June 4, 1946. E. W. BEMIS 2,401,454

TELETYPEWRITER SECRECY SYSTEM

Filed June 27, 1942 2 Sheets-Sheet 1

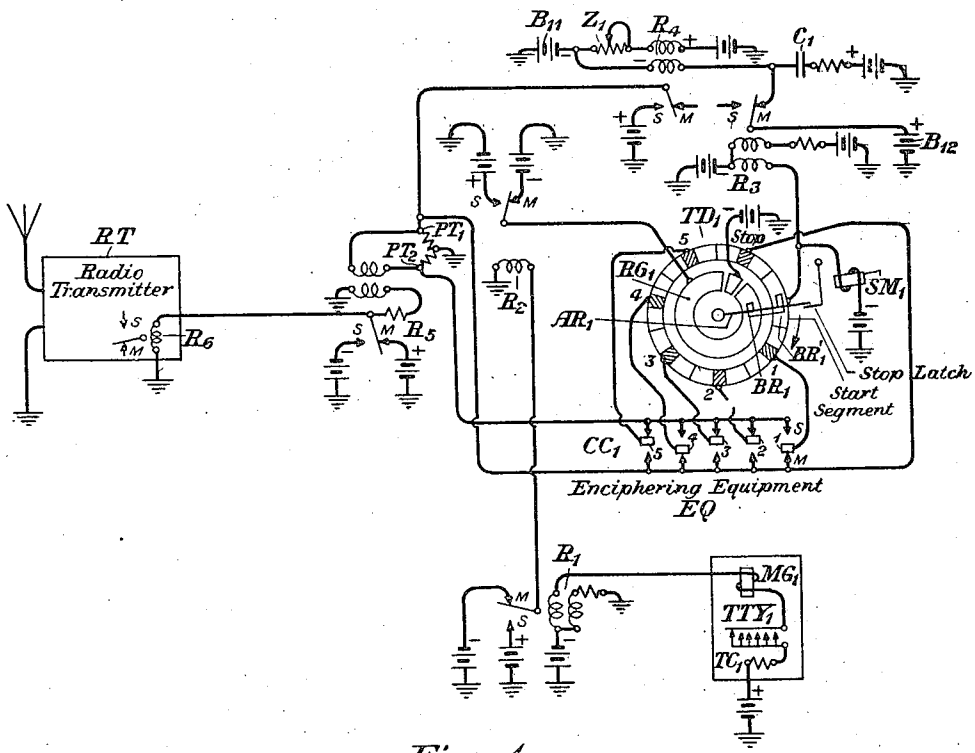


Fig. 1

INVENTOR
E. W. Bemis
BY Jefferson Ehrlich
ATTORNEY.

June 4, 1946. E. W. BEMIS 2,401,454

TELETYPEWRITER SECRECY SYSTEM

Filed June 27, 1942 2 Sheets-Sheet 2

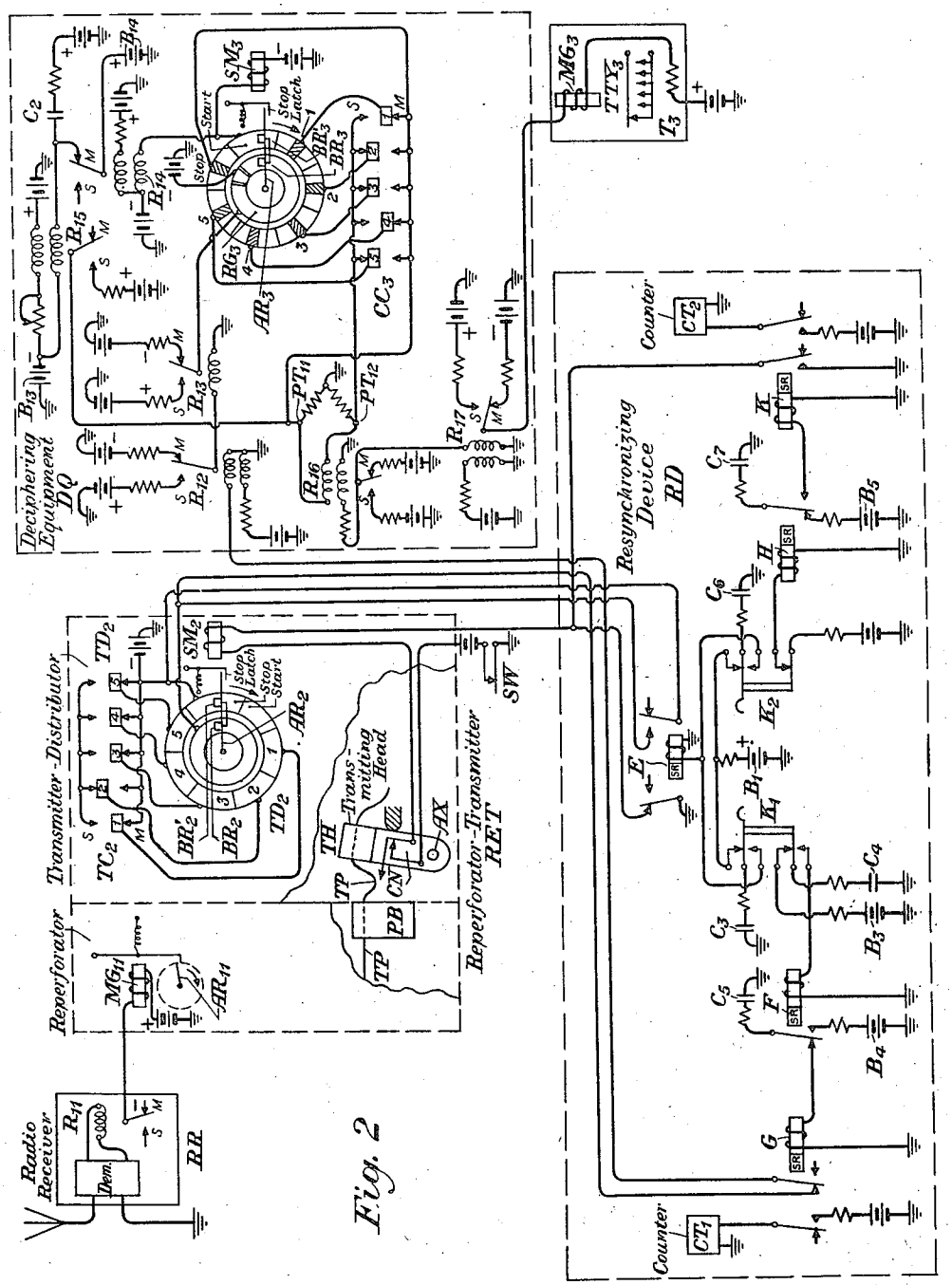


Fig. 2

INVENTOR
E. W. Bemis
BY Jefferson Ehrlich
ATTORNEY

Patented June 4, 1946 2,401,454

UNITED STATES PATENT OFFICE

2,401,454

TELETYPEWRITER SECRECY SYSTEM

Edwin Walter Bemis, East Orange, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application June 27, 1942, Serial No. 448,736

14 Claims. (Cl. 178—22)

1

This invention relates to telegraph and teletypewriter systems. More particularly, this invention relates to telegraph and teletypewriter system suitable for the secret transmission of signals.

It has heretofore been proposed to transmit telegraph or teletypewriter signals or characters secretly by converting each character to be transmitted into a different character according to a predetermined code so that the transmitted character or signal will be different from the character or signal intended to be transmitted. At the receiving station the same predetermined code will be utilized to derive from the transmitted character the original character in its true form. It is essential in such systems to maintain the coding and decoding devices, otherwise known as the enciphering and deciphering devices, respectively, in synchronism at all times in order that the characters or signals may be reproduced so as to be intelligible.

In utilizing radio or other transmission paths for the transmission of such signals it may happen at times that the transmitted signal becomes faded or otherwise suppressed, in which event the deciphering mechanism may be retarded with respect to the enciphering mechanism and thereafter the subsequent characters and signals will be rendered unintelligible. At other times extraneous voltages or static crashes or the like may be superimposed upon the transmitting medium and enter the apparatus at the receiving point, thereby causing the deciphering mechanism to step ahead of the enciphering mechanism. The reproduced signals or characters will then also be rendered unintelligible thereafter.

According to the present invention it is proposed to provide means at the receiving point to effectively restore intelligibility to the signals after the phase between the enciphering and deciphering devices has been distorted. It is also proposed to employ at the receiving point a reperforator-transmitter in addition to the deciphering equipment, whereby the received signals will be perforated in tape so that they may be stored and re-transmitter through the receiving equipment after the deciphering device has been effectively brought into synchronism with the received signals or characters.

It is a feature of this invention to employ at the receiving point apparatus for advancing or retarding the deciphering equipment step-by-step with respect to the transmitting equipment of the reperforator-transmitter. This apparatus will be used to advance or retard the deciphering

2

equipment by one or more characters until the deciphering equipment is brought into synchronism with the signals or characters being transmitted by the reperforator-transmitter. This will permit the faithful reproduction of substantially all of the characters and signals even during abnormal conditions of transmission, the reproduction being effected after synchronism is restored between the equipments.

It is a further feature of this invention to arrange the apparatus so that after the deciphering equipment is effectively brought into synchronism with the received signals or characters the perforated tape at the reperforator-transmitter may be returned to the point where the deciphering equipment fell out of step with the transmitter equipment and the signals or characters perforated in the tape then allowed to pass through the apparatus for the faithful reproduction of these characters and signals thereafter.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawings in which Figure 1 illustrates a radio transmitter apparatus including enciphering equipment, and Fig. 2 illustrates a radio receiver for reproducing the characters or signals received from the radio transmitter, the receiver including a reperforator, a transmitter-distributor and deciphering equipment, as well as apparatus for advancing or retarding the deciphering equipment to any desired extent with respect to the transmitter-distributor.

Referring to Fig. 1 of the drawings, the reference character TTY_1 designates a teletypewriter having the usual transmitting contacts TC_1 and a magnet MG_1 which controls a typing unit (not shown) for preparing local copy of signals or characters to be transmitted. Fig. 1 also shows enciphering equipment EQ including a transmitter-distributor TD_1 having enciphering contact apparatus CC_1. The enciphering equipment EQ includes a perforated tape prepared in advance (not shown), the tape having a great many characters perforated therein according to different letters and numerals. The tape may or may not be of the endless type so that the same characters in the same order may or may not be used repeatedly as desired. The radio transmitter RT will transmit through the ether a signal or character which is different from that typed by the teletypewriter TTY_1, the signal or character transmitted being dependent upon the signal or character of the enciphering equipment EQ which is "mixed" therewith. It will be shown herein-

after that in transmitting, for example, the character J from the teletypewriter TTY_1, the radio-transmitter will transmit the letter X when the enciphering equipment EQ is set for the character D.

Assuming that the teletypewriter TTY_1 is typing the character J which comprises, in addition to the usual starting and stopping pulses, the five pulses—mark, mark, space, mark and space, the starting pulse will cause the armature of relay R_1 to close its spacing contact S. The relay R_2 will in turn close its spacing contact S. Spacing or positive battery will then be connected to the starting magnet SM_1 over a circuit which includes the spacing contact S and armature of relay R_2, the inner ring RG_1 of the transmitter-distributor TD_1, the armature AR_1, brushes BR_1 and BR_1', the winding or starting magnet SM_1 and negative battery which is connected to ground. The starting magnet SM_1 will then release the brush arm AR_1 so that it will make one complete revolution. The spacing or positive battery will also be connected over a parallel circuit to the main or lower winding of relay R_3 to move its armature to its spacing contact. When this happens, current which has been flowing through the lower or main winding of relay R_4 from batteries B_{11} and B_{12} is interrupted, but the current in this winding falls to zero gradually during the interval that condenser C_1 is receiving a substantial charge of current. After the charging current has diminished sufficiently the relay R_4 will move its armature to its spacing contact S. Spacing or positive potential will thereby be applied to the point PT_1 of a balanced bridge circuit, the applied positive potential then causing a flow of current through the upper or main winding of relay R^5, whereupon the armature of relay R_5 will close its spacing contact S. Current in the lower or locking winding of relay R_5 holds the armature firmly in this position. The relay R_6 will then follow the relay R_5 to transmit the starting or spacing pulse through the antenna circuit. The modulating apparatus of the radio transmitter is not shown, as it may be of any well-known type. The resistor Z_1, included in series with the upper or bias winding of the relay R_4, is employed in a well-known manner to control the amount of delay interposed in the transmission of the starting signal to cause it to have the correct relation to the other pulses to be transmitted as described below by the radio transmitter RT.

The first marking pulse corresponding to the character J will cause relays R_1 and R_2 sequentially to close their marking contacts M. When the transmitter-distributor arm AR_1 has reached the conducting segment 1, marking or negative battery will be connected to the contact 1 of the enciphering contact apparatus CC_1 over a circuit which includes the marking contact M and armature of relay R_2, the inner ring RG_1, the brushes BR_1 and BR_1', the conducting segment 1 of transmitter-distributor TD_1 and contact 1 of the enciphering equipment EQ. The negative or marking potential will then be applied to point PT_1, which will cause the armature of relay R_5 to close its marking contact M. This will also cause relay R_6 to close its marking contact M. Thus a marking pulse will be transmitted by the radio transmitter RT to the receiving station.

The enciphering contact equipment CC_1 as shown is set for the character D in which the first and fourth pulses are marking pulses and the other three pulses spacing pulses. The marking pulse supplied by teletypewriter TTY_1, when "mixed" with the marking pulse of the contact device CC_1, resulted in a marking pulse for the radio transmitter RT.

The second pulse of the character J is also a marking pulse, as already stated, but it is observed that the contact 2 of the enciphering equipment EQ is in its spacing position, as already noted. In this case when the arm AR_1 reaches its conducting segment 2 the negative or marking battery will be connected to point PT_2 over a circuit which includes the marking battery connected to the marking contact M and armature of relay R_2, the ring RG_1, brushes BR_1 and BR_1', conducting segment 2 of transmitter-distributor TD_1, contact 2 of the enciphering contact equipment CC_1 and point PT_2. This will cause the armature of relays R_5 and R_6 to close their spacing contact S. Thus a spacing pulse will be transmitted by the radio transmitter instead of the marking pulse prepared by the teletypewriter TTY_1.

The third pulse prepared by the teletypewriter TTY_1 will be a spacing pulse, and this will "mix" with a spacing pulse at contact 3 of the enciphering contact equipment CC_1. As will be readily apparent from the description of the operation of the apparatus, a marking pulse will be transmitted as the third pulse by the radio transmitter RT. Similarly, the fourth and fifth pulses transmitted by the radio transmitter RT will also be marking pulses. Thus pulses transmitted by the radio transmitter RT will correspond to the letter X of the Baudot code. It will be understood that subsequent characters J prepared by the teletypewriter TTY_1 will ordinarily result in the transmission of still different teletypewriter characters, the characters transmitted by the radio transmitter depending upon the characters of the enciphering code with which the teletypewriter characters are "mixed."

Fig. 2 shows a radio receiver RR, together with demodulating equipment which may be of well-known type, for demodulating the received radio signals into DC telegraph signals corresponding to the transmitted signals. The received signals as demodulated will actuate the relay R_{11}, moving the armature of relay R_{11} between its marking and spacing contacts M and S in accordance with the marking and spacing pulses received. The designation MG_{11} represents the receiving magnet of the reperforator-transmitter RET which receives a starting or spacing pulse at the beginning of each received character, the starting pulse releasing the armature of the magnet MG_{11}, whereupon the rotor AR_{11} will be allowed to rotate through one complete revolution. As is well known, each rotation of the rotor AR_{11} of the reperforator will produce a set of five or less punched holes in a paper tape, the punched holes corresponding to the code of the character which was received by the radio receiver RR. This tape is, of course, suitable for use in retransmitting the received signals from a transmitter-distributor TD_2.

In accordance with one of the features of this invention the reperforator-transmitter just referred to is added to the circuit ahead of the deciphering equipment DQ. This allows the reperforator to store up incoming signals in the perforated tape during the time required for resynchronizing the deciphering equipment DQ with respect to the transmitter-distributor TD_2 as will be explained hereinafter. Without the reperforator any signals received during the proc-

ess of resynchronization might be entirely lost.

Fig. 2 shows the reperforator-transmitter RET cut away so as to illustrate the tape TP passing through a punch block PB, the punched tape then traversing the usual transmitting head TH which is rotatable about an axis AX. The transmitter-distributor TD_2 of the reperforator-transmitter RET includes the usual contact device TC having five contacts controlled by an equal number of sensing pins (not shown). These contacts will assume positions corresponding to the holes in the tape which in turn were determined by the pulses received by the reperforator from the radio receiver RR. As soon as the radio receiver RR has received the character X, the tape TP will be punched and advanced one step. The punched holes in th tape TP corresponding to this character will then enter the transmitting head TH. This will then cause the second contact of the transmitter-distributor TD_2 to be in its spacing position while the other contacts 1, 3, 4 and 5 will be in their marking positions, as shown.

The deciphering equipment DQ includes a contact device CC_3 having a series of five contacts which are positioned according to the character punched in the deciphering tape (not shown) which may or may not be of the endless type. The latter tape is identical with the tape used in the enciphering equipment referred to hereinabove in connection with Fig. 1. The five contacts of the deciphering contact equipment CC_3 are shown in positions corresponding to the character D of the deciphering code to explain the process of deciphering more clearly.

Referring to the transmitter-distributor TD_2, whenever the switch SW is closed, the starting magnet SM_2 of the transmitter-distributor TD_2 will be energized and remain energized thereafter as long as the tape TP includes punched holes corresponding to characters to be deciphered. Energization of the starting magnet SM_2 withdraws its stop-latch and releases the brush arm AR_2 in the usual manner so that the brushes BR_2 and BR_2' may sweep over the distributor rings. As the brush BR_2' moves off the stop segment and onto the "open" start segment of the outer ring of the distributor TD_2, there will be an interruption in the circuit from negative battery through the stop segment and through the brushes BR_2 and BR_2', the inner ring of TD_2, the back contact and inner armature of relay G to the upper or main winding of the relay R_{12}, whereupon the armature of relay R_{12} will close its spacing contact S. Relay R_{12} will cause relay R_{13} also to close its spacing contact S. The starting magnet SM_3 will then be energized over a circuit which includes positive battery connected to the contact S of relay R_{13}, the armature of relay R_{13}, the ring RG_3 of the deciphering equipment DQ, the brushes BR_3 and BR_3' of the deciphering equipment DQ, the winding of the starting magnet SM_3 and negative battery which is connected to ground. As the starting magnet SM_3 becomes energized, it releases its brush arm AR_3 so that it may rotate through one complete revolution.

Simultaneous with the energization of the starting magnet SM_3, the relay R_{14} will likewise be energized because its lower or main winding is connected in parallel with the winding of the starting magnet SM_3. As the armature of relay R_{14} opens its marking contact M, current which has been flowing through the lower or main winding of relay R_{15} from batteries B_{13} and B_{14} is interrupted. As in the case of relay R_4 of Fig. 1, the current through the main winding of relay R_{15} falls to zero gradually while condenser C_2 is being charged. After a short interval the armature of relay R_{15} will move to its spacing contact S. Positive battery will then be connected to the point PT_{11} of a balanced bridge circuit similar to that shown in Fig. 1. As this positive potential is applied to point PT_{11}, relay R_{16} will move its armature to its spacing contact S. A lower or locking winding of relay R_{16} holds the relay in this position until a current of opposite polarity flows in the main winding. Relay R_{16} in turn will cause relay R_{17} to close its spacing contact S. The magnet MG_3 of the receiving teletypewriter TTY_3 will then receive spacing current to start the teletypewriter printing mechanism in the usual manner.

If the tape TP is perforated according to the teletypewriter character X, as was assumed hereinabove, the first pulse will be a marking pulse and the contact No. 1 of the contact device TC_2 will be in its marking position, as shown in the drawings. In that case when the brush BR_2' is on the No. 1 segment of the transmitter-distributor TD_2, negative or marking battery will be connected to the main or upper winding of relay R_{12} over a circuit which includes contact No. 1 of the transmitter-distributor TD_2, segment 1 of the outer ring of the transmitter-distributor TD_2, brushes BR_2' and BR_2, the back contact and inner armature of relay G, the upper or main winding of relay R_{12} and ground. The armature of relay R_{12} will then move to its marking contact M, causing relay R_{13} also to move its armature to its marking contact M. During the time that brush BR_2' is on segment 1 of transmitter-distributor TD_2, the brush BR_3' of the deciphering equipment EQ will reach the conducting segment 1 of its distributor. Negative battery will then be connected to contact No. 1 of the deciphering contact equipment CC_3 and to point PT_{11} over a circuit which includes the marking contact M and armature of relay R_{13}, the inner ring RG_3 of the deciphering equipment DQ, the conducting segment 1 of the deciphering equipment DQ, contact No. 1 of contact device CC_3 and point PT_{11}. As negative battery is applied to point PT_{11}, the armature of relay R_{16} will be moved to its marking contact M. Relay R_{17} will follow relay R_{16} and move its armature also to its contact M. The magnet MG_3 of the receiving teletypewriter TTY_3 will also respond to this marking pulse in the usual manner.

The punched tape TP will register a spacing pulse for the second pulse of the received character X, as already noted. This spacing signal will cause the contact No. 2 of the distributor contact device TC_2 to be in its spacing position as shown. Inasmuch as no battery is connected to the spacing contacts of device TC_2, there will be an absence of current in the circuit to the main winding of relay R_{12} while the distributor brush BR_2' is on segment 2. This circuit to the main winding of relay R_{12} includes segment No. 2 of the outer ring of the transmitter-distributor TD_2, brushes BR_2' and BR_2, the back contact and inner armature of relay G, the main or upper winding of relay R_{12} and ground. Relays R_{12} and R_{13} will, therefore, move their armatures to their spacing contact S. When the brush BR_3' reaches conducting segment 2, spacing or positive battery will be connected to point PT_{12} over a circuit which includes the spacing contact S and armature of relay R_{13}, inner ring RG_3, brushes BR_3 and BR_3'

of the deciphering equipment DQ, conducting segment 2 of the deciphering equipment DQ, and contact No. 2 of the contact device CC_3 to point PT_{12}. As positive potential is applied to point PT_{12}, the armature of relay R_{16} will remain on its marking contact M. Relay R_{17} following relay R_{16} will also remain on its marking contact M and the marking pulse will then be received by the magnet MG_3 of the teletypewriter TTY_3. Thus the second pulse received from the transmitter-distributor TD_2 which is of a spacing character will be registered by the teletypewriter TTY_3 as a marking pulse.

Similarly the tape TP will register a marking signal for the third pulse of the received character X. This marking signal will cause negative battery to be connected to the main winding of relay R_{12}, as already explained. Relays R_{12} and R_{13} will cause their armatures to close their marking contacts M. But the third contact of the deciphering contact equipment CC_3, being in its spacing position, will connect negative battery to the point PT_{12}, causing the armature of relay R_{16} to close its spacing contact S. Relay R_{16} will, therefore, cause relay R_{17} and magnet MG_3 of the teletypewriter TTY_3 to register a spacing signal for the third pulse. Thus the received marking pulse will be translated into a spacing pulse by the deciphering equipment DQ. It will be obvious that the received fourth and fifth pulses of the character X, which are both of the marking type as perforated in the tape TP, will be converted into marking and spacing pulses, respectively, because of the positions of the fourth and fifth contacts of the deciphering contact equipment CC_3.

It will, therefore, be observed that the deciphering equipment DQ wil convert the received character X—which is different from the character J produced in the teletypewriter TTY_1 at the transmitting station into a character, namely, character J_1—which is identical with that produced at the transmitting teletypewriter TTY_1. Without the reperforator-transmitter arrangement RET, if the radio receiver RR were connected directly to the deciphering equipment DQ, the conversion to reproduce the original character would have required the synchronous operation of the contacts of the code device CC_3 of the deciphering equipment DQ with respect to the similar contacts CC_1 of the enciphering equipment EQ at the transmitting station (Fig. 1). Upon inclusion of the reperforator-transmitter RET, the conversion to reproduce the original character has required the synchronous operation of the contacts of the code device CC_3 of the deciphering equipment DQ with respect to the perforations in the tape TP as retransmitted by the reperforator-transmitter RET at the receiving station. Without this synchronization the characters reproduced by the teletypewriter TTY_3 would be unintelligible. Each character perforated in the tape TP is "mixed" with a different character set up in the contact device CC_3 of the deciphering equipment DQ to reproduce the original character.

When the signals received by the radio receiver RR include a surge or charge of electricity arising from static conditions or from some other extraneous source, the perforated tape TP may be advanced or retarded one or more steps with respect to the actual signals or characters received even though no signal or character is transmitted at the same time. In that case the transmitter-distributor TD and the deciphering equipment DQ will also be moved one or more steps ahead of or behind the signals or characters being received. The transmitter-distributor TD_2 and the deciphering equipment will then be desynchronized with respect to the actual signals received. In that case the reproduced signals recorded by teletypewriter TTY_3 will be unintelligible. The reproduced signals will also be unintelligible if the received signals are faded out or are otherwise attenuated or substantially suppressed. In that case the transmitter-distributor will also run out of phase with the actual signals received. Intelligibility may be restored for characters received in the tape TP after the disturbances above-mentioned have occurred by shifting the phase of the deciphering equipment DQ with respect to the transmitter-distributor TD_2.

In order to advance or retard the deciphering equipment DQ with respect to the perforated tape TP, the keys K_1 and K_2 of the resynchronizing device RD may be operated. It will be shown hereinafter that a single operation of key K_1 will momentarily stop the transmitter-distributor TD_2 while the deciphering equipment DQ is allowed to proceed for one character. Similarly the key K_2 may be operated once so as to hold deciphering equipment DQ inoperative while the tape TP in the transmitter-distributor TD_2 will be advanced one character. Either of these keys K_1 or K_2 may be reoperated any desired number of times to advance one of the equipments with respect to the other by any desired number of characters. Counters CT_1 and CT_2 will indicate the number of times keys K_1 and K_2, respectively, have been operated.

Condenser C_3 will be charged from battery B_1 when key K_1 is in its idle position. Likewise condenser C_4 will be charged from battery B_2 when key K_1 is in its idle position. Upon the operation of key K_1, condenser C_3 will discharge through the winding of relay E. Relay E will be operated by the discharge current for a predetermined interval of time as, for example, one-third of a second. In its operated position the left armature of relay E will open the circuit of the starting magnet SM_2 of the transmitter-distributor TD_2, thereby causing the transmitter-distributor to stop when its rotor AR_2 reaches its stop latch. The right armature of relay E will short circuit the output of the transmitter-distributor TD_2 for the time during which relay E remains operated as, for example, one-third of a second, but this short circuit is of no consequence from the standpoint of the operation of key K_1.

The operation of key K_1 also allows the previously charged condenser C_4 to discharge through the winding of the relay F, the discharge current and the slow-release time of the relay being sufficient to maintain relay F operated for a predetermined period of time, as for example, 165 milliseconds. While relay F is operated, condenser C_5 will be charged from battery B_4 through a circuit provided by the armature and front contact of relay F. When relay F releases, however, condenser C_5 will discharge into the winding of relay G, which is also of the slow-release type. The circuit of relay G is designed to operate and release in a predetermined period of time as, for example, 22 milliseconds. The operation of relay G will open the circuit between the transmitter-distributor TD_2 and the deciphering equipment DQ at the back contact of the inner armature of relay G, thereby giving a desired starting pulse of the usual duration to the deciphering equipment DQ. This starting pulse in turn permits the magnet SM_3 to become operated to cause the

rotor AR_3 of the deciphering equipment DQ to rotate through one complete revolution.

The function of relay F is to delay transmission of the above-mentioned starting pulse to the deciphering equipment DQ until the rotors AR_2 and AR_3 of the transmitter-distributor TD_2 and the deciphering equipment DQ, respectively, are brought to rest on their stop latches. The relay G times the starting pulse. The outer armature and contact of relay G control the operation of the pulse counter CT_1, the counter CT_1 registering each operation of key K_1. This pulse counter, as well as pulse counter CT_2, are of well-known types and may be returned to their starting positions in any well-known manner.

The operation of key K_2 will cause condenser C_6 to discharge through the winding of relay E, this discharge current being approximately of the same magnitude as the discharge current of condenser C_3. The discharge current will hold relay E operated, for example, about one-third of a second. As already explained, the relay E will stop the transmitter-distributor TD_2 by opening the circuit of the starting magnet SM_2 at the left contact of the relay. The right armature and make contact of relay E will short circuit the transmitter-distributor TD_2.

The lower contact of key K_2 when operated will interrupt the flow of current through the winding of relay H and this relay will release after a predetermined interval of time as, for example, 165 milliseconds. Upon the release of relay H, condenser C_7 will discharge through the winding of relay K. Relay K is designed to be operated by the discharge current for a predetermined interval of time as, for example, 22 milliseconds. The operation of relay K will connect ground through its inner armature and make contact to the starting magnet SM_2 of the transmitter-distributor TD_2, allowing the transmitter-distributor TD_2 to be restarted. But no starting pulse will be transmitted to the deciphering equipment DQ because the output of the transmitter-distributor TD_2 is short circuited by the right armature and front contact of relay E. In other words, the transmitter-distributor TD_2 will be advanced one step by the operation of key K_2, while the deciphering equipment DQ including its decoding contact device CC_3 will remain idle. The tape TP will thus be allowed to advance one character step with respect to the deciphering equipment DQ. The outer armature of relay K will control the registration by the pulse counter CT_2 of the operation of key K_2.

It will be observed that key K_1 will advance the deciphering equipment DQ by one step or character with respect to the transmitter-distributor independently of the length of time during which key K_1 remains operated. Similarly key K_2 will be used to advance the transmitter-distributor by one step or character with respect to the deciphering equipment DQ independently of the time during which key K_2 remains operated. Repeated operations of these keys will advance one equipment with respect to the other by any desired number of steps or characters independently of the time during which the keys remain depressed. The counters CT_1 and CT_2 will indicate the total number of operations of these keys as well as the difference between these operations.

Assume that an error creeps into this receiving apparatus and that thereafter the reproduced signals of the teletypewriter TTY_3 becomes unintelligible. Such unintelligibility is usually due to the deciphering equipment DQ being out of step with the characters as perforated in the tape TP. When this happens, the attendant will operate key K_1 once and observe the teletypewriter TTY_3 to determine whether unintelligibility has been restored to the reproduced signals or characters. If the unintelligibility has not been restored with one operation of key K_1, the attendant will operate key K_1 one or more additional times and again observe whether or not intelligible signals appear at the receiving teletypewriter TTY_3. If intelligibility is not restored by those operations of key K_1, the attendant will then quickly operate key K_2 the same number of times as he has previously operated key K_1, and furthermore he will operate key K_2 one or more additional times. Intelligibility may then be restored to the signals or characters at teletypewriter TTY_3. The keys K_1 and K_2 provide the attendant with a ready means for effectively shifting the decoding contact device CC_3 of the deciphering equipment DQ forward or backward with respect to the tape TP of reperforator-transmitter RET, and the number of characters shifted and the direction of the shift will be indicated by the readings of the counters CT_1 and CT_2.

As soon as the teletypewriter TTY_3 reproduces intelligible text, the tape TP and the coded tape (not shown) which controls the contact device CC_3 of the deciphering equipment DQ may both be set back the same number of characters in a well-known manner to a region of the tape where the error occurred, or even to some region beyond that point. The switch SW may then be operated to restart the apparatus for a re-run to record on the teletypewriter TTY_3 the text which was lost in the first instance. During this time, however, further characters may be received by the radio receiver RR, and these characters will be recorded by the perforated tape TP of the reperforator of Fig. 2 to be reproduced thereafter. To hasten the reproduction and recording of these additional characters it may be desirable to increase the speed of the transmitter-distributor TD_2, the deciphering equipment DQ and the teletypewriter TTY_3 at the receiving station from, for example, 60 speed operation to 75 speed operation. By so doing the time lost in the resynchronization process may be overcome in a relatively short time. Any errors that appear in the text reproduced by the teletypewriter TTY_3 will then be only those due to the receipt of voltages by the radio circuit or other transmission channel which obliterate the transmitted signals or characters, and will not be due to any absence of synchronism between the ciphering and deciphering devices.

The method of re-setting the two tapes at the receiver may be as follows: Whenever copy becomes unintelligible at teletypewriter TTY_3, the reperforator-transmitter RET may be stopped by opening switch SW, if so desired. Marks may be inscribed by pencil or otherwise on the tape TP and on the deciphering tape (not shown) at points the same number of characters back along both punched tapes after they have passed the sensing pins. In other words, the reference marks will designate points on the tapes corresponding to characters already deciphered. These characters may be those in the text prior to loss of intelligibility due to lack of synchronism. Then the key-controlled resynchronizing device RD will be manipulated as already described to restore intelligibility to the text. Then the tape TP is set back in any well-known manner to place its reference mark at its sensing pins.

The difference between the readings of counters CT_1 and CT_2 will determine the number of characters by which the deciphering tape reference mark should be shifted forward or backward from its sensing pins. The relative positions of the two tapes now are such as to provide intelligible copy of the signals or characters previously lost due to lack of synchronism.

The transmitting head TD of the transmitter-distributor TD_2 will be in the position shown in the drawings as long as there is sufficient tape TP interposed between the punch block PB and the transmitting head TH. As the tape TP becomes taut, the transmitting head TH is rotated about its axis AX in a counter-clockwise direction toward the punch block PB by the tape feed mechanism (not shown) and registers at the contacts of the transmitter-distributor TD_2 the signals conveyed by the tape perforations. The transmitting head TH will continue to rotate in a counter-clockwise direction through an increased angle until it reaches the punch block PB. Then the contacts CN on the transmitting head TH will open the circuit of the starting magnet SM_2 to stop the operation of the transmitter-distributor TD_2. This form of teletypewriter operation which involves a "creeping up the tape" transmitter is well known and need not be further described.

Although the enciphering equipment EQ at the radio transmitter of Fig. 1 and the deciphering equipment DQ at the radio receiver include contact devices CC_1 and CC_3, respectively, both of which have been described as operated or controlled by tapes (not shown), it will be understood that the contact devices CC_1 and CC_3 may be operated or controlled by other well-known apparatus which does not employ tape. For example, the contact devices CC_1 and CC_3 may be operated or controlled by a plurality of cams of different formations so as to assign different positions to the contacts of these contact devices CC_1 and CC_3 from character to character. In using tapes or cams or other apparatus for the enciphering and deciphering functions, it is essential that the tapes or cams, etc., provide a plurality of different characters arranged in a predetermined order and that these characters be arranged in the same order at both stations.

The receiving system of this invention may be used for the decipherment of ordinary telegraph signals of the Morse type, for example. Such received signals would be typed manually on a teletypewriter having a perforator (otherwise known as a keyboard perforator) and the perforated tape then inserted in the transmitter-distributor TD_2. The received signals will then be deciphered in the manner described above, the proper deciphering tape being used in the deciphering equipment DQ for the deciphering process. Any required resynchronization to restore intelligibility to the signals recorded by the teletypewriter TTY_3 would be performed by the key-controlled equipment RD.

The resynchronizing apparatus RD is described for illustrative purposes as including slow-release relays. It will be understood that other timing devices or circuits, including condensers and resistors, etc. of well-known form may be substituted therefor within the scope of this invention.

The time and other constants given hereinabove for illustrative purposes are not to be construed as limitations upon the invention. The apparatus of this invention may be caused to

operate satisfactorily with time constants of widely different magnitudes.

Although the invention has been described as applied to a secrecy system in which but one tape or equivalent device is employed for the enciphering process and an identical tape or equivalent device for the deciphering process, it will be understood that two or more such tapes or other devices may be used whenever desired. Such tapes or devices may be applied to the signals or characters simultaneously or in tandem in any well-known manner.

Although the invention has been described as applied to a radio system for transmitting teletypewriter signals between two stations, the invention is equally applicable to wire circuits, etc. It will also be understood that the apparatus has been described for the one-way transmission of teletypewriter signals merely for illustrative purposes; the circuits may be modified by those skilled in the art for the two-way transmission of signals. The signals need not be of the Baudot type but may be any form of telegraph signals well known in the art.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a teletypewriter secrecy system, the combination of means for perforating a first tape in accordance with received signals, deciphering means including a second tape perforated according to a deciphering code, said means being responsive to the perforations of both tapes to reproduce the original signals from the received signals, said means including means to advance one of the tapes with respect to the other when said tapes become de-synchronized to restore intelligibility to said signals as reproduced.

2. In a teletypewriter secrecy system for reproducing original signals from the signals received by the system, comprising means for perforating the tape in accordance with the received signals, a transmitter-distributor controlled by said perforated tape, deciphering equipment connected to said transmitter-distributor and including a tape perforated according to a predetermined deciphering code to control the deciphering equipment, a teletypewriter connected to the deciphering equipment for recording the signals reproduced thereby, and means for advancing the deciphering equipment with respect to the transmitter-distributor by any desired amount in order to synchronize the deciphering equipment with the tape perforations controlling the transmitter-distributor.

3. In a teletypewriter secrecy system, the combination of means for providing a first tape perforated according to received signals, a second tape perforated according to a deciphering code, means controlled by both tapes for mixing the signals perforated in said tapes synchronously, and key-controlled means for advancing one of the tapes with respect to the other by any predetermined amount to re-synchronize the two tapes whenever they become de-synchronized.

4. In a teletypewriter secrecy system, the combination of means for perforating a first tape in accordance with received signals, a second tape perforated in accordance with a predetermined

deciphering code, means controlled by both tapes for deriving the original signals from the received signals, said means including a key-operated device for advancing one of the tapes with respect to the other by a predetermined interval to synchronize the two tapes.

5. In a teletypewriter secrecy system, the combination of a reperforator for perforating tape in accordance with received teletypewriter signals to provide a loop of perforated tape, a transmitter-distributor controlled by said perforated tape, deciphering equipment connected to said transmitter-distributor, said deciphering equipment including a second tape perforated in accordance with a predetermined deciphering code and controlling said deciphering equipment, and key-controlled means for advancing one of the tapes with respect to the other by a predetermined number of characters when said tapes are out of step, thereby rendering the reproduced signals intelligible whenever the reproduced signals become unintelligible.

6. In a teletypewriter secrecy system in which teletypewriter characters are transmitted over a medium which may introduce extraneous voltages or the like into the transmission of said teletypewriter characters to render the reproduced characters unintelligible, comprising means for producing a first tape perforated in accordance with the received characters after transmission through said medium, a transmitter-distributor controlled by said perforated tape, deciphering equipment including a second tape perforated in accordance with a predetermined deciphering code, and means for synchronizing the two tapes comprising a key-controlled device for advancing one of the tapes with respect to the other by a predetermined number of characters.

7. In a telegraph secrecy system, the combination of means for converting intelligible signals into unintelligible signals for transmission to a distant point, said means including a device having a code of enciphering signals to be mixed with said intelligible signals to render said intelligible signals unintelligible, means for reconverting said unintelligible signals into their original intelligible form, said latter means including a device having a code of deciphering signals which is identical with the code of enciphering signals, and key-controlled means for changing the phase of the deciphering signals with respect to the enciphering signals by any desired amount.

8. In a teletypewriter secrecy system, the combination of means for converting teletypewriter characters into other teletypewriter characters for transmission to a distant point in unintelligible message form, said converting means including means for enciphering said characters with a predetermined code of teletypewriter characters, means for reconverting said transmitted teletypewriter characters into their original intelligible form, said latter means including means for deciphering said characters according to a predetermined code which is identical with said enciphering code, and means for advancing the deciphering code with respect to the received characters by any desired amount.

9. A teletypewriter secrecy system comprising a perforator for perforating tape in accordance with received signals, a transmitter-distributor controlled by said perforated tape, a loop of said perforated tape being provided between said perforator and said transmitter-distributor, deciphering equipment connected to said transmitter-distributor, said deciphering equipment having a tape perforated according to a predetermined code which is intended to be stepped synchronously with respect to the first-mentioned perforated tape, extraneous effects being introduced into the perforator to de-synchronize said tapes, and means for changing the relative positions of said tapes for restoring synchronism between said tapes.

10. A teletypewriter secrecy system comprising a perforator for perforating tape in accordance with received signals, a transmitter-distributor controlled by said perforated tape, a loop of said perforated tape being provided between said perforator and said transmitter-distributor, deciphering equipment connected to said transmitter-distributor, said deciphering equipment having a tape perforated according to a predetermined code which is intended to be stepped synchronously with respect to the first-mentioned perforated tape, extraneous effects being introduced into the perforator to de-synchronize said tapes, and means for restoring synchronism between said tapes, said latter means including means to start said transmitter-distributor one or more times while maintaining said deciphering equipment stationary.

11. A teletypewriter secrecy system comprising a perforator for perforating tape in accordance with received signals, a transmitter-distributor controlled by said perforated tape, a loop of said perforated tape being provided between said perforator and said transmitter-distributor, deciphering equipment connected to said transmitter-distributor, said deciphering equipment having a tape perforated according to a predetermined code which is intended to be stepped synchronously with respect to the first-mentioned perforated tape, extraneous effects being introduced into the perforator to de-synchronize said tapes, and means for restoring synchronism between said tapes, said latter means including means to start said deciphering equipment one or more times while maintaining said transmitter-distributor stationary.

12. A teletypewriter secrecy system comprising a perforator for perforating tape in accordance with received signals, a transmitter-distributor controlled by said perforated tape, a loop of said perforated tape being provided between said perforator and said transmitter-distributor for storing the received signals, deciphering equipment connected to said transmitter-distributor, said deciphering equipment having a tape perforated according to a predetermined code which is intended to be stepped synchronously with respect to the first-mentioned perforated tape, extraneous effects being introduced into the perforator to desynchronize said tapes, and means for restoring synchronism between said tapes, said latter means including means to step the transmitter-distributor ahead or behind the deciphering equipment by one or more steps, and means for indicating the number of steps by which the transmitter-distributor leads or lags behind the deciphering equipment.

13. In a teletypewriter secrecy system, the combination of a first device having a plurality of contacts controlled by received teletypewriter characters, a second device having a plurality of contacts controlled according to a deciphering code, said contact devices being operated step-by-step in synchronism, said devices becoming desynchronized during abnormal conditions of reception of said teletypewriter characters so that the deciphered characters become unintelligible,

and key-controlled means to change the relative positions of said contact devices to re-synchronize said devices to restore intelligibility to said deciphered characters.

14. In a telegraph secrecy system, the combination of means for converting intelligible telegraph signals into unintelligible telegraph signals for transmission to a distant point, said converting means including a device for enciphering said intelligible telegraph signals according to a predetermined code, means for reconverting said received telegraph signals into intelligible telegraph signals, said reconverting means including a device for deciphering said

received telegraph signals according to a predetermined code identical with the code employed for enciphering the telegraph signals before transmission, extraneous effects being introduced into said reconverting means to de-synchronize the received telegraph signals with respect to the re-converting means, and key-controlled means to change the relative position of the received telegraph signals with respect to the deciphering device of said reconverting means to restore synchronism between the received telegraph signals and the re-converting means.

EDWIN WALTER BEMIS.