July 2, 1946. R. M. HICKS 2,403,280

SECRET TELEGRAPH SYSTEM

Filed March 1, 1939 5 Sheets-Sheet 1

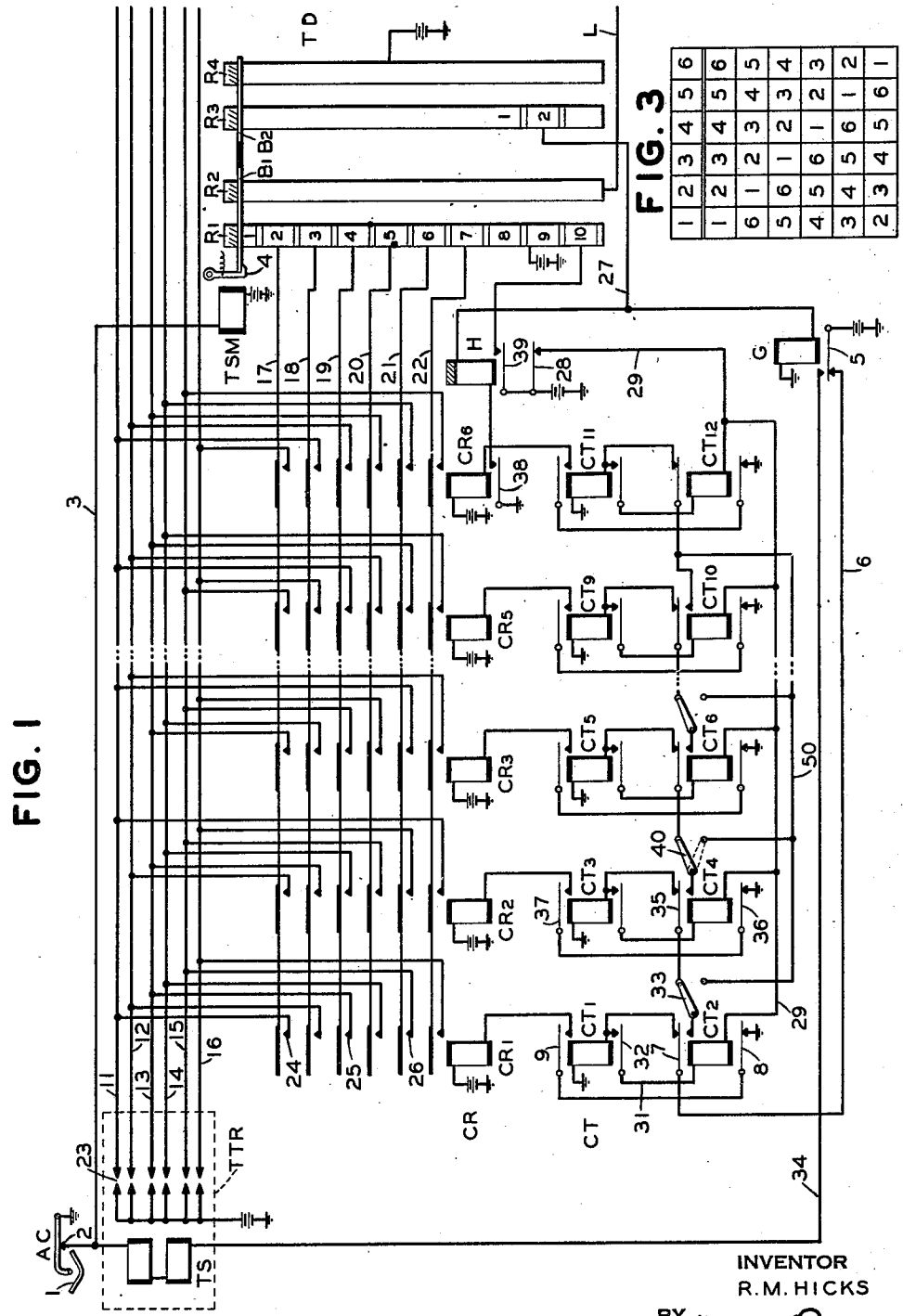


FIG. 1

1	2	3	4	5	6
1	2	3	4	5	6
6	1	2	3	4	5
5	6	1	2	3	4
4	5	6	1	2	3
3	4	5	6	1	2
2	3	4	5	6	1

FIG. 3

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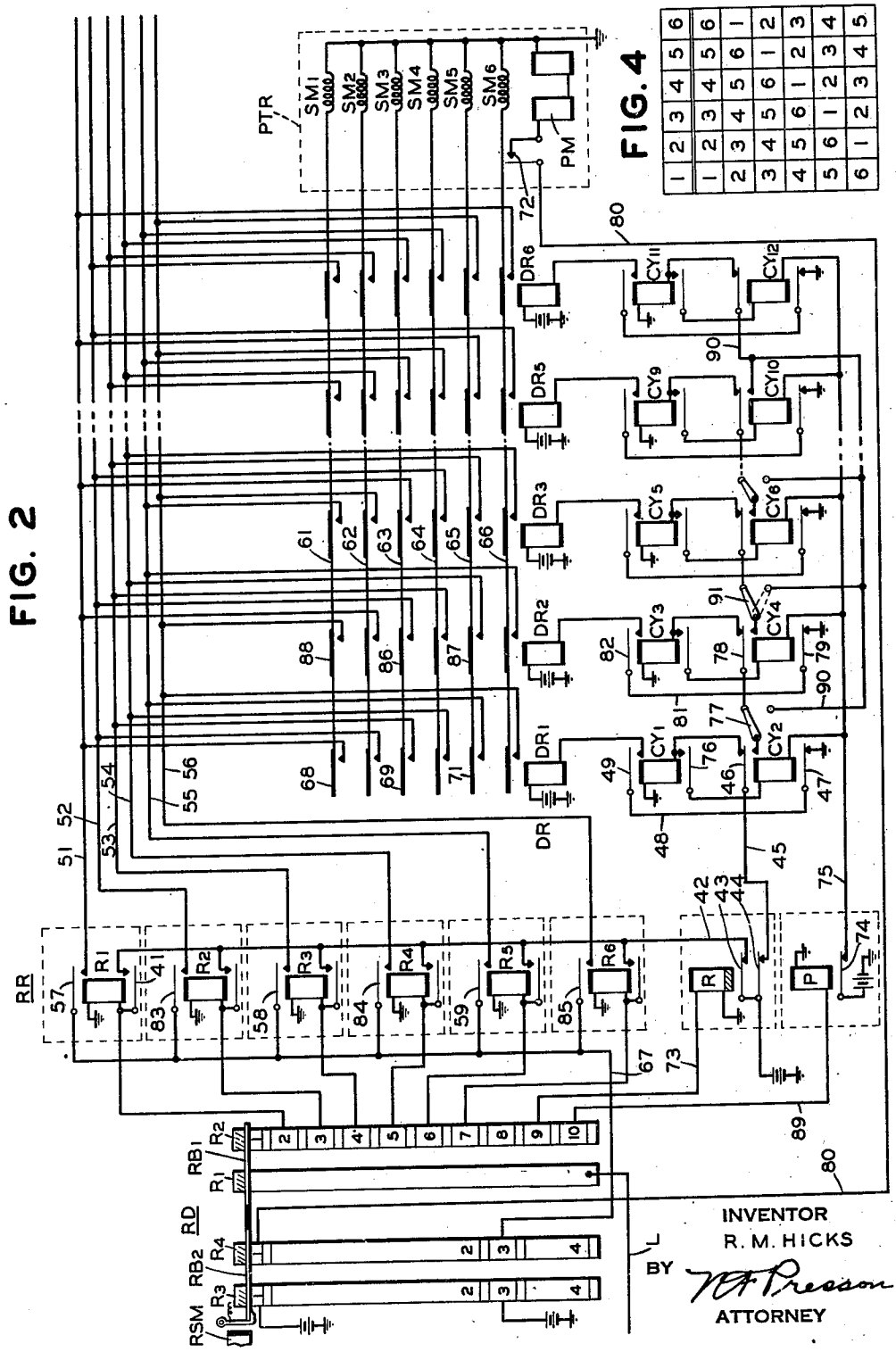


FIG. 2

FIG. 4

1	2	3	4	5	6
1	2	3	4	5	6
2	3	4	5	6	1
3	4	5	6	1	2
4	5	6	1	2	3
5	6	1	2	3	4
6	1	2	3	4	5

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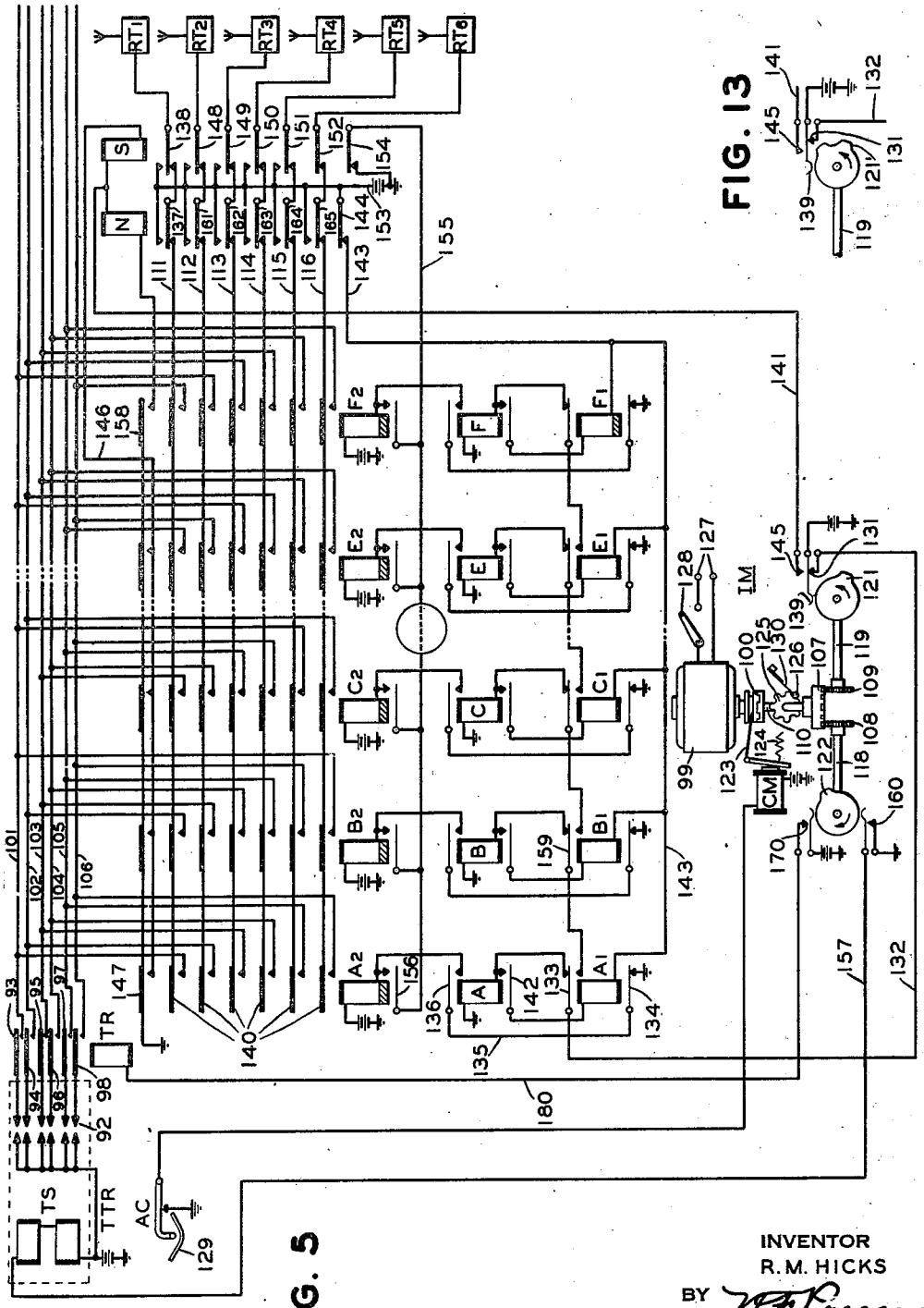


FIG. 5

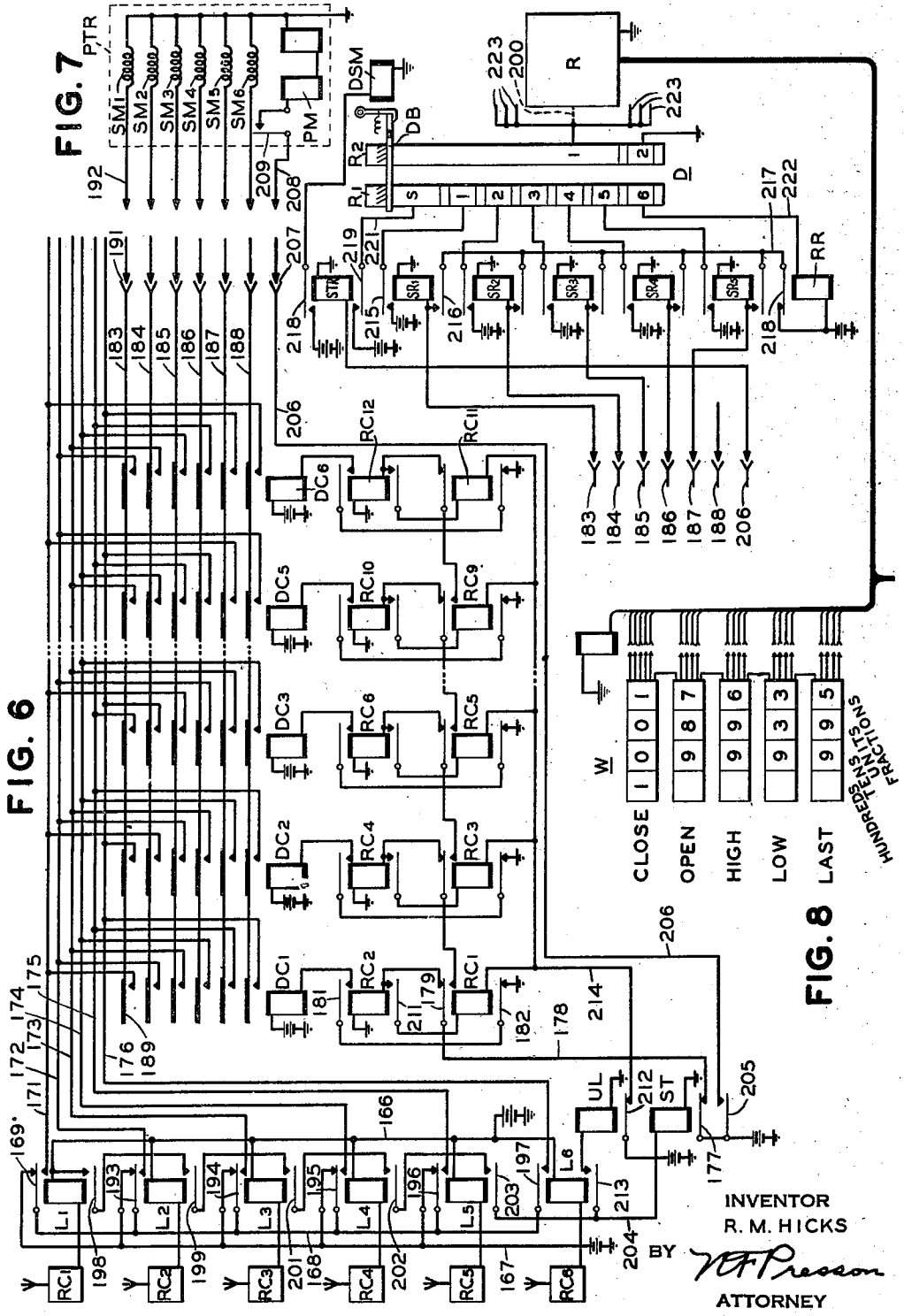
FIG. 13

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FIG. 12

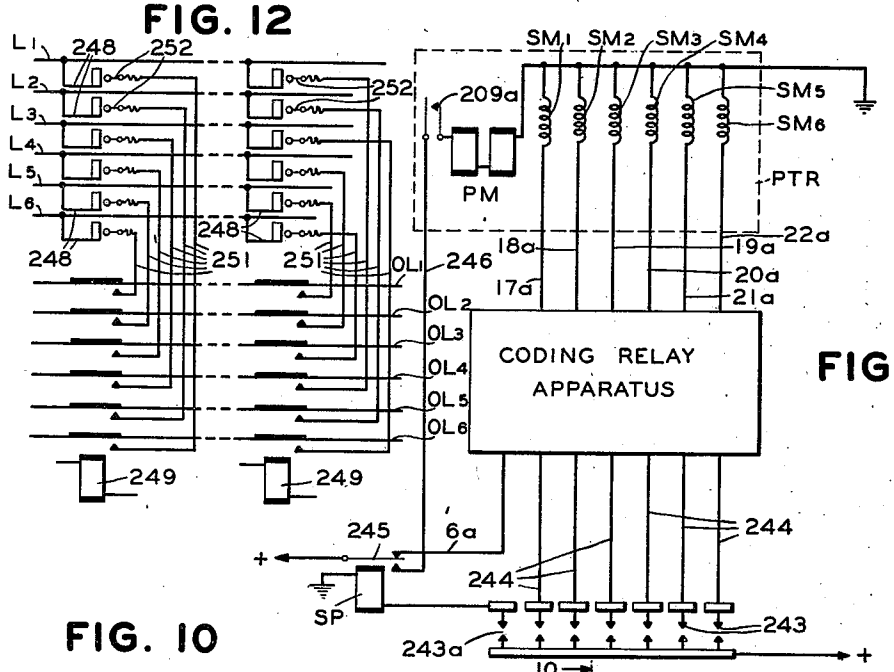


FIG. 9

FIG. 10

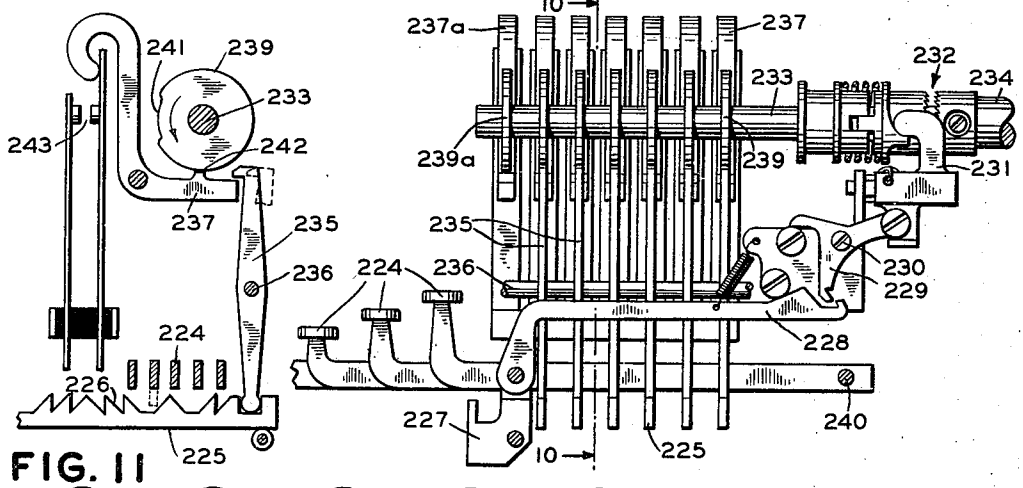
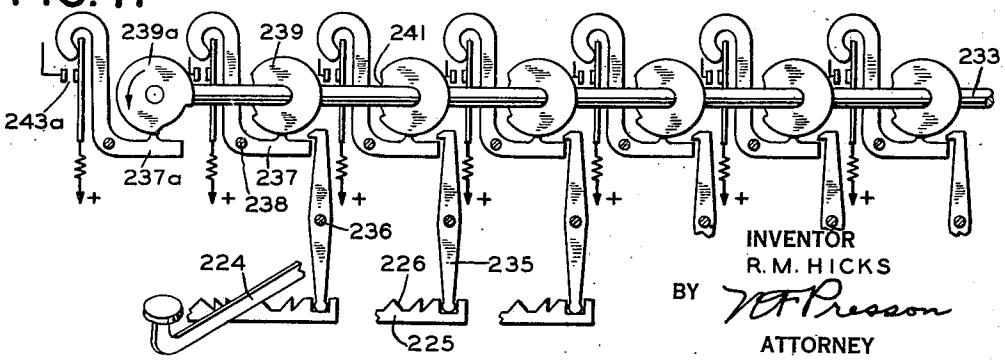


FIG. 11



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2,403,280

SECRET TELEGRAPH SYSTEM

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Application March 1, 1939, Serial No. 259,267

9 Claims. (Cl. 178—22)

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This invention relates to secret communication systems and apparatus wherein the information is transmitted in cipher form and thereafter deciphered automatically at a receiving station. More specifically the message is set up by means of a telegraph typewriter keyboard which causes a coding mechanism to function to place the message in coded form and transmit the same to a receiving station when it is decoded automatically. Coding and decoding systems of various types have heretofore been proposed, but such systems are complicated in structure, difficult to maintain in synchronous operation, and in general are not practicable for use in commercial service.

An object of the invention is a novel and improved system and apparatus in which the disadvantages of the various systems heretofore proposed are obviated, and in which the code combinations corresponding to each of the various characters comprising a message are changed automatically at frequent intervals during the transmission of the message whereby the character most frequently appearing in the coded message does so as the result of chance and not by reason of association with a particular character of the original message.

A further object of the invention is a system of the character disclosed in which the various elements may largely be composed of standard telephone and telegraph apparatus and in which the number of special parts required is reduced to a minimum.

A further object of the invention is an improved system in which a message is automatically placed in coded form such that the different character signals of the message are transmitted in permutation code and are permuted in different ways after each character or group of character signals have been transmitted, thereby to change the code frequently during the transmission of a message.

Still another object is the provision of means for restarting the cycle of operation of the encoding devices at desired intervals and for maintaining the decoding devices at a receiving station in synchronism with the coding devices of the transmitting station.

Another of the objects resides in the provision of novel and improved means for automatically changing the codes of a message in cipher at frequent intervals during the transmission of the coded message to a receiving station.

Another object resides in the provision of apparatus for receiving messages in cipher wherein

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the received message is decoded according to different codes corresponding to different portions of the message and posted on a posting device.

Another object is to provide a system for controlling the operation of a telegraph printer or stock quotation display board by telegraph signals received in permutation code wherein the code corresponding to each character of the telegraph message is changed after each character or group of characters transmitted.

A still further object of the invention is to provide signal means controlled from the transmitting station for automatically normalizing at regular intervals such receiving stations as may, through improper operation, become out of step with the transmitting station.

Further objects and advantages will be apparent from the following detailed description, taken in connection with the accompanying drawings, of which:

Fig. 1 shows transmitting apparatus in accordance with one embodiment of the invention;

Fig. 2 shows the receiving apparatus controlled by the transmitter of Fig. 1;

Fig. 3 shows one of the many code arrangements suitable for use with the transmitting systems herein disclosed;

Fig. 4 shows the code arrangement for use with the receiving mechanism when the code arrangement of Fig. 3 is employed;

Fig. 5 shows transmitting apparatus in accordance with another embodiment of the invention;

Fig. 6 shows the receiving and decoding apparatus for use with the transmitting apparatus of Fig. 5;

Fig. 7 illustrates diagrammatically a telegraph printer controlled by the apparatus of Fig. 6;

Fig. 8 is a diagrammatic illustration of a stock quotation board and control apparatus therefor operated by the receiving apparatus of Fig. 6;

Fig. 9 shows a system for converting a coded telegraph message into a plurality of different codes;

Fig. 10 is a view in section, partly broken away, taken along the line 10—10 of Fig. 9;

Fig. 11 is a view in perspective partly broken away of the sending device of Fig. 9;

Fig. 12 shows a suitable arrangement for readily changing the connections between the incoming conductors and the contacts of the coding relays; and

Fig. 13 shows a modified cam arrangement which may be used with the impulse machine of Fig. 5.

Referring now to the drawings, on which like

parts are designated by like numerals, there is shown on Figs. 1 and 2 thereof a complete system comprising a transmitting and receiving station, respectively. The transmitting station comprises a tape transmitter TTR, a set of coding relays CR, a set of counting relays CT and a transmitting distributor TD having an outgoing line L connected thereto.

The receiving station comprises, among other elements, a receiving distributor RD connected to the transmitting station by means of the line L, a set of receiving relays RR, a set of decoding relays DR, a counting relay chain CY and a telegraph printer designated PTR for recording the telegraph message set up in the tape of the tape transmitter TTR. The printer may be of the type known in the telegraph art as 25–A, patented March 20, 1923, Patent No. 1,448,750.

The operation of the system will now be described in detail. Assume, for example, that the tape transmitter has been provided with a copious supply of tape 1, perforated by a tape perforating machine, as is well known in the telegraph art, to represent a message and that the code employed during the process of perforation is a code suitable for operation of the printer PTR, Fig. 2. Since in the assumed case, there is an ample supply of perforated tape in the tape transmitter, the auto-control AC will have its contacts 2 closed thereby applying ground to one end of the windings of the tape-step magnet TS and the transmitting distributor start magnet TSM by way of conductor 3 thereby causing the start magnet to attract the latch 4 and release the distributor brushes B1 and B2 for rotation, the motor mechanism for operating the distributor not being illustrated as this construction is well known in the art to which the invention relates. As the brushes of the transmitting distributor move away from their stop or rest position the start magnet RSM of the receiving distributor RD, Fig. 2, is caused to operate, as is the common practice in distributors of the type herein disclosed, thereby setting the receiving distributor into operation.

Since at this time relay G, Fig. 1, is unoperated, battery at armature 5 of relay G and break contact thereof is applied to conductor 6, armature 7 and break contact of relay CT2 and thence to the winding of relay CT, thereby causing relay CT1 to operate. The operation of relay CT1 closes a circuit from ground at the break contact and armature 8 of relay CT2, armature 9 and make contact of relay CT1 to the winding of coding relay CR1 thereby causing relay CR1 to operate and connect the conductors 11, 12, 13, 14, 15 and 16 to the conductors 17, 18, 19, 20, 21 and 22 respectively. The conductors 17, 18, 19, 20, 21 and 22 are connected to segments 2, 3, 4, 5, 6 and 7 respectively of the ring R1 of the transmitting distributor TD. If the character perforated in the tape is such that the tongues 23 of the tape transmitter TTR are closed in combination to connect battery to conductors 11, 13 and 15, for example, the circuits including these conductors will be continued by way of operated contacts 24, 25 and 26 of relay CR1 to conductors 17, 19 and 21 respectively such that battery will be applied to the line L during the time that the brush B1 of the distributor TD is in engagement with the segments 2, 4 and 6 of the ring R1 thereof. When the brush B2 engages segment 2 of ring R3, a circuit is completed from battery at ring R4, brush B2, segment 2 of ring R3, conductor 27 and thence to the winding of relay G, causing relay G to operate and at its armature 5 remove battery from conductor 6, thereby causing relay CT2 to operate over the following circuit: battery at armature 28 and break contact of relay H, conductor 29, winding of relay CT2, conductor 31, armature 32 and make contact of relay CT1, winding of relay CT1 and thence to ground. The operation of relay CT2 at its armature 8, removes ground from the winding of relay CR1 causing relay CR1 to release, and at its armature 7, closes a circuit in part for the subsequent operation of the next succeeding pair of counting relays, with the switch 33 in the position illustrated on the drawings. As armature 5 of relay G engages its make contact battery is applied to conductor 34 extending to the windings of the tape step magnet TS thereby causing the magnet TS to operate and step the next transverse row of perforations into operative position with respect to the tongues 23 of the tape transmitter. As the brush B1 engages segment 9 of the ring R1 battery is applied to the line L. As the brush B2 passes off segment 2 of the ring R3, relay G releases thereby deenergizing the tape step magnet and again applying battery to conductor 6, the circuit now being continued through armature 7 and make contact of relay CT2, switch 33, armature 35 and break contact of relay CT4, winding of relay CT3 and thence to ground thereby operating relay CT3. A circuit is now completed from ground at the armature 36 of relay CT4 by way of armature 37 and make contact of relay CT3 to the winding of code relay CR2 causing relay CR2 to operate and connect the conductors 11, 12, 13, 14, 15 and 16 to the conductors 22, 17, 18, 19, 20 and 21 respectively.

If it be assumed, for example, that the character previously set up in the tape transmitter is to be repeated, battery will again be applied to conductors 11, 13 and 15 and by virtue of the operation of relay CR2, these conductors are now in electrical circuit with conductors 22, 18 and 20 respectively whereby battery is applied to the line L as the brush B1 passes over segments 3, 5 and 7 of the ring R1.

When the brush B2 crosses segment 2 of the ring R3, relay G operates to effect the operation of relay CT4 and cause the tape to be stepped ahead. The operation of relay CT4 at its armature 36 releases code relay CR2 and at its armature 35 connects the pulsing circuit to the pair of counting relays CT5 and CT6, the operation of relay CT5 causing relay CR3 to operate and interchange the connections between the tongues 23 of the tape transmitter TTR and the segments 2, 3, 4, 5, 6 and 7 of the ring R1 in accordance with the arrangement shown on Fig. 3 of the drawings in which the topmost horizontal row of digits represents the six units of the code setup by the tongues 23 of the tape transmitter and each succeeding horizontal row of digits shows the manner in which the original code is altered by the operation of the code relays CR1 to CR6 as these relays are successively operated. During the fourth, fifth and sixth revolutions of the distributor TD, the counting relays CT7 to CT12 are caused to operate and control the operation of the code relays CR4 to CR6 to switch the connections between the tape transmitter tongues and the transmitting segments of the distributor TD generally in the manner of the foregoing description. Because of space limitations, relays CT7, CT8 and CR4 are not shown on Fig. 1 of the drawings, but it will be understood that they are interposed as indicated by the dotted line portions of the conductors shown in the figure.

The operation of relay CR6 at its armature 38 connects ground to the winding of relay H, which operates when brush B2 engages segment 2 of the ring R3 and at its armature 39 connects battery to segment 10 of the ring R1 whereby a battery signal is applied to the line L during the passage of the brush B1 over this segment to cause the release of the receiving equipment as will more clearly appear as the description proceeds. The operation of relay H at its armature 28 removed battery from conductor 29 thereby releasing the operated relays of the counting chain CT and coding relay CR6. As the brush B2 passes off segment 2 of the ring R3, battery is removed from conductor 27 and the relays G and H release. Relay H is sufficiently slow in releasing to maintain battery on segment 10 of the ring R1 until after the brush B1 has passed off this segment. The release of relay G at its armature 5 connects battery to conductor 6 thereby operating relays CT1 and CR1 whereupon the cycle of operation of the transmitter is repeated until the tape 1 causes the auto-stop AC to open its contacts 2 and bring the transmitting and receiving distributors to rest by deenergization of their stop magnets TSM and RSM respectively. During the first revolution of the transmitting and receiving distributors, it will be recalled, segments 2, 4 and 6 of the transmitting distributor were energized and during the time that the brush B1 was passing over these segments, the brush RB1 of the receiving distributor RD, Fig. 2 was in engagement with the correspondingly designated segments of the ring R2 of the receiving distributor thereby causing receiving relays R1, R3 and R5 to be operated from battery signals received over the line L.

The operation of relay R1 at its armature 41 closed a locking circuit by way of conductor 42 to maintain the relay R1 operated after the distributor brush RB1 has passed off segment 2 of the ring R2 as follows: Ground, winding of relay R1, armature 41 and make contact of relay R1, conductor 42, break contact and armature 43 of relay R and thence to battery. In a similar manner the relays R3 and R5 lock to armature 43 of relay R during this revolution of the receiving distributor.

Now since during the time that the brush RB1 was traversing segments 1 to 7 of the ring R2 of the receiving distributor during the first revolution thereof, relay R was unoperated, a circuit is completed from battery at armature 44 and break contact of relay R, conductor 45, armature 46 and break contact of relay CY2 to the winding of relay CY1 and thence to ground thereby causing relay CY1 to operate. The operation of relay CY1 completes a circuit from ground at armature 47 of relay CY2, conductor 48, armature 49 and make contact of relay CY1 to the winding of decoding relay DR1 thereby causing relay DR1 to operate and place the receiving equipment in condition to receive and decode the character received during the first revolution of the distributor RD. More specifically, the operation of the decoding relay connects the conductors 51, 52, 53, 54, 55 and 56 to the conductors 61, 62, 63, 64, 65 and 66 respectively extending to the selection magnets SM1 to SM6 of the printer PTR.

When the brush RB2 engages segment 3 of the ring R3 a circuit is completed from battery at segment 3 of the ring R3, brush RB2, segment 3 of the ring R4, conductor 67, armature 57 and make contact of relay R1, conductor 51, make contact and armature 68 of relay DR1, conductor

61, selection magnet SM1 of the printer and thence to ground. A circuit is also closed from battery on conductor 67, armature 58 and make contact of relay R3, conductor 53, armature 69 and make contact of relay DR1, conductor 63 and thence to the printer selection magnet SM3. In a similar manner battery on conductor 67 is extended by way of armature 59 of the relay R5 and armature 71 of the relay DR1 to the printer selection magnet SM5. The printer selection magnets SM1, SM3 and SM5 are operated over the circuits just described thereby storing in the printer the first character transmitted having code units 1, 3 and 5 marking in character and thus setting the printer in operation to close its contacts 72 and prepare in part a circuit to the print magnet PM.

When the brush RB1 is in engagement with segment 9 of the ring R2 the relay R operates over the following circuit: battery on segment 9 of the ring R1 of the transmitting distributor, brush B1, ring R2, line L, ring R1 of the receiving distributor RD, brush RB1, segment 9 of the ring R2, conductor 73, winding of relay R and thence to ground. The operation of relay R at its armature 43 removes battery from conductor 42 thereby releasing relays R1, R3 and R5. When armature 44 of relay R moved away from its break contact battery was removed from conductor 45 thereby causing relay CY2 to operate over the following circuit: battery, armature 74 and break contact of relay P, conductor 75, winding of relay CY2, armature 76 and make contact of relay CY1, winding of relay CY1 and thence to ground. The operation of relay CY2 at its armature 47 removed ground from conductor 48 thereby causing relay DR1 to release.

As brush RB1 passes off from segment 9 of the ring R2 relay R releases and at armature 44 thereof applies battery to conductor 45, armature 46 and make contact of relay CY2, switch 77, armature 78 and break contact of relay CY4, winding of relay CY3 and thence to ground thereby causing relay CY3 to operate and close a circuit from ground at the break contact and armature 79 of relay CY4, conductor 81, armature 82 and make contact of relay CY3 to one end of the winding of decoding relay DR2, the other end of which is connected to battery. Relay DR2 operates and, as indicated on Fig. 4, connects the conductors 51, 52, 53, 54, 55 and 56 to the conductors 62, 63, 64, 65, 66 and 61, respectively.

When the distributor brush RB2 engages segment 1 of the ring R3 a circuit is completed from battery at segment 1 of the ring R3, brush RB2, segment 1 of the ring R4, conductor 80, contacts 72 of the printer which close automatically whenever the selection magnets SM1 to SM6 respectively have received a character signal, winding of the print magnet PM and thence to ground, thereby causing the print magnet to operate and print the character having the code units 1, 3 and 5 marking and the code units 2, 4 and 6 spacing.

In the assumed example, it will be recalled, the second character of the original message had the code units 1, 3 and 5 thereof marking in character whereas, due to the operation of coding relay CR2, Fig. 1, this character was transmitted over the line L as a signal having the code units 2, 4 and 6 thereof marking and the codes 1, 3 and 5 spacing in character. During the second revolution of the receiving distributor, therefore, marking signals will be received during the time that the brush RB1 is in engagement with the segments 3, 5 and 7 of the ring R2 of

the receiving distributor and relays R2, R4 and R6 will be operated and lock by way of conductor 42 to battery at the break contact and armature 43 of relay R.

When the brush RB2 engages segment 3 of the ring R3, battery is applied to conductor 67 extending to armatures 83, 84 and 85 of relays R2, R4 and R6 respectively and thence to conductors 52, 54 and 56, contacts and armatures 86, 87 and 88 of relay DR2, from whence the circuits are continued by way of conductors 63, 65 and 61 to the selection magnets SM1, SM3 and SM5 of the printer PTR thus causing these selection magnets to operate and store within the printer the second character comprising the code units 1, 3 and 5 marking and the code units 2, 4 and 6 spacing in character.

As brush RB1 engages segment 9 of the ring R2, relay R operates thereby releasing relays R2, R4 and R6 and causing the operation of relay CY4 and the release of relay DR2. The operation of relay CY4 at its armature 78 transfers the pulsing circuit comprising the conductor 45 to the next pair of counting relays. When segment 1 of the ring R3 is engaged by the brush RB2 the print magnet PM operates to print the second character stored in the printer selection magnets.

In a similar manner during the third, fourth, fifth and sixth revolutions of the receiving distributor the pairs of counting relays CY5—CY6 to CY11—CY12 are operated thereby controlling the operation of the decoding relays DR3 to DR6 successively to decode the message coded by the relays CR3 to CR6 respectively.

During the sixth revolution of the transmitting distributor, it will be recalled, battery was applied to the line L during the time that the brush B1 was in engagement with segment 10 of the ring R1 of the distributor TD from whence the circuit is continued by way of ring R1 of the receiving distributor, brush RB1, segment 10 of the ring R2 and conductor 89 to the winding of relay P causing relay P to operate. The operation of relay P at its armature 74 removes battery from conductor 75 thereby releasing the relays of the counting chain CY and the decoding relay DR6. The release of counting relay CY2 at its armature 46 causes relay CY1 to reoperate over the following circuit: battery, armature 44 and break contact of relay R, conductor 45, armature 46 and break contact of relay CY2, winding of relay CY1 and thence to ground. The operation of relay CY1 at its armature 49 causes the decoding relay DR1 to operate. As the brush RB1 leaves segment 10 of the ring R2, the relay P releases and when the brush RB2 engages segment 1 of the ring R3, the print magnet PM operates to print the last character received and stored within the printer. The receiving apparatus of Fig. 2 has now completed a complete cycle of operations and restored to normal.

Whereas in the foregoing example, the system of Figs. 1 and 2 has been described with reference to transmitting and receiving six characters before restoring to normal it is not so limited as a greater or lesser number of coding and decoding relays CR and DR with their associated control relays and switches may be provided whereby any desired rearrangement of the code units may be employed for transmission of the message signals.

Thus, where a six-unit code is employed, the possible number of different connections of the contacts of the coding relays CR will be factorial 6, which is 720, and therefore it is possible to employ 720 coding relays each differently connecting the segments 2 to 7 of the distributor TD to the tongues 23 of the tape transmitter TTR. With such an arrangement it will be appreciated that the possibility that any given character in a message will be represented a second time in the message by the same code combination is so extremely remote as to prevent deciphering of the message by unauthorized parties. In addition to this, the arrangement of the coding relays in each of the groups may be changed within the group and the groups may be changed with respect to each other, thus increasing the number of coding arrangements for which the system is adapted. In the group of coding relays shown in Fig. 1, each of the coding relays CR is connected in a different manner to the tongues of the tape transmitter, and it will be appreciated that if two or more of the coding relays are connected in an identical manner to the tongues, this will further increase the number of possible coding arrangements.

Furthermore, the cycle of coding and decoding operations may be repeated at more frequent intervals, if desired, by operating any of the switches of Figs. 1 and 2. If, for example, the switch 40 of Fig. 1 and the switch 91 of Fig. 2 were moved to the positions indicated in dotted outline on the drawings, the operation of relay CT4, Fig. 1, at armature 35 thereof switches the pulsing circuit by way of switch 40 and conductor 50 to the pair of counting relays CT11—CT12. In a similar manner, the operation of relay CY4, Fig. 2, at armature 78 thereof, switches the pulsing circuit by way of switch 91 and conductor 90 to the pair of counting relays CY11—CY12.

The coding relays CR1, CR2 and CR6 and the decoding relays DR1, DR2 and DR6 operate successively to code and decode the successive characters of a message according to the connections set up at the contacts of these relays, the code thus being altered three times before the cycle of operations just described is repeated.

The apparatus and circuits comprising the transmitting and receiving system of Figs. 5 and 6 respectively will now be described with reference first to the receiving printer shown on Fig. 7 and subsequently with reference to the stock quotation receiving and posting system of Fig. 8 wherein the stock prices are simultaneously displayed on market quotation boards at a plurality of brokers offices.

Referring first to Fig. 5, there is shown thereon a tape transmitter TTR having the tongues 92 thereof in electrical circuit with the armatures 93, 94, 95, 96, 97 and 98 of the transmitting relay TR, the make contacts of this relay being connected to conductors 101, 102, 103, 104, 105 and 106 respectively. The operation of the coding relays A2 to F2 connects these conductors to conductors 111, 112, 113, 114, 115 and 116 in accordance with the particular coding relay operated generally in the manner of the circuit arrangement of Fig. 1. The group of conductors 111 to 116 are connected by way of break contacts of relays N and S to the radio transmitters RT1, RT2, RT3, RT4, RT5 and RT6, each of which is adapted to transmit a radio signal superimposed upon a carrier wave, having a different frequency from the others of the radio transmitters, whenever a signal is impressed upon the signal control circuits connected thereto.

The operation of the coding relays A2 to F2 in successive order is controlled by the relay counting chain comprising the relays A to F1.

The impulse machine IM comprises a motor 99 connected by the clutch 100 to a shaft 110 carrying a gear 107 which engages the gears 108 and 109 thereby operating the shafts 118 and 119 to rotate the impulse cams 121 and 122 in accordance with the gear ratios of the gears 108 and 109. Thus the cams 121 and 122 may rotate at the same speed, or the cam 122 may make several revolutions while the cam 121 is making a single revolution, the cam 122 controlling the rate at which a message is transmitted and the cam 121 controlling the frequency at which the code is altered. Thus, by the proper selection of the gears 108 and 109, the code may be altered after each character is transmitted or after a group of characters have been transmitted by the transmitters RT1 to RT6.

The cam arrangement of Fig. 13 may be employed, if desired, with the impulse machine IM, wherein the single lobe cam 121 of Fig. 5 is replaced by a cam 121' having two lobes arranged to operate the impulse spring 139 at irregular intervals, for example, after one character has been transmitted and again after three characters have been transmitted by the transmitters RT1 to RT6, thus providing an arrangement whereby the permutation code is changed at irregular intervals. For example, the cam 121' may be employed to alter the code after two and six characters respectively have been transmitted by the proper choice of the gear ratio between the gears 107 and 109. It will be understood that the cam 121' may comprise more than two lobes thereby changing the code three or more times during each revolution thereof and after three or more groups of characters have been transmitted, each group comprising a different number of characters. It will also be understood that the two lobes shown on Fig. 13 may be in such spaced relationship to each other that two and three characters respectively, or any other number of characters may be transmitted before the spring 139 operates. Regardless of the particular arrangement of the cam 121' employed, the jockey wheel 125 prevents the cam 121' coming to rest in any position such that spring 139 is in electrical circuit with contact 145.

The clutch 100 is held in engagement by the clutch magnet CM which, when energized, attracts its armature and moves the clutch arm 123 to cause the clutch to operate and drive the shaft 110 by the motor 99. When the clutch magnet CM is deenergized the retractile spring 124 operates to disengage the clutch and bring the shaft 110 and impulse cams 121 and 122 to rest. The shaft 110 is provided with a jockey wheel 125 having protuberances thereon which coact with the roller 126 of the jockey spring 130 to prevent the cams 121 and 122 coming to rest with the lobes thereof in contact with any of their associated impulse springs.

The operation of the transmitting apparatus of Fig. 5 will now be described. The terminals 127 are connected to a source of electrical power and the switch 128 is closed thereby setting the motor 99 in operation.

Assume, for example, that a copious supply of perforated tape 129 has been inserted into the tape transmitter TTR thereby causing the autostop control AC to close its contacts and, furthermore, that the gears 108 and 109 are so selected that the cams 121 and 122 rotate at the same speed whereby the code is altered after the transmission of each character.

The closure of contacts 131 of the impulse machine IM applies battery to conductor 132, armature 133 and break contact of relay A1, winding of relay A from whence the circuit is continued to ground thereby operating relay A. A circuit is now completed from ground at the break contact and armature 134 of relay A1, conductor 135, armature 136 and make contact of relay A, winding of relay A2 and thence to battery thereby operating relay A2 which at the armatures 140 thereof connects the conductors 101, 102, 103, 104, 105 and 106 to conductors 111, 112, 113, 114, 115 and 116 respectively. The closure of contacts 170 of the impulse machine by the cam 122 applies battery to conductor 180 extending to the transmission relay TR to cause relay TR to operate and connect the tongue contacts 92 of the tape transmitter TTR to the group of conductors 101 to 106.

If the first character of the message to be transmitted has the code units 1, 3 and 5 thereof marking and the code units 2, 4 and 6 spacing in character, battery will be applied by the tongue contacts 92 to armatures 93, 95 and 97 of relay TR and make contacts thereof and thus to conductors 101, 103, and 105, the conductor 101 being connected in circuit with the conductor 111 by virtue of the operated condition of relay A2 from whence the circuit is continued by way of break contact and armature 137 of relay N, break contact and armature 138 of relay S to the radio transmitter RT1 causing this transmitter to send out a radio signal of a predetermined frequency of oscillation. In like manner the conductors 103 and 105 are electrically connected by way of conductors 113 and 115 and break contacts of relays N and S to the radio transmitters RT3 and RT5 thereby causing these transmitters to operate and send out a radio signal at their respective frequencies of oscillation. Thus, in the example assumed, with coding relay A2 operated, the operation of relay TR causes a radio signal to be transmitted by the conjoint operation of the transmitters RT1, RT2 and RT3. When interrupter contacts 170 open, relay TR releases and the radio signal is interrupted.

When interrupter spring 139 is operated by the cam 121 battery is removed from conductor 132 and is applied to conductor 141. The removal of battery from conductor 132 caused relay A1 to operate over the following circuit: ground, winding of relay A, make contact and armature 142 of relay A, winding of relay A1, conductor 143, break contact and armature 144 of relay N and thence to battery. The engagement of interrupter spring 139 with contact 145 applied battery to conductor 141, winding of relay S from whence the circuit is continued by way of conductor 146, make contact and armature 147 of relay A2 to ground thereby causing relay S to operate and at its armatures 138, 148, 149, 150, 151 and 152 disconnect the transmitting stations RT1 to RT6 from the group of conductors 111 to 116 and apply battery at conductor 153 to the transmitters RT1, RT2, RT3, RT4 and RT5 to transmit a signal comprising the code units 1 to 5 marking and unit 6 spacing in character and cause the counting relay chain in the receiving station, Fig. 6, to step and prepare the apparatus thereat to receive the next message signal in a different code.

The operation of relay S at its armature 154 removes ground from conductor 155, armature 156 and make contact of relay A2 and one end of the winding of relay A2, thereby causing re-

lay A2 to release. Relay A2 is slow to release thereby maintaining ground, at its armature 147 and make contact thereof, on the conductor 146 for a sufficient length of time to hold relay S operated until after the counting relay chain at the receiving station has operated. When relay A2 releases, ground is removed from conductor 146 and relay S releases.

When impulse spring 139 again engages contact 131 battery is applied to conductor 132, armature 133 and make contact of relay A1, armature 159 and break contact of relay B1 and thence to the winding of relay B thereby operating relay B and thus causing relay B2 to operate and connect the group of conductors 101 to 106 to the conductors 111 to 116 in accordance with the altered code arrangement employed. The first message signal and the code shift signal have now been transmitted.

As the contacts 160 of the interrupter cam 122 close, ground is applied to conductor 157 extending to the tape step magnet TS thereby operating the magnet to step the next transverse row of perforations of the tape into the tape transmitter TTR. A cycle of operation for the transmission of a single character of a message has now been completed.

In a similar manner, the second, third, fourth, fifth and sixth characters are transmitted by the radio stations RT1 to RT6 in accordance with the wiring arrangement of the coding relays B2 to F2, a code change signal following each character signal. When relay F2 operates preparatory to sending the sixth coded signal, a circuit is closed from grounded armature 158 of relay F2 to one end of the winding of relay N which operates when the interrupter spring 139 is moved into engagement with contact 145. The operation of relay N at its armatures 137, 161, 162, 163, 164 and 165 connects battery at conductor 153 by way of break contacts and armatures 138, 148, 149, 150, 151 and 152 of relay S to the transmitting stations RT1, RT2, RT3, RT4, RT5 and RT6 thereby sending a signal comprising the code units 1, 2, 3, 4, 5 and 6 marking in character to normalize the receiving apparatus. The operation of relay N at its armature 144 removed battery from conductor 143 thereby releasing the operated relays of the counting relay chain. When armature 158 of relay F2 moves away from its make contact, ground is removed from the winding of relay N and relay N releases. The engagement of interrupter spring 139 with the contact 131 applies battery to conductor 132, armature 133 and break contact of relay A1 and thence to the winding of relay A, thereby operating relay A and causing the coding relay A2 to operate and prepare the code connections for the seventh message signal to be transmitted.

Referring now to Fig. 6 of the drawings, the radio signals transmitted by the apparatus of Fig. 4 are received by the radio receiving stations RC1 to RC6, each of which is adapted to respond to signals from the transmitting stations RT1 to RT6 respectively. The operation of receiving station RC1 operates relay L1 to battery on conductor 166. In similar manner the operation of receiving stations RC3 and RC5 causes relays L3 and L5 to operate. When relay L1 operates, battery at conductor 167 is applied through break contacts and armatures 193 and 195 of relays L2 and L4 respectively in parallel to conductor 168, armature 169 and make contact of relay L1 and thence to conductor 171.

Relay RC2 of the counting relay chain is operated from battery at armature 177 and break contact of relay ST, conductor 178, armature 179 and break contact of relay RC1, winding of relay RC2 and thence to ground. The operation of relay RC2 at its armature 181 completes a circuit from ground at break contact and armature 182 of relay RC1 to the winding of relay DC1, which operates and connects the group of conductors 171 to 176 to the group of conductors 183 to 186 respectively thereby continuing the circuit including conductor 171 by means of the make contact and armature 189 of relay DC1 to conductor 183 connected to slip connection 191 and thus applying battery to conductor 192 extending to the first selection magnet SM1 of the printer PTR. Since the other end of the winding of this selection magnet is connected to ground, the selection magnet SM1 operates to store the first unit of the character code signal. In like manner the selection magnets SM3 and SM5 are operated by the relays L3 and L5 to store the third and fifth code units respectively of the first character of the message. When the transmission of the character signal is terminated the relays L1, L3 and L5 release and at their armatures 169, 194 and 196 remove battery from the conductors 171, 173 and 175.

After the character signal is received by the receiving apparatus, the transmitting stations, it will be recalled, send out a stepping signal comprising the code units 1, 2, 3, 4, and 5 marking and the code unit 6 spacing in character. The receiving stations RC1 to RC5 respond to this stepping signal thereby causing relays L1 to L5 to operate and at their armatures 169, 193, 194, 195 and 196 remove battery from conductor 168 thereby preventing the operation of any of the selection magnets of the printer while this signal is being received.

Relay ST operates over the following circuit: battery on conductor 166, make contact and armature 198 of relay L1, make contact and armature 199 of relay L2, make contact and armature 201 of relay L3, make contact and armature 202 of relay L4, make contact and armature 203 of relay L5, conductor 204, winding of relay ST and thence to ground. The operation of relay ST at its armature 205 applies battery to conductor 206, slip connection 207, conductor 208, printer contacts 209, which close whenever any of the selection magnets SM1 to SM6 have been operated, winding of print magnet PM and thence to ground thereby operating the magnet PM and causing the printer to print the character having the code units 1, 3 and 5 marking and the code units 2, 4 and 6 spacing in character.

When armature 177 of relay ST moves away from its break contact, battery is removed from conductor 178 thereby operating relay RC1 over a circuit from ground, winding of relay RC2, make contact and armature 211 of relay RC2, winding of relay RC1, break contact and armature 212 of relay UL and thence to battery. The operation of relay RC1 at its armature 182 removes ground from one end of the winding of relay DC1 thereby causing relay DC1 to release. When the stepping signal has terminated, relays L1 to L5 and ST release and relays RC4 and DC2 operate to prepare the apparatus to receive the second character of the message in accordance with the code altered by the coding relay B2, Fig. 5, and to decode the same and operate the printer PTR to print the decoded character.

The cycle of operations just described is re-

peated causing the relay counting chain to operate and control the operation of decoding relays DC3 to DC6 in successive order until the sixth character has been decoded by the relay DC6 after which the stepping signal comprising the code units 1 to 5 marking is replaced by the release signal comprising the code units 1 to 6 marking in character, the relays ST and UL operating in response to this signal as receiving station RC6 caused relay L6 to operate and at its armature 213 and make contact thereof close as circuit from battery on conductor 204 to the winding of relay UL and thence to ground. The operation of relay UL at its armature 212 removed battery from conductor 214 extending to the relay counting chain thereby releasing the operated ones of the counting chain relays and the decoding relay DC6. The release of the relays L1 to L6 at the termination of the release signal caused relays UL and ST to release and relays RC2 and DC1 to operate and prepare the apparatus and circuits of Fig. 6 to receive the next succeeding character of the message.

The apparatus for displaying stock prices and the like on electric display boards and the control apparatus therefor is shown in diagrammatic form on Fig. 8 of the drawings, the apparatus comprising, among other elements, a set of sending relays SR1 to SR5 and a distributor D for controlling the receiving and selecting mechanism R over a single line wire 200 to post the close, open, high, low and last prices upon a selected group of stock indicating devices such as those selected by the relay designed W. The mechanism for selecting and actuating the electromagnetic digit indicators represented diagrammatically on Fig. 8 of the drawings by the rectangle designated R is disclosed in the copending application of Merton L. Haselton for Electrical indicating means, Serial No. 310,719, filed October 6, 1928, now Patent No. 2,248,820, issued July 8, 1941.

In this embodiment of the present invention the printer PTR is disconnected from the group of conductors 183 to 188 and conductor 206 and the relay STR and sending relays SR1 to SR5 are connected in any suitable manner such as by slip connections, switch contacts or the like, to the conductors 206, 183, 184, 185, 186 and 187 respectively. Thus, when a siganl is received by the relays L1 to L5, Fig. 6, it is decoded by the operated ones of the decoding relays DC1 to DC6 into the original message signal comprising a five unit permutation code which is impressed upon certain of the conductors 183, 184, 185, 186 and 187 in combination to cause the relays SR1 to SR5 to operate selectively and at theiir armatures 215 apply battery to certain of the segments 1 to 5 of the ring R1 of the distributor D in accordance with the operated condition of the sending relays SR. The operated ones of the sending relays SR lock by way of their make contacts and armatures 216, conductor 217, armature 218 and break contact of release relay RR and thence to battery.

When the code shift signal is received by the relays L1 to L5 causing relay ST to operate, battery at armature 205 thereof is applied to conductor 206 thereby operating the start relay STR, Fig. 8. The operation of relay STR at its armature 218 applies battery to the distributor start magnet DSM causing it to operate and set the distributor D in operation to transmit the signal stored in the sending relays SR to the reeciving station R, the circuit therefor comprising the distributor brush DB, segment 1 of the ring R2 and

the line 200. The operation of relay STR at its armature 219 applies battery to conductor 221, segment S of the ring R1, brush DB, segment 1 of the ring R2 and thence to the line 200 thereby setting the receiving station distributor in operation to receive the message signal during the passage of the brush DB over the segments 1 to 5 of the ring R1.

When the brush DB engages segment 6 of the ring R1 a circuit is established from ground at segmet 2 of the ring R2, brush DB, segment 6 of the ring R1, conductor 222, winding of relay RR and thence to battery thereby causing relay RR to operate. As armature 218 of relay RR moves away from its break contact, battery is removed from conductor 217 and the relays SR1 to SR5 are thus all restored to their unoperated positions.

Since the code shift signal persisted for a less period of time than that required for the distributor to complete its revolution, battery will be removed from conductor 206 releasing relay STR and the distributor is thus brought to rest with the brush DB resting on segment S of the ring R1. The first character of the message comprising the stock range signal has now been transmitted to the receiving station R.

In similar manner, the stock selection and price signals are transmitted during succeeding revolutions of the distributor D until a complete stock quotation has been transmitted, the receiving station R functioning automatically to select the stock relay, as for example the relay W, Fig. 8, and to post the quotation upon the indicators of the selected stock, such as for example a last price of 99⅝ for the stock Western Union corresponding to the relay designated W. The line wire 200 may be branched as 223 whereby several receiving stations R may be operated simultaneously by the distributor D.

In Figs. 9, 10 and 11 of the drawings, there is disclosed a system for converting a telegraph message into a differently coded message, the system comprising a transmitting mechanism on which a message may be set up, a system of coding and counting relays for converting the telegraph signals set up by the transmitting mechanism into a plurality of different codes as the telegraph transmitter is operated to transmit successive character signals and a telegraph printer for recording the characters represented by the different coded signals received. More specifically, the transmitting mechanism comprises a set of key levers 224 pivoted at 240 and arranged substantially like those of an ordinary typewriter which cooperate with a set of six permutation bars 225 arranged underneath and at right angles to the key levers. The permutation bars 225 have notches 226 differently arranged on their top surface in such a manner that they are positioned in one of two positions in various combinations representative of the actuated key lever. Extending beneath all the key levers is a universal bail 227, Fig. 9, which is adapted to pivot in a counter-clockwise direction whenever a key lever is actuated. The universal bail 227 cooperates with a hooked lever 228 and a three armed lever 229 pivoted at 230 to actuate a clutch throwout lever 231 whenever a key lever is depressed. The clutch throwout lever cooperates with a clutch operated by a continuously running shaft 234 and indicated in general by the reference numerals 232, to release a shaft 233 for one revolution at a time in a manner well known in the art.

Associated with each of the permutation bars

225 is a set of individual levers 235 each of which is pivoted at 236 and is associated with a contact actuating bell crank lever 237. The contact actuating levers 237 are pivoted at 238 and each has an associated cam 239 on the shaft 233 in which are single notches such as 241 all in substantial alignment. With the permutation bar 225 in its right hand position as shown in solid outline in Fig. 10, the associated lever 235 is adapted to be in a position to restrain upward movement of the right hand end of its associated contact actuating lever 237 as the notch 241 in its associated cam 239 rotates into operative relation with the cam following projection 242. With a permutation bar 225 in its left hand position the upper end of its associated lever 235, as shown by the dot-dashed outline thereof, is pivoted out of operative relation with the right hand end of its associated contact actuating bell crank 237 and therefore as its associated cam 239 rotates, it being released as hereinbefore described, the bell crank 237 is permitted to pivot a slight amount in a counter-clockwise direction by means hereinafter described.

In the normal position of the bell crank 237 as shown, the associated contacts 243 are held in an open condition and when the bell crank pivots in a counter-clockwise direction as described, the contacts 243 are allowed to close. Thus, depending upon the settings of the permutation bars 225, the contacts 243 are allowed to close or remain open in a combination which represents the designation of the actuated key lever.

A seventh contact actuating bell crank 237*a* has an associated cam 239*a* which invariably operates to close its associated universal contact 243*a* on every revolution of the shaft 233. The cams 239 operate their associated contact actuating levers 237 during the first part of the revolution of the shaft 233 whereas the cam 239*a* operates its contact actuating lever 237*a* near the end of a revolution of the shaft 233. One of the springs of the contacts 243 is connected to positive potential and the others by conductors 244 to the coding relay system as shown in Fig. 9. One side of the universal contacts 243*a* is connected to a source of potential and the other through the coil of the stepping relay SP to ground in such a manner that the relay SP operates whenever the contacts 243*a* are closed.

The operation of relay SP at its armature 245 interrupts a circuit from positive source of potential by way of conductor 6*a* to the counting relay chain of the coding system to cause the operation of the next succeeding coding relay. As armature 245 of relay SP engages its make contact, battery is applied by way of conductor 246 to the printer contacts 209*a* and thence to the print magnet PM of the printer PTR from whence the circuit is continued to ground, thereby operating the print magnet to print the character stored in the selection magnets SM1 to SM6. The coding system of Fig. 9 may be similar to the coding relay system of Fig. 1, the conductors designated 244 corresponding to the group of conductors 11 to 16, the conductor 6*a* to the conductor 6 and the conductor 17*a* to 22*a* to the conductors 17 to 22 respectively. The relay SP corresponds to the relay G of Fig. 1 and is operated by the closure of contact 243*a* of the transmitting mechanism whereas in Fig. 1, relay G is operated by the brush B2 engaging segment 2 of the ring R3 of the transmitting distributor.

The connections between the conductors 244 and the group of conductors 17*a* to 22*a* are controlled by the particular coding relay operated, for example, the arrangement according to Fig. 3 may be employed or it may be in accordance with the arrangement of Fig. 4, as the case may be, or any other suitable arrangement may be employed.

Thus, by the system shown on Fig. 9, a telegraph message may be converted into a message in cipher, for example, by employing a coding system having the arrangement of Fig. 3, and the message in cipher will be printed by the telegraph printer PTR. This cipher may then be transmitted by a telegraph operator to a distant city and then received and set up on the keyboard of Fig. 9 which has associated therewith a coding system in accordance with the arrangement of Fig. 4, thereby automatically decoding and printing the message in its original form by means of the printer PTR.

To facilitate the rearrangement of the sequence of different codes or the employment of different code changes for different messages in the transmitting and receiving apparatus, the incoming lines L1, L2, L3, L4, L5 and L6 corresponding, for example, to the conductors 11 to 16, Fig. 1, may terminate on jacks 248 as shown in Fig. 12 and the contacts of the coding relays designated generally by the numeral 249 may be connected by means of flexible conductors 251 to plugs 252. Thus, by merely inserting the plugs 252 of any coding relay into a set of jacks 248 associated with the lines L1, L2, L3, L4, L5 and L6, the operation of the coding relay will establish any desired relationship between the lines L1 to L6 and the outgoing lines OL1 to OL5 corresponding, for example, to the conductors 17 to 22, Fig. 1. Whenever any such change in the coding arrangement of the transmitting station takes place, it will be understood that a corresponding complementary change is to be made in the coding arrangement of the receiving station by rearranging the plugs in the different jacks thereat, whereby the cipher message will be automatically decoded into its original form at the receiving station.

While the invention has been described with reference to certain preferred examples thereof which give satisfactory results, it will be understood by those skilled in the art to which the invention pertains, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is my intention therefore to cover in the appended claims all such changes and modifications.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a system of the character disclosed, a source of permutation code signals respectively corresponding to the different characters of a message, means including a plurality of coding relays for converting the character signals into a plurality of different permutations, a counting mechanism for operating the coding relays in succession, an outgoing communication channel, distributor structure for transmitting the differently permuted character signals over said channel, and means included in said distributor structure for controlling the operation of said counting mechanism as the distributor operates.

2. In a system of the character disclosed, a source of permutation code signals each representing a character of a message, said source comprising a plurality of transmitting elements,

a group of conductors in electrical circuit with said transmitting elements, a plurality of coding relays, means comprising a counting relay chain for operating said coding relays in predetermined order, distributor structure comprising a plurality of transmitting segments connected to the contacts of said coding relays, means for setting up circuit connections between said group of conductors and the contacts of said coding relays whereby the operation of each coding relay connects the conductors of the transmitting elements of said source of signals to the transmitting segments of said distributor in any desired order, means operable at will for changing said setting up means to effect changes in said circuit connections thereby to alter the code, and means included in said distributor structure for controlling the operation of the counting relay chain.

3. In a system for the dissemination of a message in cipher, a first group of conductors, means for applying permutation code signals to said conductors in accordance with the different characters of the message, a second group of conductors, a plurality of coding relays each having a plurality of coding contacts to which said first and second groups of conductors are connected for selectively connecting the first group of conductors to said second group of conductors in different combinations to encipher the characters of the message, means including said coding relays and conductors for causing the coding relays to produce enciphered characters corresponding in number to the original characters applied to the relays whereby the encoded message contains but one enciphered character for each original character of the message, cyclic counting mechanism for causing said coding relays to operate successively in a predetermined sequence during a cycle of operation thereof, and switching means for varying the number of coding relays which are effective during said cycle of operation thereby to change the encoding system.

4. In a system of the character disclosed, the combination of a transmitting station having means for setting up coded signals representative of the successive characters of a message, relay coding means for converting said signals into cipher signals, a cyclic relay counting mechanism for operating said relay coding means, a channel of communication, distributor structure operatively connected to the relay coding means for transmitting signals including said cipher signals over the channel, means included in the distributor structure for controlling the operation of said relay counting mechanism as the distributor operates, and means operated by the counting mechanism when a cycle of operations thereof has been completed for causing the distributor to transmit a special signal over said channel.

5. In a system of the character disclosed, the combination of a transmitting station having means for setting up code signals in successive order representative of the characters of a message, means including a cyclic counting chain of relays for converting said signals into cipher signals, means for transmitting signals including said cipher signals to a receiving station, means including a cyclic counting mechanism at the receiving station responsive to the signals received for deciphering said cipher signals and posting the characters of the message represented thereby, means at the transmitting station operated by the counting relays for releasing the counting relays and for transmitting a special signal to the receiving station, and means at the receiving station responsive to said special signal for restoring said counting mechanism to a predetermined position.

6. In a system of the character disclosed, a transmitting station having a source of coded signals representative of the different characters of a message, means including a set of coding relays each operable in succession for converting the coded signals into a different code in accordance with the coding relay operated, a counting mechanism for successively operating said coding relays, a channel of communication, means including a transmitting relay for transmitting said converted signals over the channel, and means for varying at will the number of characters transmitted by said transmitting station during a single operation of said counting mechanism.

7. In a system of the character disclosed, the combination of a transmitting station having a source of coded signals representative of the different characters of a message, means including a plurality of coding relays each operable in succession for converting the coded signals into different codes in accordance with the coding relay operated, means including a counting mechanism for operating said coding relays in succession, a channel of communication, means for transmitting said converted signals over said channel, a receiving station having means for receiving and storing said converted signals, means controlled by said receiving means for decoding and posting the message characters represented by said converted signals, means at the transmitting station for varying at will the number of characters transmitted over the channel during a single operation of said counting mechanism, means operable when a predetermined number of converted signals have been transmitted in any one code for causing said transmitting means to transmit a special signal over said channel, and means at the receiving station automatically responsive to said special signal for controlling the decoding means to decode subsequent converted signals received by the receiving means and cause said posting means to post the characters represented by the converted signals.

8. In a system of the character disclosed, the combination of a telegraph keyboard transmitter having a plurality of signal transmitting contact elements settable in code combinations in accordance with the characters of a message to be transmitted, a universal contact on said keyboard transmitter operable whenever any one of the key levers is actuated, a set of coding relays, a first group of conductors connected to said transmitting contact elements, a second group of conductors connected to said coding relays, a telegraph printer connected to said second group of conductors, means comprising contact members controlled by the coding relays for altering the relationship between the first and second groups of conductors as the coding relays are operated, and means controlled by the universal contact for operating the coding relays in predetermined order to cause the message printed by the printer to appear in cipher.

9. In a system of the character disclosed, the combination of a telegraph printer keyboard having a plurality of contact elements settable in code combinations to represent the characters of a message in cipher, a universal contact on said mechanism adapted to operate whenever any one of the key levers is depressed, a set of decoding relays, a first group of conductors connected to

said contact elements, a second group of conductors connected to said decoding relays, a telegraph printer controlled by said second group of conductors, means controlled by each of the decoding relays for establishing a predetermined relationship between the first and second groups of conductors as the decoding relays are operated

in succession, and means controlled by said universal contact for operating the decoding relays to decipher the message and cause the printer to print the original message represented by the cipher.

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