are normally inhibited but deliver a signal from the distributor line 113 to its respective expanding unit 120 upon the receipt of a gating signal at its lead 126.

The leads 126 of the gates 114 receive gating signals

of 200 micro-second duration from the output of respective monostable flip-flop circuits 128. The flip-flop circuit 128 is normally in its reset condition inhibiting its gate, but assumes its set condition for a period of 200 micro-seconds on receiving a trigger pulse from the matrix selector 68' through a delay element 130. The matrix selector 68' is activated by the digital counter 72' over its output leads 70'. The counter 72' has a counting cycle of 100 and is actuated one count for each two consecutive timing pulse signals from the source 54 when the control switch 132 is in its closed position as shown in FIGURE 4. Thus, upon delivery of every second pulse to the input lead 74' of the counter 72', the counter 72' is actuated to its next count delivering a signal to the matrix selector 68' and causing the delivery of an output pulse over one of its output lines 76' corresponding to the count of the counter 72'. As the counter 72' successively steps from count number 1 to 100, each of the flip-flop circuits 128 of the synchronizing means 40 is triggered once during its particular channel period of the sampling cycle. The pulse source 54 of the various systems 10 may be synchronized by synchronizing signals on the terminal 32 from a master clock, although such synchronizing signals may not be required very often, especially if a highly precise timing means is utilized in the source 54 such as an atomic clock.

The delay elements 130 may have a variable delay to adjust the gating interval with respect to its position within the 200 micro-second channel period. The variation of the delay 130 may also be used to accommodate differences in propagation times for signals derived from different locations. It is also noted that since the signals received and delivered to the distributor line 112 may also contain channel identification signals, the delay 130 is adjusted to exclude the transmission of such signals through the gate 140, and only to pass the compressed information signal which follows, to the corresponding expanding unit 120 of the particular channel period.

Thus, the series of 100 channel periods with their corresponding identifying signals and information signals are received and delivered to the distributor line 112 and appropriate time gating signals are delivered to gates 114 to deliver the compressed information signals to respective expanding units 120 corresponding to respective information sources. Since each of the channels is identical, it may be necessary to identify the number 1 channel, or any one of the other channels in order to absolutely identify a particular channel period with respect to all of the systems 10. This may be accomplished by delivering a 25 cycle unambiguous timing or synchronizing signal to the pulse source 54 from a master clock as well as by other means. Synchronization may be maintained by a divider 134 which delivers one output pulse signal for each 200 input pulse signals. An output signal from divider 134 resets the counter 72' to its zero count period, just before the digital counter is set to its one count to initiate the first channel period. Thus, even if signals to the input line 74' of the digital counter 72' is interrupted by opening the switch 132, the counter 72' will be reset by the divider 134 and conditioned for operation when the switch 132 is reset to its closed condition.

When the channel periods of the signals delivered to the distributor line 112 are to be identified by their identification signals preceding the information signal of the channel period, the switch 132 may be set to its open condition, while a switch 136 which had been open is set to its closed condition. The switch 136 in its closed position delivers signals present on the distributor line 112 through a delay element 138 to the input of a channel identifier 140. The channel identifier 140 includes means for decoding the identification signal which precedes the information signal of the channel period present on the line 112, and delivering an output pulse on one of its 100 lines 142 corresponding to the particular channel period being received and identified. By this means a

pulse is delivered to the appropriate flip-flop circuit 128 for presenting a gating signal to its gate 114 to allow transmission of the information signal on line 112 to its corresponding signal expanding unit 120. Since the time separation between the occurrence of the identifying signal and the compressed information signal may be standardized, the delay 138 may be adjusted to provide the gating signal to gate 114 at their required time after the occurrence of the identification signal for the exclusion of the identification signal and the complete transmission of the information signal as previously described. Operation by this means, of course, eliminates the time adjustment required in the delivery of the gating signal to gate 114 to accommodate signals derived from different instances, as was accomplished by delays 130 used in connection with the matrix selector 63'.

The FIGURE 5 illustrates in greater detail the signal expanding unit 120 of FIGURE 4.

The information signals delivered during the period of 200 micro-seconds to the line 118 from gate 114 is received by the input lead 144 of a delay line 146 which may be of the high quality ultra-sonic quartz type. The delay line 146 provides a delay of 199 micro-seconds, for the purpose of the example presented, and delivers its output signals, which are in the form of frequency modulated signals to an amplifier limiter 148. The signals from the amplifier limiter 148 are delivered to input leads 150, 152 respectively of an output gate 154 and a signal circulating gate 156. The output gate 154 is normally inhibited, while the circulating gate 156 normally passes signals from the amplifier limiter 148 to the input 144 of the delay line 146.

A monostable flip-flop circuit 158 is normally in its reset condition delivering a signal over its output line 162 to gate 154 maintaining it in its inhibited condition, while delivering an output signal over its line 162 maintaining the gate 156 in its signal transmitting condition. The flip-flop circuit 158 receives triggering pulses at its input lead 164 which are derived over line 124 through a variable delay 166. The pulses on line 124 are at the rate of 5 kilocycles from the pulse source 54.

Upon receiving a pulse on its input lead 164 the flip-flop circuit 158 assumes its set condition for a period of 0.5 microsecond after which it automatically resumes its reset condition. In its set condition, the flip-flop circuit 158 delivers a signal to the output gate 154 permitting it to deliver signals from its input lead 150 to a frequency discriminator 168. At the same time, the flip-flop circuit 158 delivers a signal to the circulating gate 156 inhibiting the delivery of signals to the input lead 144 of the delay line 146. Thus, samples of signals delivered by the delay line 146 are received by the discriminator 168 at the rate of 5 kilocycles. Since signals which are delivered to the discriminator 168 are not delivered to the delay line 146, after 200 samples are taken, all of the circulating signals in the delay line 146 have been removed and the delay line 146 is cleared to receive 200 new signal samples over line 118 extending over a period of 200 micro-seconds. Thus, information is periodically supplied to the delay line 146, for delivery over an expanded time interval. The expansion rate of the expanding unit 120, provide for illustration in this case, is 200 to 1 and the same as the compression rate of the compressing unit 52. The signals provided at the 5 kilocycle rate to the frequency discriminator 168 are detected and delivered to a low pass filter 170. The filter 170 provides an appropriate smoothing action for the audio signals considered in this example, for delivering to the information utilizing means 48 in the form of headphones 122.

The variable delay 166 provides an adjustment for coordinating the delivery of signals from the gate 114 to the sampling times of the gate 154. Thus, the variable delay 166 may adjust the centering of the gating signal

to gate 154 to allow the passage of a complete signal sample on line 150, rather than providing a gating signal during the interval between signal samples on the line 150.

Summarizing the operation of the signal receiving portion of the system 10, the sampling cycles at the rate of 25 cycles per second bearing information in 100 sequentially occurring channel periods is received by the antenna 30' of the system 10 and provided as a frequency modulation signal to the distributor line 112 of the synchronizing means 40. The channel periods are appropriately identified by the digital counter 72' or the channel identifier 140 and gated to its appropriate signal expanding unit 120. The signal expanding units 120 perform the reverse operation of the compressing units 52 in the transmitting portion 12 of the system 10. This results in the delivery of 100 information signals to the information utilizing means 48 in the form of headphones 122. The headphones 122 receive information concurrently corresponding to the information concurrently delivered to the microphones 50 of the information sources of the transmitting portions 12 of the signaling systems 10 of the network.

The method of the invention comprises deriving information from a plurality of sources, compressing the information to a fraction of the time during which it occurs, delivering this information in sequence into a plurality of channel periods with the information extending over a portion of the channel period for transmission by a transmitter with all channels in a common radio frequency band. Information signals of each channel may also be preceded within the channel period by a channel identification signal. The information signals transmitted are received in sequence occurring in the channel periods of a sampling cycle and the information -ezupn lq spouuep supuodsaruo o1 pounqisp are pousis tion of the identification signals preceding them or by coordination by reference to a common timing means. Received information signals are expanded to assume their original time duration and delivered to separate individual information utilizing means.

Each channel period provides a communication network which may be utilized in turn by any one of a plurality of information sources and utilizing means of various systems 10 at different locations. Thus, if five parties are communicating with each other at five different locations, any one party who is to transmit information delivers a signal such as an audio signal to the microphone 50 of the channel period which is to be utilized by all parties of the net. Assuming that the channel period is number 72, each of the other locations connect their information utilizing devices, or headphones 122 to the expanding unit 120 receiving information signals in the 72nd channel period. Upon the completion of a transmission by a party at one of the systems 10, a party at any of the other systems 10 may transmit to the other parties. Each party at a particular system 10 takes its turn in transmitting, while the other parties at the remaining systems 10 receive the information. Thus, any number of parties or stations may intercommunicate using the one channel period, the only condition limiting communication between parties being the distance between the furthest locations which must be accommodated by the desired dead space for propagation time. The illustrated system 10 provides one hundred such separate nets for intercommunication.

Since transmission and reception on the same channel does not take place simultaneously at any one signaling system 10, the same antenna 30 may be utilized for receiving and transmitting. However, in this case, when the transmitter 28 is delivering energy, the receiver 36 may be disconnected from the antenna to prevent it from being overloaded. This may be accomplished by the methods well known in the transmitting and receiving art.

Although time multiplexing of information signals in a plurality of channels between two fixed stations has been employed, such systems cannot be used for intercommunication between a plurality of systems at many different locations because of the differences in propagation time between the various systems. The signaling system and method of the invention also has the advantage of transmitting during one channel period a compressed signal having many so called "bits" or components of information. This is highly efficient since the dead period for accommodating the propagation time is provided once for many information components of the compressed signal, whereas if a single "bit" or information component is transmitted during each channel period, the maximum propagation time must be separately allowed for each such component which is transmitted. Thus, the transmission of many information components and the compression of the information signals provides a high degree of efficiency and materially increases the rate of information transfer between a plurality of systems at various locations within a predetermined operating range.

While this invention has been described and illustrated with reference to a specific embodiment, it will be understood that the invention is capable of various modifications and applications, not departing essentially from the spirit thereof which will become apparent to those skilled in the art.

What is claimed is:

1. The method of signaling on a single carrier frequency which comprises the steps of obtaining a plurality of information signals to be transmitted from different locations providing different signal propagation times between locations, respectively time compressing said information signals, sequentially transmitting with a single carrier frequency each respective one of said compressed information signals from said respective locations during a portion only of a respective one of a plurality of channel periods of a sampling cycle providing a dead time between compressed signals delivered during adjacent channel periods to limit interference between said signals due to variations in transmission time, and receiving said signals within their said selected channel periods at a location providing variations in transmission times between said signals.

2. The method of claim 1 for signaling between a plurality of at least three different locations having different signal propagation times which includes the step of providing a dead time between compressed signals of adjacent channel periods to provide for the maximum propagation time between any two of said locations.

3. The method of claim 2 including the steps of receiving sequential compressed signals propagated from one or more sources during respective channel periods, distributing said compressed signals according to their channel periods, and respectively expanding said compressed signals to provide respective information signals.

4. The method of signaling on a single carrier frequency between a plurality of systems at different locations forming a network which comprises the steps of providing at least three systems at respective locations with different signal propagating times between locations, providing a sampling cycle with a plurality of at least three adjacent channel periods, providing a compressed signal for transmission by one of said systems during a selected one of said channel periods, providing sufficient dead time within each channel period to allow for differences in propagation times between systems, receiving transmitted signals on a single carrier frequency within its said channel period by all of the systems which are not transmitting on said channel period, and expanding said compressed signal at each of said systems receiving said signal to provide an information signal corresponding to said channel period.

5. The method of claim 4 including the step providing that each of said systems selectively and concurrently receives and transmits information during respective channel periods of said sampling cycle with only one system of said network at a time transmitting on any particular channel period.

6. The method of claim 5 providing that said systems take turns in transmitting to the remaining systems of said network during any particular channel period of said sampling cycle.

7. The method of claim 6 which includes the step of providing synchronizing signals to each of the systems of the network and using the synchronizing signals for identifying the channel periods of the sampling cycle.

8. The method of claim 6 which includes the step of providing respective identification signals for identifying the channel periods of the information signals by each system transmitting information signals, and wherein the systems receiving said signals distribute said information in accordance with the identification signals received for providing respective information signals.

9. A signaling system comprising means for receiving a sequence of time compressed signals, synchronizing means distributing compressed signals received by said system, and signal expanding means receiving signals from said synchronizing means and concurrently delivering a plurality of information signals over a period of time greater than the period of the signals as received by said expanding means, said synchronizing means being provided with means to accommodate variations in propagation time for signals received from systems at different distances from said system for timing the distribution and delivery of information signals to said expanding means.

10. The system of claim 9 in which said synchronizing means distributes sequentially received information signals to respective ones of a plurality of output lines.

11. The system of claim 10 including timing means providing a sampling cycle comprising a plurality of channel periods, and said synchronizing means receiving timing signals from said timing means and delivering output signals to corresponding output lines of said plurality of output lines during respective channel periods.

12. The system of claim 11 in which said timing means delivers timing signals to said signal timing means for coordinating said synchronizing and expanding means and has an input lead for receiving synchronizing signals from a master timing means for coordinating said system with one or more other systems.

13. A signaling system comprising a plurality of information sources, a plurality of signal compressing units for receiving information signals from a respective one of said sources and providing output signals comprising said information signals during a reduced period of time, a plurality of signal gate circuits delivering output signals from respective units during the receipt of a conditioning signal, channel selecting means sequentially providing conditioning signals to gating circuits, and an output conductor receiving the sequence of compressed signals delivered by said gating circuits.

14. The system of claim 13 including timing means providing a sampling cycle including a plurality of channel periods, each of said gates delivering an output signal during its respective channel period and for a duration less than the duration of said channel period.

15. The system of claim 14 in which said channel selecting means includes a counter receiving count signals from said timing means, a matrix selector having a plurality of output lines corresponding to the channel periods and energized by the output count of said counter to provide a signal to its corresponding output line, and a plurality of monostable circuits delivering a conditioning signal to a respective gating circuit for a predetermined period less than the channel period.

16. The system of claim 15 including a plurality of channel identifiers for receiving signals from respective

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output lines of said selector for providing a channel identifying signal to said output conductor preceding the delivery of an information signal by the corresponding gate circuit of the channel period.

17. The system of claim 15 in which said signal compressing units each have a delay line, a signal circulating gate for delivering signals from the output to the input of said delay line, an input gate for delivering signal samples from a respective one of said information sources, and a circuit periodically conditioning said input gate and inhibiting said circulating gate at a rate less than the period of said delay line.

18. The system of claim 17 including a transmitter receiving the signals delivered by said output conductor for modulating a carrier signal and producing an output signal for propagation to other said systems of a network of systems.

19. A signaling system comprising a transmitting portion having a signal compressing means for concurrently receiving a plurality of information signals over a period of time and providing respective output signals comprising said input signals during a reduced period of time, and synchronizing means sampling respective output signals of said compressing means and delivering an output signal having a cycle comprising a predetermined plurality of channel periods with a respective one of said sampled signals occurring only during a portion of its channel period for accommodating maximum propagation times between various respective locations of a plurality of said signaling systems.

20. The system of claim 19 including a receiving portion having synchronizing means distributing compressed channel signals received by said system, and signal expanding means receiving signals from said synchronizing means and delivering respective information signals.

21. The system of claim 20 including timing means providing a sampling cycle comprising said plurality of channel periods, the synchronizing means of said transmitting portion receiving timing signals from said timing means and delivering output signals of said respective information signals from said compressing means during respective channel periods, and the synchronizing means of said receiving portion receiving timing signals from said timing means and delivering output signals to corresponding output lines during respective channel periods.

22. The system of claim 21 in which the channel periods of said sampling cycle each exceeds the duration of its respective compressed information signal from the synchronizing means of said transmitting portion to accommodate maximum propagation times between various respective locations of a plurality of said signaling systems, and the synchronizing means of said receiving system is provided with means to accommodate variations in propagation time for signals received from systems at different distances from said system for timing the distribution and delivery of information signals to said expanding means.

23. The system of claim 22 in which said timing means delivers timing signals to said signal compressing and expanding means and has an input lead for receiving synchronizing signals from a master timing means.

24. The system of claim 23 including an antenna, a transmitter delivering a carrier signal modulated by the output signal of the synchronizing means of said transmitting portion, and a receiver for delivering a sequence of compressed information signals from one or more remote systems; and switching means for connecting selectively said transmitter to said antenna when a signal is to be radiated and connecting said antenna to said receiver for receiving information signals.

25. A signalling system comprising an information distributor line for receiving a sequence of signals occurring during respective channel periods of a sampling cycle; a plurality of distributor gating circuits each having an input lead receiving signals from said distributor line,

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an output lead, and being conditioned to transmit signals from its input lead to its output lead by receiving a gating signal; channel selecting means sequentially providing gating signals to respective ones of said distributor gating circuits; and a plurality of signal expanding units receiving signals from the output leads of respective distributor gating circuits for providing respective information output signals.

26. The system of claim 25 including timing means delivering timing signals to said channel selecting means, and means for adjusting the delivery of gating signals by said selecting means to said gating circuits for delivering information signals of respective channel periods from said distributor line to respective signal expanding units.

27. The system of claim 26 in which said channel selecting means includes a counter receiving count signals from said timing means, a matrix selector having a plurality of output lines corresponding to the channel periods and energized by the output count of said counter to provide a signal to its corresponding output line, and a plurality of circuits each energized by a respective output line of said selector delivering a gating signal to a respective gating circuit for a predetermined period less than the channel period for transmitting information signals to respective expanding units.

28. The system of claim 27 in which said timing means includes a divider delivering an output signal to said counter resetting the counter to its zero count at the beginning of each sampling cycle.

29. The system of claim 27 in which said signal expanding units each have a delay line, a signal circulating gate for delivering signals from the output to the input of said delay line, an output gate for delivering signal samples to provide respective information output signals, an input line connected to the input of the delay line for receiving information signals from its respective gating circuit, and a circuit periodically conditioning said input gate and inhibiting said circulating gate at a rate less than the period of said delay line.

30. The system of claim 29 including a receiver delivering sequential channel signals received from systems at various locations over a single radio frequency band to said distributor line, and an input terminal for providing synchronizing signals from a master timing means to said timing means.

31. The system of claim 25 in which said channel selecting means includes a pulse actuated channel selecting circuit having an input lead for receiving timing signals and a plurality of output lines for delivering gating signals to said gating circuits, and an identifying circuit having a signal input lead and a plurality of output lines for delivering gating signals to said gating circuits, a timing means for delivering timing signals to define the channel periods of said sampling cycle, and switching means for controlling the delivery of signals from said timing means to the input lead of said selecting circuit and the delivery of signals from said distributor line to the input lead of said identifying circuit.

32. The system of claim 25 in which said channel selecting means includes a channel identifier receiving channel identification signals from said distributor line and providing gating signals to the respective ones of said gating circuits corresponding to the received identification signal.

33. The system of claim 25 including means for adjusting the delivery of gating signals by said selecting means to said gating circuits for the delivery of information signals of respective channel period from said distributor line to respective signal expanding units a predetermined time after the receipt of said channel identification signals.

34. The system of claim 33 in which said channel identifier includes signal decoding means having an input lead for receiving time sequenced identification signals

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and a plurality of output lines corresponding to the channel periods and each singly energized by a respective one of the codes of said identification signals to provide a signal to its corresponding output line, and a plurality of circuits each energized by a respective output line of said decoding means and delivering a gating signal to a respective gating circuit for a predetermined period less than said channel period.

35. The system of claim 34 in which said signal expanding units each have a delay line, a signal circulating gate for delivering signal samples to provide respective information output signals, an input line connected to the input of said delay line for receiving information signals from its respective gating circuit, and a circuit periodically conditioning said input gate and inhibiting said circulating gate at a rate less than the period of said delay line.

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36. The system of claim 35 including a receiver delivering sequential channel identification and information signals received from systems at various locations over a single radio frequency band to said distributor line.

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**UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION**

Patent No. 3,150,374

September 22, 1964

David E. Sunstein et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 36, for "is" read -- are --; column 5, line 53, for "unit" read -- units --; column 6, line 75, for "set" read -- reset --; column 7, line 1, for "reset" read -- set --; line 73, for "113" read -- 112 --; column 9, lines 13 and 14, for "instances" read -- distances --; column 10, the inverted line 36 should appear as shown below instead of as in the patent:

signals are distributed to corresponding channels by utilizing

Signed and sealed this 28th day of December 1965.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER  
Commissioner of Patents