PULSE TIME DIVISION MULTIPLEX SYSTEM

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Fig. 5.

Fig. 4.

Fig. 3.

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PULSE TIME DIVISION MULTIPLEX SYSTEM

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1. This invention relates to a multichannel communication system. More particularly it deals with a method and means for producing synchronizing pulses along an electromagnetic wave carrying a plurality of signal modulated undulations.

Previously, synchronizing pulses were distinguished from signal time modulated pulses or undulations on a multichannel pulse wave by their width, which was usually constant and greater than that of the substantially instantaneous signal modulated pulses. These synchronizing pulses were separated from multichannel pulse waves by means of a width discriminator and then subsequently utilized in establishing the base waves for channel separation, demodulation, and synchronization of return signal channels. However, such width synchronizing pulses have certain disadvantages under practical operating conditions. One disadvantage is that, with some types of repeater equipment, critical adjustment is necessary in order to prevent a cumulative loss of the width characteristic of the synchronizing pulse through decrease in the slopes of its leading and trailing edges. The effect of such loss in width is usually to widen the synchronizing pulses so that both the leading and trailing edges of successive pulses are out of synchronism with each other. Another disadvantage is that a system of this type is susceptible to noise entering on the trailing edge of the pulses. But reduction of noise by differentiation cannot be employed because differentiation of the width synchronizing pulses destroys their width characteristics as well as their identity. Thus, in transmitting, repeating and receiving multichannel waves containing width synchronizing pulses, stringent equipment requirements are necessary to prevent their distortion and deterioration.

Accordingly, it is an object of this invention to produce synchronizing pulses in a simple and novel manner which are not distorted by ordinary communication equipment.

Another object is to produce synchronizing pulses of substantially the same shape as the signal modulated pulses on a multichannel pulse wave so as not to be affected by pulse sharpening and noise reducing circuits.

Another object is to produce a synchronizing unit comprising a pair of synchronizing pulses, each pulse of the pair being a very short duration and being spaced closely together so as to be distinguished from the channel pulses.

Another object is to produce synchronizing pulses on a multichannel pulse wave which are not adversely distorted by repeater equipment, or by differentiation.

Another object is to produce synchronizing pulses on a multichannel pulse wave which are of such a characteristic as to greatly minimize the usual distortion effects of noise.

Another object is to separate such a pair of synchronizing pulses from a multichannel pulse wave in a novel and effective manner.

Another object of this invention is to provide means for carrying out the previous objects.

Still other objects of the invention will appear from time to time in the description which follows.

Generally speaking, this invention relates to a multichannel communication system having a multichannel pulse wave containing spaced pairs of synchronizing pulses located at intervals between groups of signal modulated pulses. The multichannel pulse wave may be composed of a plurality of trains of different signal modulated pulses. Means may be provided for producing a plurality of such signal modulated pulse trains from the same pulse wave source and for combining the plurality of pulse trains on a single multichannel pulse wave wherein the trains of pulses may be interleaved or similarly combined so that the pulses of one channel will not interfere with those of other channels. It is desirable, that the signal channel modulated pulses are time modulated either with respect to a given synchronizing pulse or to each other, such as, for example, by one of the systems disclosed in my joint copending applications, E. Labin et al., Ser. No. 523,922, filed April 7, 1944; E. Labin et al., Ser. No. 591,065, filed April 30, 1948, now Patent No. 2,429,631, issued Oct. 28, 1947; or in the copending application of E. Labin, Ser. No. 546,373, filed July 24, 1944, now Patent No. 2,445,753, issued July 27, 1946.

The pair of synchronizing pulses of this invention may be produced from any pulse sources, but preferably the same source as used for producing the signal modulated pulses. In such a case, the pulse wave may be coupled to a suitable reflecting delay line to produce two pulses of very short duration and spaced very closely together, usually not further apart than the two edges of the previously used width synchronizing pulses mentioned above. It is important that the time space between the two pulses of the marker pair is less than the space between them and any other pulses or between any other pulses in said multichannel pulse wave. This is necessary to readily distinguish the synchronizing pulses from the other
or signal modulated pulses on the multichannel pulse waves. It is desirable that the pair of synchronizing pulses have substantially the same shape as the signal channel modulating pulses. However, the signal modulated pulses to be synchronized may differ in shape from the synchronizing pulses of this invention, i.e., the synchronizing pulses may be of any desired shape and amplitude. If the pulses are only timed displaced on the multichannel pulse wave, both the signal time modulated pulses and the double synchronizing pulses may be shaped to insure sharpness before and/or after being combined on the multichannel pulse wave.

Another method for producing the pair of synchronizing pulses may involve a cathode ray device similar to the one disclosed in my joint application, E. Labin et al., Ser. No. 591,085, filed April 30, 1945. According to my present invention the synchronizing pulse aperture in the target plate consists of two parallel narrow slits instead of one wide slit as shown in said application.

The resulting multichannel pulse wave may be transmitted, repeated and received over suitable communication means such as by radio or by wire. Upon reception of the multichannel pulse wave, and before the pair of synchronizing pulses are separated from the wave, the pulses thereof may be processed and sharpened such as by a differentiator and clipper, if the pulses are of the same duration as the channel pulses.

One method for separating the synchronizing pulses may be to pass them through a suitable trigger circuit to make a width pulse out of each pair (providing there is an even number of pulses in between each pair of synchronizing pulses). The resulting width synchronizing pulse may have their leading edges corresponding to the first of the pair of the synchronizing pulses and their trailing edges corresponding to the second of the pair of the synchronizing pulses. These width synchronizing pulses may then be separated by known width discriminating means.

Another system for separating the synchronizing pulses is to reflect the received multichannel pulse wave in a delay line in which the delay is sufficient to cause the first of the synchronizing pulses to be superimposed upon the second of the synchronizing pair of the received pulse wave. This combination of the synchronizing pulses produces output pulses of substantially double amplitude, and may be obtained from the pulse train by amplitude discrimination. From the synchronizing pulses thus obtained, suitable de-blocking means or phasing means may be operated for separating the channels on the original multichannel pulse wave. The separating and demodulating circuits may be of any suitable design, such as a multivibrator circuit for producing a de-blocking wave for separating the pulses, or a cathode ray separating device such as disclosed in my joint copending application, E. Labin et al., Ser. No. 565,152, filed November 25, 1944, now Patent No. 2,465,380, issued March 30, 1949.

And other features and objects of the invention will become more apparent upon consideration of the following detailed description of embodiments to be read in connection with the accompanying drawings in which:

Fig. 2 is a schematic diagram partially in block of the system for producing the synchronizing pulses from a multichannel pulse wave of the type produced in the system of Fig. 1 and for separating and demodulating the signal channels on such a multichannel pulse wave;

Fig. 3 is a graph of waveforms useful in explaining the operation of the system of Fig. 2; and

Fig. 5 is a schematic showing of a further embodiment of the invention.

Referring to Fig. 1, the base pulse wave 1 may be produced in a suitable pulse wave generator 2 and may then be passed through line 3 to a synchronizing pulse generator circuit 4 and also through line 5 to a suitable system of modulator circuits 6.

The synchronizing pulse generator circuit 4 may comprise a suitable coupler 7, a delay line 8, and, if desired, a shaper 9, such as a differentiator and/or amplifier, or the like. The coupler 7 may comprise a pentode 10 with suitable circuits to prevent the reflected pulses from the delayed line 9 from being fed back to the input of lines 3 and 5. The output from the tube 10 is passed through line 11 and is joined to the B+ terminal 12 through an impedance 13 across one end of the delay line 8. This impedance 13 is matched with that of the delay line 8 to prevent distortion and reflection of the reflected pulses. The delay line 8 may comprise a network of inductances and condensers which are coupled in series and parallel respectively, to assimilate a transmission line. It is important that the end 14 of the delay line opposite the impedance 13 be open so that the pulses are reflected without inversion. The reflected pulses, together with the pulses of wave 1, Fig. 2, are combined at jack 15 to produce the synchronizing pulse wave 16 comprising a train of double pulses 17 and 18. Wave 16 is then passed through line 19, and may be passed through shaper 9, before being withdrawn from the synchronizing pulse generator circuit 4 through line 20 to a suitable mixer 21. As seen from Fig. 3, the first of the pair of pulses 17 corresponds to the pulse 20 in the line 20 and the second of the pair of pulses corresponds to the delayed and reflected train of pulses from the delay line 8. The spacing between the pair of pulses 17 and 18 may be very small.
not be fed back into the circuit of another. Suitable means for doing this is to provide a parallel network of triodes in which the pulse trains are applied to the grids and the plate circuits are coupled. The resulting combined multichannel trains of synchronizing and signal pulses 37 is withdrawn through line 38 for transmission.

A system for the separation and demodulation of the multichannel pulse waves produced by the system shown in Fig. 1 is shown in Figs. 3 and 4. After transmission the multichannel pulse wave 37, shown in Fig. 2, may be slightly distorted as shown by the wave 39 in Fig. 4. In order to sharpen up the wave 39 which is received over line 40 it may be passed into a suitable processing circuit 41 which may comprise a differentiator 42 and a double clipper 43. The differentiator 42 may comprise a condenser 44 and resistor 45. The differentiator is coupled to the input circuit of the double diode 46 of the double clipper circuit 43. The clipping level line 40, shown in Fig. 4 is determined by the amount of bias applied at 46 through resistor 45 on to the anode 45 of the double diode 46. The variable resistor 46, in the cathode circuit of the double diode 46, determines the width of the clipped sector 45, above the level 47 shown in Fig. 4. From the other anode 45 of the tube 46 is withdrawn a suitable sharpened pulse train 50 which may then be passed into a suitable synchronizing pulse separating circuit 50 through line 51.

The synchronizing separator circuit 54 may comprise a coupler 55, and a delay line 56 coupled thereto in a manner similar to coupler 7 and delay line 8 with one end of the delay line coupled across a matched impedance while the other end is open as shown in Fig. 1. The delay in line 8 is sufficient to cause the second pulse of the pair of synchronizing pulses of wave 53 to be aligned with the first pulse of the synchronizing pulses of wave 55. These two pulse waves 53 and 55 are then combined to produce the pulse wave 59 wherein the two aligned synchronizing pulses are mentioned, one upon the other, to produce the increased amplitude pulses 60. Wave 59 is withdrawn through line 61 into a suitable clipper 62 for clipping the pulses 65 from the wave 59 above the line 63 to produce a synchronizing pulse wave 64 which is withdrawn from the clipper through line 65. Wave 64 is a synchronizing pulse wave similar to and in synchronism with the wave 1 produced in the pulse generator 2 of Fig. 1. With this pulse wave 64, suitable deblocking and separating circuits may be operated for separation of the different channels on the multichannel pulse wave 53.

One circuit for separating the pulses of the wave 53 may comprise the cathode ray device described in my joint copending application E. Lahn et al., Ser. No. 585,152, filed November 23, 1944, previously mentioned. A schematic reproduction of such a separating circuit is shown at 66 in Fig. 3. Since this circuit comprises a cathode ray device, the synchronizing pulse wave 64 is passed through a phase wave generator 67 for producing a base wave which in turn is passed through line 68 into a phase shifter and splitter circuit 69 for generating the rotary sweep potentials for the electron beam in the cathode ray tube 70. The energy from the phase shifter and splitter circuit 69 is connected to the vertical and horizontal plates 71 and 72 respectively of tube 70. The time modulated pulses from the pulse wave 53 is withdrawn from processing circuit 41 through line 71 to the grid 74 of the tube 70. The tube also comprises a suitable electron gun 75 and accelerating electrodes 76 for projecting a beam of electrons between the plates 71 and 72 so that it may be rotated around the path of the separate target plates at the opposite target end of the tube. Each target plate 71, 78, 79, 80-81, corresponds to a different channel a, b, c, d, e, etc., respectively. It should be noted that there is space between the target plates 71 and 81 to provide for the space of the synchronizing pulses M shown on the wave 53, so that they will not affect any channel target in the tube. The location of the channel pulses on wave 53 is synchronized with the rotation of the beam by the synchronizing pulses M and the gate grid 74 controlled by the time delay of the channel pulses determines how much the electron beam is permitted to contact each target plate each revolution of the beam. Thus, output pulses are produced from each target whose amplitudes correspond to the degree of coincidence of the beam and the target. These output pulses may be passed through a low pass filter such as that shown at 82 in the circuit from target 71, for converting the new pulse train into a single wave which is withdrawn through line 83. Similarly, the new pulse trains withdrawn from the other targets are passed through suitable demodulator circuits and signals are withdrawn through lines 84, 85, 86, etc., corresponding signal channels b, c, d, etc., etc.

As previously stated, the pair of synchronizing pulses may be produced in a cathode ray device similar to that shown in my joint copending application, Ser. No. 581,065, filed April 30, 1945. Such a cathode ray device is schematically shown in Fig. 5 of the drawings herein the device comprises a cathode ray tube 71 having a suitable electron gun 88, control grid 89 and accelerating electrode 90, as well as horizontal and vertical deflecting plates 91 and 92, respectively, for rotating the beam of electrons around the inside of the tube. At the end of the tube 71 opposite that of the gun 88 is an aperture plate 93 containing two different types of slots, those which are at an angle to the radius of the plate, which are the signal channel modulating slot 94, and the pair of synchronizing slots 95, which are narrow, close together, and substantially radially disposed on the plate 93. As the electron beam from gun 88 passes over these slots, it contacts the target plate 96, which may be a collector or a secondary emission electrode. Also provided in the device 87 is a radial deflecting electrode 97 having disposed therearound a series of channel deflecting electrodes 98 corresponding to each signal channel modulating slots 94.

In the operation of this device shown in Fig. 5 the electron beam is deflected radially by the different signal energies applied to the electrodes 98 as it is swept around past each of them and across the slots 94 in the plate 93. The greater the radial deflection caused by the signal energy on the electrode 98, the greater is the displacement of the spot of electrons passed through the angular slot 94 onto the target 96. The time modulation of the signal channel pulses is measured with respect to the time positions of the synchronizing pulses produced when the rotating electron beam passes over the slots 95. The cathode ray device as shown in Fig. 5 may
be employed instead of the modulator circuit 6 shown in Fig. 1.

While the principles of the invention have been described in connection with several specific embodiments, it is to be clearly understood that the above descriptions are made only by way of example and not as limitations on the scope of the invention as defined in the objects and the accompanying claims.

I claim:

1. In a multichannel pulse wave communication system, a pulse source, a delay device for delaying the pulses from said pulse source, a plurality of sources of signal energy, a plurality of pulse modulators for time modulating pulses from said delay device according to said signal energy to produce a plurality of time modulated pulse trains, means to produce a pair of synchronizing pulses of the same polarity spaced at intervals along said pulse wave, the spacing between the pulses of said pair being less than the spacing between any other adjacent pulses on said wave, and means for combining said pair of synchronizing pulses and said trains of signal modulated pulses to produce said multichannel pulse wave.

2. The system of claim 1 wherein said means for producing said pair of pulses comprises an open circuit reflecting delay line with a balanced impedance at the closed end thereof.

3. In a multichannel pulse wave communication system, a pulse source, a delay device for delaying the pulses from said pulse source, a plurality of sources of signal energy, a plurality of pulse modulators for time modulating pulses from said delay device according to said signal energy to produce a plurality of time modulated pulse trains, means to produce a pair of synchronizing pulses of very short duration and of the same polarity spaced at intervals along said pulse wave, the spacing between the pulses of said pair being less than the spacing between any other adjacent pulses on said wave, means for combining said synchronizing pulses and said trains of signal modulated pulses to produce said multichannel pulse wave, means for transmitting and receiving said pulse wave, means for separating the pair of synchronizing pulses from the received pulse wave, means controlled by the separated synchronizing pulses for separating the different channels of signal energy into separate trains of modulated pulses and means for demodulating said trains to reproduce said signals.

4. The system of claim 3 wherein said means for separating said pairs of synchronizing pulses comprises an open circuit reflecting delay line with a balanced impedance at the closed end thereof.

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