

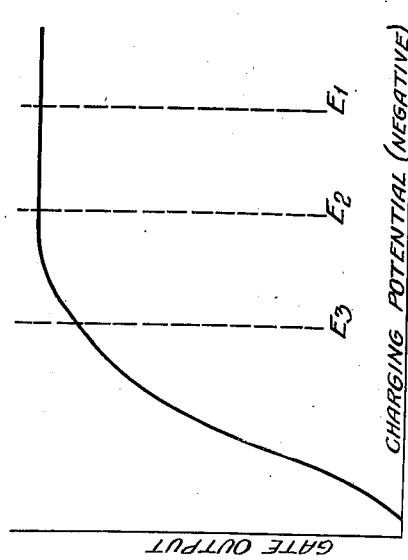
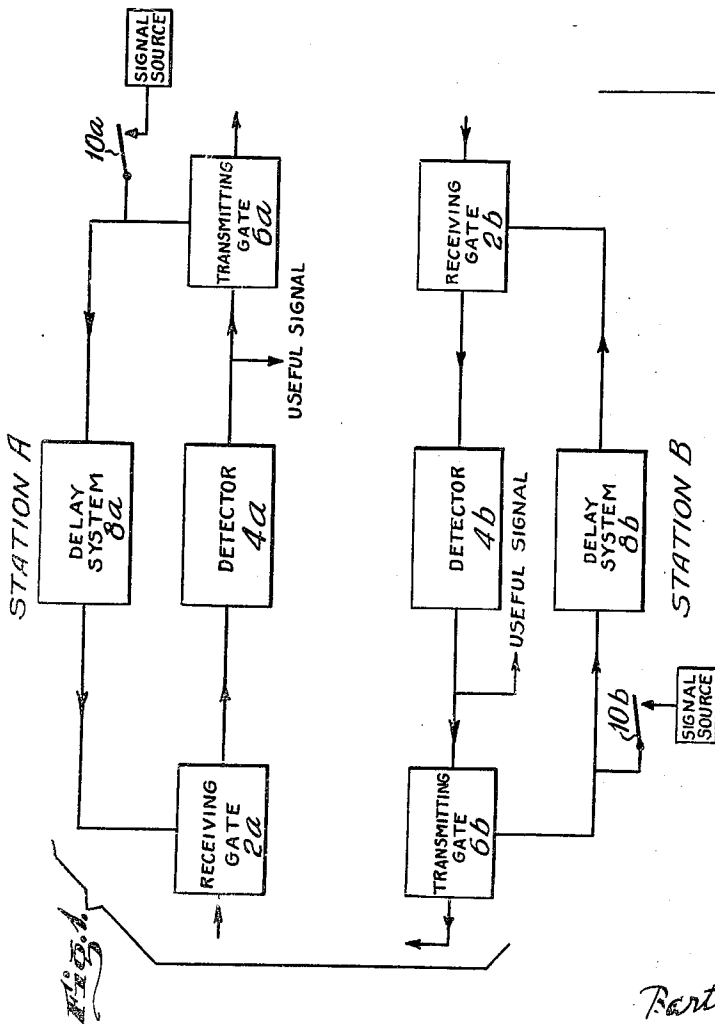
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C. E. ATKINS
SECRET SIGNALING SYSTEM

2,404,356

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2 Sheets-Sheet 1



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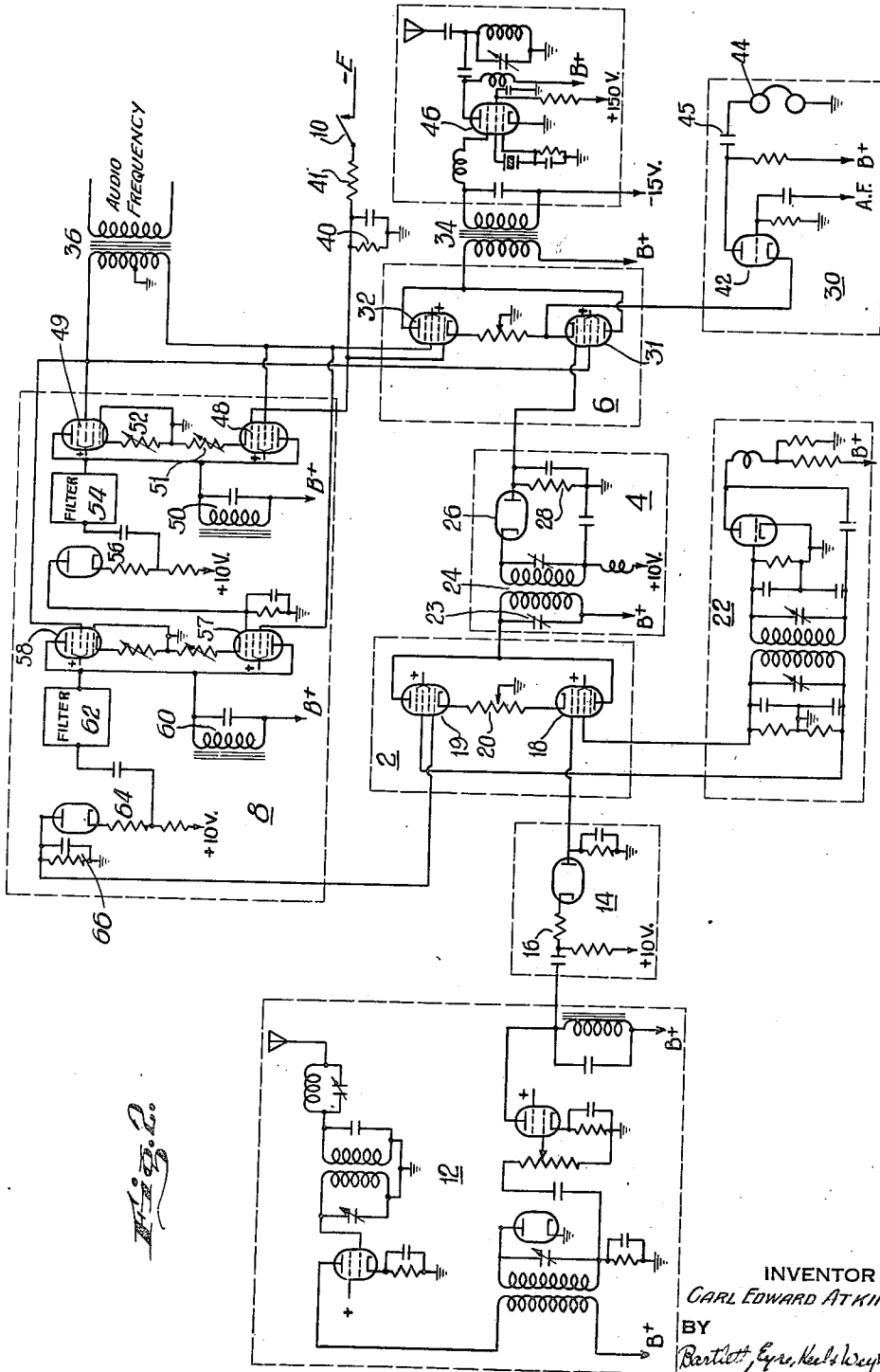
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SECRET SIGNALING SYSTEM

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10 Claims. (Cl. 179—1.5)

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My present invention relates to secret station-to-station communication systems, of the general type disclosed in my copending applications Serial No. 443,898, filed May 21, 1942, and Serial No. 504,679, filed October 2, 1943, wherein the signal originating at one station is used to scramble the signal transmitted from the other station. In the system of application Serial No. 504,679, intermodulation is effected by simultaneously keying the equipment at the two stations. A monotone of the same frequency is injected in such phase relationship that there is no change in amplitude when the keys at both stations are simultaneously depressed but only a change of phase. The present system differs from the system above briefly described and from the system of application Serial No. 443,898 in that when the keys at the two stations are simultaneously depressed no signal is transmitted from one station to the other. In the present system the signal energy from one transmitter serves to reverse the background conditions for the other. Thus during a period of silence a telegraphic symbol may be transmitted while during the subsequent period, which may be a millisecond, several seconds or even a minute, the appearance of a signal might mean that no character at all was being sent but that an alternate type of background was being used.

For an understanding of the present invention reference may be had to the accompanying drawings, of which

Fig. 1 is a simplified block diagram of equipment at two communicating stations for operation of the new system;

Fig. 2 is a circuit diagram of the complete equipment suitable for use at each station and representing the preferred embodiment of the invention; and

Fig. 3 is a graph explanatory of the relation between charging potential and gate output in the various networks of Fig. 2.

The new system and its operation will first be described by reference to the simple diagram of Fig. 1. As shown in Fig. 1, the essential equipment at station A comprises a receiving gate 2a, detector 4a, transmitting gate 6a, a delay system 8a, and a key 10a for introduction of the signal, the output from those various instrumentalities being delivered in the directions indicated by the respective arrows. Station B is provided with similar equipment, namely, receiving gate 2b, a detector 4b, a transmitting gate 6b, a delay system 8b, and a key 10b. Each "gate" has two input terminals and one output terminal. Its function is to pass a signal when activated by

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either of two sources but not when activated by both sources simultaneously. Thus when key 10a is depressed and if there is no output from the detector 4a, transmitting gate 6a will operate to pass a signal, but if the input terminals of gate 6a are simultaneously activated from the signal source by the key 10a and from the detector 4a, no signal is passed by the gate. Conversely, if key 10a is not depressed but a signal is impressed upon gate 6a from detector 4a, the gate passes the signal. The same is true of transmitting gate 6b and of receiving gates 2a and 2b. These gates are varieties of electronic switches and will be more fully described hereinafter in connection with Fig. 2. The equipment at each station will include also, of course, the necessary radio frequency apparatus for the transmission and radiation of the signal passed by the transmitting gate and for reception and demodulation of the energy radiated from the other station before delivery of the signal to the receiving gate. These elements of the system have been omitted from Fig. 1 for simplicity but are included in the circuit drawing of Fig. 2.

In operation of the system of Fig. 1, if key 10a is depressed, transmitting gate 6a is activated and a signal is sent to station B, where, after reception and demodulation, receiving gate 2b is activated and passes the signal on to detector 4b. In the output of detector 4b the signal is available as useful intelligence and is also used to actuate transmitting gate 6b which causes the signal to be returned to station A for application to one input terminal of receiving gate 2a. At the same time that the depression of key 10a started the signal on its way to station B and back to station A, it also started a similar signal, a pulse of exactly the same time duration, through the local delay system 8a. Delay system 8a, as more fully described in connection with Fig. 2, is constructed to simulate the time characteristics of the equipment at station B and of the intervening space. Thus the returning signal arrives at one of the input terminals of receiving gate 2a simultaneously with the arrival at the other input terminal of a similar signal locally retained by and delivered through the delay system 8a and hence both input terminals of the gate 2a being activated, no signal is passed to detector 4a. Similarly, when key 10b only is depressed, the signal is passed by transmitting gate 6b, radiated from station B, received at station A, passed by receiving gate 2a, detected at station A, passed by transmitting gate 6a, transmitted back to station B and blocked at receiving gate 2b by the dupli-

cate signal retained and delayed by delay system 8b. If key 10a is depressed and subsequently key 10b is depressed at the moment when the signal from key 10a first reaches the portals of transmitting gate 6b, that is after transmission from station A, reception and detection at station B, then transmitting gate 6b will not operate and nothing will be transmitted to station A. However the depression of key 10b will be detected at station A because receiving gate 2a, being activated only by the delayed signal through system 8a, will pass energy to operate detector 4a. If key 10a is still depressed, then after detection by detector 4a, transmitting gate 6a will cease to operate. No signal will be radiated to station B but receiving gate 2b will operate because of activation through delay system 8b. Thus if both keys are depressed for a substantial length of time no signal is sent from one station to the other but the fact of the depression of the key of one station is made apparent by the operation of the detector at the other station. If after both keys have been depressed and no signal is being transmitted from one station to the other, as above described, one of the keys is lifted, a signal will be sent from that station and after a suitable delay a signal will follow from the other station. If both keys are worked the keying at the two stations will be superimposed and each signal will be subjected to a more or less capricious scrambling. Thus if one key is held down for a sustained period of time, periods of depression of the other key correspond to periods of no signal transmission between stations. Thus the holding down of one key has the effect of reversal of background for the other, so far as concerns an interceptor of the transmitted radiation.

Specific apparatus functioning as above described in connection with the simple block diagram of Fig. 1 is shown in Fig. 2 to which reference may now be had. In Fig. 2 a suitable receiving mechanism 12 is shown within the dashed line enclosure as including an antenna, a wave trap tuned to the transmitting frequency of the same station and conventional radio frequency amplifier, demodulator and audio frequency amplifier circuits. The output of the receiving mechanism 12 is fed to a rectifier 14 which differs from the conventional half wave diode rectifier circuit in the inclusion of a series resistor 16. The function of resistor 16 will become apparent hereinafter. The output from rectifier 14 provides the D. C. voltage needed for activation of the receiving gate 2. As shown, gate 2 includes a pair of tubes 18 and 19 such as the 6 SA7GT. The cathodes of the tubes are connected through a resistor 20 having an adjustable center grounded tap. The inner grid of tube 18 is connected to the output circuit of rectifier 14 and the inner grid of tube 19 is connected to delay system 8. The outer grids of tubes 18 and 19 are excited by radio frequency voltages from an oscillator circuit through a tuned transformer with a center tapped arrangement. The oscillator circuit, here shown as of the Colpitts type, and the transformer are indicated by the reference number 22. The plates of tubes 18 and 19 are parallel connected to a tuned circuit comprising a variable capacity 23 connected across the primary of a radio frequency transformer 24. The tap on resistor 20 is so adjusted that when the inner grids of tubes 18 and 19 are at ground potential, substantially no energy appears in the output circuit of the gate. When a negative potential is applied to the inner grid of either tube 18 or 19, that tube is blocked,

the balance of the "gate" is upset and energy is passed. When the inner grids of both tubes are negative, both tubes are blocked and the "gate" passes no energy. The gate 2 is thus a kind of three position switch which is "off" when the inner grids of both tubes are at ground potential, can be turned "on" by a suitable negative voltage on the inner grid of either one of the tubes, and can be turned "off" again if the corresponding grid of the other tube is likewise made negative.

In the particular embodiment of the invention illustrated in Fig. 2, receiving gate 2, as heretofore indicated, is excited by radio frequency energy applied to the outer grids of tubes 18 and 19. Audio frequency energy could be employed for this purpose but radio frequency energy is preferred in order that transmitting gate 6 can be actuated by a rectifier system containing little or no time delay.

Energy passed by the transformer 24 is rectified by rectifier 26 and appears across load network 28. As previously indicated network 28 need introduce little or no time delay and its rectified potential is almost immediately applied to a grid of one tube of the transmitting gate 6. The elements 23, 24, 26 and 28 comprise the detector 4 corresponding to the units 4a and 4b of Fig. 1. As indicated in Fig. 1, the output of the detector may yield the useful signal, for example, the voltage across network 28 can be directly utilized as a signal or indicator operating means. Preferably, however, this voltage is used indirectly to operate a separate detector unit 30 as hereinafter described.

The transmitting gate 6 is substantially similar to gate 2 except that it is arranged for excitation by audio frequency rather than radio frequency energy. As shown, gate 6 includes two tubes 31 and 32 having their cathodes connected by a resistor having a variable center tapped ground connection, their anodes connected in parallel to the primary of a transformer 34 and their outer control grids connected for excitation across a center tapped secondary of transformer 36 connected to a source of audio frequency energy. The inner control grid of tube 31 is connected to the network 28 of detector 4 and the inner control grid of tube 32 is connected through a network 40 simulating the characteristics of network 28; and a resistor 41 with the key 10. The key 10, when closed applies a negative potential to the grid of tube 33 sufficient to block operation of the tube.

The detector unit 30 includes a high μ triode 42 the grid of which is excited by an audio frequency tone and the cathode of which is connected to the cathode of tube 31 of gate 6. Normally the positive potential on the cathode of tube 42, due to the space current of gate tube 31 so blocks the tube 42 that the audio frequency tone is not heard in the ear phones 44 connected to the plate of tube 42 through the blocking condenser 45. When gate tube 31 is blocked, however, by voltages appearing across network 28 of detector 5, tube 42 becomes operative and a tone is heard in the head phones 44. This corresponds to the keying action at the cooperative station when the system is operating properly.

In the particular embodiment of the invention illustrated in Fig. 2, the output of transmitting gate 6 is used to amplitude modulate a transmitter 46. Instead of amplitude modulation, phase or frequency modulation could be employed at one or both stations.

The delay system 8 which comprises a series

of gates and filters will now be described. The first gate includes a pair of tubes 48 and 49 having their anodes connected in parallel through a load impedance 50 to a source of positive potential and their cathodes connected to ground through adjustable resistors 51 and 52. The outer grids of tubes 48 and 49 are connected for excitation to the transformer 36. The inner grid of tube 48 is connected through network 40 and resistor 41 with key 10 while the inner grid of tube 49 is grounded. Thus when key 10 is up, both inner grids are at ground potential and the gate comprising tubes 48 and 49 does not pass energy, but when key 10 is depressed, tube 48 is blocked by the application of negative voltages to its cathode, the gate becomes unbalanced and a signal appears across impedance 50. This signal is fed through a delay filter 54 designed and adjusted to simulate the delay occasioned by transmission of the signal through the space from one station to the other. From the filter 54, the signal is fed through a rectifier network having time characteristics simulating those of detector 14 at the other station. Output from rectifier 56 unbalances a second gate of the delay system 8 comprising the tubes 57 and 58 causing the signal to appear across a load impedance 60 and to be fed to a second delay filter 62. Filter 62, like filter 54, is designed to simulate the delay occasioned by transmission of the signal through space from one station to the other. Finally, the output from filter 62 is applied to a rectifier 64 having time characteristics similar to rectifier 14 of the same station. The rectified potential across the network 66 in the output of rectifier 64 is applied to the inner grid of tube 19 of receiving gate 2.

When two stations are each equipped with the instrumentalities of Fig. 2 and when the various networks thereof are properly adjusted, the system will operate as previously described in connection with Fig. 1. In order to insure that the concurrent depression of the keys at the two stations causes an absence of signalling between the stations, precise timing is essential, that is the charge rates and also the discharge rates of all important time delay networks must be identical. This is due to the fact that the depression of a key while the system is quiescent calls for the charging of all the cascade networks and the concurrent and synchronous charging of similar networks in the delay system 8, while when the system is operative due to the depression of one key, the subsequent depression of the key at the other station serves to discharge all the signal channel networks while matching this action timewise with a charging procedure in the local delay system 8. This requirement explains the special form of rectifier units used in the system. The series resistors, such as resistor 16 in unit 14, retards the charging rate for the shunt condenser in the output network of the rectifier so that the same amount of time will be required for charging as for discharging. It should be noted that when the exciting input voltage of a rectifier unit disappears, the rectilinear character of the diode of the rectifier serves to isolate the output network from the rest of the system so that its discharge rate is for the most part a function of its own constants.

Since the gates are voltage operated devices, any consideration of the time delay involved in operating them must also consider the magnitude of the various negative charging potentials and therefore the absolute value to which any of the

network condensers become charged at maximum. In Fig. 3 the relation between charging potential and gate output is graphically represented. If the maximum negative charging potential for the inner grid of one of the tubes of a gate is represented by E_1 on Fig. 3, then from the graph it is apparent that the gate output will reach its maximum prior to complete charging of the gate grid and that minor variations in the charging potential will have no effect upon the gate output. On the other hand, with a maximum charging potential represented by the line E_3 , the gate output will not reach its maximum value and variations in the charging potential result in variations in gate output. In order for the system as a whole to operate as hereinbefore described, it is thus necessary to correlate the magnitudes of the resistors and condensers of the various networks and the charging potential, such as E_1 , E_2 or E_3 , so as to insure equal time delays during charging and discharging of the grids of the various gates.

The invention has now been described in connection with one specific embodiment thereof. Obviously the invention as diagrammatically illustrated in Fig. 1 could be embodied in equipment differing from that specifically illustrated in Fig. 2, and various changes in the circuits of Fig. 2 will occur to those skilled in the art. For example, although the blocking of a gate tube has been shown and described as being effected by the application of a negative voltage to the inner grid of the tube, the tube could be blocked by other means, as for example by grounding of the outer grid. Although the particular half wave rectifier circuits with their accompanying time delay element heretofore described are preferably employed in the system, full wave rectifiers involving substantial reduction in time delay could be employed if desired. Other alternatives within the spirit of the invention as defined in the appended claims will occur to those skilled in the art.

I claim:

1. A secret station-to-station signaling system comprising in combination a receiving "gate" and a transmitting gate at each station, each of said "gates" having two input terminals and each adapted to pass energy when activated at either one of said terminals and to block the passage of energy when activated at neither of the input terminals or at both simultaneously, key means at each station connected to one of said input terminals of each of said gates for activation thereof, means interposed between said key means and the terminal of said receiving gate for introducing a time delay between operation of the key means and activation of the terminal of the receiving gate, a detector connected between said receiving gate and the other input terminal of said transmitting gate, and means at each station for transmitting energy passed by the transmitting gate to the other station for actuation of the other input terminal of the receiving gate at that station whereby the detector at each station can be made to respond only to signals initiated by the key means at the distant station.

2. A station-to-station secret signaling system comprising interconnected receiving and transmitting means at each station, signal introducing means at each station, detecting means at each station interposed between said receiving and transmitting means, means at each station for creating a delayed replica of the locally in-

roduced signal, means for suppressing the transmission of a signal when the signal introducing means and the detecting means are simultaneously operated, and means jointly controlled by said means for creating a delayed replica of the local signal and by said receiving means for suppressing operation of the detecting means when the energy passed by said receiving means results from the retransmission from the other station of the signal previously introduced at the same station whereby no signal is transmitted from one station to the other during simultaneous operation of the signal introducing means at both stations.

3. The secret signaling system according to claim 2 wherein said means for suppressing the transmission of a signal when the signal introducing means and the detecting means are simultaneously operated comprises a pair of tubes each having a cathode, an anode and at least two grids, a center grounded resistor connected between said cathodes, an output circuit connected to said transmitting means and to which the anodes of said tubes are parallel connected, a source of energy connected to one grid of each tube for applying alternating voltages thereto in opposite phase, a second grid of one tube being connected to said signal introducing means and a second grid of the other tube being connected to said detecting means whereby the application of negative voltage to the second grid of one tube only resulting either from the operation of the signal introducing means or of the detecting means blocks one tube, upsets the balance of the tubes and permits passage of energy to the transmitting means, whereas simultaneous application of negative voltage to the second grids of both tubes blocks both tubes and suppresses the passage of energy to the transmitting means.

4. The secret signaling system according to claim 2 wherein each of said receiving means includes a rectifier circuit and wherein each of said means for creating a delayed replica of the signal includes a circuit simulating the time constants of the rectifier circuit at the same station, a circuit simulating the time constants of the rectifier circuit at the other station, and circuits simulating the time constants of the space intervening between the stations, each of said circuits having charging periods equal to their discharging periods.

5. In a secret station-to-station signaling system, an electronic switch having two input terminals and one output terminal and arranged to pass energy when a negative voltage is impressed on either input terminal and to be blocked when negative voltage is impressed on neither or both input terminals, a source of negative voltage, a network between said source and one of said input terminals and key means between said source and said network, said network having equal charging and discharging periods, a detecting circuit connected to said other input terminal, and transmitting means connected to the output terminal of said electronic switch for transmission of a signal when said key is operated and the detecting circuit is not energized or when said key is in open circuit position and the detecting circuit is passing energy.

6. The signaling system according to claim 2 wherein said receiving means includes a rectifier circuit comprising a diode, an input circuit connected to the cathode of said diode comprising a condenser and resistor connected in series and a resistor having one end connected to said condenser and to said first resistor and its other end connected to a source of low positive potential and an output circuit connected to the anode of said diode comprising a resistor and a condenser connected in parallel, the various resistors and condensers being so proportioned that the time rate of charging of said output network, upon application of energy to the condenser in the input circuit equals the time rate of discharge of the output network upon cessation of the application of energy to the input condenser.

7. In a secret station-to-station signaling system equipment at each station comprising receiving means, an electronic switch, a detector, a second electronic switch and transmitting means all connected in a chain in the given order, key operated means connected to both of said electronic switches, and a delay circuit interposed between said key operated means and the first mentioned switch, said first mentioned switch operating to pass energy to said detector only when activated either by said key means through said delay circuit or by said receiving means and said second mentioned switch operating to pass energy to said transmitting means only when activated either by said key means or by said detector.

8. Station equipment in a secret signaling system according to claim 7 wherein said delay circuit of one station includes networks simulating the time constants of the chain of the other station, of the intervening space between stations and of the receiving means at the same station whereby energy passed by said second switch as a result of operation of said key means, transmitted to the other station, passed through the equipment at the other station, retransmitted back to the first station and received by the receiving means at the first station arrives at said first mentioned switch simultaneously with energy passed by said delay circuit as a result of the same operation of the key means.

9. The method of secret signaling between two stations which comprises blocking the transmission of a signal between stations during such periods as keys are simultaneously depressed at both stations and during such periods detecting at one station the signal at the other station by reference to the signal at the same station.

10. The method of secret signaling between two stations which comprises passing modulating energy to a transmitter at one station for transmission to the other station upon operation of the key at the same station, detecting the modulation at the other station and passing modulating energy to the transmitter at the other station in response to such detection for retransmission to the first station, blocking detection of such modulation at the first station by energy controlled by operation of the key and delayed at the first station, while blocking transmission of modulating energy to the transmitter of a station during concurrent detection and key operation of the same station.

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