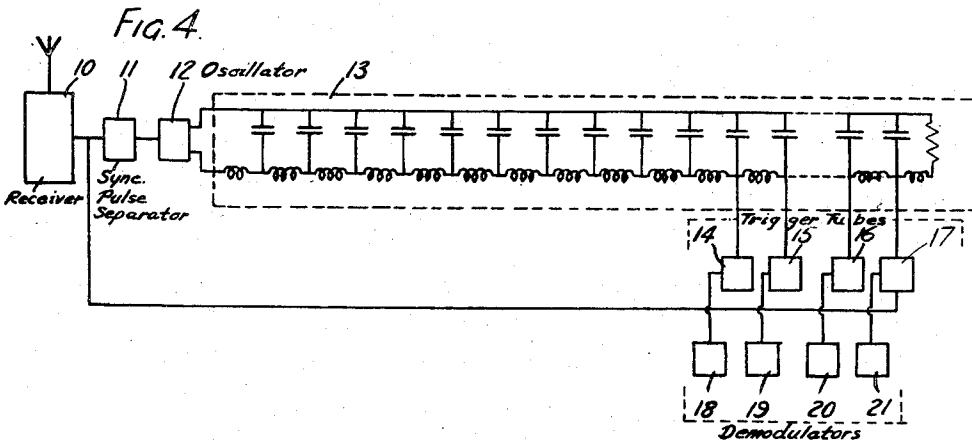
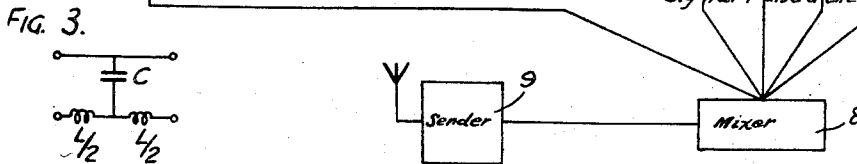
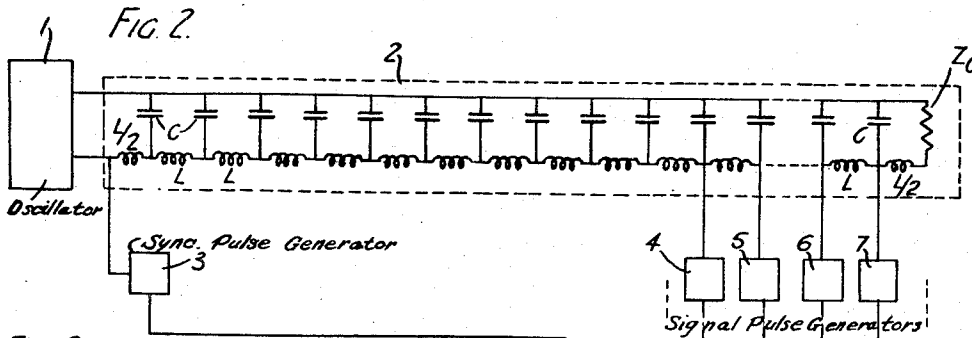
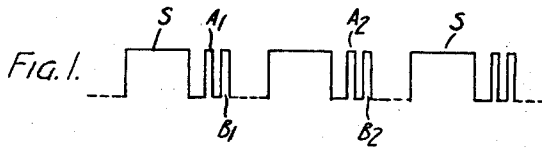


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 MULTICHANNEL SIGNALING SYSTEM USING DELAY
 LINE TO OBTAIN TIME DIVISION
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MULTICHANNEL SIGNALING SYSTEM USING
DELAY LINE TO OBTAIN TIME DIVISIONDennis Illingworth Lawson, Cambridge, England,
assignor to Pye Limited, Cambridge, England,
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2 Claims. (Cl. 179-15)

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The present invention relates to multi-channel signaling systems and more particularly to arrangements for transmitting a plurality of electric signals simultaneously on a single ultra-short wave carrier, for example, on centimetre waves. The arrangement according to this invention may be used for transmitting telephone, telegraph, facsimile, teleprinter or other kinds of signals and enables any desired number of channels, for example, a hundred channels, to be transmitted on the single carrier frequency.

The present invention is based on transmitting the signals in the form of a series of pulses, the pulses corresponding to the different channels being transmitted successively in time so that a group of pulses comprising a pulse of each series is transmitted before the next succeeding pulse of any series is sent. The receiving station is provided with means for separating the pulses so that only the series of pulses corresponding to one channel are passed to the appropriate reproducing device, the pulses corresponding to other channels being similarly separated and directed to their corresponding reproducing devices. A synchronizing signal is transmitted between each group of pulses in order to maintain the separating arrangement at the receiver in synchronism with the transmitted groups of pulses.

From another aspect the invention consists in transmitting the signals on a common carrier wave in the form of a series of modulated pulses, the transmission of the pulses corresponding to the different channels being displaced in time so that successive pulses of one channel are separated by a time period within which one pulse of each of the other channels is transmitted. The signals of the various channels are thus transmitted sequentially in groups, the pulses of each series of pulses of one channel being correspondingly positioned in each group. Means are provided at the receiver for separating out the pulses of each group and directing them to the appropriate reproducing device. Preferably between each group of pulses a synchronising signal is transmitted in order to maintain the separating arrangement at the receiver in synchronism with the transmitted groups of pulses. This synchronising signal is preferably of longer duration than the signal pulses so that the synchronizing pulses can be separated out by virtue of this fact at the receiver and used for successively actuating the means for separating the different channels in the receiver.

A feature of the invention consists in employ-

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ing an artificial line for effecting the phase displacement of the pulses at the transmitting station by passing a sine wave through the line and tapping off voltages along the line for effecting the triggering of the pulse transmitters. At the receiving station a similar artificial line may be employed correspondingly to trigger separating devices for separating the received pulses.

The signal pulses transmitted may be modulated in width or height as known per se, or they may be modulated in phase as described in my concurrent application Serial No. 516,491, filed December 31, 1943, for improvements in "Pulse modulation signaling systems." Some of the pulses transmitted may be modulated by one method and some by another method, or all the pulses may be modulated by the same method.

In order that the invention may be more clearly understood it will be further explained by reference to an example described below in conjunction with the accompanying drawing in which

Fig. 1 is a diagram of the waveform transmitted according to the invention;

Fig. 2 is a schematic diagram of the transmitter;

Fig. 3 shows the prototype section of an artificial line employed in the invention;

Fig. 4 is a schematic diagram of a suitable receiver.

The example to be described is of a system operating on centimetre waves and comprising 100 signal channels. The signals of the channels are transmitted in groups of 100 signal pulses, one for each channel, and each group of signal pulses is preceded by a synchronising pulse of longer duration than the signal pulses. The repetition frequency of the pulse groups may, for example, be 6 kc. per second, thus giving a recurrence period of 166 microseconds between successive synchronising pulses and between successive signal pulses of each channel. As shown in the waveform diagram of Fig. 1, the synchronising and signal pulses are transmitted in the form of rectangular pulses which may be produced in known manner. The groups of signal pulses are indicated at A₁, B₁, etc., A₂, B₂, etc., the pulses A₁, A₂, etc., comprising the signal of one channel, the pulses B₁, B₂, etc. comprising the signal of a second channel, and so on. The synchronising pulses S, transmitted for the purpose of maintaining the receiver in step with the transmitter, are made of longer duration than the signal pulses so that they can be discriminated and separated out by virtue of this fact at the receiver, and a time space is provided

between each synchronising pulses S and the following first signal pulse A₁, A₂, etc., of each group.

An arrangement suitable for generating and transmitting the waveform of Fig. 1 is illustrated diagrammatically in Fig. 2 in which 1 represents an oscillator generating a sinusoidal wave of the repetition frequency of the signaling cycle, viz. 6 kc./sec. in the example quoted, which is fed into a phase delay unit 2 in the form of an artificial line constituted by a series of sections having the prototype shown in Fig. 3 which comprises a series inductance L and a shunt capacity C. For a hundred channel system the artificial line may comprise 110 sections, 8 of which are used for developing the synchronising pulse, 2 of which are left blank to provide a space between the synchronising pulse and the first signal pulse of a group, and the remaining 100 sections are used for generating the signal pulses in proper time sequence. Thus the first section of the artificial line from the oscillator 1 is connected to a synchronising pulse generator 3 and the 11th to the 110th sections are connected respectively to the 100 signal pulse generators of which the first two and last two are indicated by 4, 5, 6 and 7. The signal pulse generators are modulated with the sound or other intelligence to be transmitted through the various channels and the outputs from the synchronising pulse generator and the signal pulse generators are fed to a mixer 8 where they are mixed in sequence to give a complex signal having the waveform shown in Fig. 1, which is used to modulate a carrier wave transmitter 9 in known manner. The mixer 8 may employ multi-grid mixing valves of the character disclosed in the concurrent application of B. J. Edwards, Serial No. 528,985, filed March 31, 1944, for improvements in "Electron discharge devices."

With the given recurrence period of 166 microseconds, and with the given artificial line of 110 sections, the delay time per section as shown in Fig. 3 becomes $166/110$ microseconds, or approximately 1.5 microseconds. If L is the inductance and C is the capacity of the section and if the resistance per section is small compared with ωL the phase delay β per section is given by

$$\cos \beta = 1 - \frac{1}{2} \omega^2 LC$$

and since β is small

$$\beta = \omega \sqrt{LC}$$

The time delay T per section is therefore

$$T = \frac{\beta}{\omega} = \sqrt{LC}$$

The characteristic impedance of the line is given by

$$Z_0 \sim \sqrt{\frac{L}{C}}$$

Z_0 is conveniently chosen so that the line may be readily matched to the master oscillator 1. For example, if $Z_0 = 2700$ ohms and $T = 1.5$ microseconds then $C = 550$ pF, $L = 4$ mh. and

$$\frac{L}{2} = 2mh$$

The artificial line described is not the only type that would produce the requisite phase shifts; for instance, a series resistance and shunt capacity line could be used, or alternatively a band or high pass filter.

It will be clear that by the arrangement de-

scribed the generators of the synchronising and signal pulses are triggered in sequence and at the correct time intervals, the synchronising pulse being of longer duration than the signal pulse, to produce cycles of groups of pulses which are transmitted over the common carrier wave.

The corresponding receiving station for use with such a transmission is schematically shown in Fig. 4 where 10 represents a receiver of known type, from the output of which the synchronising pulses are separated by virtue of their longer duration by means of a separator circuit 11, such as is already used in television systems, and are used for synchronising a 6 kc. sine wave generator 12, the output from which is fed through a phase delay unit 13 consisting of an artificial line similar to that used at the transmitter. The phase-shifted sine wave is picked off from the 11th to the 110th sections of the unit 13 to trigger one hundred gate valves of which the first two and last two are represented at 14, 15, 16 and 17, and to each of which is also fed the output from the receiver 10, so that each gate valve allows only the series of signal pulses corresponding to one channel to pass therethrough and be fed to the appropriate one of the demodulating and reproducing devices 18 to 21.

The particular embodiments described are given only by way of example, as various other arrangements may be devised for carrying the invention into effect. The scope of the invention is therefore to be limited only by the appended claims.

I claim:

1. A multi-channel signaling system having, at the transmitter, a synchronising pulse generator, a plurality of signal pulse generators one for each channel, an oscillator for generating a controlling wave, phase-shifting means fed with said wave for producing a series of delays therein and having a series of outputs associated with said pulse generators respectively for triggering said pulse generators successively so as to produce during each cycle of said wave a group of signal pulses together with a synchronising pulse of approximately the same amplitude as but of longer duration than the signal pulses, said phase-shifting means comprising an artificial line composed of a series of similar delay sections, of which a number of sections in sequence are allotted one to each signal pulse generator so as to produce signal pulses of equal duration from the respective signal generators successively, and a plurality of sections in sequence are all allotted to the synchronising pulse generator so as to produce a synchronising pulse of correspondingly longer duration than a signal pulse, means for modulating each signal pulse generator with the signal of the respective channel, means to combine the outputs of said synchronising and modulated signal pulse generators in sequence, and means to modulate a single carrier frequency with said combined output, the system having, at a receiving station, means for separating the pulses of each received group of pulses into separate series of pulses corresponding to the respective channels, and means for phasing said separating means in synchronism with said controlling wave at the transmitter under control of the received synchronising pulses.

2. A multi-channel signaling system having, at the transmitter, a synchronising pulse generator, a plurality of signal pulse generators one for each channel, an oscillator for generating a controlling wave, phase-shifting means fed with said

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wave for producing a series of delays therein and
 having a series of outputs associated with said
 pulse generators respectively for triggering said
 pulse generators successively so as to produce
 during each cycle of said wave a group of signal
 pulses together with a synchronising pulse of ap-
 proximately the same amplitude as but of longer
 duration than the signal pulses, said phase-shift-
 ing means comprising an artificial line composed
 of a series of similar delay sections, of which a
 number of sections in sequence are allotted one
 to each signal pulse generator so as to produce
 signal pulses of equal duration from the respec-
 tive signal generators successively, and a plural-
 ity of sections in sequence are all allotted to the
 synchronising pulse generator so as to produce a
 synchronising pulse of correspondingly longer
 duration than a signal pulse, means for modu-
 lating each signal pulse generator with the sig-
 nal of the respective channel, means to combine
 the outputs of said synchronising and modulated
 signal pulse generators in sequence, and means to
 modulate a single carrier frequency with said
 combined output, the system having, at a receiv-
 ing station, means comprising a plurality of sig-
 nal separating devices, one for each channel, for
 separating the pulses of each received group of
 pulses into separate series of pulses correspond-

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ing to the respective channels, a wave generator
 for producing a wave of frequency equal to that
 of the controlling wave at the transmitter, means
 responsive to the longer duration of the synchro-
 nising pulses for separating the synchronising
 pulses from the received transmission, means for
 applying the synchronising pulses to said wave
 generator for synchronising the output wave
 thereof with said controlling wave, phase-shift-
 ing means in the form of an artificial line which
 is a duplicate of the said artificial line at the
 transmitter, those sections of the line at the re-
 ceiver which correspond to the sections of the
 line at the transmitter which are allotted to the
 signal pulse generators being respectively associ-
 ated with said separating devices, means for ap-
 plying said synchronised wave to each of said
 separating devices through said artificial line at
 the receiver so as, under the timing influence of
 said line, to trigger each of said separating de-
 vices in turn to respond to the signal pulses of
 the corresponding channel, and thereby separate
 the pulses of each received group of signal pulses
 into separate series of pulses corresponding to the
 respective channels, and means for demodulating
 the output of each of said devices.

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