Feb. 18, 1947. H. E. THOMAS 2,415,919

MULTIPLE PULSE CHARACTERISTIC COMMUNICATION SYSTEM

Filed May 30, 1945

Fig. 1.

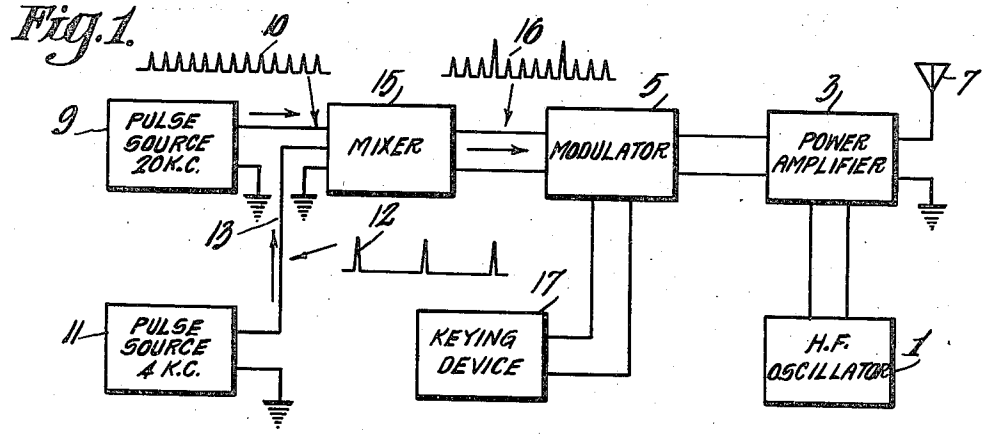
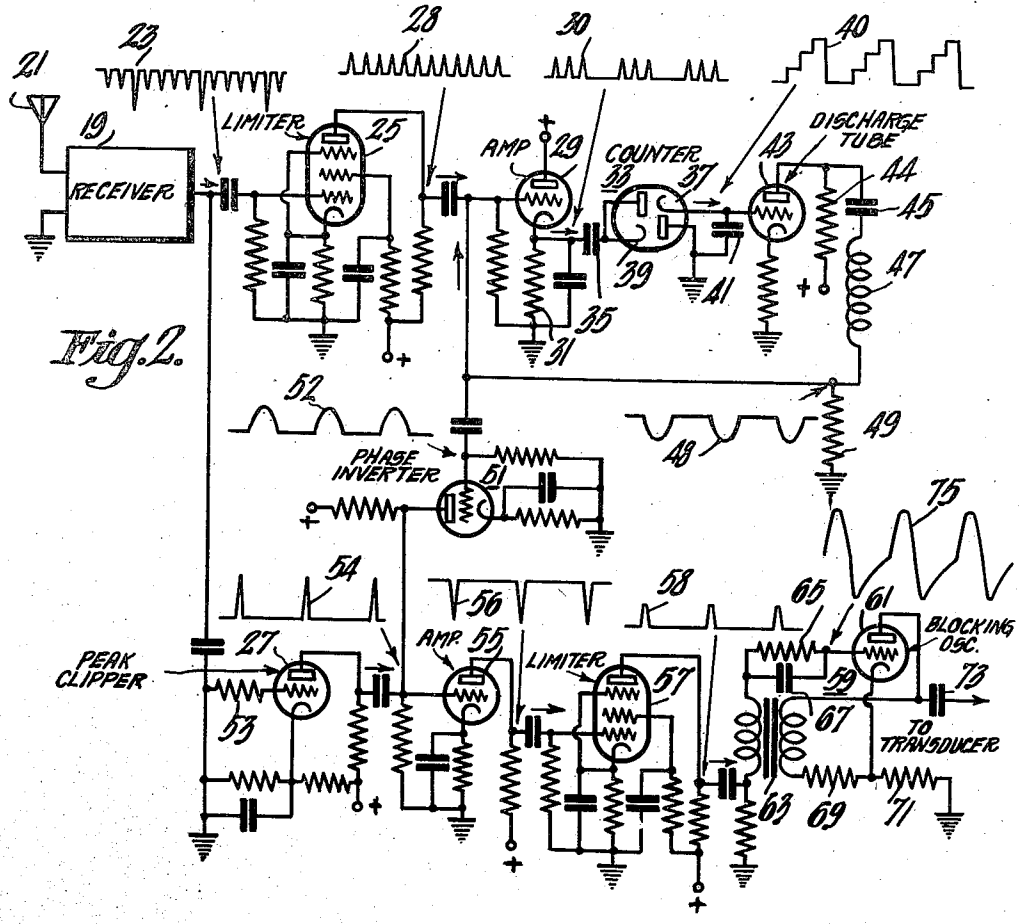


Fig. 2.



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Patented Feb. 18, 1947

2,415,919

UNITED STATES PATENT OFFICE

2,415,919

MULTIPLE PULSE CHARACTERISTIC COMMUNICATION SYSTEM

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Application May 30, 1945, Serial No. 596,695

3 Claims. (Cl. 250—8)

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This invention relates to the art of signalling with discrete pulses, and more particularly to improvements in pulse communication systems of the type described in my copending U. S. patent application Serial Number 596,694 filed May 30, 1945, and entitled Multiple pulse characteristic communication system.

The principal object of the present invention is to provide an improved method of and means for minimizing the effects of noise or other interference 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, and

Figure 2 is a circuit diagram of a receiver system for cooperation with the transmitter system of Figure 1.

Referring first to Figure 1, the transmitter system 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 an antenna 7, all in accordance with conventional practice. A pulse source 9 is arranged to produce brief voltage pulses 10 at a regular repetition rate of, for example 20 kilocycles per second. A similar source 11 produces pulses 12 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 nth (in the present example, every 5th) pulse from the source 9 coincides with a pulse from the source 11. The pulses from the source 11 are made from two to ten times the amplitudes of those from the source 9.

The outputs 10 and 12 of the pulse sources 9 and 11 are applied to a mixer circuit 15, where they are added together to provide a pulse train 16 comprising a sequence of four low amplitude pulses and one high amplitude pulse, repeating cyclically. 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 16.

A keying device 17 supplies dot-dash or other communication signals to the transmitter whereby the pulse train 16 is transmitted in dot-dash groups or the like.

Referring to Figure 2, the receiver system includes a radio receiver 19 of conventional design, comprising the usual amplifier and demodulator means, and provided with an antenna 21. The

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receiver 19 is arranged to respond to signals radiated by the transmitter system of Figure 1, and provides an output pulse train 23 similar to the pulse train 16 but inverted in polarity with respect thereto. The output of the receiver 19 is applied to a limiter 25 and to a peak clipper 27.

The limiter 25 comprises a pentode tube connected in a resistance coupled amplifier circuit and supplied with plate and screen voltages adjusted so that its output is restricted to a predetermined amplitude. This amplitude is set somewhat below that of the 20 kilocycle component pulses of the train 23. The output of the limiter 25 thus comprises a train 28 of constant-amplitude 20-kilocycle pulses.

The output of the limiter 25 is applied to an amplifier 29. The entire load resistance 31 of the amplifier 29 is included in its cathode circuit. The cathode of the amplifier 29 is coupled to a counter circuit 33, comprising a capacitor 35 connected to a pair of oppositely polarized diode rectifiers 37 and 39. The diode 39 is connected directly to ground and the diode 37 is connected to a storage capacitor 41. The capacitor 41 is connected to a control grid of a gas filled discharge tube 43.

The anode circuit of the discharge tube 43 includes a capacitor 45, an inductor 47 and a resistor 49. The resistor 49 is coupled to the control grid of the amplifier 29, and to a phase inverter 51.

The peak clipper 27 comprises a resistance coupled amplifier circuit including a resistor 53 in series with the control grid connection. The resistor 53 is of such a value as to substantially limit the flow of grid current when the control grid is positive with respect to the cathode, and to have substantially no effect when the control grid is negative with respect to the cathode.

The output circuit of the peak clipper 27 is coupled to an amplifier 55, which is designed to pass 4000 kilocycle pulses. The amplifier 55 is connected to a limiter 57, similar to the limiter 25. The output of the limiter 57 is applied to a blocking oscillator 59.

The oscillator 59 comprises a tube 61 with its anode and grid circuits coupled closely together through a transformer 63. The grid circuit includes a leak resistor 65 and a capacitor 67. The cathode of the oscillator tube 61 is connected to a voltage divider consisting of resistors 69 and 71, 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 65 and the capacitor 67 are ad-

justed so that a pulse of current in the anode circuit induces, via the transformer 63, a voltage pulse in the grid circuit which drives the control grid positive. Grid current flows through the resistor 65, producing a voltage drop which charges the capacitor 67 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 capacitor 67 leaks off. Then the circuit starts to oscillate again and another plate voltage swing occurs so that the cycle starts over again.

The resistors 69 and 71 are proportioned to bias the cathode sufficiently positive to prevent the above described operation from recurring unless a positive impulse is applied to the control grid to initiate a pulse of anode current. However, the resistor 65 and capacitor 67 are made of such values that the operation would repeat at a rate of 4,000 cycles per second if the cathode bias did not prevent. The anode of tube 61 is coupled through a blocking capactor 73 to a utilization device (not shown) such as a recorder, indicator and other transducer.

The operation and adjustment of the receiver system are as follows:

The limiter 25 separates the 20 kilocycle pulses from the output of the receiver 19 by eliminating the higher amplitude 4 kilocycle pulses. The limiter output 27 is amplified by the amplifier 29. Owing to the cathode follower type of connection of the amplifier 29, the pulses 30 of its output are of the same polarity as the input pulses 27.

The counter capacitor 35 is substantially completely charged and discharged with each pulse of the train 30. Charging current flows through the diode 37 and the capacitor 41. The discharge current flows through the diode 39 but not through the capacitor 41. This causes a voltage 40 to build up step-wise across the capacitor 41.

The voltages applied to the discharge tube 43 are adjusted to prevent conduction until the voltage across the capacitor 41 has built up to a value corresponding to three steps. At this point the grid to cathode voltage of the tube 43 becomes such as to initiate discharge in the anode circuit. A surge of anode current flows through the load resistor 44, causing the voltage at the anode to drop to a value sufficiently low to stop the discharge. The current surge provides a negative voltage pulse which is applied through the capacitor 45 and the inductor 47 to the resistor 49. The values of the three last-mentioned elements are designed to control the wave shape of the pulse train 48 which appears across the resistor 49, in such manner that the pulses 48 each have a width equal to twice the repetition period of the 20 kilocycle pulses (that is, 100 microseconds).

The pulses 48 are applied to the control grid of the amplifier 29 and have sufficient negative amplitude to cut off the amplifier 29 for a period of substantially 100 microseconds. Thus the output 30 of the amplifier 29 comprises a train of three 20 kilocycle pulses followed by an interval of 100 microseconds, then three more 20 kilocycle pulses. No 20 kilocycle pulses are applied to the counter 33 during the period of discharge of the tube 43. The above described operation repeats at the rate of 4,000 cycles per second. Consequently, the voltage 48 appearing across the resistor 49 is, in effect, a train of 4

kilocycle pulses each having a duration period of 100 microseconds.

The pulse train 48 is applied also to the phase inverter 51. The output of the phase inverter 51 is a similar pulse train 52, of positive polarity. The wide 4 kilocycle pulses 52 are applied to the amplifier 55 concurrently with the sharp 4 kilocycle pulses 54 from the peak clipper 27.

The amplifier 55 is biassed somewhat beyond cutoff. The amplitudes of the pulse trains 52 and 54 are adjusted to such values that neither one alone can cause conduction through the amplifier 55. However, when one of the pulses 54 appears within the 100 microsecond duration period of one of the pulses 52, the amplifier 55 operates, providing a sharp output pulse 56. In the normal operation of the system, this occurs at a 4 kilocycle repetition rate. The system thus operates in the manner of a gate—the wide pulses unblocking the amplifier long enough and in synchronism so that the narrow high amplitude pulses pass through.

The 4 kilocycle pulses 56 are of negative polarity, owing to phase inversion in the amplifier 55. The limiter 57 inverts the phase again and limits the amplitude, providing a positive 4 kilocycle pulse train 58. The pulses 58 appear across the resistor 68, triggering the blocking oscillator 59 at regular intervals. The resulting 4 kilocycle output wave 75 of the oscillator 59 is employed to actuate the transducer, not shown.

Since the blocking oscillator tends to run at 4,000 cycles per second, random pulses of noise or other interference will not control it; it waits for the synchronizing pulse from the limiter 57. High amplitude pulses occurring at frequencies other than 4 kilocycles are rejected, since the amplifier 55 is blocked, except at 4 kilocycle intervals, by the phase inverter output 52. In the present example, the amplifier 55 is operative only two-fifths of the time. Noise voltages appearing in the remaining three-fifths of the time cannot reach the blocking oscillator 61, although they will actuate the counter 33 and may tend to shift the time at which the discharge tube 43 operates to block the amplifier 29 and unblock the 4 kilocycle amplifier 55. However, the width of the pulses 48 will allow considerable leeway in time for the desired 4 kilocycle pulses 54 to get through.

It is to be understood that the pulse frequencies mentioned in the foregoing description are given only by way of example, and that other frequencies may be employed within the scope of my invention, which contemplates the use of two superimposed pulse trains of integrally related frequencies and distinguishable amplitudes. The higher frequency train is utilized to periodically unblock a normally blocked amplifier, in synchronism with the lower frequency train. This discriminates against random noise and other interference while allowing the low frequency pulse train to pass. The low frequency pulse train keys a blocking oscillator which energizes an indicator or other utilization device.

I claim as my invention:

1. A signalling system including means for producing and transmitting a signal comprising two simultaneous trains of discrete pulses, having respective repetition frequencies which are related to each other by an integral number, and respectively different amplitudes, means for receiving said signal, means for separating said two component trains from said received signal, counter means responsive to the higher frequency

one of said trains to produce a voltage of step wave form at a repetition frequency equal to that of said lower frequency pulse train, discharge tube means responsive to said step wave voltage to produce a third train of pulses having a repetition frequency equal to that of said lower frequency pulse train and pulse duration periods substantially greater than the repetition period of said higher frequency pulse train, normally blocked amplifier means, means for applying said lower frequency pulse train component of said signal to said amplifier, means for applying said third pulse train to said amplifier whereby said amplifier is operative only during brief intervals coinciding approximately with the pulses of said lower frequency component train, a normally blocked relaxation oscillator, and means for applying the output of said amplifier to said relaxation oscillator, whereby said oscillator operates only in response to the simultaneous reception of both of said pulse train components of said signal.

2. A method of communication including the steps of transmitting a composite signal comprising two trains of discrete pulses having respective repetition frequencies related by an integral number and respectively different amplitudes, receiving said composite signal, separating said composite pulse trains in accordance with their relative amplitudes, generating in response to the higher frequency component train a further pulse train having the same repetition frequency as that of said lower frequency component train and pulse duration periods substantially greater than the repetition period of said higher frequency component train, superimposing said lower frequency component train upon said locally generated pulse train to produce a resultant pulse train, and producing an indication only in response to the attainment by said resultant pulse train of a predetermined amplitude substantially greater than that of either of the components thereof.

3. A signalling system including means for producing and transmitting a signal comprising two simultaneous trains of discrete pulses, having respective repetition frequencies which are related to each other by an integral number, and respectively different amplitudes, means for receiving said signal, means for separating said two component trains from said received signal, normally blocked amplifier means, means for applying the lower frequency one of said component pulse trains to said amplifier means, means responsive to the higher frequency one of said component trains to periodically unblock said amplifier means, during brief intervals approximating the instants of appearance of the pulses of said lower frequency train, and normally blocked relaxation oscillator means connected to the output of said amplifier.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,199,634	Koch	May 7, 1940
2,041,245	Haffcke	May 19, 1936