

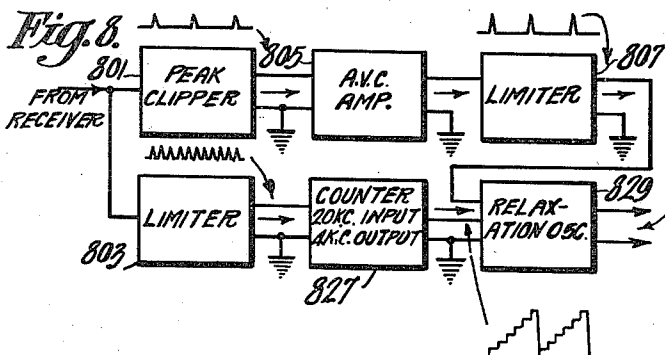
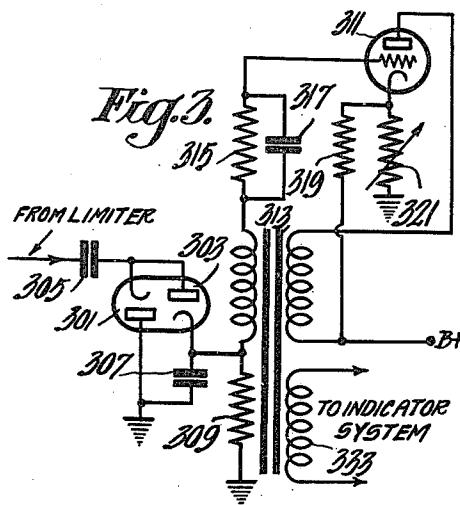
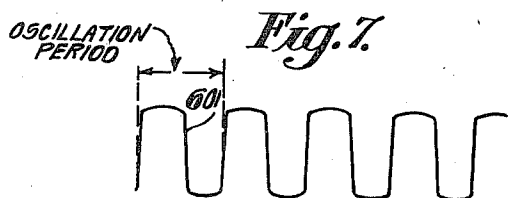
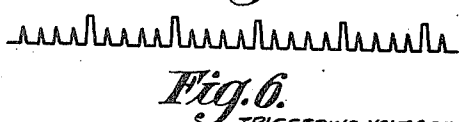
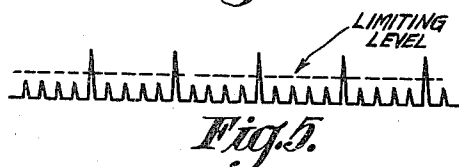
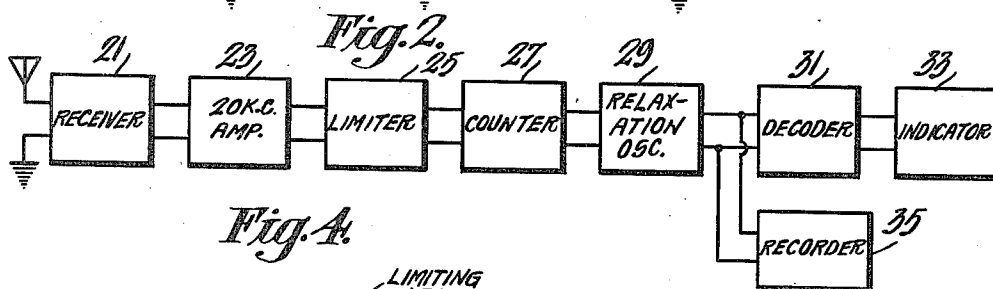
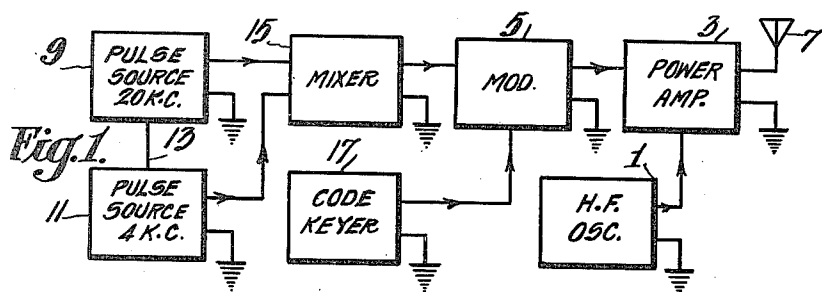
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2,415,918

MULTIPLE PULSE CHARACTERISTIC COMMUNICATION SYSTEM

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This invention relates to the art of radio signalling with discrete pulses of high frequency energy.

The principal object of the invention is to provide an improved method of and means for effecting secrecy in pulse communication.

Another object is to provide an improved method of and means for minimizing the interfering effects of noise or undesired signals upon the operation of systems of the described type.

The invention will be described with reference to the accompanying drawing, wherein:

Figure 1 is a block diagram of a transmitter system according to the invention,

Figure 2 is a block diagram of a receiver system for cooperation with the transmitter of Figure 1,

Figure 3 is a circuit diagram of a counter and a relaxation oscillator which may be used as elements of the system of Figure 2,

Figure 4 is an oscillogram of a typical pulse train produced in the operation of the system of Figures 1 and 2,

Figure 5 is an oscillogram of the pulse train of Figure 4 after passing through an amplitude limiter,

Figure 6 is an oscillogram of the output voltage of a counter circuit of the system of Figure 2, produced in response to the pulse train of Figure 5,

Figure 7 is an oscillogram of the output voltage of a relaxation oscillator of the system of Figure 4, in response to the voltage of Figure 6, and

Figure 8 is a block diagram of a modification of the receiver system of Figure 2.

Refer to Figure 1. A transmitter system suitable for the practice of the instant invention includes a high frequency oscillator 1, a power amplifier 3, and a modulator 5. The output of the oscillator 1 is amplified by the amplifier 3, modulated by the modulator 5, and applied to antenna 7, all in accordance with conventional practice.

A pulse source 9 is arranged to produce brief voltage pulses at a regular repetition rate of, for example, 20 kilocycles per second. A similar source 11 produces pulses at a repetition rate which is an integral fraction of that of the source 9, for example 4000 cycles per second. The sources 9 and 11 are synchronized by a connection 13 so that every n th (in the present example, every 5th) pulse from the source 9 coincides with a pulse from the source 11. The pulses from the

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source 11 are made from two to ten times the amplitude of those from the source 9.

The outputs of the pulse sources 9 and 11 are applied to a mixer circuit 15, where they are added together to provide a pulse train comprising a sequence of four low amplitude pulses and one high amplitude pulse, repeating cyclically as illustrated in Figure 4. This pulse train is applied to the modulator 5, causing the transmitter to radiate a high frequency signal whose amplitude pulsates in accordance with the pulse train of Figure 4.

A keying device 17 supplies dot-dash or other communication signals to the transmitter whereby the pulse train of Figure 4 is transmitted in dot-dash groups or the like.

The receiver system (Figure 2) includes a conventional radio receiver 21, an amplifier 23, a limiter 25, a counter circuit 27, and a relaxation oscillator 29, connected in cascade in the order named. The output of the receiver 21 is of the same form as that of the mixer 15 of Figure 1, shown in Figure 4. The amplifier 23 is designed to pass pulses of the type produced by the source 9 of Figure 1. Since the four kilocycle pulses appear merely as higher amplitude pulses in the 20 kilocycle pulse train, they also are amplified. The wave form of the output of the amplifier 23 is thus substantially the same as that of Figure 4.

The limiter 25 is adjusted to limit the pulse amplitude to a value somewhere between that of the 4 kilocycle pulses and that of the 20 kilocycle pulses, as indicated by the dash line marked "Limiting level" in Figure 4. The resulting output of the limiter 25 is shown in Figure 5. It is apparent that every fifth pulse is of substantially greater amplitude than the others, but the difference is smaller than in the train of Figure 4.

The limiter output is applied to the counter 27, which is adjusted so as to require five of the lower amplitude (20 kc.) pulses in order to build up a predetermined voltage E . The oscillator 29 is adjusted to have a natural frequency of operation of 4000 cycles per second, but to be normally blocked until a voltage of magnitude E is applied to it. The oscillator 29 will operate through one cycle upon the application of the critical voltage, discharging the counter and blocking itself until the counter output builds up again.

One suitable circuit for the counter 27 and the relaxation oscillator 29 is shown in Figure 3. The counter includes a pair of diodes 301 and 303, connected in opposite polarities through a "bucket" capacitor 305 to the limiter output. The cathode circuit of the diode 303 includes a storage ca-

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pacitor 307. A resistor 309 is connected in parallel with the capacitor 307.

On each positive excursion of a pulse in the train shown in Figure 5, the diode 303 conducts to discharge the capacitor 305 into the storage capacitor 307. On the negative excursion, the diode 301 conducts and the charge is restored on capacitor 305. Thus each pulse adds to the total voltage across the capacitor 307, producing a step-wise increase in voltage as shown by the oscillogram of Figure 6. The resistor 309 is made of sufficiently high resistance so that leakage through it from the capacitor 307 is negligible in the normal operation of the system.

The oscillator circuit comprises a tube 311 with its anode and grid circuits coupled closely together through a transformer 313. The grid circuit includes a leak resistor 315 and a capacitor 317. The cathode of the oscillator tube 311 is connected to a voltage divider consisting of resistors 319 and 321, which are connected in series across the anode supply, from B+ to ground. The coupling between the anode and grid circuits, and the values of the resistor 315 and the capacitor 317 are adjusted so that the action is that of a so-called "blocking oscillator." The blocking oscillator might be said to act as a transformer coupled relaxation oscillator. Without its grid resistor and condenser the inductive coupling from plate to grid is connected to cause the circuit to oscillate at a frequency determined by the inductance of the transformer windings and their distributed capacity. In starting the blocking oscillator cycle, a pulse of current in the anode circuit induces, via the transformer 313, a positive voltage pulse in the grid circuit which drives the control grid positive. Shortly thereafter, grid current flows through the resistor 315, producing a voltage drop which charges the capacitor 317 in such polarity that the grid terminal is negative with respect to the other terminal of the capacitor. This negative voltage drives the grid to cutoff where it remains until the charge on the grid condenser leaks off. Then the plate circuit starts to oscillate again and another plate voltage swing occurs so that the cycle starts over again.

In the system of Figure 3, the resistors 319 and 321 are proportioned to bias the cathode sufficiently positive to prevent the above described operation from recurring unless a sufficiently positive voltage is applied to the control grid to initiate a pulse of anode current. However, the resistor 315 and capacitor 317 are made of such values that the operation would repeat at a rate of 4000 cycles per second if the cathode bias did not prevent.

The grid current pulse is started when the voltage across the capacitor 307 has attained a high enough value so that the grid of the tube 311 is positive, causing the grid-cathode circuit to present a relatively low resistance. The capacitor 307 is thus discharged as indicated by the portions 601 on the oscillogram of Figure 6. The counter circuit voltage again builds up the charge step by step, until the oscillator is triggered again. The anode current of the oscillator varies as shown in Figure 7. Since the blocking oscillator tends to run at 4000 cycles per second, random pulses of noise or other interference will not trigger it; i. e. it waits for the synchronizing pulse from the counter circuit.

Every fifth step of the counter voltage is greater than the intervening steps, as a result of the higher amplitude of the four kilocycle pulses

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which are superimposed on the 20 kilocycle pulses. This affords an additional synchronizing effect on the oscillator, tending to trigger it at the proper time even if noise pulses are "counted" to some extent.

The resistor 309, although high enough to have substantially no effect on the normal operation of the counter circuit, is of sufficiently low resistance to prevent pulses which recur at a frequency substantially lower than 20 kilocycles from building up a voltage on the storage capacitor 309 great enough to trigger the oscillator. Thus random noise pulses arriving in the absence of the 20 kilocycle signal will not cause operation of the oscillator.

The oscillator 29 (see Figure 2) is coupled to a utilization device such as a decoder 31 and indicator 33, a recorder 35 (for example, a teletype recorder), or other known means for utilizing dots and dashes of the 4000 cycle oscillator output. Referring again to Figure 3, the transformer 313 is provided with a tertiary winding 333 from which the oscillator output is taken.

It will be apparent to those skilled in the art that the method of the present invention may be practiced by other means than those shown in Figures 1, 2 and 3. For example, a relaxation oscillator of the multivibrator type, such as that described in U. S. Patent 2,157,434, or other known type of relaxation oscillator may be substituted for the blocking oscillator of Figure 3.

Referring to Figure 8, a modified pulse selector arrangement for the receiver system is shown, including a peak clipper 801 and a limiter 803 connected to the receiver output circuit. The limiter 803 is adjusted to a lower level than that of the system of Figure 2, so as to provide only the 20 kilocycle pulses in its output. The 4 kilocycle pulses are cut down to the level of the 20 kilocycle pulses and so are not distinguishable.

The limiter 803 is connected to a counter 827, similar to the counter 27 of Figure 2. The counter output is applied to a relaxation oscillator 829, like the oscillator 29 of Figure 2. The limiting level and the constants of the counter 827 are adjusted so that the 20 kilocycle signal will not build up quite enough voltage to trigger the oscillator 829, without the addition of a further voltage.

The peak clipper 801 is designed to pass only the peaks of the receiver output, and hence its output consists only of pulses corresponding to the top portions of the 4 kilocycle pulses. These are applied to an amplifier 805, and thence through a limiter 807 to the oscillator 829. The 4 kilocycle pulses from the limiter 807 alone are not of sufficient amplitude to trigger the oscillator 829, but when these pulses are superimposed on the output of the counter 827, the two are enough to trigger the oscillator, which provides a 4000 cycle output in the presence of both signals. As in the system of Figure 2, random noises or other interference is not effective to control the oscillator.

The pulse frequencies specified in the foregoing description are mentioned merely by way of example. Other integrally related frequencies may be used, and any practical number of superimposed pulse trains of different amplitudes may be employed in accordance with the principles set forth.

Briefly summarizing, the present invention contemplates the transmission and reception of superimposed trains of pulses of harmonically related repetition rates and different amplitudes,

with means connected to the receiver responsive only to the simultaneous appearance of all of said pulse trains, in their predetermined frequency and amplitude relations, to effect an indication.

I claim as my invention:

1. A method of radio communication including the steps of producing a radio frequency carrier, producing a train of recurrent pulses having a predetermined repetition frequency, producing a second train of recurrent pulses having a repetition frequency harmonically related to that of said first train and an amplitude substantially different from that of said first train, superimposing said pulse trains, modulating said carrier with said superimposed pulse trains, receiving said modulated carrier, locally generating an alternating current in response to the combined effect of both of said received pulse trains, and utilizing said locally generated current.

2. A method of communication including the steps of transmitting a composite signal comprising a plurality of superimposed trains of discrete pulses having repetition frequencies related by integral numbers and having respectively different amplitudes, receiving said composite signal, separating said component pulse trains in accordance with their relative amplitudes, generating in response to the higher frequency component trains, further pulse trains having the same repetition frequency as that of the lowest frequency component train, combining said further trains with said lowest frequency train, and producing an indication only in response to the simultaneous presence of said further trains and said lowest frequency train.

3. A signalling system including means for generating at least two simultaneous trains of discrete pulses having respective repetition frequencies related to each other by an integral number and having respectively different amplitudes, means for combining said trains to provide a composite signal, means for transmitting said composite signal, means for receiving said transmitted signal, limiter means adjusted to limit substantially the amplitudes of said component

pulse trains to a common value, peak-responsive means adjusted to respond only to the peaks of the highest amplitude component pulse train of said signal, means responsive to the output of said limiter means to produce a voltage pulsating at the same frequency as said highest amplitude component pulse train, and means responsive only to the presence of both said pulsating voltage and the output of said peak-responsive means to effect an indication.

4. A signalling system including means for generating a plurality of trains of discrete pulses having respective repetition frequencies related to each other by integral numbers and having respectively different amplitudes, means for combining said trains to provide a composite signal, means for transmitting said composite signal, means for receiving said transmitted signal, amplifier means designed to pass the highest frequency component train of said signal, limiter means adjusted to pass, without substantially limiting, the lowest amplitude component train of said signal, and to pass with substantial limiting, the higher amplitude components of said signal, counter means connected to said limiter means and responsive to the output thereof to produce a step-like voltage wave, a relaxation oscillator designed to operate at the frequency of said lowest frequency component pulse train, means biasing said oscillator normally to prevent operation thereof, and means for applying said step-like wave to said oscillator whereby the effect of said bias is momentarily overcome at intervals corresponding to the frequency at which said oscillator is designed to operate.

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