May 31, 1949. C. E. CLEETON 2,471,413

PULSE CODE-SIGNALING SYSTEM

Filed May 15, 1940 2 Sheets-Sheet 1

FIG. 1

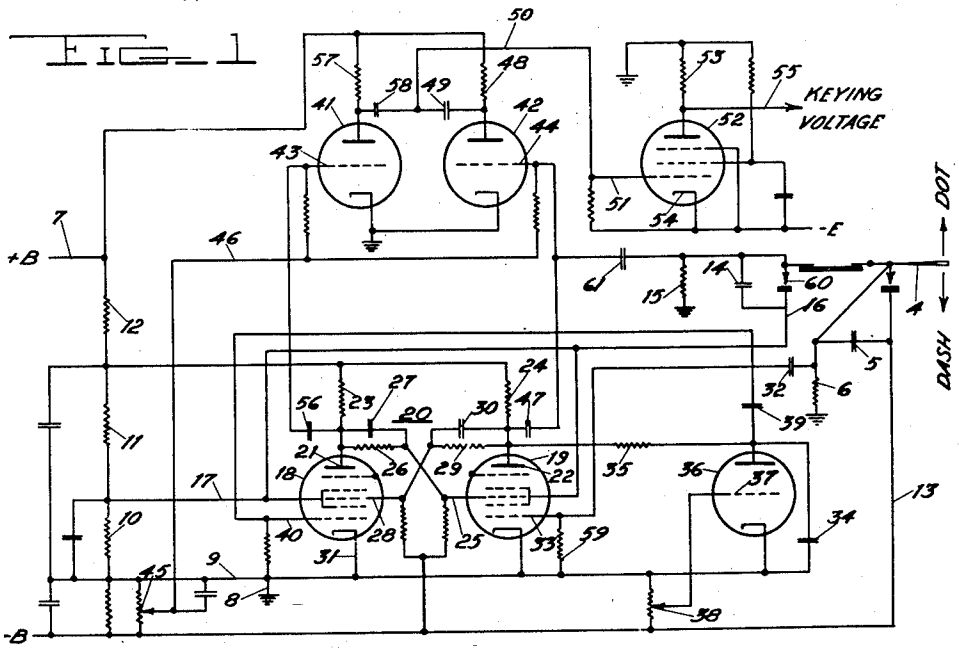
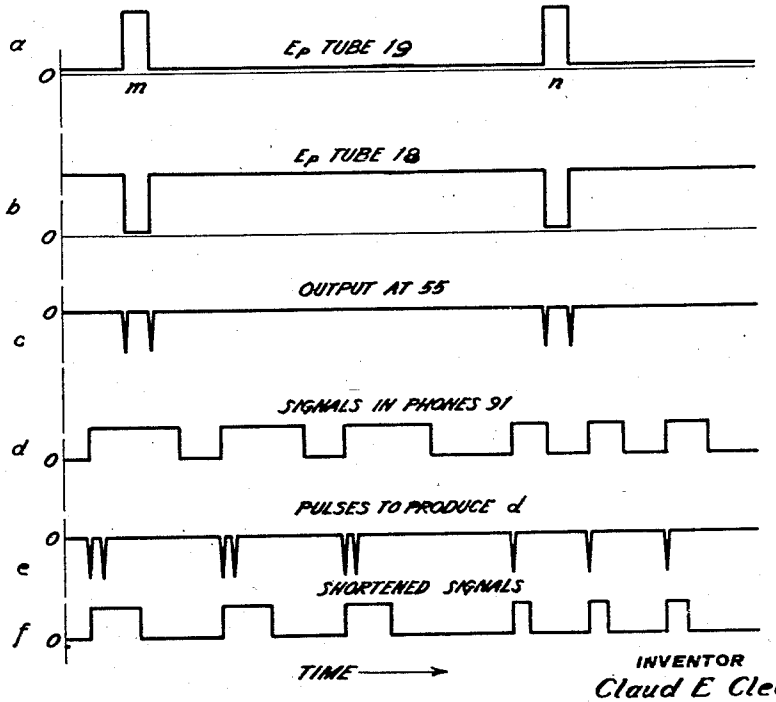


FIG. 2



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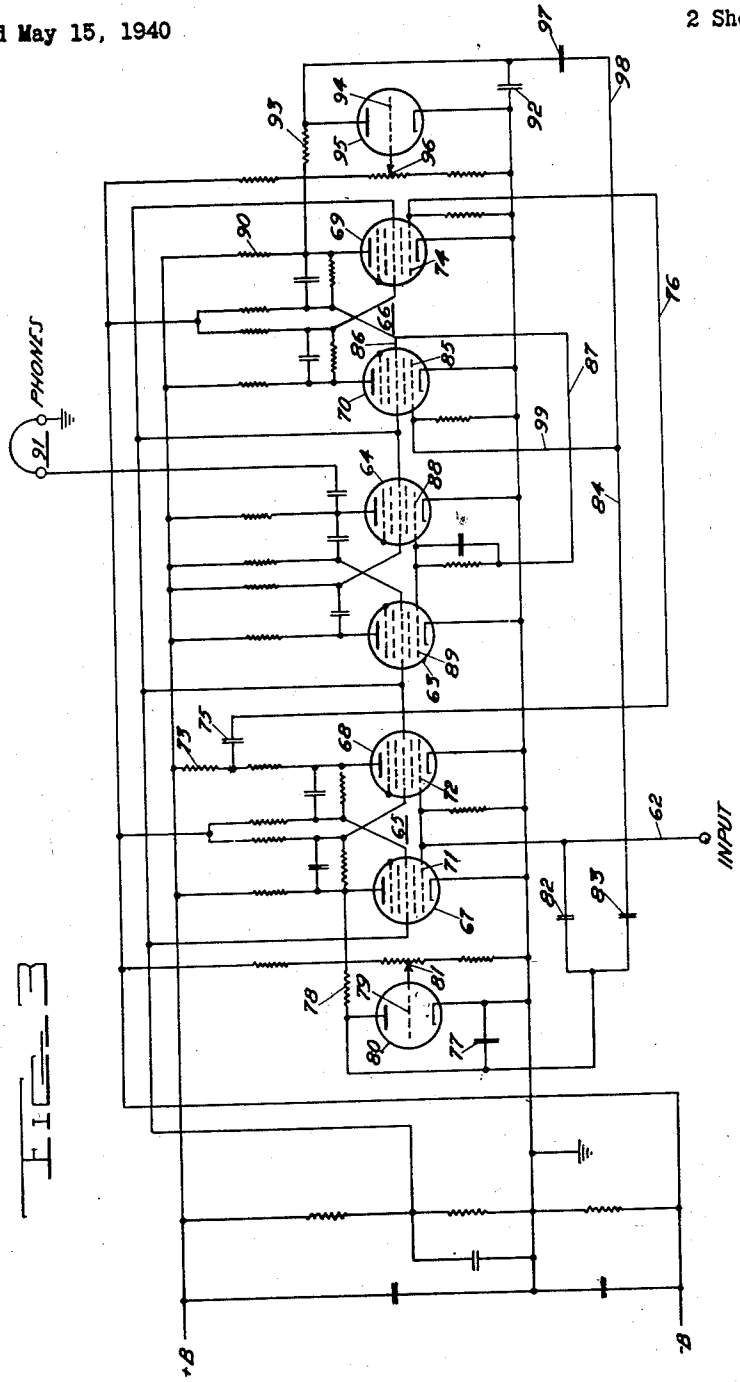

FIG. 3

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UNITED STATES PATENT OFFICE

2,471,413

PULSE CODE-SIGNALING SYSTEM

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14 Claims. (Cl. 178—68)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention relates to means for keying a transmitter for dot and dash signaling, whereby a dot is represented by one pulse and a dash by a pair of pulses, and means associated with a receiver to convert one pulse into a perceptible signal having a duration corresponding to a dot and a pair of pulses into a perceptible signal having a duration corresponding to a dash.

Among the several objects of this invention are:

To provide electronic apparatus controlled by a key wherein movement of the key in one direction gives rise to two keying pulses in a predetermined time relation and movement in the other direction gives rise to one keying pulse;

To provide electronic apparatus associated with a receiver that will respond to one pulse by emitting a signal of a length representing a dot and to two pulses in predetermined relation by emitting a signal of length representing a dash;

To provide a system permitting great increase in the peak power of a transmitter whereby the receiver sensitivity may be reduced to exclude noise;

To provide a signaling system giving an output of constant amplitude; and

To provide a system affording some degree of secrecy due to the necessity of special translating apparatus in the receiver.

In the drawings:

Fig. 1 depicts schematically the at present preferred form of means for producing the pulses;

Fig. 2 shows a group of related graphs wherein are represented corresponding voltage conditions in various parts of the apparatus; and

Fig. 3 shows diagrammatically one form of receiving apparatus useful in translating the pulses derived from the apparatus of Fig. 1.

According to my present invention the dot of the conventional telegraphic code is represented by an electrical pulse of a duration very short compared to the duration of the dot and the dash is represented by a pair of pulses separated by a predetermined time interval. As hereinafter used, the term "signal element" is a generic expression designating either a dot or a dash.

The receiving means consists of any receiving and amplifying system suitable for pulse reception, connected to a special circuit that distinguishes between the single pulse representing a dot and the pair of pulses representing a dash

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and keys on a local oscillator for a time corresponding to a dot or a dash depending upon whether one or two pulses are received. Preferably, the duration of the audio dash signal is three times as great as that of the dot.

One great advantage of this system over conventional code signaling means is that the peak power during the pulse may be many times the average power that the transmitter is capable of handling since the ratio of the length of the pulse to the average time between pulses may be of the order of one to one thousand for ordinary sending speeds. Due to the great increase in peak power of the transmitter, the receiver sensitivity may be reduced to a point where noise is completely eliminated. Furthermore, since the audio signal originates in the receiver, the amplitude of the audio signal will be constant. The present apparatus requires the least number of pulses per signal element of any pulse system or communication known to me.

Referring now to Fig. 1, there is shown a "bug" type of key 4 movable in two directions as indicated by the arrows adjacent thereto. When key 4 is in the neutral position capacitor 5 charges up through grounded resistor 6 indicated as connected to +B lead 7 through ground connection 8, common ground lead 9 and series resistors 10, 11 and 12. The other side of capacitor 5 is connected to —B through lead 13.

Also, when key 4 is in the position mentioned, capacitor 14 charges through grounded resistor 15, grounded connection 8 and the remainder of the path of +B as above set forth. The other side of capacitor 14 is connected through lead 16 and grid connection 17 to the high potential side of resistor 10.

Tubes 18 and 19 are connected together to constitute a locked electronic relay or switch, designated generally by the numeral 20. Respective anodes 21 and 22 are connected to the B supply through respective anode resistors 23 and 24. Anode 21 is connected to grid 25 of tube 19 by a resistor 26 and capacitor 27 in parallel and likewise anode 22 of tube 19 is connected to grid 28 of tube 18 by resistor 29 in parallel with capacitor 30. The normal initial condition of the relay 20 is for tube 19 to be conducting and tube 18 to be blocked by the negative potential impressed upon grid 28 due to the I. R. drop across resistor 24.

This condition is readily effected by opening in any manner the circuit of cathode 31 of tube 18 whereby the plus anode potential of tube 18 is impressed upon grid 25 of tube 19 and the negative potential due to the drop through resistor 24 is applied to grid 28 of tube 18. When the conditions in relay 20 have been set up as above described, if key 4 is moved downwardly capacitor 5 discharges and a negative pulse is transmitted through capacitor 32 to grid 33 of tube 19 which blocks the tube 19 and renders tube 18 conducting. When tube 19 is blocked the potential on anode 22 rises and the capacitor 34 is charged through resistor 35 during a predetermined time interval at the end of which the breakdown potential of gas tube 36 is reached, tube 36 becomes conducting and capacitor 34 is discharged. The breakdown potential of tube 36 is determined by the bias applied to grid 37 through variable resistor 38.

The discharge of capacitor 34 through tube 36 impresses, through capacitor 39, a negative potential upon grid 40 of tube 18 which blocks tube 18 and causes tube 19 to become again conducting as above set forth.

Amplifier tubes 41 and 42 are biased to cut off through connection of their grids 43 and 44 to variable resistor 45, through lead 46. When tube 19 was rendered non-conducting by discharge of capacitor 5 the potential on anode 22 rose substantially to the full value of the anode potential supply and a positive pulse was transmitted through capacitor 47 to grid 44, which transiently unblocked tube 42 and the flow of anode current through anode resistor 48 produced a potential drop that was applied through capacitor 49 and lead 50 to grid 51 of tube 52. Tube 52 is biased to be conducting in the absence of negative signal on grid 51 and hence the potential at the anode connected end of anode resistor 53 is almost —E below ground potential, since resistor 53 is connected to ground and —E is the potential applied to cathode 54 of tube 52. When the negative pulse was applied to grid 51 the tube 52 was transiently block and the potential at the anode-connected end rose almost to ground potential and a positive keying pulse was sent out over output lead 55.

Likewise, when the discharge of capacitor 34 shifted conductivity from tube 18 to tube 19 the positive pulse impressed upon grid 43 of tube 41 through capacitor 56 transiently unblocked tube 41 and the I. R. drop across resistor 57 was transmitted through capacitor 58 to grid 51 and a second keying pulse was sent out.

The duration of the negative pulse applied to grid 33 when capacitor 5 discharges is determined primarily by the value of capacitor 32 and resistor 59 while the time between the successive pulses applied to grids 44 and 43 is fixed primarily by the value of resistor 35 and capacitor 34.

When key 4 is moved upwardly, contact 60 is closed and capacitor 14 is discharged which applies, through capacitor 61, a positive pulse to grid 44 of tube 42, transiently unblocks the tube 42 and results in the applying of a negative pulse to grid 51 of tube 52 and the emission of a single keying pulse over output lead 55. It is thus apparent how I produce the pair of pulses corresponding to a dash and a single pulse corresponding to a dot.

It is obvious that signal elements transmitted in the form of pulses as above described must be translated before the message conveyed by such signal elements can be deciphered. Fig. 3 discloses an operative system for achieving this result. The input 62 is connected to the output of any type of receiver or amplifier capable of responding satisfactorily to the extremely short pulses sent out as a result of the keying pulses derived in the manner above described.

Tubes 63 and 64 are interconnected to form an audio frequency oscillator of the well known multi-vibrator type which is believed to require no detailed description. Locked electronic relays or switches 65 and 66 are in general similar to the electronic relay 20 in Fig. 1. The initial condition of relay 65 is for tube 67 to be conducting and tube 68 to be blocked while in relay 66 tube 69 is initially conducting and tube 70 initially blocked.

When a negative pulse comes in over input 62 it is applied to both grid 71 of tube 67 and grid 72 of tube 68 but since tube 68 is non-conducting it has no effect thereon. However, the negative pulse applied to grid 71 blocks tube 67 and causes tube 68 to become conducting. The flow of current through tube 68 produces an I. R. drop across resistor 73 which is applied to grid 74 of tube 69 by means of capacitor 75 and lead 76, thus blocking tube 69 and causing tube 70 to become conducting. When tube 67 is blocked capacitor 77 begins to charge through resistor 78 and at the end of a period determined by the bias impressed upon grid 79 of gas tube 80 through variable resistor 81, the break-down potential of tube 80 is reached and the capacitor 77 discharges therethrough. The time of charging of capacitor 77 is made equal to the desired duration of a dot and when capacitor 77 discharges a negative pulse is applied through capacitor 82 to grid 72 of tube 68, blocking tube 68 and causing tube 67 to become again conducting. At the same time, a negative pulse is transmitted through capacitor 83 and lead 84 to grid 85 of tube 70 which blocks tube 70 and causes tube 69 to become conducting again and the system is restored to its initial condition. However, when tube 69 was rendered non-conducting the high potential on the anode thereof that was transmitted to grid 86 of tube 70 to cause tube 70 to conduct, was also transmitted by lead 87 to grids 88 and 89 of multi-vibrator tubes 64 and 63, respectively, and the multi-vibrator began to oscillate, which oscillations continued so long as tube 69 was blocked but ceased immediately when tube 69 became again conducting due to the I. R. drop across resistor 90 having been applied to grids 88 and 89. Consequently, the duration of the audio signal in headphones 91 was equal in length to the charging period of capacitor 77 and represented a dot.

The capacitor 92 began to charge when tube 69 was rendered non-conducting and continued to charge for an interval determined by the value of capacitor 92, the value of resistor 93 and the bias applied to grid 94 of gas tube 95 through variable resistor 96. The time of charging of capacitor 92 is fixed to be three times the charging period of capacitor 77 and consequently represents the duration of a dash signal. However, when but one pulse is received over input 62 capacitor 77 discharges and returns relays 65 and 66 to their initial condition before capacitor 92 is charged and hence the capacitor 92 has no effect upon the operation.

However, when a pair of pulses are received the time between the pulses is less than the charging period of capacitor 77. The first pulse of the pair changes conductivity from tube 67 to tube 68 and, through capacitor 75 and lead 76

the potential drop through resistor 73 changes conductivity from tube 69 to tube 70 in relay 66 and starts the capacitor 92 to charging. The second pulse of the pair changes conductivity from tube 68 back to tube 67 but, since the positive pulse applied to grid 74 of tube 69 through capacitor 75 cannot cause the relay to switch, capacitor 92 continues to charge. When capacitor 92 reaches the break-down potential of tube 95 is discharges through tube 95 and transmits a negative pulse through capacitor 97 and leads 98 and 99 to grid 85 of tube 70, blocking tube 70 and causing tube 69 to become conductive and placing relay 66 in its initial condition.

Inasmuch as the multi-vibrator oscillator continued to operate throughout the time of charging of capacitor 92 an audio signal was received in phones 91 that was three times the duration of the signal heard when a single pulse was applied through input 62 and hence was interpreted as a dash. It is thus apparent that the system shown in Fig. 3 will respond to a single pulse, representing a dot, with an audio signal of fixed duration and likewise will respond to a pair of pulses over input 62 with an audio signal three times the duration of the dot signal and will thus represent a dash. It is apparent that this affords a considerable degree of secrecy in that a receiver not equipped with the system shown in Fig. 3 or an equivalent thereof will not produce the proper audio signals.

The graphs in Fig. 2 show certain voltage relations existing among the elements of the apparatus herein disclosed. Graph *a* represents the anode potential of tube 19 while graph *b* represents the simultaneously existing anode potential on tube 18. That is, when tube 19 is conducting and the anode potential is low due to the drop across resistor 24, tube 18 is non-conducting and its anode potential is high. Graph *c* of Fig. 2 illustrates the output through lead 50 when the key 4 is moved down to send a dash. Graph *d* represents the envelope of the audio signal in phones 91 when three dashes and then three dots are transmitted while graph *e* represents the pulses over lead 50 that produce the signal shown in graph *d*. Graph *f* shows how the duration of the signal elements may be varied by changing the values of the resistors and capacitors that control the audio signal duration. The principal reason for altering the duration of the signal elements is to adapt the system for various sending speeds.

It is to be understood that the multi-vibrator shown in Fig. 3 is only one of many possible arrangements for producing an audio signal. Likewise, two pulses may be used to represent a dot and one to represent a dash simply by interchanging the key contacts on the transmitter and the time duration of the receiver corresponding thereto.

Variable resistors 81 and 96, that control the breakdown voltages of tubes 80 and 95, respectively, may be operated from a single control so that the charging time of capacitor 92 will always be three times that of capacitor 77.

Likewise, instead of the multi-vibrator circuit shown to produce the audio signal in the phones 91, any type of audio-oscillator may be used and allowed to operate continuously with the output thereof feeding into an amplifier tube and the amplifier tube may be changed from conducting to non-conducting condition by the potential applied through lead 87. While the tubes shown in the switching relays are illustrated as being

pentagrid mixer types, such as the RCA 6L7, it is to be understood that any suitable "scale-of-two" electronic counter may be substituted for the various relays shown.

The invention herein described and claimed may be used and/or manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. A pulse code-signaling system, comprising a locked electronic relay including two vacuum tubes each having at least two grids, an anode and a cathode; a respective anode resistor connecting each said anode to a common positive supply, a resistor and a capacitor connected in parallel between each said anode and a grid of the other tube whereby when either tube is conducting the potential drop across the respective anode resistor holds the other tube non-conducting, a storage capacitor connected in parallel with one said tube to be charged when said one tube is non-conducting and the other is conducting, a discharge device connected in parallel with said storage capacitor held non-conducting until said storage capacitor reaches a predetermined potential and then becomes conducting to discharge said storage capacitor, means to apply to another grid of said other tube a negative potential when said storage capacitor discharges to render said other tube non-conducting and thereby render said one tube conducting, a first capacitor connected to charge from said supply, a key movable in one direction to discharge said first capacitor, means connecting another grid of said one tube to said first capacitor to apply a negative pulse to said other grid to render said one tube non-conducting when said first capacitor is discharged; two amplifying tubes each having a cathode, a grid and an anode, means to apply a blocking bias to said amplifying tubes, means connecting each said amplifying tube to a respective said relay tube anode whereby when a relay tube is changed from conducting to non-conducting condition a positive pulse is applied to the respectively connected amplifying tube grid to unblock momentarily such tube, a keying tube biased to be conducting, means connected to both amplifying tubes and to said keying tube to apply to said keying tube a pulse to block momentarily said keying tube when either amplifying tube conducts, means to derive a positive keying pulse from said keying tube when blocked, a second capacitor connected to charge from said source, means to connect said second capacitor to said key to discharge said second capacitor when said key is moved in another direction, and means to apply a positive pulse to the grid of one of said amplifying tubes to unblock momentarily such amplifying tube when said second capacitor is discharged, whereby a pair of keying pulses is set up when said key is moved in said one direction and a single pulse when said key is moved in said other direction.

2. A pulse code-signaling system, comprising a locked relay including two vacuum tubes and a network connecting said tubes whereby when either tube is made conducting the other tube is made and held non-conducting; a storage capacitor connected in parallel with one said tube to be charged when said one tube is non-conducting and the other tube is conducting, means connected in parallel with said capacitor and responsive to a predetermined potential on said capacitor to discharge said capacitor, means to

apply to the other said tube a blocking negative pulse when said storage capacitor is discharged and thereby render said one tube conducting; two amplifier tubes biased to be non-conducting in the absence of a positive signal, means connecting each said amplifier tube to a respective said relay tube to unblock momentarily an amplifier tube when the respectively connected relay tube is made non-conducting; a keying tube biased to be conducting, means connecting both amplifier tubes to said keying tube to block said keying tube momentarily when either amplifier tube is made conducting, means to derive a positive keying pulse from said keying tube when blocked as aforesaid; a first capacitor connected to be charged, a circuit including a key movable in one direction to discharge said first capacitor means to apply a negative pulse from said first capacitor to said one relay tube when said first capacitor is discharged, a second capacitor connected to be charged, a circuit including said key to discharge said second capacitor when said key is moved in the other direction, means to apply a positive pulse from said second capacitor to one said amplifier tube when said second capacitor is discharged, whereby when said key is moved in one direction a pair of keying pulses is produced and when said key is moved in the other direction a single keying pulse is produced.

3. A pulse code-signaling system, comprising a receiving device that includes a multivibrator oscillator and a first and a second electronic relay, each said relay including two vacuum tubes each having a cathode, an anode and at least first and second grids, an anode resistor connecting each anode to a common supply source, a capacitor and a resistor in parallel connecting each said anode to the second grid of the other tube in the same relay, a discharge device connected in parallel with a respective one tube of each said relay and biased to be non-conducting at less than predetermined anode potentials, a first and a second capacitor respectively connected in parallel with each said discharge device to be charged from said source when the respective said one tube is non-conducting, the connection between each said device and its said one tube including a timing resistor, said second capacitor having a charging time three times as long as that of said first capacitor, means connecting the said first capacitor to the first grids of both tubes in said first relay and to the first grid of the said other tube in said second relay to apply a negative pulse to the said first grids when said first capacitor is discharged, means connecting said second capacitor to the first grid of said other tube of said second relay, means connected to apply a negative pulse to the first grid of said one tube of said second relay when the said other tube of said first relay becomes conducting, means to start and keep said multivibrator oscillator in operation when said one tube of said second relay is not conducting, and input means connected to said first grids of both tubes of said first relay.

4. In a pulse code-signaling system, receiving apparatus comprising an audio oscillator biased to non-operation in the absence of a positive signal; two locked electronic relays each including two vacuum tubes and interconnecting networks having a stable conductivity condition when either tube in a relay is conducting and the other tube in such relay is thereby held non-conducting; means respectively connected to one tube of each said relay to store energy to a predetermined potential in a predetermined time

interval while the other tube of such relay is conducting and then discharge to change the conductivity condition of the relay, the charging time of the storage means of the second relay being three times that of the storage means of the first relay; input means connected to both tubes of said first relay to apply a signal to change the conductivity conditions of said first relay, means connecting the network of said first relay to the said one tube of said second relay to change said one tube of the second relay from conducting to non-conducting condition when said other tube of said first relay conducts, means connecting the network of said second relay to said oscillator to cause said oscillator to operate while said one tube of said second relay is non-conducting, means connecting the storage means of said first relay to the said other tube of both relays to change the conductivity condition of said other tubes when said first relay storage means discharges, and means connecting the storage means of said second relay to the said other tube of said second relay to change the conductivity condition of said other tube of the second relay when said second relay storage means discharges, whereby a single pulse applied to said input causes said oscillator to operate while the storage means of said first relay charges and a double pulse causes said oscillator to operate while the storage means of said second relay charges.

5. In a pulse code-signaling system, receiving apparatus comprising two electronic relays each having two alternative current paths, each said path including elements to provide a potential drop when current flows therein, means to apply the potential drop in either path of a relay to hold the other path in the same relay non-conductive, respective means connected to one path in each said relay to change the current from the other path in each said relay to the said one path in each after a predetermined time interval of flow of current in the respective said other path, the said time interval in said second relay being noticeably longer than in the first relay, input means connected to apply to both paths in said first relay a signal to interchange the conductivity conditions of said paths, means connecting said other path in said first relay to said one path in said second relay to change the current from said one path in said second relay to the said other path in said second relay when current flows in said other path of said first relay, an audio oscillator connected to be biased to non-operation when current flows in said one path of said second relay but biased to operate while current flows in said other path in said second relay, whereby a single pulse applied to said input causes said oscillator to operate during the shorter of said time intervals and a double pulse applied to said input causes said oscillator to operate during the longer of said intervals.

6. A pulse code-signaling system, comprising two paths for electric current, a key, means controlled by said key when moved in one direction to change current from one said path to the other, means to change said current automatically back to said one path after a predetermined interval, means to produce a keying pulse at each change of current path, other means to produce a single pulse when said key is moved in the opposite direction; means to receive transmitted signal pulses corresponding to said keying pulses including two electronic relays each having two current paths, input means to interchange current between the paths of the first said relay,

a first timing means connected to the first path of said first relay to change the current automatically from the second path in both relays to the first path in both after a predetermined time interval, means connecting the second path of the first relay to the first path of the second relay to change the current from the first to the second path of the second relay, a second timing means connected to the said first path of said second relay to change the current automatically from the second to the first path of the second relay after a time interval differing in duration from the first mentioned interval, and an audio oscillator connected to operate only while the second path of the second relay is conducting, whereby a single input pulse places said first timing means in control and said oscillator operates for the duration of the first mentioned interval and a pair of pulses places said second timing means in control and said oscillator operates for the duration of said second interval.

7. A pulse code-signaling system, comprising a first and a second energy storage means, a key movable in one direction to discharge the energy from said first storage means, means to generate keying pulses, means to apply to said generating means potentials derived from the discharge of energy from said first storage means to generate a pair of pulses; means to apply to said generating means potentials derived from the discharge of said second storage means to generate a single pulse; means responsive to received signals corresponding to said pulses including an oscillator that is biased for non-operation in the absence of signal, means responsive to a pair of pulses to bias said oscillator for operation during an interval corresponding to a dash, and means responsive to a single pulse to bias said oscillator for operation during an interval corresponding to a dot.

8. A pulse code-signaling system, comprising a first and a second energy storage means, a key movable in one direction to discharge the energy from said first storage means, means to generate keying pulses, means to apply to said generating means potentials derived from the discharge of energy from said first storage means to generate a pair of pulses; means to apply to said generating means potentials derived from the discharge of said second storage means to generate a single pulse; means responsive to received signals corresponding to said pulses including an oscillator that is biased for non-operation in the absence of signal, means responsive to a pair of pulses to bias said oscillator for operation during an interval of predetermined length, and means responsive to a single pulse to bias said oscillator for operation during an interval of different predetermined length.

9. A pulse code-signaling system, comprising a key, means controlled by said key to produce a pair of keying pulses when said key is moved in one direction, means controlled by said key to produce a single keying pulse when said key is moved in the opposite direction; means to receive transmitted signal pulses corresponding to said keying pulses including an oscillator, means to bias said oscillator to non-operation in the absence of signal, means responsive to a single pulse to bias said oscillator to operate for a predetermined interval, and means responsive to a double pulse to bias said oscillator to operate for an interval of different duration.

10. A method of code communication by pulses, comprising the steps of storing two quantities of energy, discharging one said quantity to produce the first pulse of a pair of keying pulses and to initiate the storage of a third quantity of energy over a predetermined time interval, said third quantity automatically discharging at the end of said interval to produce the second pulse of said pair; discharging the other of said two quantities to produce a single keying pulse; receiving a signal corresponding to the first of the pulses of said pair and applying it to initiate an observable signal and also to initiate the storage of a fourth quantity of energy over a definite time interval and a fifth quantity of energy over a different time interval, receiving a signal corresponding to the second pulse of said pair and applying it to terminate the storage of said fourth quantity before the end of said definite time interval, said fifth quantity then automatically discharging at the end of said different definite interval and terminating said observable signal; receiving a signal corresponding to said single pulse and applying it to initiate an observable signal and to initiate the storage of said fourth and fifth quantities of energy, said fourth quantity discharging automatically at the end of said definite time interval to terminate said observable signal and the storage of said fifth quantity of energy, the discharge of one or the other of said two quantities of energy being effected in any selected order.

11. A pulse code signaling system, comprising keying means to generate selectively a single pulse or a pair of pulses, a normally inoperative audio signal generator, and timing means associated with said generator responsive to received signals corresponding to said pulses for rendering said generator operative for a predetermined period of time in response to a single pulse and for a different period of time in response to a pair of pulses.

12. In combination, a trigger circuit having a stable condition and an unstable condition and comprising a pair of vacuum tubes, a condenser connected between the grid of one tube and the anode of the other tube, a condenser shunted by a resistor connected between the anode of said last tube and the grid of said first tube, a similar trigger circuit having a stable condition and an unstable condition, a connection including a series condenser for coupling said two trigger circuits in cascade relation, and means for applying an initiating voltage pulse to the grid of one tube of said first trigger circuit of such polarity and magnitude as to change the condition of the first trigger circuit.

13. In combination, a first electron discharge device trigger circuit having only one degree of electrical stability, said trigger circuit comprising a pair of electrode structures which are interconnected so that one structure is conductive and the other non-conductive in the stable state, and vice versa in the active state, a connection for supplying an input pulse to said circuit for changing it from the stable to the active or unstable state, said circuit having an adjustable element for controlling the time of the active state, a second similar electron discharge device trigger circuit, means including a reactance and a resistor coupling said two trigger circuits together, and an adjustable element in said second trigger circuit for controlling the time of the active state of said second circuit.

14. In combination, a first electron discharge device trigger circuit having only one degree of

electrical stability, said trigger circuit comprising a pair of electrode structures which are interconnected so that one structure is conductive and the other non-conductive in the stable state, and vice versa in the active state, a connection for supplying an input pulse to said circuit for changing it from the stable to the active state, said circuit having an adjustable element for controlling the time of the unstable condition, a second similar electron discharge device trigger circuit, means including a reactance coupling said two trigger circuits together, and an adjustable element in said second trigger circuit for controlling the time of the active state of said second trigger circuit.

CLAUD E. CLEETON.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
676,936	Burke	June 25, 1901
1,616,326	Nelson	Feb. 1, 1927
1,836,574	Burton	Dec. 15, 1931
1,936,153	Burton	Nov. 21, 1933
2,061,734	Kell	Nov. 25, 1936
2,116,649	Watson	May 10, 1938
2,142,351	Fitch	Jan. 3, 1939
2,153,178	Fitch	Apr. 5, 1939
2,195,856	Fitch	Apr. 2, 1940