Oct. 10, 1939. R. E. MATHES 2,175,847

SECRECY SYSTEM FOR TELEGRAPHY

Filed Nov. 16, 1937 2 Sheets-Sheet 1

Fig. 1

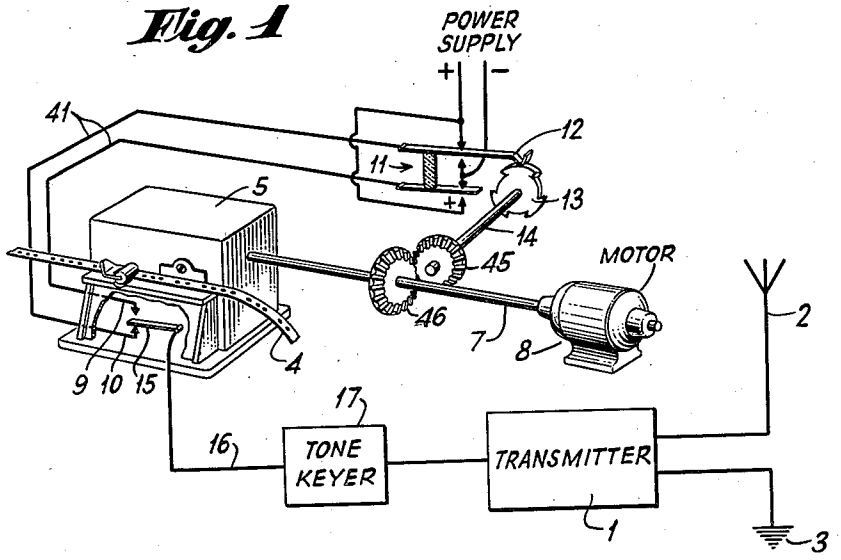
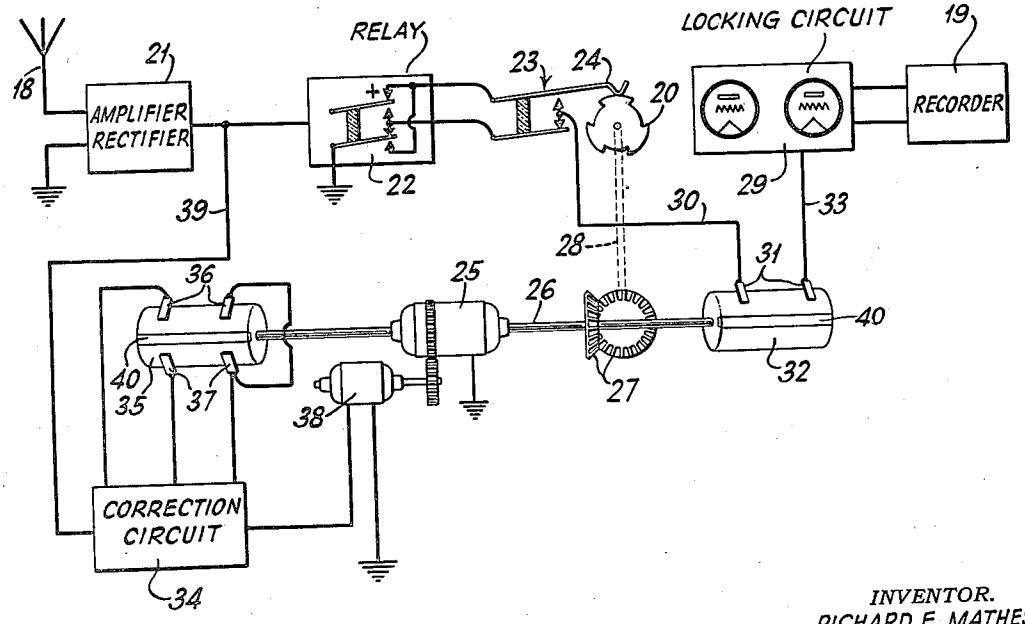


Fig. 2



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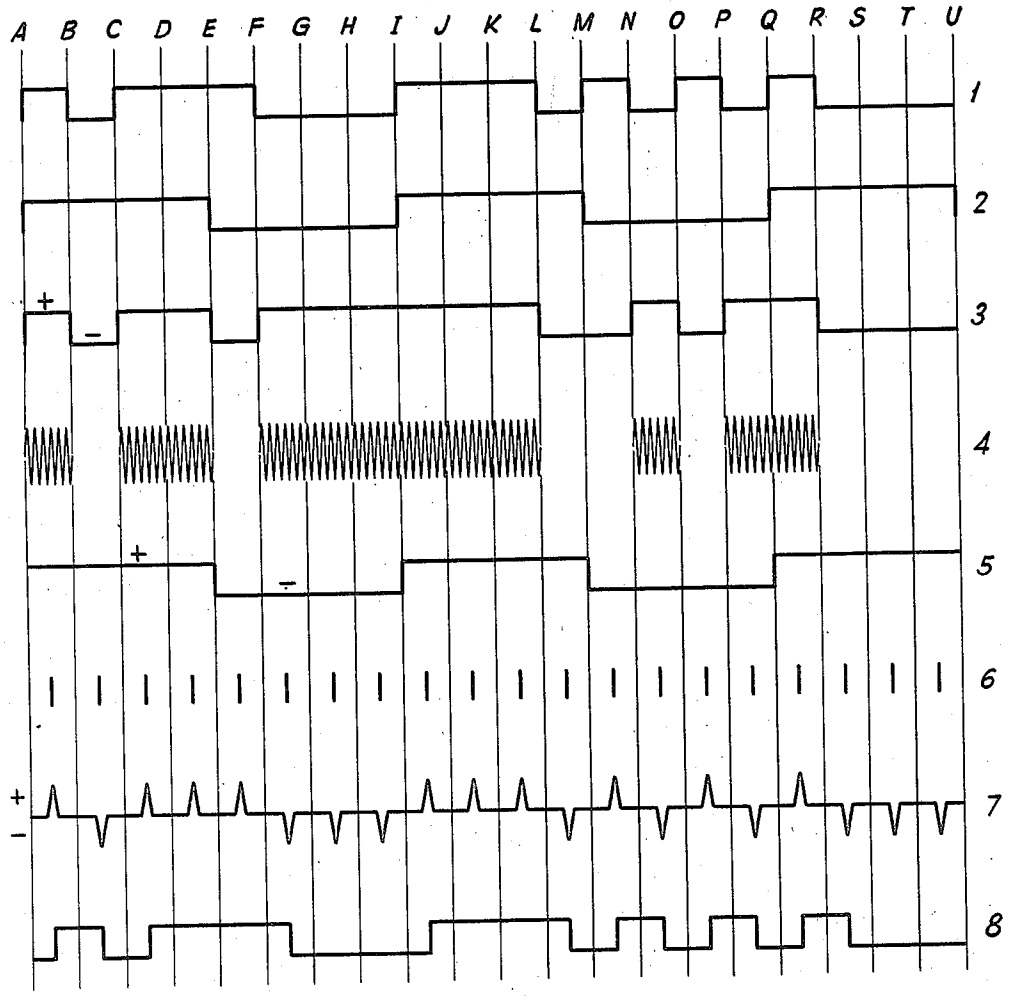
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Fig. 3



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SECRECY SYSTEM FOR TELEGRAPHY

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6 Claims. (Cl. 178—22)

This invention relates to a telegraph communication system, and has for its primary object to provide a method of and means for sending and receiving telegraph signals in secrecy. More specifically, the present invention relates to a telegraph communication system wherein there are provided rotating mechanisms at the transmitter and receiving stations, which rotating mechanisms are adapted to function in synchronism.

In brief, the present invention provides an interrupting device, such as a cam or switch, at both the transmitting and receiving stations, for reversing the sense of the signals at arbitrarily selected intervals, whereby unauthorized parties not knowing and having the means for changing the message or signal characters in accordance with the interruptions cannot receive the correct message.

In the preferred embodiment of the invention it is proposed to employ a cam at the transmitter, and another cam at the receiver, both cams functioning in synchronism. Means are also provided to correct the phase of the rotating mechanism at the receiver whenever said mechanism departs from true synchronism with the rotating mechanism at the transmitter. To overcome any possible distortion in the received signal due to slight departures from true synchronism outside of a desired tolerance limit, or due to elongation or foreshortening of the signals on account of conditions on the transmission medium between stations, the cam arrangement at the receiver is arranged to function only at the end of a baud (a unit or dot length), while the signal path in the receiver is arranged to respond to changes in sense of the signal only in the center portion of a baud.

A more detailed description follows in conjunction with the drawings, wherein Fig. 1 shows a transmitting station and Fig. 2 a receiving station, both equipped with an interrupting device in accordance with the principles of the invention. Fig. 3 illustrates graphically the manner in which the signal to be transmitted is changed by the interrupting device at the transmitter, and the signal received and changed at the receiver in opposite sense to reproduce the transmitted intelligence.

Referring to Fig. 1 in more detail, there is shown suitable radio transmitting apparatus 1 connected to an antenna 2 and a ground 3. Means are provided (not shown) for perforating the paper tape 4 according to the message to be sent. The perforation of the tape may be effected by any suitable perforator, such as the Kleinschmidt apparatus which is well known in the art. This tape is utilized to affect a relay controller such as the Wheatstone automatic tape transmitter, for actuating a circuit in accordance with the perforations in the tape. This controller, herein designated as 5, is driven by a shaft 7 which is connected to a motor 8. The power supply apparatus, which serves to supply positive and negative potentials to the contacts 9 and 10 of the tape transmitter, is arranged in circuit with a suitable double pole switch 11 which in turn responds to movement of a cam follower 12 resting on the periphery of the cam 13, in turn linked through a shaft 14 and gears 45 and 46 to the shaft 7. The output energy from the tape transmitter 5 is derived from an armature 15 adapted to contact either 9 or 10, depending upon the perforations in the tape, and passes over connection 16 to a suitable tone keyer 17 which converts the direct current signal pulses into audio frequency energy. This audio frequency energy, interrupted in accordance with direct current signals on line 16, is then passed on to a suitable transmitter 1 for transmission to the distant receiving station.

In the operation of the transmitter of Fig. 1, rotation of the cam 13 will move cam follower 12 up and down in accordance with depressions on the cam. Movement of the cam follower 12 will accordingly cause movement of the double pole switch 11, thus changing the polarities applied to contacts 9 and 10 by the power supply in accordance with the depressions in the cam 13. The circuit path from the power supply through the switch 11 and leads 41 to the contacts 9 and 10 of the automatic transmitter will be obvious from a mere inspection of the drawings. The change in sense of the polarities applied to contacts 9 and 10 by the cam 13 is arranged to occur in synchronism with the mechanism in transmitter 5 whenever it tends to move armature 15. Putting it another way, the polarity reversals produced by the cam 13 may occur, where a dot of baud or unit length is to be transmitted, only at the end of the baud; or where a dash having a length equal to a plurality of bauds is to be transmitted, the polarity reversal may occur at the end of any of the component bauds constituting the dash. The occurrence of these reversals is determined by the arrangement of the cam and may occur at the end of every baud or at multiple sequences thereof. In one embodiment constructed in practice, the cam was cut

to produce reversals at the end of every four bauds.

A better understanding of the foregoing operation of the transmitter may be had by referring to the graphical representations 1, 2, 3, and 4 of Fig. 3. In this Fig. 3, the distance between any two adjacent vertical lines represented by the letters A, B, C, D, E, F, etc., indicates the individual bauds comprising the message signal. Graph 1 represents the message signal set up on the tape 4 to be transmitted and also indicates the up and down movements of the armature 15. Graph 2 represents the changes in polarity of the contacts 9 and 10 under the influence of the cam follower 12 resting on cam 13. Graph 3 represents the message signal appearing on connection 16, as derived from the armature 15 of the automatic transmitter 5, by virtue of the cooperative action of this armature and the cam 13. It should be observed that the message signal on the tape as represented by Graph 1, has now been changed to a different message signal, as represented on Graph 3. Graph 4 represents the current transmitted from the transmitter 1. This current, it should be noted, is of alternating character and is interrupted in accordance with the marking and spacing signals appearing in Graph 3.

Fig. 2 shows the equipment at the radio receiver for converting the signals received on the antenna 18 to the original signals appearing on the tape 4 for utilization purposes by a suitable recorder 19. At this receiver, there is provided another cam 20 whose construction is identical with that of cam 13 at the transmitter. Cam 20 is designed to provide the same type of reversal in the circuit and in the same sequence as is provided by the cam 13 in the transmitter. In the operation of the receiver, the signals received over antenna 18 are amplified and rectified at 21 and then caused to operate a suitable relay 22, of the vacuum or electromagnetic type, before being passed on to the utilization circuit 19. In the output of relay 22 there is provided a double pole switch 23 which is moved in response to the movement of cam follower 24 resting on the periphery of cam 20. This cam, it should be noted, is driven by a drive motor 25 over shaft 26, gears 27, and shaft 28. The received message signals which are changed in character by the cam 20 are passed on to a locking circuit 29 over a path including a connection 30, a pair of brushes 31 on a kicker commutator 32, and another connection 33. Locking circuit 29 consists essentially of a pair of electron discharge devices (shown diagrammatically) which have their anodes and control electrodes resistively interconnected in a manner such that the apparatus has two degrees of electrical stability. These two electron discharge devices are unstable when both are drawing current but stable when one device is passing current and the other device blocked or prevented from passing current. The change from one condition of stable equilibrium to the other condition, or the reverse, is caused by the application of a suitable predetermined potential on the connection 33. Since this particular locking circuit is well known and described in my United States Patent No. 2,010,505, granted jointly to myself and J. L. Callahan August 6, 1935, and also described in my United States Patent No. 1,844,950, granted to J. L. Finch February 16, 1932, to which reference is herein made, it will not be further described herein. A suitable utilization device 19, such as a printer or ink recorder, is connected to the locking circuit 29 for visually reproducing the transmitted intelligence.

In order to synchronize the operation of cam 20 at the receiver with the operation of cam 13 at the transmitter, there is provided a correction circuit 34 which functions from the steep slopes of the received signal impulses. This correction circuit includes a kicker commutator 35 having two pairs of brushes 36 and 37 and a correction motor 38 for maintaining the drive motor 25 in synchronism with the rotation of the motor 8 at the transmitter. Correction circuit 34 utilizes a portion of the signals rectified in apparatus 21 and diverted into connection 39 for effecting correction. For a more detailed description of the operation of this correction circuit, reference is made to my United States Patent No. 2,062,009, granted November 24, 1936. The kicker commutators 32 and 35 each comprise a rotating insulating device across whose length is a suitable metal bar 40 for respectively short circuiting the pairs of brushes 31, 36, and 37. The general arrangement of these kicker commutators is more adequately described in my United States Patent No. 2,038,375, granted April 21, 1936, that also shows another synchronization system which may be employed in the present invention. Although the commutators are shown in the drawings as being of a particular type, it should be distinctly understood that these may be of any suitable form to provide a circuit closure.

To overcome any possible distortion in the received signal due to slight departures from true synchronism outside of a desired tolerance limit, or due to elongation or foreshortening of the signals on account of conditions on the transmission medium between stations, the cam arrangement 20 is designed to function only at the end of a baud or a multiple thereof, while the kicker commutator 32 is designed to short circuit the brushes 31 by means of bar 40 only in the middle of each and every baud. This arrangement is achieved mainly by the mechanical phasing between the operation of the cam 20 and the commutator 32. The operation of the cam 20 and kicker commutator 32 will be better understood by referring to Graphs 5, 6, 7, and 8 of Fig. 3. Graph 5 shows the occurrence of the reversals of signal sense caused by double pole switch 23 under the influence of cam 20. A comparison of this graph with Graph 2 will show that the reversals in signal sense at the receiver occur at the same time, in the same sequence and for the same duration as the reversals at the transmitter. Graph 6 shows, by means of short vertical lines, the time of occurrence of the kicker closure at the middle of each baud. Graph 7 illustrates the relative polarities and the times of occurrence of the short pulses on connection 33 due to the closures of commutator 32. It should be noted that the double pole switch 23 at no time functions to change its position at the same time with the closure of the brushes 31 of the kicker commutator 32. In view of the fact that the locking circuit 29 is connected through to the relay 22 only at the middle of each baud for a short interval of time, there is avoided any possibility of asynchronism between the change of the incoming signals from mark to space, and vice versa, and the functioning of double pole switch 23, from influencing the locking circuit and thus creating spurious signals in the utilization circuit 19. This possibility would exist if connection 33 were directly connected to

connection 30 without the interposition of the kicker commutator 32. Graph 8 illustrates the signal reproduced by locking circuit 29 for use by the utilization circuit 19.

In view of the foregoing, it will be obvious that the original signals appearing on tape 4 in the transmitter will appear as a meaningless combination in the transmitting medium, so that unauthorized listeners not having the exactly equivalent cam decoding apparatus will be unable to convert the received signals into the original form. It will also be apparent that the invention is not limited to the precise arrangement of parts illustrated in the drawings, since various modifications may be made without departing from the spirit and scope of the invention. For example, cams 13 and 20 may have any suitable form, and, if desired, may be replaced by another Wheatstone transmitter having a perforated tape control for changing the sense of the intelligence signals in accordance with the perforations in the tape. As a further example, the commutators 32 and 35 may comprise any suitable type of circuit closure, either mechanical or electrical; if the latter, a vacuum type of commutator would be preferred. Other modifications will immediately suggest themselves to those skilled in the art.

What is claimed is:

1. A telegraph communication system comprising a transmitting station arranged to transmit intelligence bearing signal impulses of unit and multiple unit length, said impulses being composed of alternating current oscillations, and a receiving station, both of said stations having rotating mechanisms, means at said transmitting station including a double pole switch and a cam for reversing at predetermined intervals the sense of the signals to be transmitted, said reversals in sense being arranged to occur only at the end of a unit length of signal constituting a component element of an impulse. a rectifier at said receiving station for translating the received alternating current oscillations into direct current impulses whose envelope is in accordance with the received signal impulses, means at said receiving station including a relay, a double pole switch and a cam for reversing the sense of the received signal at the same intervals, also at the end of a unit length of signal, and in the same sequence as the reversals at the transmitter, and means at said receiving station responsive to the received signal impulses for synchronizing the rotating mechanism thereat in accordance with the rotating mechanism at said transmitting station.

2. A telegraph communication system comprising a transmitting station arranged to transmit intelligence bearing signal impulses of unit and multiple unit length, said impulses being composed of alternating current oscillations, and a receiving station, both of said stations having rotating mechanisms, means at said transmitting station including a double pole switch and a cam for reversing at predetermined intervals the sense of the signals to be transmitted, said reversals in sense being arranged to occur only at the end of a unit length of signal constituting a component element of an impulse, a rectifier at said receiving station for translating the received alternating current oscillations into direct current impulses whose envelope is in accordance with the received signal impulses, means at said receiving station including a relay, a double-pole switch and a cam for reversing the sense of the received signal at the same intervals, also at the end of a unit length of signal, and in the same sequence as the reversals at the transmitter, a utilization circuit, and means for passing said received signal of reversed sense to said utilization circuit only in the middle of a unit length of signal, and means at said receiving station responsive to the received signal impulses for synchronizing the rotating mechanism thereat in accordance with the rotating mechanism at said transmitting station.

3. In a telegraph communication system employing code telegraph signals whose elements are of unit length duration and multiples of said unit length, the method of obtaining secrecy which includes the steps of changing the sense of some of the signals to be transmitted during predetermined discrete intervals, continuously transmitting and receiving the interspersed changed and unchanged portions of said signals, restoring the original sense of the changed signals as received during identically predetermined intervals, and utilizing at a point of reception only the middle portion of each unit length of said code signals.

4. In a telegraph communication system employing a code wherein a dot signal is of unit length duration and a dash signal an integral multiple of said unit length, the method of obtaining secrecy which includes the steps of reversing the sense of some of the signals to be transmitted during predetermined discrete intervals which terminate only at the end of a unit length of signal constituting a component element of said code, and restoring the sense of the received reversed signals during similar predetermined discrete intervals, whereby the received reversed signals whose original sense is restored are utilizable in the same manner as the non-reversed signals, and utilizing only the middle portion of each unit length of said signals at the point of reception.

5. In a telegraph communication system employing a code wherein a dot signal is of unit length duration and a dash signal an integral multiple of said unit length, the method of obtaining secrecy which includes the steps of reversing the sense of the signals to be transmitted during predetermined discrete intervals which terminate only at the end of a unit length of signal constituting a component element of said code, transmitting other signals without reversal during intervening intervals, synchronously restoring the original sense of the reversed signals as received, and selecting for subsequent utilization only the middle portion of each unit length of all the signals, whereby spurious signals are avoided.

6. A telegraph system comprising means for transmitting signals characterized by marking and spacing elements, the duration of each element being of unit length or a multiple of said unit length, means periodically and intermittently operative to interchange the marking and spacing elements of the signals as transmitted, the operation of said means being coincident with the termination of a predetermined unit length of said signals, a receiver having means operative in synchronism with the element-interchanging means for restoring the sense of the interchanged signal elements, and a responsive device actuated by the middle portions only of the unit lengths of said signals.

RICHARD E. MATHES.