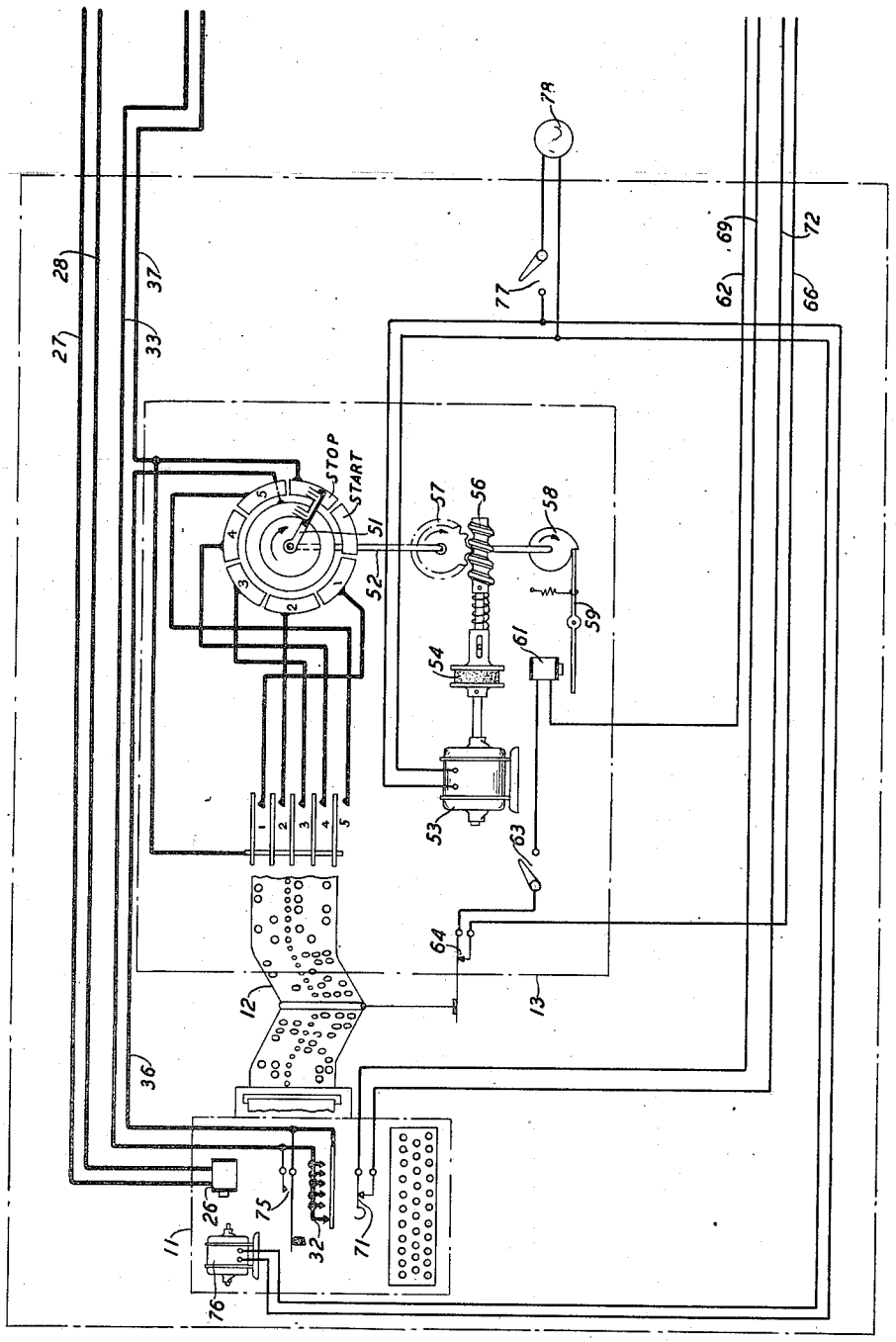
Aug. 13, 1946. K. E. FITCH ET AL 2,405,571

CRYPTOGRAPHIC TELEGRAPH SYSTEM

Filed Feb. 29, 1944 4 Sheets-Sheet 1

FIG. 1



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CRYPTOGRAPHIC TELEGRAPH SYSTEM

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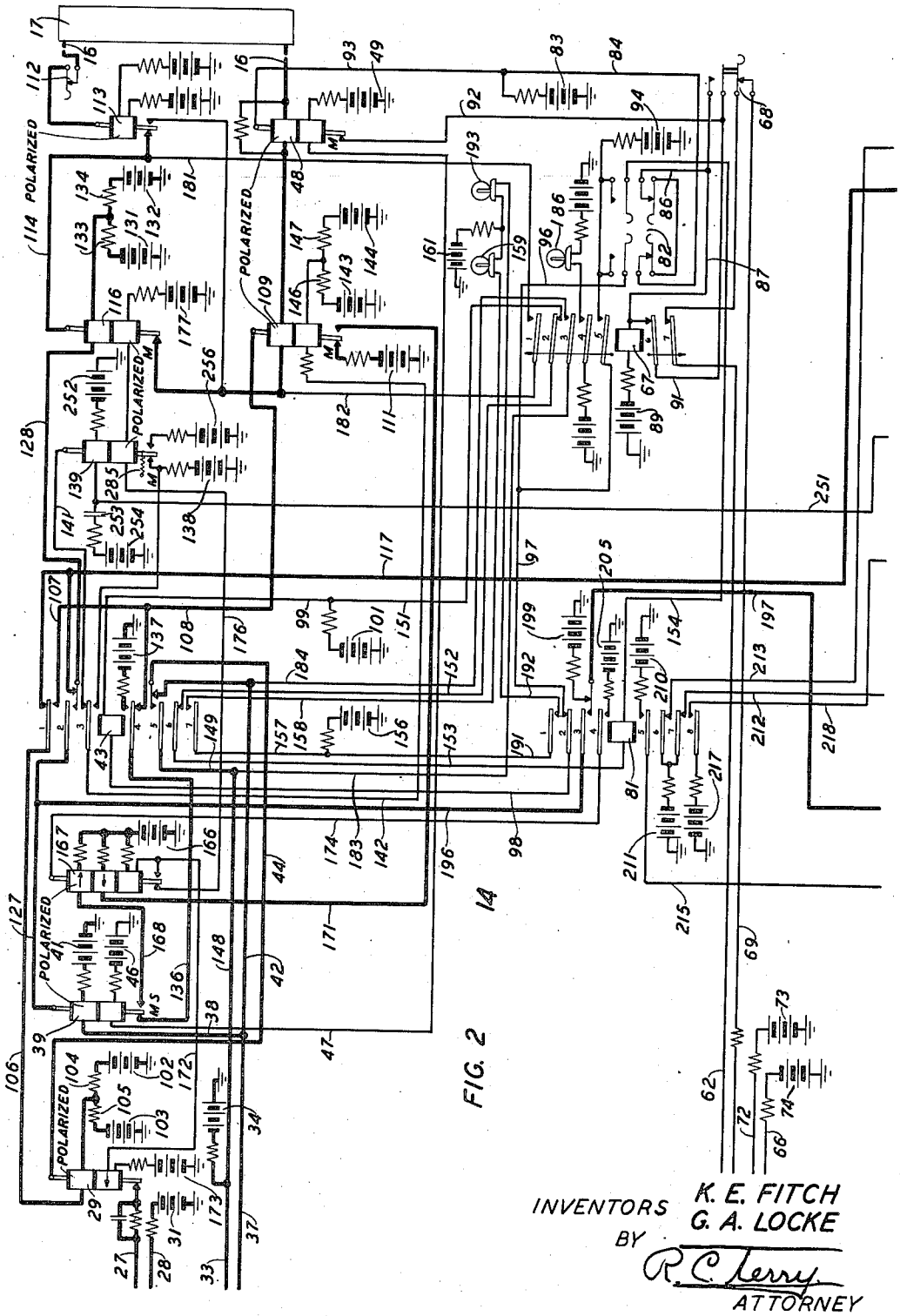


FIG. 2

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CRYPTOGRAPHIC TELEGRAPH SYSTEM

Filed Feb. 29, 1944 4 Sheets-Sheet 3

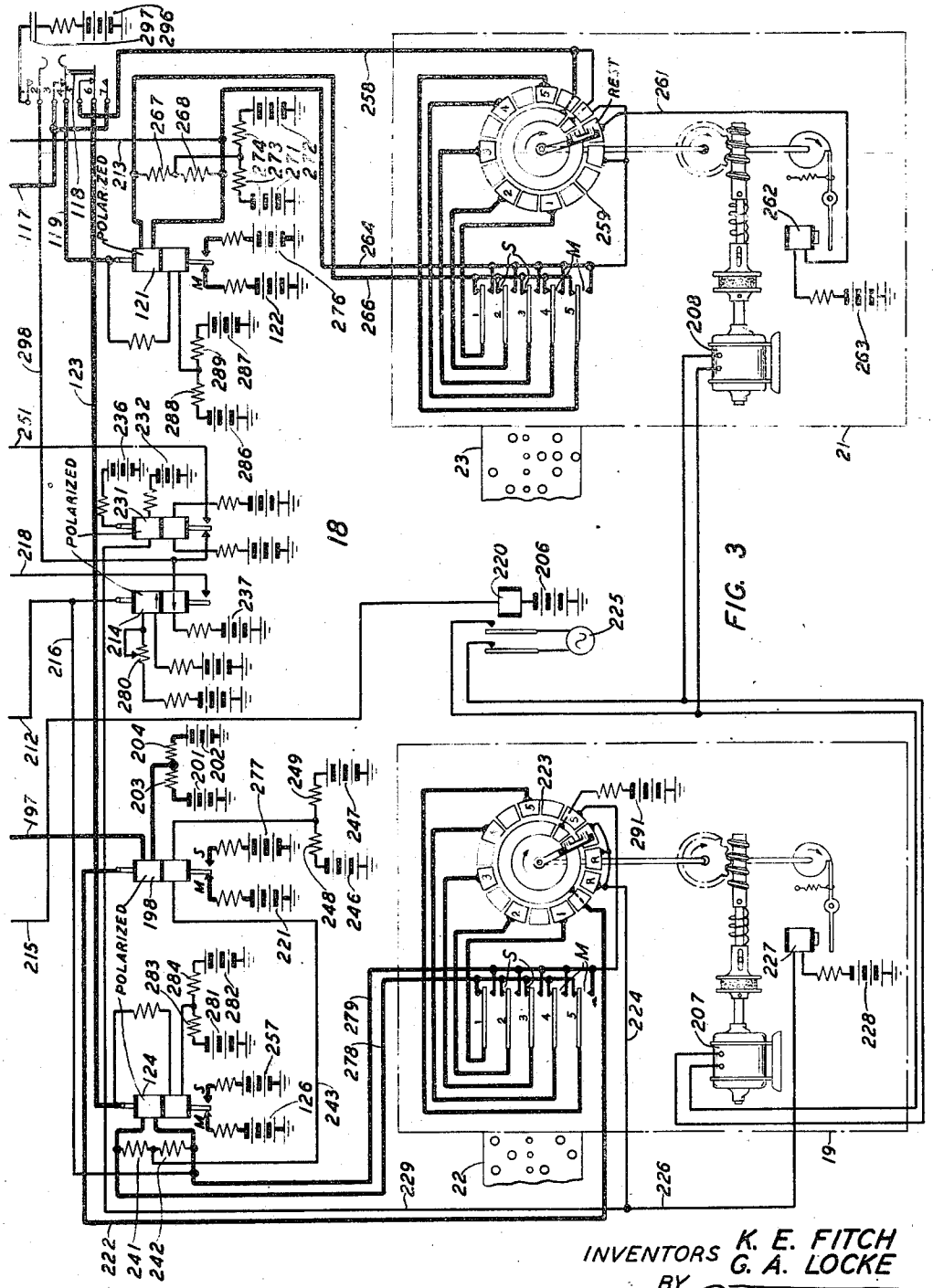


FIG. 3

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CRYPTOGRAPHIC TELEGRAPH SYSTEM

Filed Feb. 29, 1944 4 Sheets-Sheet 4

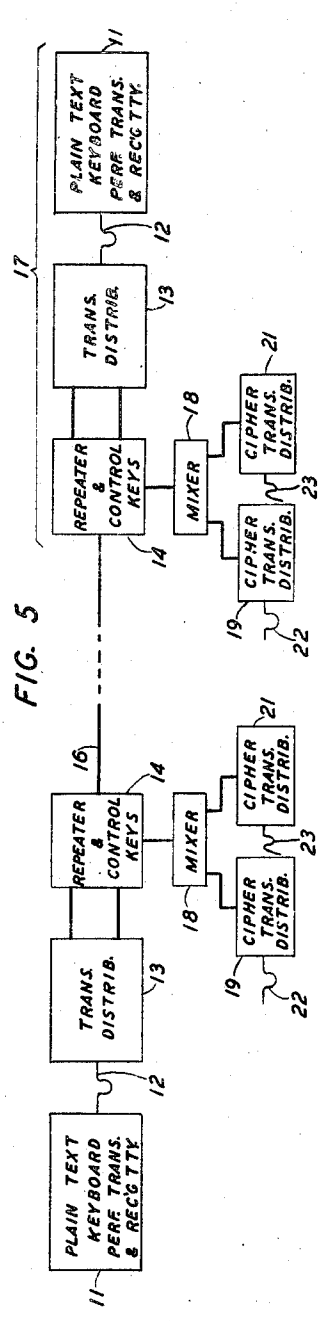


FIG. 5

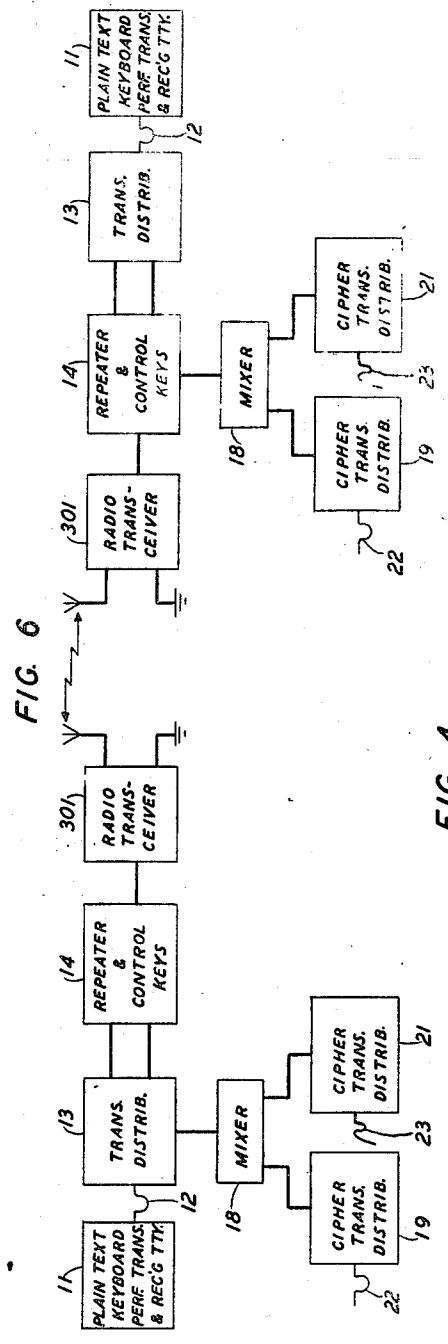


FIG. 6

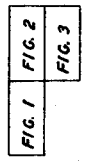


FIG. 4

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Patented Aug. 13, 1946 2,405,571

UNITED STATES PATENT OFFICE

2,405,571

CRYPTOGRAPHIC TELEGRAPH SYSTEM

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Application February 29, 1944, Serial No. 524,452

19 Claims. (Cl. 178—22)

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This invention relates to telegraph systems and apparatus, and particularly to cryptographic systems.

An object of the invention is to cipher and decipher telegraph signaling combinations, code element by code element, by multiple ciphering and deciphering operations.

Another object of the invention is to provide a convertible ciphering and deciphering system wherein single or multiple ciphering and deciphering are optionally available.

Another object of the invention is to provide an improved form of automatically reversible repeater for associating the ciphering apparatus with the signaling channel in accordance with the direction of transmission.

The invention features ciphering and deciphering mechanism including two storage-type signal transmitters each having a random sequence of key or cipher codes in storage, one or both of which may be operated in accordance with the adjustment of a switch to provide single or multiple ciphering.

The invention also features ciphering and deciphering apparatus having two storage-type key or cipher signal generators which are operable in synchronism with plain text signals to be ciphered or in synchronism with ciphered signals to be deciphered, in such manner that each impulse of the text or ciphered signal is caused to interact with an impulse produced by one of the storage-type signal generators to produce a resultant impulse which in turn is caused to interact with an impulse produced by the other storage-type signal generator to produce a further resultant impulse which is the ciphered impulse in the case of ciphering plain text signals or is the plain text impulse in the case of deciphering signals received in cipher.

In the preferred embodiment of the invention, a telegraph station is provided with a telegraph signal transmitter and a receiver printer separately connected to a repeater. Also connected to the repeater is a ciphering or mixing relay unit and a telegraph line. The repeater is provided with a manually operable key for establishing either of two operative conditions of the repeater. With the switching key in one condition the repeater is arranged to repeat signals generated by the transmitter directly to the line, and to repeat signals received over the line directly to the receiving printer. The mixing relay unit is bypassed and is held inoperative, and this is the plain text transmitting and receiving condition. In the other condition of the switching key signals

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generated by the transmitter are recorded by the receiving printer directly under the control of the transmitter for home record purposes and are also repeated to the mixing relay unit and are there ciphered. The ciphered signals are then repeated to the line. When ciphered signals are received over the line, the repeater detects the reversal of the direction of transmission and executes a reversal of relationship with respect to the line, the mixing relay unit and the receiving printer, in accordance with which the received signals are repeated to the mixing relay unit, in which they are deciphered to derive the plain text signals, and these signals are repeated to the receiving printer.

The mixing relay unit has associated with it two storage-type signal generators or transmitters which may be tape transmitters. Each storage-type signal generator has in storage a random sequence of key codes, the sequence being different for each of the two signal generators. As each signaling impulse enters the mixing relay unit from the repeater by operating a relay according to the characteristics of the impulse, one of the cipher signal generators generates an impulse and a second relay is operated under the joint control of the first relay and the first cipher signal generator. The second relay controls a third relay jointly with the other cipher signal generator as it generates a ciphering impulse. The operative condition of the third relay represents the resultant impulse which has been ciphered or deciphered in multiple, and this impulse reenters the repeater and is repeated to the line or to the receiving printer, depending on the origin of the impulse which entered the cipher or mixing relay unit.

The mixing relay unit is provided with a manually operable key for establishing either of the two operative conditions. When the key is in one condition the operation of the mixing relay unit is as outlined in the preceding paragraph, both of the cipher signal generators contributing to the ciphering or deciphering of each impulse. When the key is adjusted to its other condition it disables one of the cipher signal generators, leaving only one operative. Under these circumstances the signals to be ciphered or deciphered are repeated into the mixing relay unit to operate a first relay which jointly with the operative one of the cipher signal generators controls a second relay. The condition of the second relay as thus controlled represents a singly ciphered or deciphered impulse which reenters the repeater and is repeated to the line or to the receiving

printer in accordance with the direction of transmission.

Any two or more stations equipped as outlined above may be associated with a channel for intercommunication either in plain text or in single or multiple cipher. The two ciphering tapes at each station must have identical sequences of key codes and these must be kept in synchronism so that like key codes control the cipher signal generators for the ciphering and deciphering of any transmitted and received signal code. The operation of the system is start-stop, so that the key code sequences are kept in step automatically. During message transmission all participating stations must be operated alike in the matter of single or multiple ciphering. This may be specified or agreed upon, as well as the starting point in one or both of the key code sequences, by intercommunication in plain text form prior to beginning cipher communication.

For a complete understanding of the invention reference may be had to the following detailed description, to be interpreted in the light of the accompanying drawings wherein:

Fig. 1 is a schematic representation of plain text transmitting and receiving apparatus at a telegraph station;

Fig. 2 is a schematic representation of a reversible repeater according to the present invention;

Fig. 3 is a schematic representation of a mixing relay unit combined with multiple cipher signal generators according to the present invention;

Fig. 4 is a diagrammatic view showing how Figs. 1, 2 and 3 are to be arranged to exemplify a complete cryptographic telegraph system;

Fig. 5 is a diagrammatic view in block form showing the relationship among the principal elements of a complete wire telegraph cipher system; and

Fig. 6 is a diagrammatic view in block form showing the relationship among the principal elements of a complete cipher system when adapted to radio transmission.

Referring first to Fig. 5 the reference numeral 11 represents a teletypewriter set which may comprise a receiving printer, a keyboard operated tape perforator, and a keyboard operated transmitter. A set which combines these units is disclosed in Patent 1,965,572, granted July 10, 1934, to C. W. Burcky et al. The receiving printer unit which is contemplated in the Burckey et al. patent is disclosed in full detail in Patent 1,904,164, granted April 18, 1933, to S. Morton et al. Under some circumstances it may be desirable to use a teletypewriter set comprising only a receiving printer and a keyboard transmitter and to employ a separate keyboard perforator. In that event the transmitting and receiving teletypewriter set may be of the type shown in the Morton et al. patent and the keyboard perforator may be of the type shown in Patent 1,182,179, granted May 9, 1916, to C. L. Krum et al. The disclosures of the aforementioned patents are incorporated herein by reference as part of the present specification.

The perforator associated with teletypewriter set 11 delivers perforated tape 12 which feeds through and controls a tape transmitter distributor 13. This transmitter may be of the type shown in Patent 2,055,567, granted September 29, 1936, to E. F. Watson, and the disclosure of this patent is incorporated herein by reference as part of the present specification.

The tape transmitter 13 and the keyboard transmitter and receiving printer included in teletypewriter set 11 are connected to a reversing repeater 14 which is an improvement on the reversing repeater shown in the patent concurrently granted on copending application, Serial No. 435,178, filed March 18, 1942, by K. E. Fitch et al. The relation of the repeater 14 to tape transmitter 13 and to the teletypewriter set 11 is that the repeater is arranged to receive plain text signals from either of the transmitters and to repeat plain text signals into the receiving printer. A communication line 16 extends from repeater 14 to a remote station 17 which may have equipment identical with that at the station here being described.

A mixing relay unit 18 is connected to the repeater 14 and has associated with it two cipher code transmitter distributors 19 and 21. Each of the cipher code transmitter distributors is provided with a supply of perforated tape 22 and 23, respectively, having a random sequence of ciphering codes perforated in it for controlling the generation of ciphering codes. The mixing relay unit 18 is arranged to receive signals from repeater 14, plain text signals when the repeater is repeating signals from tape transmitter distributor 13 or the keyboard transmitter contained in set 11, and ciphered signals when the repeater is receiving such signals from line 16. In cooperation with cipher signal generators 19 and 21 the mixing relay unit ciphers or deciphers the signals which it receives from repeater 14 and returns the resultant signals to the repeater where they are repeated to line 16 or the receiving printer in set 11, in the case of performance of ciphering or deciphering operations respectively.

Referring now to Fig. 1 the reference numeral 26 designates a selector magnet which may be interpreted as representing the receiving printer of teletypewriter set 11. Its terminals are connected to conductors 27 and 28 which extend into repeater 14 shown in Fig. 2 where they are connected respectively to the marking contact of a biased polar relay 29 and to the positive terminal of battery 31 which has its negative terminal grounded. The keyboard transmitter, represented by transmitting contacts 32 in Fig. 1, has one terminal connected to conductor 33 which extends into Fig. 2 and is connected to the negative terminal of battery 34 which has its positive terminal grounded. The other terminal of transmitter 32 is connected to the continuous or collector ring of tape transmitter 12 by conductor 36. The stop segment and the five transfer contact tongues of transmitter distributor 13 are connected to conductor 37 which extends into Fig. 2 and is connected through conductor 38 and the operating winding of biased polar relay 39 to the positive terminal of battery 41 which has its negative terminal grounded, and are also connected through conductor 42 to the fixed contact engageable by the movable front contact of armature 5 of a relay 43. The front contact is connected by conductor 44 to the armature of relay 29.

The conductive paths thus far traced comprise a pair of parallel circuits beginning at the negative terminal of battery 34 and extending through conductor 33, transmitting contacts 32, conductor 36, continuous ring, interconnected brushes and stop segment of transmitter distributor 13, conductor 37, and then paralleling through conductor 38, winding of relay 39, to positive battery 41 and through conductor 42, fixed and front con-

tacts of armature 5 of relay 43, conductor 44, armature and marking contact of relay 29, conductor 27, winding of selector magnet 26 in teletypewriter set 11 and conductor 28 to positive battery 31. The selector magnet 26 and the operating winding of relay 39 are held energized, which is the marking condition. Upon the interruption of the common portion of these parallel paths, either at the transmitting contacts 32 or at the segments of transmitter distributor 13, selector magnet 26 and the operating winding of relay 39 will be deenergized. Thus the selector magnet 26 follows signals generated by keyboard transmitter 32 or tape transmitter 13 to produce a home record, and relay 39 which has negative battery 46 connected to one of the terminals of its biasing winding and positive battery on its other terminal through conductor 47 and the biasing winding of biased polar relay 48 to positive battery 49, also follows signals generated by either of the transmitters for the purpose of repeating such signals. It will be apparent that the circuit of selector magnet 26 is interruptable not only by transmitting contacts 32 and tape transmitter distributor 13 but also by the armature of relay 29, so that relay 29 serves to repeat signals to the printer in teletypewriter set 11.

Brush arm 51 of tape transmitter distributor 11 is carried by a shaft 52 which is driven by motor 53 through friction clutch 54 and gears 56 and 57. A stop cam 58 is secured to shaft 52 and is held against rotation, to hold the brushes on the stop segment, by stop lever 59 when stop magnet 61, for which lever 59 serves as armature, is deenergized. One terminal of magnet 61 is connected to conductor 62 which extends into Fig. 2. The other terminal of magnet 61 is connected to one terminal of a manually operable switch 63. The other terminal of switch 63 is connected to one terminal of taut tape switch 64, the other terminal of which is connected to conductor 66 extending into Fig. 2.

Conductor 62 is connected in Fig. 2 to armature 7 of a normally energized break detecting relay 67, the front contact of which is connected through the normally closed contacts of a break release key 68 to conductor 69 which extends into Fig. 1. In Fig. 1 conductor 69 is connected to one contact spring of a key 71, the other spring of which is connected by conductor 72 extending into Fig. 2 to the positive terminal of battery 73 which has its negative terminal grounded. Key 71 is a manually controllable key, and as disclosed in the Burcky et al. patent is closed when the keyboard mechanism of teletypewriter set 11 is being operated to perforate tape. If signals are to be transmitted from contacts 32 while tape is being perforated, manually operable contacts 75 which are closable to shunt contacts 32 are left open and switch 63 should be left open to prevent operation of transmitter distributor 13. Perforation of tape without transmission of signals from the tape and without transmission from contacts 32 may be accomplished by leaving switch 63 open and closing key 75. With switch 63 closed, key 71 closed, break relay 67 energized and the break release key 68 normal, the circuit of stop magnet 61 of tape transmitter 13 will be energized and stop cam 58 will be released for rotation. The circuit of magnet 61 is completed through conductor 66 to the negative terminal of battery 74 in Fig. 2. The terminals of motor 53 of tape transmitter distributor 13 and of motor 76 of teletypewriter set 11 are connectable through a manually operable switch 77 to source of power 78.

The armature of relay 39 (Fig. 2) which receives signals from keyboard transmitter 32 of teletypewriter set 11 or tape transmitter distributor 13 and repeats such signals onwardly, is connected to the armature 2 of relay 43 and to armature 3 of a relay 81. These relays control plain text or cipher operation, respectively, and are alternatively energizable under the control of a manually operable key 82 the controlling element of which is movable rightwardly or leftwardly from a central or neutral position. Neither the armature 2 of relay 43 nor the armature 3 of relay 81 has a back contact so that with the relays 43 and 81 released the conductive paths from the armature of relay 39 terminate at these armatures and the operation of relay 39 under the control of keyboard transmitter 32 or tape transmitter distributor 13 will not affect any other part of the repeater.

Key 82 when in its central or neutral condition provides for local testing or practice operation of a station. With the key in this condition neither of the relays 43 and 81 is operated and selector magnet 26 of teletypewriter set 11 is directly controllable from keyboard transmitter 32 or tape transmitter distributor 13 in a circuit from negative battery 34 over conductor 33, the keyboard and tape transmitters, conductor 37, conductor 42, fixed contact and movable front contact associated with armature 5 of relay 43, conductor 44, armature and marking contact of relay 29, conductor 27, selector magnet 26, conductor 28 to positive battery 31. Relay 39 will follow signals generated by the keyboard or tape transmitter but will not repeat these signals because the conductive path from its armature is open at the armature 2 and front contact of relay 43 and at the armature 3 and front contact of relay 81. Thus the signals generated by either of the transmitters will not be repeated to line 16. Should a break signal be received over line 16 while a local testing operation is in progress relay 67 will not be released because it is held energized directly from battery 83 over conductor 84, the two sets of normally closed contacts of key 82, connected in series, conductors 86 and 87 and winding of relay 67 to battery 89. Were it not for the provision of this direct energizing circuit for relay 67 in the local test condition relay 67 could be released under the control of a break signal to disable the keyboard transmitter 32 and tape transmitter distributor 13 and thus interfere with the local testing operation.

In order to condition the repeater for the transmission of plain text or unciphered signals key 82 is operated to the left or text position to close the normally open contacts and to open the normally closed contacts. The normally closed contacts are included in a conductive path from the positive terminal of battery 83, the negative terminal of which is grounded, through conductor 84, the left-hand and right-hand normally closed contacts of key 82 in series, conductors 86 and 87 and winding of break detecting relay 67 to the negative terminal of battery 89, the positive terminal of which is grounded. The conductive path which has been interrupted is the energizing circuit for relay 67 but a holding circuit is traced from the winding of the relay through the front contact and armature 6 of the relay, conductor 91, conductor 92, marking contact and armature of break relay 48 and the conductor 93 to battery 83. Thus break detecting relay 67 remains energized and is releasable under the control of break relay 48 upon operation of

that relay to spacing. However, relay 67 has a slow-release characteristic and it is necessary for break relay 48 to operate to and remain in spacing condition for an interval exceeding any spacing intervals normally occurring during signal transmission. It will be apparent that when key 82 is in the neutral position, relay 67 is not releasable in response to operation of break relay 48 to spacing because it is held energized over conductor 84 and through the break contacts on both sides of key 82.

At the left-hand make contacts of key 82 a circuit is completed from the positive terminal of battery 94 through the left-hand make contacts of key 82, conductors 96 and 97, back contact and armature 2 of relay 81, conductor 98, winding of relay 43 and conductor 99 to the negative terminal of battery 101, the positive terminal of which is grounded. Relay 43 becomes energized over this circuit and attracts its seven armatures. Armature 1 of relay 43 completes a circuit from a potential divider comprising positive and negative batteries 102 and 103 and resistors 104 and 105 through the operating winding of relay 29, conductor 106, armature 1 and front contact of relay 43, conductors 107 and 108 and armature and marking contact of relay 109 to the negative terminal of battery 111, the positive terminal of which is grounded. The operating winding of relay 109 is included in a loop circuit which terminates line 16 and which includes break key 112, armature and normal contact of relay 113, conductor 114, armature and marking contact of relay 116, operating winding of relay 109, operating winding of break relay 48 to the other side of line 16. The function of relay 109 is to receive its signals from line 16 and to repeat them leftwardly through the repeater, and the function of relay 116 is to impress signals on line 16. Previous to the energization of relay 43 the circuit of the operating winding of relay 29 was extended through the back contact of armature 1 and through conductor 117 extending into Fig. 3, contacts 3 and 4 of key 118 if the key is in the normal condition, conductor 119, and armature and marking contact of relay 121 to the negative terminal of battery 122, the positive terminal of which is connected to ground, or if key 118 should have been in the off-normal position, through contacts 6 and 7, conductor 123 and the armature and marking contact of relay 124 to the negative terminal of battery 126, the positive terminal of which is connected to ground. In any case the battery connection applied to conductor 106 through the armature 1 of relay 43 is of the same polarity when relay 43 is energized and the connection is received from battery 111 as it is when relay 43 is deenergized and the battery connection is received from battery 122 or 126, it being assumed that the relays 109, 121 and 124 are on their marking contacts, so that the direction of current flow through the operating winding of relay 29 is not changed as relay 43 becomes energized, and the armature of relay 29 remains on its marking contacts.

Armature 2 of relay 43 extends a conductive path from the armature of relay 39 through conductor 127, armature 2 and make-before-break front contact of relay 43, conductor 128 and operating winding of relay 116 to a potential divider comprising batteries 131 and 132 and resistors 133 and 134. In completing this path the armature 2 interrupts a conductive path through the fixed contact and the make-before-break front contact associated with armature 2 of relay 43 from conductor 117 previously identified, through conductor 128 and the operating winding of relay 116 to the potential divider connected on the opposite side of that winding. Thus a negative battery connection supplied over conductor 117 from the armature and the marking contact of either of the relays 121 and 124 is removed from the operating winding of relay 116 but the marking contact of relay 39 is connected by conductor 136 to the armature 4 of relay 43 which receives battery connection at its front contact from the negative terminal of battery 137, the positive terminal of which is grounded. Thus the direction of current through the operating winding of relay 116 remains unchanged and the armature of the relay is held on its marking contact.

At the back contact associated with armature 4 of relay 43 a connection from the armature of relay 109 to the marking contact of relay 39 is interrupted but there has been no previous conductive circuit through this path because, as previously stated, the conductive path from the armature of relay 39 terminated at armature 2 of relay 43 and armature 3 of relay 81 which have no back contacts.

Armature 3 of relay 43 disengages from its back contact, interrupting a circuit from the negative terminal of battery 138 through the marking contact and armature of relay 139, conductor 141, back contact and armature 3 of relay 43, conductor 142, and biasing winding of relay 109 to a potential divider comprising negative and positive terminals of batteries 143 and 144, respectively, and resistors 146 and 147. At the front contact of armature 3 a direct connection from battery 138 is substituted for the connection through the marking contact and armature of relay 139 so that the circuit of the biasing winding of relay 109 cannot be interrupted nor the direction of current therethrough reversed while relay 43 remains energized.

Armature 5 of relay 43 establishes a conductive path from the negative terminal of battery 34 through conductor 148 and conductor 149, armature 5 and front contact of relay 43 and conductor 44 to the armature of relay 29. At the fixed contact associated with the front contact of armature 5 in make-before-break manner a conductive path is interrupted from the armature of relay 29 through conductor 44, to conductor 42 which is in one of the parallel paths controlled by transmitters 13 and 32. The effect of this is to remove printer 26 of teletypewriter set 11 from direct control by keyboard transmitter 32 or tape transmitter distributor 13 and to place it under the exclusive control of relay 29. The manner in which printer 26 is operated under the control of relay 29 to make a home record of message signals generated by keyboard transmitter 32 or tape transmitter distributor 13 will be described later.

Armature 6 of relay 43 has only a back contact and interrupts a conductive path from battery 101 through conductor 151, front contact and armature 2 of break detecting relay 67, conductor 152, back contact and armature 6 of relay 43, conductor 153, winding of relay 81, conductor 154 to the right-hand make contacts of key 82. Relay 43 thus precludes the operation of relay 81, which is desirable, since it would be inconsistent for both relays to be operated because relay 43 arranges the repeater for plain text transmission and relay 81 arranges the repeater for cipher transmission. Armature 7 of relay 43 completes a circuit from the positive terminal of battery

156 through conductor 157, armature 7 and front contact of relay 43, conductor 158 and lamp 159 to the negative terminal of battery 161. Lamp 159 lights and serves as an indication that repeater 14 is in the condition for plain text transmission to and fro between the station shown in Fig. 1 and line 16.

When keyboard transmitter 32 or tape transmitter distributor 13 is operated it interrupts, in accordance with start-stop permutation code signals, the circuit from battery 34, through conductors 33 and 37 and operating winding of relay 39 to battery 41. In response to each spacing pulse generated by either of the transmitters, relay 39 operates its armature to the spacing contact thereby interrupting the path from battery 137 through front contact and armature 4 of relay 43 and the marking contact and armature of relay 39, and completing a path from battery 166, the uppermost winding of relay 167, conductor 168, spacing contact and armature of relay 39, conductor 127, armature 2 and front contact of relay 43, conductor 128 and operating winding of relay 116 to the potential divider comprising batteries 131 and 132 and resistors 133 and 134. Battery 166 has its negative terminal grounded whereas battery 137 has its positive terminal grounded so that the direction of current through the operating winding of relay 116 is reversed and this relay operates its armature away from its marking contacts, thus opening the previously traced loop circuit terminating line 16 and impressing a spacing impulse on the line 16.

Relay 109, having its operating winding in the loop which terminates line 16, is operated to spacing by the current in its biasing winding when the loop is opened by the operation of relay 116 to spacing. The previously traced circuit from battery 111 through the marking contact and armature of relay 109 and the operating winding of relay 29 to the potential divider comprising batteries 102 and 103 and resistors 104 and 105 is interrupted and a substitute circuit is extended from the spacing contact of relay 109, through conductor 171 and the middle winding of relay 167 to battery 166. The polarity of battery 166 is the opposite of that of battery 111 so that current through the operating winding of relay 29 is reversed and the relay operates to spacing, interrupting a previously traced circuit for the winding of selector magnet 26 of the teletypewriter set 11 in Fig. 1.

From the foregoing description of the transmission of signals from keyboard transmitter 32 or tape transmitter distributor 13 it will be noted that the signals are received by relay 39 and are repeated by that relay to relay 116 which in turn repeats the signals to line 16. At the same time relay 109 receives the same signals from line 16 and repeats them to relay 29 which in turn repeats them to selector magnet 26. Thus all four of the signal repeating relays participate in the transmission of signals to line 16 and in the preparation of a home record of the signals transmitted. When signals are received from a remote station over line 16 in plain text form, the relay 109 is operated in accordance with the received signals and repeats them to relay 29 which in turn repeats them to selector magnet 26. Neither of the relays 39 and 116 operates under these circumstances because keyboard transmitter 32 and tape transmitter distributor 13 should be idle during signal reception from a remote station.

As previously set forth, the upper winding of relay 167 is connected in series with the operating winding of relay 116 when relay 39 is operated to spacing and the second winding of relay 167 is connected in series with the operating winding of relay 29 when relay 109 operates to spacing. The polarity applied to these two windings of relay 167 upon completion of their energizing circuits, is such that the upper winding seeks to drive the armature to the right-hand contact and the second winding seeks to drive the armature to the left-hand contact. The circuit of the third winding of relay 167, which is a locking winding, extends from the positive terminal of battery 166 through the lower winding, conductor 172 and lower or biasing winding of relay 29 to the positive terminal of battery 173, the negative terminal of which is grounded. Batteries 173 and 166 are thus placed in opposition and no current flows through the lower winding of relay 167 or through the biasing winding of relay 173 When signals are transmitted toward line 16, the first and second windings of relay 167 become energized substantialliy simultaneously, the first under the control of relay 39 and in series with the operating winding of relay 116 and the second under the control of relay 109 and in series with the operating winding of relay 29. These two windings oppose each other so that the armature of relay 167 tends to remain on whichever contact it is then engaging. The armature of relay 167 is connected by conductor 174 to armature 4 of relay 81 which at this time is deenergized. Thus no circuit will be completed through the armature and either of the contacts of relay 167 regardless of which contact the armature may engage. When signals are being received from line 16 the second winding of relay 167 will become energized under the control of relay 109 but the first winding will not become energized because its circuit remains open at the spacing contact of relay 39. The second winding seeks to operate the armature of the relay to its left-hand contact and since this is the only winding which becomes energized alone during the transmission of plain text signals, the armature will probably be operated to and remain on its left-hand contact. The left-hand contact of relay 167 is connected by conductor 176 to the positive terminal of battery 177 through the biasing winding of relay 139 and the biasing winding of relay 116. The right-hand contact of relay 167 is connected to the biasing winding of relay 29 and to the lower winding of relay 167. With relay 81 released, no current flows in the biasing windings of relays 29, 116 of 167. Thus the relays 29 and 116 are free to follow polar signals applied to their operating windings and the lower winding of relay 167 has no effect on that relay.

A break signal may be transmitted to line 16 toward a remote station by operation of key 112 in Fig. 2 or may be received over line 16 from the remote station. Break relay 48 has its operating winding included in the loop which terminates line 16 and this relay operates to its spacing contact in response to all spacing signals. Upon the operation of break relay 48 away from its marking contact the previously described locking circuit for break detecting relay 67, which includes the armature and marking contact of relay 48 and armature 6 and front contact of relay 67, is interrupted. Relay 67 has a slow-release characteristic so that it will not relase during spacing intervals normally occurring in signal transmission. However, when key 112 is

opened for an interval longer than the release time of relay 67 or a correspondingly long spacing signal is received over line 16, relay 67 will release.

At the armature 1 and back contact a conductive path is completed from the left-hand contact of relay 113 over conductor 181, the specified armature and contact of relay 67, and conductor 182 to the operating winding of relay 109 and the marking contact of relay 116. The effect of this is to short-circuit the armature and marking contact of relay 116 so that if the relay should thereafter be operated in response to signals generated by keyboard transmitter 32 or tape transmitter distributor 13 the signals will not be impressed upon line 16. At the armature 2 and front contact of relay 67, battery 101 is disconnected from conductor 152 which extends to the back contact associated with armature 6 of relay 43. Since this relay is energized and the conductive path of armature 6 to the winding of relay 81 is at this time interrupted, the disengagement of armature 2 of relay 67 from its front contact has no effect. At the armature 3 and back contact of relay 67 a circuit is completed from battery 34 over conductor 143, conductor 183, armature 3 and back contact of relay 67, conductor 184, and conductors 42 and 38 to the operating winding of relay 39. This is a short-circuiting path around keyboard transmitter 32 and tape transmitter distributor 13 and prevents the transmitters from operating relay 39.

Armature 4 of relay 67 completes a circuit from battery of one polarity through the armature and back contact and lamp 186 to battery of the opposite polarity which lights the lamp to give a visual indication of the reception of the break signal. Armature 5 and back contact establish a conductive path from battery 94 to conductor 97 in shunt with the left-hand make contacts of key 82 but as these contacts are now closed the circuit over conductor 97, which is the energizing circuit for relay 43 is not affected as this relay is already energized. At armature 7 and front contact of relay 67 a circuit is interrupted which is traced from battery 73 over conductor 72 extending into Fig. 1, through contacts 71, conductor 69 extending into Fig. 2, break contacts of break release key 68, armature 7 and front contact of relay 67, conductor 62 extending into Fig. 1, start magnet 61, manually operable switch 63 and taut tape contacts 64 of transmitter distributor 13 and conductor 66 extending into Fig. 2 to battery 74. The interruption of this circuit results in the release of magnet 61, if that magnet had been energized, to stop tape transmission.

After the break signal has terminated and transmission into line 16 is to be resumed the repeater may be restored to normal condition by the operation of break release key 68, the make contacts of which, upon being closed, complete the energizing circuit for relay 67, and the break contacts of which have no effect on the apparatus upon being opened, but upon being reclosed reestablish the energizing circuit for transmitter distributor start magnet 61, the circuit having been prepared for reclosure at the armature 7 and front contact of relay 67.

When transmission in cipher is to take place the repeater is adjusted for this type of operation by moving the actuator of key 82 from its left-hand to its right-hand position, thus reopening the left-hand make contacts, reclosing the left-hand break contacts, closing the right-hand make contacts and opening the right-hand break contacts. With the closure of the left-hand break contacts the energizing circuit for relay 67, which is held energized by its locking circuit previously described, is momentarily reclosed and is then reopened at the right-hand break contact. Upon the reopening of the left-hand make contacts the energizing circuit for relay 43 is interrupted and this relay releases, restoring all the circuit conditions which were described prior to the description of its energization, including the extinguishment of lamp 159. Upon the closure of the right-hand make contacts the circuit is completed from battery 94 over these contacts, conductor 154, winding of relay 81, conductor 153, armature 6 and back contact of relay 43, now released, conductor 152, armature 2 and front contact of relay 67 and conductor 151 to battery 101. Over this circuit relay 81 becomes energized.

A circuit is completed from battery 156 over conductor 191, armature 1 and front contact of relay 81, conductor 192, lamp 193 to battery 161. Lamp 193 lights to indicate that the repeater is in condition for cipher transmission. Armature 2 and back contact of relay 81 interrupt the energizing path for relay 43 so that this circuit cannot be established. At armature 3 and the front contact of relay 81 a conductive path is established from the armature of relay 39 over conductors 127 and 196, the specified armature and contact of relay 81, conductor 197 extending into Fig. 3, operating winding of relay 198 to a potential divider comprising batteries 201 and 202 and resistors 203 and 204. The front contact associated with armature 3 of relay 81 has make-before-break association with a fixed contact to which the negative terminal of battery 199 is connected. In the opposite direction from the armature of relay 39 the conductive path is traced through the marking contact, conductor 136, armature 4 and back contact of relay 43, conductor 108 and the armature and marking contact of relay 109 to negative battery so that the battery polarity on the operating winding of relay 198 in Fig. 3 is not changed, negative battery 111 being substituted for negative battery 199.

At armature 4 and the front contact of relay 81 a conductive path is completed from the negative terminal of battery 205 through the specified armaure and front contact and conductor 174 to the armature of relay 167. If this armature is engaging the left-hand contact as it probably will be the path will be extended over conductor 176 and through the biasing windings of relays 139 and 116 to the positive terminal of battery 177. Current will flow in these windings to hold the armature of relay 139 on its marking contact and to lock relay 116 against operation by its operating winding. At the armature 5 and front contact of relay 81 a conductive path is established from the positive terminal of battery 210 through the specified front contact and armature, conductor 215 extending into Fig. 3 and winding of a relay 220 to the negative terminal of battery 206. Relay 220 has its two armatures connected to a source of power 225 and its front contacts connected to the driving motors 207 and 208, of cipher signal generating tape transmitter distributors 19 and 21, respectively. This causes the motors of both of the cipher signal transmitters 19 and 21 to be started.

At armatures 6 and 7 of relay 81 which have only back contacts, battery 211 is disconnected from conductors 212 and 213. Conductor 212 ex-

tends into Fig. 3 and is connected to the armature of relay 214 and is also connected over conductor 216 to one terminal of the operating winding of relay 124. Conductor 213 extends into Fig. 3 and is connected to one terminal of the operating winding of relay 121. At the armature 8 of relay 81 battery 217 is connected over the specified armature and its front contact and conductor 218 extending into Fig. 3 to the right-hand contact of relay 214.

With relay 81 operated the repeater 14 in Fig. 2 and the mixing relay circuit 16 and cipher signal generators 19 and 21 in Fig. 3 are arranged for cipher signal transmission and reception. Assuming first that message transmission is to proceed from the station in Fig. 1 toward line 16, keyboard transmitter 32 is operated or tape transmitter distributor 13 is set in operation by closure of the circuit for its start magnet 61 and plain text signals are transmitted to relay 39 by the selective opening and reclosing of the circuit from battery 34 over conductor 33, keyboard transmitter contacts 32, conductor 36, segments of the distributor of tape transmitter-distributor 13, conductor 37 and operating winding of relay 39 to battery 41. Relay 39 is thus caused to follow the signals. From the junction of conductors 37 and 38 a path in parallel with that through the operating winding of relay 39 to battery 41 is traced over conductor 42, fixed contact and movable front contact associated with armature 5 of relay 43, which is now released, conductor 44, armature and marking contact of relay 29, conductor 27, winding of selector magnet 26 of teletypewriter set 11, and conductor 28 to battery 31 which has the negative terminal grounded as in the case of battery 41. It will be apparent from this that with the repeater arranged for cipher transmission and reception selector magnet 26 is controlled, to produce a home record, directly by keyboard transmitter 32 or tape transmitter-distributor 13 and not through the agency of several of the repeater relays including the relay 109, as is the case when plain text signals are transmitted into line 16.

When relay 39 responds to the start impulse of a code combination initiated by keyboard transmitter 32 or tape transmitter distributor 13 its armature is operated to the spacing contact and a circuit is completed from the positive terminal of battery 166 through the upper winding of relay 167, armature and spacing contact of relay 39, conductors 127 and 196, armature 3 and front contact of relay 81, conductor 197 and operating winding of relay 198, to the potential divider comprising batteries 201 and 202 and resistors 203 and 204. The polarity which has previously been applied to the winding of relay 198 has been negative from battery 111 through the marking contact and armature of repeater relay 109, conductor 108, back contact and armature 4 of relay 43, conductor 136 and the marking contact and armature of relay 39 so that relay 198 operates its armature to its spacing contact. Prior to the operation of relay 198 to its spacing contact, battery 221 on its marking contact was connected through the armature and over conductor 222 to the inner ring of the distributor 223 of cipher signal generator 19. The inner ring of the distributor is coextensive with three adjacent rest segments the first of which the distributor brush engages when the distributor is stopped, and with five code segments, the first of which is separated from the last rest segment by a free or dead segment, each two of which are separated by free or dead segments and the last of which is separated by a free or dead segment from a stop segment which is immediately adjacent the first rest segment. A conductive portion of the inner ring of the distributor insulated from the remainder is coextensive with the stop segment. From the principal portion of the inner ring the circuit over conductor 222 continues through the brushes of the distributor, through the rest segment, conductors 224 and 226 and winding of start magnet 227 for distributor 223 to the negative terminal of battery 228, the positive terminal of which is grounded. In parallel with the conductor 226 and winding of start magnet 227 a circuit is traced over conductor 229 and operating winding of biased polar relay 231 to negative battery 232. Over these circuits the start magnet 227 of distributor 223 is energized to start rotation of the disributor brushes and the armature of relay 231 is operated to its right-hand contact.

Prior to the operation of relay 231 to its right-hand contact a circuit is traced from positive battery 236 through the armature and left-hand contact of relay 231 and lower winding of relay 214 to negative battery 237. The lower winding is thus energized, opposing the upper winding, which seeks to drive the armature to the single right-hand contact of the relay, and driving the armature away from the right-hand contact. As soon as the armature of relay 231 leaves its left-hand contact the circuit through the lower winding of relay 214 is interrupted and its upper winding drives the armature to the right-hand contact. A circuit is thus completed from positive battery 217 in Fig. 2 through armature 8 and front contact of relay 81, conductor 218, the right-hand contact and armature of relay 214 and conductor 216 to the lower terminal of the operating winding of relay 124 which is also connected to the lower or marking contacts of cipher signal generator 19. The upper or spacing contacts are connected to the upper terminal of the operating winding of relay 124. A potential divider or bridge circuit comprising resistors 241 and 242 is connected in parallel with the operating winding of relay 124 and the mid-point of this potential divider is connected through conductor 243 and the lower or locking winding of relay 198 to a potential divider comprising batteries 246 and 247 and resistors 248 and 149. With positive battery 217 connected to the lower terminal of the operating winding of relay 124 current divides, some flowing through resistor 242, conductor 243 and the lower winding of relay 198 to the potential divider comprising resistors 248 and 249, and the remainder flowing through the operating winding of relay 124 and resistor 241 and then through conductor 243 and the lower winding of relay 198 to the potential divider comprising resistors 248 and 249. These battery connections to the operating winding of relay 124 cause the lower terminal to be more positive than the upper terminal and when this condition exists the armature of relay 124 is driven to its right-hand or spacing contact.

Before proceeding with the description of the result of the operation of the armature of relay 124 to its spacing contact the effect of completion of the travel of armature of relay 231 to its right-hand contact will be described. When this armature transit is completed positive battery 236 is connected over the armature and right-hand contact of relay 231 and conductor 251 extending into Fig. 2 through the upper winding of re-

lay 139 to negative battery 252 and through condenser 253 to positive battery 254. Prior to the operation of relay 231 to its right-hand contact there was no current through the upper winding of relay 139 because there is no direct current path through condenser 253 and the condenser is charged. However, there was current through the lower winding of relay 139 from battery 177 through the lower windings of relays 116 and 139, conductor 176, left-hand contact and armature of relay 167, conductor 174 and armature 4 and front contact of relay 81 to battery 205. Current in this circuit energized the lower winding of relay 139 and kept the armature on the left-hand contact. When relay 39 operated to spacing in response to the start signal and completed the circuit of the first winding of relay 167 this relay operated its armature to the right-hand contact thus interrupting the flow of current through the lower winding of relay 139 and also through the lower winding of relay 116. With no current through either of the windings of relay 139 the armature should remain on its left-hand contact. However, with relay 231 operated to its right-hand contact and positive battery 236 connected over conductor 251 to the upper winding of relay 139, relay 139 is at once operated to its right-hand contact and condenser 253 discharges.

A conductive path is now established from positive battery 256 through the right-hand contact and armature of relay 139, conductor 141, back contact and armature 3 of relay 43, conductor 142 and biasing winding of relay 109 to the potential divider comprising batteries 143 and 144 and resistors 146 and 147. This reverses the flow of current through the biasing winding of relay 109 and that winding now aids the operating winding in the loop terminating line 16 so that even though the loop is opened as at the armature and marking contact of relay 116, the armature of relay 109 will be held on its marking contact.

With the armature of relay 167 operated to its right-hand contact a holding circuit is established from positive battery 166 through the lower winding, right-hand contact and armature of the relay, conductor 174 and armature 4 and front contact of relay 81 to negative battery 205. The armature is thus positively held on its right-hand contact. A circuit in parallel with the lower winding of relay 167 and battery 166 is completed over conductor 172 and the biasing winding of relay 29 to positive battery 173. The biasing winding when thus energized influences the armature of the relay toward the marking contact and prevents the armature from leaving that contact even though the direction of current in the operating winding should be reversed.

Returning to consideration of the mixing relay circuit in Fig. 3, with the armature of relay 124 operated to its spacing contact in response to the start pulse repeated by relay 39 as hereinbefore described, positive battery 257 is connected over the spacing contact and armature of relay 124, conductor 123, contacts 5 and 6 of switch 118 and conductor 258 to the inner ring of distributor 259 in cipher signal generator 21. This distributor may have the same arrangement of segments as distributor 223 but they are connected somewhat differently. Thus the short segment in the inner ring which is coextensive with the stop segment in the outer ring is connected to conductor 258 as is the remainder of the inner ring so that the inner ring is, in effect, continuous. The stop segment is connected to the marking contacts of the tape sensing mechanism associated with distributor 259 as is also connected the segment immediately following the one on which the brushes rest when distributor 259 is stopped. The rest segment is connected by conductor 261 through start magnet 262 for distributor 259 to negative battery 263. The five code segments are connected to the five contact tongues of the tape sensing mechanism. With positive battery 257 connected over the path previously traced to the inner ring of distributor 259 the path is extended through the brushes of the distributor and through the rest segment and conductor 261 to start magnet 262 which becomes energized and releases the brushes of distributor 259 for rotation.

As soon as the brush for distributor 259 moves off the rest segment and on to the next segment which is the start segment the positive battery connection supplied over the spacing contact and armature of relay 124 to the inner ring of distributor 259 is extended over conductor 264 to the lower terminal of the operating winding of relay 121. The upper terminal is connected by conductor 266 to the spacing contacts of the tape sensing mechanism and the winding is bridged by a potential divider comprising resistors 267 and 268 the mid-point of which is connected to a potential divider comprising batteries 271 and 272 and resistors 273 and 274. With positive battery connected to the lower terminal of the operating winding of relay 121 current flowing through the potential divider comprising batteries 271 and 272 and resistors 273 and 274 divides, a portion flowing through the resistor 268 to the junction of resistors 273 and 274 and the remainder flowing through the operating winding of relay 121 and through resistor 267 to the junction of resistors 273 and 274. With the lower terminal of the operating winding of relay 121 positive the flow of current is in the direction to operate the armature to spacing, disconnecting negative battery 122 from conductor 119 and substituting positive battery 276. This positive battery connection is extended from conductor 119 through contacts 3 and 4 of key 118, conductor 117, back contact and armature 1 of relay 43, conductor 106 and operating winding of relay 29 to the potential divider comprising batteries 102 and 103 and resistors 104 and 105 and in parallel therewith through the make-before-break contacts associated with armature 2 of relay 43, conductor 128 and winding of relay 116 to the potential divider comprising batteries 131 and 132 and resistors 133 and 134. The battery connection supplied over these paths seeks to operate the relays 29 and 116 to spacing. Relay 29 is now locked in the marking condition under the control of relay 167 as previously stated so that it cannot respond to this spacing condition. The circuit of the biasing winding of relay 116 is opened at the left-hand contact of relay 167 as previously stated so that relay 116 is operated to spacing thus opening the loop circuit which terminates line 16 and transmitting the start pulse of spacing nature to the line. Since the operating winding of relay 109 is in the loop circuit which terminates line 16 this winding becomes deenergized but the relay is not operated to spacing because the biasing winding holds the armature to marking under the control of relay 139 which now has its armature operated to the right-hand contact as previously stated.

It will be noted that the armature of relay

124 in Fig. 3 is connected through the biasing winding of that relay to a potential divider comprising batteries 281 and 282 and resistors 283 and 284. The current flowing through the biasing winding when the armature is on the marking or spacing contact from batteries 126 or 257, respectively, is in the direction to hold the armature on the contact which it is then engaging, thus the current through the biasing winding always opposes operation of the armature to the other contact, but the operating winding when it seeks to operate the armature to the other contact, dominates the biasing winding and effects movement of the armature to the other contact. Similarly one terminal of the biasing winding of relay 121 is connected to the armature and the other terminal is connected to a potential divider comprising batteries 286 and 287 and resistors 288 and 289. The biasing circuit for relay 198 is similar to that for relays 124 and 121. Negative battery 221 applied through the marking contact and armature of relay 198 and over conductor 222 and through either of the conductors 278 and 279 and resistors 241 and 242, respectively, to conductor 243, biases the armature of relay 198 toward the marking contacts whereas positive battery 277 connected over the spacing contact and armature of relay 198 and over the paths just described biases the armature to the spacing contact.

The condition of the signal generating or repeating relays at this time is that relay 39 is operated to spacing in response to the start signal generated at the local station, relay 198 is operated to spacing under the control of relay 39, distributor 223 is started under the control of relay 198, relay 124 is operated to spacing under the control of distributor 223, distributor 259 is started under the control of relay 124, relay 121 is operated to spacing under the control of distributor 259, and relay 116 is operated to spacing under the control of relay 121. From this it will be apparent that the start impulse of spacing nature is repeated in a straightforward manner through the repeater and mixing relay circuits to the line 16 and undergoes no alteration or conversion in the ciphering apparatus.

As soon as the brushes of distributor 259 leave the start segment they interrupt the circuit of the energizing winding of relay 121. However, this relay is held in the spacing condition by its biasing winding and continues to generate the start pulse of spacing nature which relay 116 repeats to the line. The brush has two dead or insulated segments to cover before it reaches the first code segment. The last rest segment of distributor 223 corresponds to the first dead or insulated segment of distributor 259 and as the brushes of distributor 223 leave the last rest segment they interrupt the circuit over conductor 229 thus opening the circuit of the operating winding of relay 231. This relay restores its armature to the left-hand contact, thus interrupting the positive battery connection to the junction of condenser 253 and the operating winding of relay 139 in Fig. 2. Current continues to flow through the operating winding of relay 139 to charge condenser 253 and the capacitance of condenser 253 and the resistive values of resistors associated with batteries 252 and 254 are such that the armature of relay 139 is held on its right-hand contacts for an interval substantially equal to that required for the brushes of distributors 223 and 259 to complete one revolution. At the end of this interval the charging current for condenser 253 has decreased to a sufficiently low value that a biasing spring 285 is able to return the armature of relay 139 to its left-hand contact. By means of the condenser charging circuit including the operating winding of relay 139 and the mechanical restoration spring 285, relay 139 holds relay 199 locked against response to interruption of current through its operating winding and restores it to signal responsive condition at the end of a transmitted code combination.

With the armature of relay 231 restored to its left-hand contact the circuit through the lower or operating winding of relay 214 is reestablished and the armature is moved away from the right-hand contact. Positive batery 217 on armature 8 of relay 81 in Fig. 2 is thus disconnected from the lower terminal of the operating winding of relay 124. It was the establishment of this connection of positive battery to the lower terminal of the operating winding of relay 124 which caused that relay to operate to spacing to initiate the operation of distributor 259 and thus the transmission of the start pulse to line 16. It is to be noted that relay 214 was operated, to operate relay 124 to spacing, under the control of relay 231 which was in turn operated over a circuit including the brushes of distributor 223 in their rest position. Thus the operation of relay 124 to spacing to initiate the transmission of the start pulse does not await the actual setting in motion of the brushes of distributor 223 which may possibly be delayed slightly because start magnet 227 is under the necessity of operating the start lever for the distributor under the resistive forces of a restoring spring and of frictional engagement of the distributor stop cam with the start lever. As previously described, relay 124 controls the starting of distributor 259. From the instant that relay 198 operates to spacing in response to the start pulse generated at the local station and repeated by relay 39, there is required only the operation of relays 231, 214 and 124 in succession to complete the energizing circuit for start magnet 262 of distributor 259. These are all polar relays and they respond very quickly. Thus the energizing circuit for start magnet 262 is completed almost as soon as the energizing circuit for start magnet 227 and the two distributors may be started almost together. The biasing circuit of relay 214 includes variable resistor 280 so that the time of operation of relay 124 to spacing and of completion of the energizing circuit of start magnet 262 with respect to the time of completion of the energizing circuit of start magnet 227 may be varied. The actual initiation of transmission of the start pulse to line 16 is controlled by distributor 259, since relay 121 is operated to spacing when the brushes of distributor 259 have been started and have reached the start segment which is adjacent to the rest segment. This is desirable since distributor 259 and relay 121 which it controls are the final signal generating elements of the mixing relay apparatus and it is preferable to have the transmission of the start signal as well as the code signals controlled by them rather than to have the initiation of the start signal controlled by relay 124 before distributor 259 has been started.

Following the start pulse generated by the keyboard transmitter 32 or tape transmitter distributor 13 in Fig. 1, the five code pulses of a signal combination are transmitted and are repeated by relay 39 to relay 198 in Fig. 3. Relay 198 may thus present its armature in marking or spacing

condition for each plain text code impulse, connecting either negative battery 221 or positive battery 277 over conductor 222 to the inner ring of distributor 223. As the brushes of distributor 223 traverse the five code segments, the transmitting contact tongues connected to those segments may be in engagement with marking or spacing contacts depending upon the nature of the code combination in ciphering tape 22 presented to the tape sensing elements during one cycle of the brushes of distributor 223. With relay 198 presented in the marking condition and the brushes of distributor 223 traversing a code segment connected to a transmitting contact tongue which is engaging a marking contact, negative battery 221 is connected over conductor 222, inner ring, brushes and a code segment of distributor 223, the contact tongue associated with the distributor code segment, marking contact of the tape sensing mechanism, conductor 279, branching paths comprising resistor 242 as one branch, operating winding of relay 124 and resistor 241 as the other branch, conductor 243 and biasing winding of relay 198 to the potential divider comprising batteries 246 and 247 and resistors 248 and 249. The polarity applied to the junction of resistor 242 and the operating winding of relay 124 at this time is the opposite of that applied from battery 217 in Fig. 2 through conductor 218 and the right-hand contact and armature of relay 214 for the generation of the start signal so it follows that the armature of relay 124 will be operated to marking. Thus a marking condition of relay 198 and a marking condition established in the cipher signal generating transmitter distributor 19 cooperates to establish a marking condition of relay 124. When the relay 198 responds to a spacing condition, battery of opposite polarity is connected over conductor 222 and assuming again a marking condition in the cipher signal generator 19 the circuit will be completed over conductor 279 as before, but with the reverse polarity supplied by relay 198, the relay 124 will be operated to spacing. Thus a spacing condition of relay 198 and a marking condition in cipher signal generator 19 cooperate to produce a spacing condition of relay 124. When the relay 198 is in the marking condition and a spacing condition exists in the cipher signal generator 19, negative battery on the marking contact of relay 198 is connected through the armature, conductor 222, continuous ring, brushes and code segment of the distributor then being traversed by the brushes, transmitting contact tongue associated with that segment, spacing contact and conductor 278, branching paths comprising resistor 241 as one path and the operating winding of relay 124 and resistor 242 as the other path, and conductor 243 to the biasing winding of relay 198. The marking battery connection of negative polarity is now connected to the upper terminal of the operating winding of relay 124 instead of to the lower terminal, which is the opposite of the condition first described and accordingly the armature of relay 124 is operated to spacing. It follows from this that when a marking condition of relay 198 cooperates with a spacing condition in cipher signal generator 19, relay 124 is operated to spacing. Finally, there is the condition when relay 198 is on the spacing contact and cipher signal generator 19 has a spacing condition. The conductive path will be the same as that just traced but the polarity is reversed so that the armature of relay 124 is operated to marking. Accordingly, a spacing condition of relay 198 cooperating with a spacing condition in cipher signal generator 19 produces a marking condition of relay 124. These four possible conditions may be summarized by saying that when like conditions of relay 198 and cipher signal generator 19 occur, relay 124 is placed in the marking condition and that when opposite conditions occur in relay 198 and cipher signal generator 19 with either in the marking condition and the other in the spacing condition, a spacing condition of relay 124 results.

The marking and spacing polarities on the armature of relay 124 are supplied over conductor 123, contacts 5 and 6 of key 118, conductor 258 and inner ring of distributor 259 and code segments to the contact tongues of the tape sensing mechanism which senses ciphering code combinations in tape 23. The tape sensing contact tongues assume marking or spacing positions in accordance with the perforations in tape 23 and extend the marking and spacing polarities over conductors 264 and 266 to the lower and upper terminals of the operating winding of relay 121. The control of relay 121 jointly by relay 124 and the tape sensing mechanism associated with distributor 259 is the same as the control of relay 124 jointly by relay 198 and the tape sensing mechanism associated with distributor 223. When a marking polarity from relay 124 is supplied over a marking contact of the tape sensing mechanism associated with distributor 259 or a spacing polarity is supplied over a spacing contact of the tape sensing mechanism relay 121 is operated to marking. When a marking or spacing polarity is supplied from relay 124 over a spacing or marking contact respectively of the tape sensing mechanism, relay 121 is operated to spacing. The resulting marking or spacing polarities applied to the armature of relay 121 are supplied over conductor 119, contacts 3 and 4 of key 118 and conductor 117 to the operating winding of relay 29, which does not follow the signals because its armature is locked on the marking contact under the control of relay 167, as previously described, and to the operating winding of relay 116 which follows the signals and repeats them to line 16.

Following the transmission of the five code impulses of a ciphered code relay 39 responds to the stop pulse of marking nature generated by the keyboard transmitter 32 or tape transmitter distributor 13 and repeats this marking condition to relay 198. At about this time the brushes of distributor 223 pass over the stop segment and connect negative battery 291 over the short segment in the inner ring of distributor 223, brushes and stop segment of that distributor and conductor 279 to the lower terminal of the operating winding of relay 124. It will be noted that the polarity of battery 291 is the same as the polarity of battery 221 on the marking contact of relay 198 and that it is applied over conductor 279 to which the marking contacts of the tape sensing mechanism are connected. It thus corresponds to the previously described situation when a marking condition of relay 198 cooperates with a marking condition of cipher signal generator 19 and these two conditions being alike, relay 124 is operated to the marking contact. The marking polarity which is negative is supplied through the marking contact and armature of relay 124 to the inner ring of distributor 259 and through the brushes and stop segment of that distributor over conductor 264, to which the marking contacts

of the tape sensing mechanism associated with distributor 259 are connected, to the lower terminal of the operating winding of relay 121. This corresponds to the situation under which a marking condition of relay 124 cooperates with a marking condition of cipher signal generator 21 and the two conditions being alike relay 121 is operated to its marking contact and in turn operates relay 116 in the repeater to its marking contact, thus transmitting the stop signal.

In this way transmission of ciphered signals to line 16 will continue as long as either of the transmitters in Fig. 1 is operated, the code impulses of the plain text signals being ciphered impulse by impulse by the cipher signal generator 19 and the resulting ciphered code impulses appearing at relay 124 being ciphered a second time impulse by impulse by the cipher signal generator 21 and the resulting ciphered signals are impressed on line 16 by relay 116. The distributors 223 and 259 are stopped at the end of each cycle upon reaching their rest segments and are restarted under the control of the start pulse of the next plain text signal. Upon completing each cycle the distributors 223 and 259 advance their tapes 22 and 23, respectively, to present the next ciphering code in each of the tapes to the tape sensing mechanisms. Tapes 22 and 23 should have different random sequences of ciphering codes so that the signals transmitted over line 16 will be in cipher. It is important that the sequences be different because should the sequences of codes be identical in the two tapes, cipher signal generator 21 would decipher the signals generated by relay 124 and plain text signals would be transmitted into line 16. In all probability identical codes in the tapes 22 and 23 may occasionally be presented to their tape sensing mechanism simultaneously so that a plain text code having been ciphered by cipher signal generator 19 will be deciphered by cipher signal generator 21 and transmitted to line 16 in the same form in which it was generated by either of the transmitters in Fig. 1. Such occurrences will be as unpredictable as any other codes resulting from the double ciphering operation and will not facilitate breaking the codes and discovery of the plain text message if it should be unauthorizedly intercepted.

At the conclusion of transmission from either of the transmitters shown in Fig. 1, the system remains in its steady marking condition, condenser 253 becomes fully charged, current through the operating winding of relay 139 dies out and the biasing winding restores the armature to the left-hand contact thus unlocking relay 109 and restoring normal biasing current to that relay. If the remote station should begin transmitting ciphered signals over line 16, these signals will be received by relay 109, the armature being operated to spacing in response to the start pulse of the first code received. Upon the operation of relay 109 to spacing, a circuit is completed from battery 166 through the second winding of relay 167, conductor 171, spacing contact and armature of relay 109, conductor 108, back contact and armature 4 of relay 43, conductor 136, marking contact and armature of relay 39, conductors 127 and 196, armature 3 and front contact of relay 81, conductor 197 and operating winding of relay 198 in the mixing relay circuit (Fig. 3) to the potential divider comprising batteries 201 and 202 and resistors 203 and 204. Relay 198 is operated to spacing by the current which flows over this circuit and the second winding of relay 167 overpowers the third or locking winding of relay 167 and restores the armature of that relay to the left-hand contact. With the armature of relay 167 restored to its left-hand contact, the locking current through the biasing winding of relay 29 is cut off by the disconnection of negative battery 205 from relay 29, leaving positive battery 166 connected through the lower winding of relay 167 in opposition to positive battery 173 on the biasing winding of relay 29 so that no current flows and relay 29 is free to follow polar signals generated by relay 121 in the mixing relay circuit. Negative battery 205 becomes connected through the left-hand contact of relay 167 and conductor 176 through the lower winding of relay 139 and the biasing winding of relay 116. Current in this circuit locks the relay 116 on its marking contact and the relay 139 on its left-hand contact so that relay 116 is prevented from following the polar signals generated by relay 121 and supplied over conductor 117, the make-before-break contact associated with armature 2 of relay 43, conductor 128 and the operating winding of relay 116. Relay 139 is prevented from operating its armature to the right-hand contact under the control of relay 231 in the mixing relay circuit and is thus prevented from locking relay 109 against reception of signals from line 16. From this it will be apparent that relay 167 is a reversing relay automatically operable from one to the other of its two contacts according to the direction of signal transmission, whether from the station shown in Fig. 1 to relay 39 and thus toward line 16 or whether from line 16 to relay 109 and thus toward the station shown in Fig. 1. In either case relay 167 locks against operation of the sending relay which, if permitted to operate, would send signals back in the direction from which they had been received.

Relay 198 in responding to the start pulse repeated to it by relay 109 starts distributor 223 and operates relay 214 which in turn operates relay 124 to spacing. Relay 124 starts distributor 259 which operates relay 121 to spacing and relay 29 responds to the operation of relay 121 to spacing and repeats the start pulse to selector magnet 26 of the teletypewriter unit 11. It will be observed that these operations are identical with those which are performed when relay 198 is operated in response to the start pulse received from keyboard transmitter 32 or tape transmitter distributor 13 and repeated to relay 198 by relay 39. The distributors 223 and 259 successively alter the ciphered signals received by relay 109 in the same manner that they alter the plain text signals received by relay 39 and thereby decipher the received signals so that plain text signals are generated by relay 121, are repeated by relay 29 and are received by selector magnet 26. In order for the ciphered signals to be correctly deciphered to derive the plain text signals, it is only necessary that during the reception of a ciphered code combination the same two ciphering code combinations be presented by the tapes 22 and 23 to their tape sensing mechanisms during traversal by distributors 223 and 259 of their code segments as the codes which reacted upon the plain text code at the remote transmitting station to effect the ciphering of the plain text code. Thus the two ciphering tapes at one station must have identical sequences of codes with the two tapes at the other station and must be started at the same points in the respective tapes at the beginning of message transmission. Fur-

thermore, for double ciphering operation employing two ciphering tapes at each end of the transmitting system, it is not necessary that the two tapes be in the corresponding cipher signal generators at both stations provided the two tapes are of unlimited length. A plain text code which has been ciphered first by a code combination in tape 22 controlling cipher signal generator 19 and then by a code in tape 23 controlling cipher signal generator 21 may be deciphered with the tapes transposed, namely, with tape 23 controlling cipher signal generator 19 but presenting the same code combination as that in tape 23 which controlled the second ciphering operation at the transmitting station, and with tape 22 controlling cipher signal generator 21 and presenting the same signal combination to the tape sensing mechanism as that which controlled the first ciphering operation at the transmitting station. This possibility of transposition of the two tapes presupposes that all of the ciphering tapes are of unlimited length. If they should be in the form of closed loops or bands, they could be transposed at one of two interconnected stations only if they are of equal length, which is undesirable because the cycle of ciphering before the sequence repeats is too short. If loops of tape of unequal length should be transposed at one station decipherment of received codes would fail when the shorter of the two loops of tape at each station had completed one cycle and had begun to repeat its sequences of codes.

With a ciphering system of the type hereinbefore described the circuit for intercommunication between two stations if not set up on a permanent basis is established through any intermediate switching station by the transmission of plain text codes, which is accomplished with key 82 operated to the left, to inform the attendant at the switching station or stations of the identity of the station with which communication is desired. After the connection has been established intercommunication in plain text takes place between the two stations for the purpose of arriving at an agreement as to the starting points in the two ciphering tapes 22 and 23 for the cipher transmission. The cipher tapes are adjusted to the agreed positions in their respective tape sensing mechanisms whereupon key 82 is operated to the right to adjust the repeater shown in Fig. 2 and the mixing relay unit 18 shown in Fig. 3 for the ciphering and deciphering condition. Thereafter all message material passing in one direction or the other between the two stations over line 16 will be ciphered.

Key 118 is provided for the purpose of converting mixing relay unit 18 from a double ciphering condition to a single ciphering condition. When the key is in the condition shown in Fig. 3, the double ciphering condition is established. When key 118 has been operated to the single ciphering condition spring 1 engages spring 2, springs 3 and 4 are disengaged, spring 6 is disengaged from spring 5 and is engaged with spring 7. With spring 6 disengaged from spring 5, conductor 258 extending to the inner ring of distributor 259 is isolated so that the distributor 259 cannot be started. With spring 4 disengaged from spring 3 and with spring 6 engaging spring 7, the armature of relay 121 is disconnected from conductor 117 which extends to the operating winding of relay 116 and the armature of relay 124 becomes connected through conductors 123 and 117 to the operating winding of relay 116 so that relay 116 will be responsive directly to the operation of relay 124. Springs 1 and 2 of key 118 establish a connection from positive battery 296 through condenser 297 and conductor 298 to one terminal of the operating winding of relay 214 which has negative battery on its other terminal which also receives positive battery connection as previously described through the armature and left-hand contact of relay 231.

Upon reception by relay 198 of the start pulse of a plain text code combination from relay 39 or of a ciphered code combination from relay 199, the relay 198 operates to spacing and in the manner previously described completes the energizing circuit for start magnet 227 of distributor 223 and also operates relay 231 to its right-hand contact. Prior to movement of the armature of relay 231 away from its left-hand contact, condenser 297 has been discharged because it has positive potential on both terminals. Upon the operation of relay 231 away from its left-hand contact, battery 236 becomes disconnected from the operating winding of relay 214 but current continues to flow in the operating winding to charge condenser 297. As soon as the charging current for the condenser has diminished to the point at which the biasing winding of relay 214 is able to assume control of the armature, the biasing winding moves the armature to the right-hand contact, the effect of which, as previously described, is to operate relay 124 to spacing, and the armature of relay 124, now being connected to the operating winding of relay 116 and to the operating winding of relay 29, causes whichever of those relays that is not locked against operation to repeat the start pulse of spacing nature to line 16 or to printer magnet 28. The reason for delaying the operation of relay 214 to its right-hand contact is to delay the beginning of transmission of the start pulse in the event that distributor 223 should be somewhat slow in starting due to the load on the armature of start magnet 227 which the magnet must overcome. The interval between the operation of the armature of relay 231 away from its left-hand contact and the operation of relay 124 to spacing may be varied to achieve the desired time relationship between the starting of distributor 223 and the initiation of transmission of the start pulse by varying the value of resistor 289. Following the start pulse, relay 198 responds to the code impulses of the plain text or ciphered signals and relay 124 is operated under the joint control of relay 198 and the code in cipher tape 22 to control relay 116 for transmitting the ciphered code to line 16 or to control relay 29 for the transmission of the deciphered code to selector magnet 26 of teletypewriter set 11, depending upon the condition of relay 167 in accordance with the direction in which transmission is proceeding. During the single ciphering or deciphering operation distributor 259 remains idle and relay 121 remains in the marking condition because these elements have been isolated from control by the other elements of mixing relay unit 18 as a result of the operation of key 118. The double ciphering and deciphering condition may be reestablished by restoring key 118 to the condition shown in Fig. 3.

During the transmission of signals in cipher a break signal may be transmitted by operating break key 112. This key is located directly in the loop circuit which terminates line 16 at each station and not in the circuit of keyboard transmitter 32 and tape transmitter distributor 13 as in the usual case of telegraph systems having no ciphering feature, for the reason that cipher sig-

nal generators 19 and 21 would cipher any steady spacing condition generated by keyboard transmitter 32 or tape transmitter distributor 13 and would cause the transmission of codes having some marking pulses which would prevent break relay 48 from being operated to the spacing condition long enough for break detecting relay 67 to release.

Upon the operation of break key 112 at either station for an interval longer than the release time of break detecting relay 67, the break relay 48 will go to spacing and remain in that condition long enough to release the relays 67. At armature 1 and back contact of relay 67, a short circuit is established around the contacts of relay 116 as previously described so that continued operation of relay 116 under the control of relay 124 or 121 will not cause continued transmission of signals to line 16 after the break key at the remote end has been reclosed. At the armature 2 and front contact of relay 67 the energizing circuit of relay 81 will be interrupted so that the armatures of that relay will be restored to the condition shown in Fig. 2 and operation of the mixing relay unit 18 and the cipher signal generators 19 and 21 in Fig. 3 under the control of relay 39 in Fig. 2 will cease. With relay 81 released, the armature 5 and back contact of relay 67 completes the energizing circuit for relay 43 which converts repeater 14 from the idle condition established by the release of relay 81 to the plain text transmission condition which is the same condition established when key 82 is operated to the left. Under the control of relay 43, lamp 159 becomes lighted to indicate that the plain text transmission condition has been established and lamp 193 is extinguished by the release of relay 81. The operations performed by the other armatures of relay 67 upon the release of that relay are the same as those heretofore described in connection with reception of the break signal while the repeater 14 is in the plain text transmission condition under the control of key 82 operated to the left.

Both stations are now in condition to receive and record plain text signals but neither station is in the condition to transmit such signals because their transmitters are disabled by the released relay 67. The most usual reason for transmitting a break signal is to notify a station which is transmitting that the copy is not being correctly received and that a portion should be retransmitted. There is no reason why this information should be transmitted in cipher and if the condition which caused failure of proper reception of the message should be an out-of-step condition of one or both of the ciphering tapes, the request for retransmission of a portion of the ciphered message would become garbled by the out-of-step ciphering of the request at the two stations and the request would not be correctly received. Furthermore, it is likely that an out-of-step condition of the ciphering tapes will result from the transmission of the break signal and the tapes must be reset before further cipher transmission can proceed. Finally, the repeaters at both stations have been placed in the plain text handling condition and either station is in condition to receive without further attention by an operator. If the operator at the station which transmitted the break signal should merely operate the break release key 68 momentarily to effect reenergization of relay 67, the repeater at that station would be restored to the cipher transmitting condition and the ciphered request for retransmission of a portion of the message or any other information which the receiving station desired to communicate to the transmitting station would be ciphered before transmission but would not be deciphered at the receiving station. Accordingly, it is necessary for the station which is about to transmit to operate key 82 to the left before operating break release key 68 in order to prevent the reoperation of relay 81 and the release of relay 43. These operations having been performed at one of the stations that station may transmit instructions or requests to the other station in plain text and the signals will be correctly received and recorded. If the station receiving these signals has reason for replying, as will probably be the case, and in order for a new agreement as to the starting points on the ciphering tapes to be reached before the system is restored to the ciphering condition the break release key must be operated at that station and key 82 must be operated to the left. After these routine matters have been attended to and the cipher tapes have been adjusted to the agreed positions in their sensing mechanisms, the system may be restored to the cipher transmission condition by the manual reoperation of keys 82 to the right at both stations, whereupon signals transmitted in either direction through the system will be ciphered at the transmitting station and will be deciphered at the receiving station.

It will be noted that relay 113, the armature and left-hand contact of which are included in the loop circuit which terminates line 16, has a single winding to which positive and negative batteries are connected. Thus the relay 113 will be normally energized to hold the armature in engagement with its left-hand contact. Although individual batteries have been shown in the drawings for the many components of the system, it will be understood that all power connections of positive and negative polarities will usually be derived from a single direct current source. Upon shutting down the system, such as at the close of a business day, it will be an economical practice to disconnect the source of direct current from all circuits. When this occurs some of the polar relays may be operated to their spacing contacts. If the relay 116 should be operated away from its marking contact upon the removal of power from its winding, the loop circuit which terminates line 16 would be opened, which is an undesirable condition. Accordingly, relay 113 is included in the system and when the power connection is removed from its winding along with the removal of power from all other components of the system, the armature will be operated to the right-hand contact. This establishes a conductive path from the armature of relay 113 to the operating winding of relay 109 in short-circuiting relation to the path through conductor 114 and the armature and marking contact of relay 116 so that even if this relay should be operated to the spacing condition, the loop circuit terminating line 16 will remain closed.

The system has been shown in Figs. 1, 2 and 3 as arranged for transmitting signals over a telegraph line 16. The system is also adapted for transmitting ciphered signals over radio channels as indicated in Fig. 6. When this arrangement is employed repeater 14 is connected to a radio transmitter and receiver 301 in such a way that relay 116 of the repeater (Fig. 2) operates a conventional keying device in the radio transmitter to cause the transmitter to transmit marking and spacing signals and receiving relay 109 and break relay 48 are operable under the con-

trol of the output circuit of the radio receiver so that they are responsive to marking and spacing signals received from a remote radio transmitter and so that break relay 46 will be operated to and remain in the spacing condition in response to a long spacing signal to release break detecting relay 67 and thus control the conversion of repeater 14 from the cipher signal transmitting condition to the plain text receiving condition in the same manner that a break signal received over a telegraph line produces this result.

Although particular embodiments of the invention have been shown in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiments but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a telegraph system, first means for generating signal combinations each comprising a succession of impulses, second means for concurrently generating signal combinations each comprising a succession of impulses, means for interactively combining corresponding impulses of said concurrently generated code combinations, third means for concurrently generating signal combinations each comprising a succession of impulses, means for interactively combining corresponding impulses produced by said first-mentioned combining means and said third means for generating signal combinations, a telegraph line, and means for causing impulses produced by said second-mentioned combining means to be impressed on said line.

2. In a telegraph system, first means for generating signal combinations comprising impulses succeeding one another at predetermined intervals, second means for generating signal combinations comprising impulses succeeding one another at predetermined intervals, third means for generating signal combinations comprising impulses succeeding one another at predetermined intervals, means for interactively combining impulses generated in corresponding intervals by said first and second signal generating means, means for interactively combining impulses generated in corresponding intervals by said first-mentioned combining means and said third signal generating means, a telegraph line, and means for causing impulses produced by said second-mentioned combining means to be impressed on said line.

3. In a telegraph system, means for generating signal combinations in a sequence comprising a message, each signal combination comprising a succession of impulses, first means for concurrently generating signal combinations in a random sequence, each signal combination comprising a succession of impulses, means for interactively combining corresponding impulses of said concurrently generated code combinations, second means for concurrently generating signal combinations in a different random sequence, means for interactively combining corresponding impulses generated by said first-mentioned combining means and said second random sequence signal generating means, a telegraph line, and means for causing impulses produced by said second-mentioned combining means to be impressed on said line.

4. In a telegraph system, means for generating signal combinations in a sequence comprising a message, each signal combination comprising impulses succeeding one another at predetermined intervals, first means for generating signal combinations in a random sequence, each signal combination comprising impulses succeeding one another at predetermined intervals, means for interactively combining impulses generated in corresponding intervals by said two signal generating means, second means for generating signal combinations in a different random sequence, each signal combination comprising impulses succeeding one another at predetermined intervals, means for interactively combining impulses generated in corresponding intervals by said first-mentioned combining means and said second random sequence signal generating means, a telegraph line, and means for causing impulses produced by said second-mentioned combining means to be impressed on said line.

5. In a telegraph system, a message signal transmitter for transmitting code combinations impulse by impulse in succession, a transmitter for transmitting a random sequence of code combinations impulse by impulse in succession, means controlled by said transmitters for producing code combinations in cipher impulse by impulse in succession, a second transmitter for transmitting a different random sequence of code combinations impulse by impulse in succession, means controlled jointly by said cipher code combination producing means and said second random sequence code transmitter for producing further code combinations in cipher impulse by impulse in succession, a telegraph line, and means for causing the impulses produced by said last-mentioned means to be impressed on said line.

6. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a storage type of signal generator having a sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, means for interactively combining signal elements generated by said two signal generators element by element in succession, a second storage type of signal generator having a sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, and means for interactively combining the signals generated by said second storage type of signal generator with signals generated by said first-mentioned combining means element by element in succession.

7. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a tape controlled signal generator having a sequence of non-message signals in the controlling tape thereof for generating telegraph signals element by element in succession, means for interactively combining signal elements generated by said two signal generators element by element in succession, a second tape controlled signal generator having a different sequence of non-message signals in the controlling tape thereof for generating telegraph signals element by element in succession, and means for interactively combining signals generated by said second tape controlled signal generator with signals generated by said first-mentioned combining means element by element in succession.

8. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a storage type of signal generator having a sequence of non-

message signals in storage therein for generating telegraph signals element by element in succession, means for interactively combining signal elements generated by said two signal generators element by element in succession, a second storage type of signal generator having the sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, means for interactively combining signals generated by said second storage type of signal generator with signals generated by said first-mentioned combining means element by element in succession, and means for disabling said second storage type of signal generator and second-mentioned combining means.

9. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a storage type of signal generator having a sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, means for interactively combining signal elements generated by said two signal generators element by element in succession, a second storage type of signal generator having a sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, means for interactively combining signals generated by said second storage type of signal generator with signals generated by said first-mentioned combining means element by element in succession, a telegraph line, means for causing signals produced by said second-mentioned combining means to be impressed on said line, and means for disabling said second storage type of signal generator and said second-mentioned combining means and for causing signals generated by said first-mentioned combining means to be impressed on said line.

10. In a telegraph system, a telegraph channel, a transmitter operable to generate message signals, means for causing signals generated by said transmitter to be impressed on said channel, a transmitter adapted to operate conjointly with said first-mentioned transmitter to encipher said message signals, means for causing said ciphered signals to be impressed on said channel, and mutually exclusive means for precluding concurrent effectiveness of said means for causing message signals to be impressed on said channel and said means for causing enciphered signals to be impressed on said line.

11. In a telegraph system, a telegraph channel, a transmitter operable to generate message signals, means including a relay for causing signals generated by said transmitter to be impressed on said channel, a transmitter adapted to operate conjointly with said first-mentioned transmitter to encipher said message signals, means including a relay for causing said enciphered signals to be impressed on said channel, and means for precluding concurrent operation of said relays.

12. In a telegraph system, a telegraph channel, a transmitter operable to generate message signals, means including a relay for causing signals generated by said transmitter to be impressed on said channel, a transmitter adapted to operate conjointly with said first-mentioned transmitter to encipher said message signals, means including a relay for causing said enciphered signals to be impressed upon said channel, and an energizing circuit for each of said relays including an armature and back contact of the other relay whereby to preclude concurrent energization of both of said relays.

13. In a telegraph system, a telegraph channel, a transmitter operable to generate message signals, means including a relay for causing signals generated by said transmitter to be impressed on said channel, a transmitter adapted to operate conjointly with said first-mentioned transmitter to encipher said message signals, means including a relay for qualifying said second-mentioned transmitter to operate conjointly with said first-mentioned transmitter and for causing said enciphered signals to be impressed on said channel, and means for precluding concurrent energization of both of said relays.

14. In a telegraph system, a telegraph channel, a transmitter operable to generate message signals, means including a relay for causing signals generated by said transmitter to be impressed on said channel, a transmitter adapted to operate conjointly with said first-mentioned transmitter to encipher said message signals, means including a relay for qualifying said second-mentioned transmitter to operate conjointly with said first-mentioned transmitter and for causing said enciphered signals to be impressed on said channel, means for precluding concurrent energization of both of said relays, and signal responsive means operable when said second-mentioned relay is energized to release said second-mentioned relay and to energize said first-mentioned relay.

15. In a telegraph system, a telegraph channel, a transmitter operable to generate start-stop message signals, first and second ciphering signal generators operable in cycles initiated by start impulses and terminated by stop impulses, means responsive to start impulses generated by said transmitter for starting said first ciphering signal generator, means controlled by said starting means for starting said second ciphering signal generator, and means controlled by said second ciphering signal generator for generating start impulses and for impressing said start impulses on said channel.

16. In a telegraph system, a telegraph channel, a transmitter operable to generate start-stop message signals, first and second ciphering signal generators operable in cycles initiated by start impulses and terminated by stop impulses, a relay responsive to start impulses generated by said transmitter for starting said first ciphering signal generator, a second relay also controlled by said first-mentioned relay for starting said second ciphering signal generator, and a third relay controlled by said second ciphering signal generator for generating start impulses and for impressing said start impulses on said channel.

17. In a telegraph system, a telegraph channel, a transmitter operable to generate start-stop message signals, first and second ciphering signal generators operable in cycles initiated by start impulses and terminated by stop impulses, a relay responsive to start impulses generated by said transmitter for starting said first ciphering signal generator, a second relay controlled by said first-mentioned relay for starting said second ciphering signal generator, a third relay controlled by said second ciphering signal generator for generating start impulses and for impressing said start impulses on said channel, and manually operable switching means for disabling said second ciphering signal generator and said third relay and for causing said second relay to impress start impulses on said channel.

18. In a telegraph system, the method of en-

ciphering message signals which comprises generating telegraph message code signals impulse by impulse in succession, concurrently generating enciphering code signals impulse by impulse in succession, causing concurrently generated message code impulses and enciphering code impulses to interact to produce altered signal code combinations impulse by impulse in succession, concurrently generating other enciphering code signals impulse by impulse in succession, causing concurrently generated impulses of said altered signal combinations and impulses of said other enciphering code signals to interact to produce other altered signal combinations impulse by impulse in succession, and transmitting the impulses of said other altered signal combinations.

19. In a telegraph system, the method of enciphering message signals which comprises generating telegraph message code signals impulse by impulse in succession, concurrently generating

enciphering code signals impulse by impulse in succession, causing concurrently generated message code impulses and enciphering code impulses to interact to produce altered signal code combinations impulse by impulse in succession, concurrently generating other enciphering code signals impulse by impulse in succession, causing concurrently generated impulses of said altered signal combinations and impulses of said other enciphering code signals to interact to produce other altered signal combinations impulse by impulse in succession, transmitting the impulses of said other altered signal combinations, and selectively omitting the production of said other altered signal combinations and transmitting the impulses of said first-mentioned altered signal code combinations.

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