Aug. 20, 1946. W. Y. LANG ET AL 2,406,020

TELEGRAPH SIGNAL ENCIPHERING MECHANISM

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FIG. 1

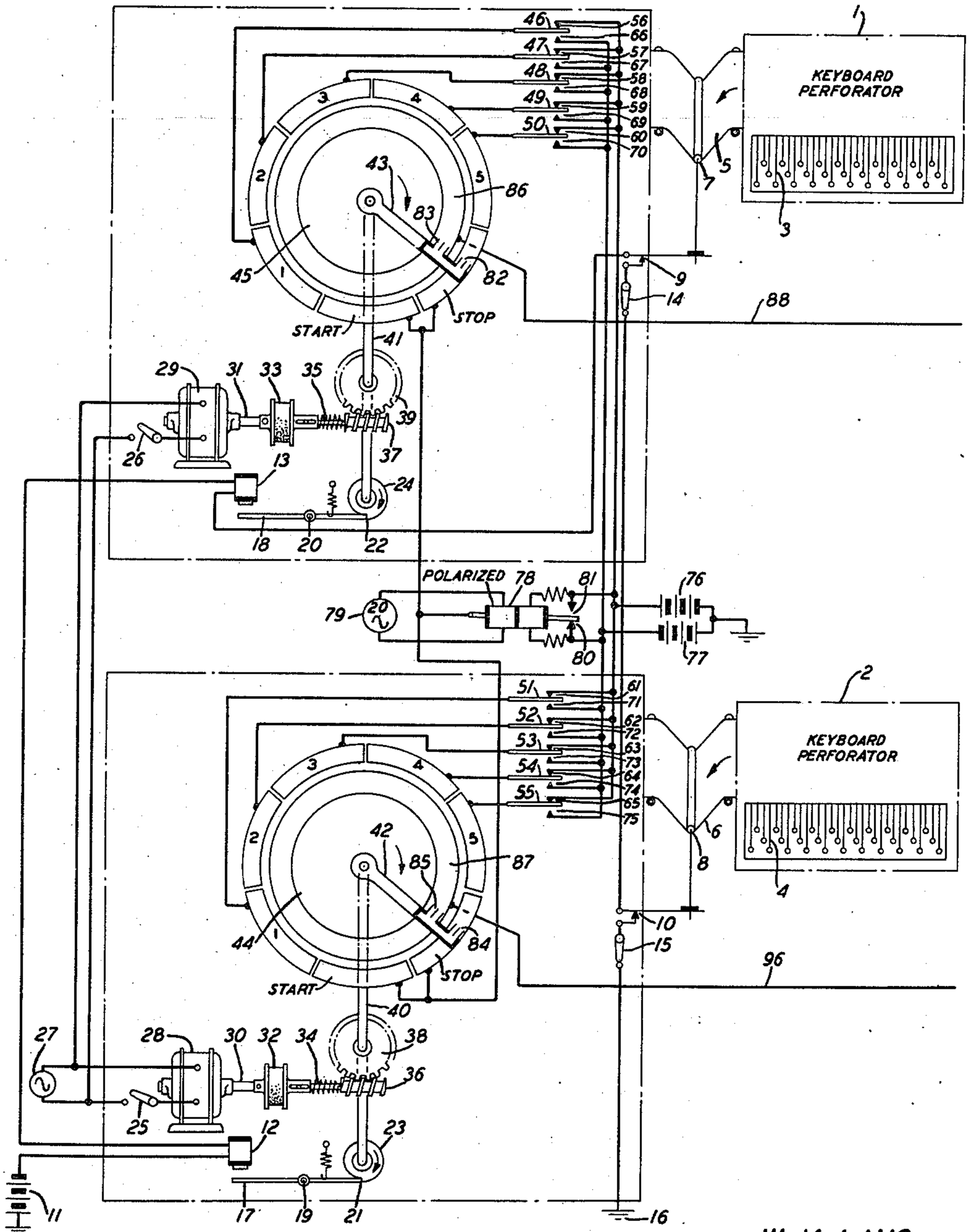

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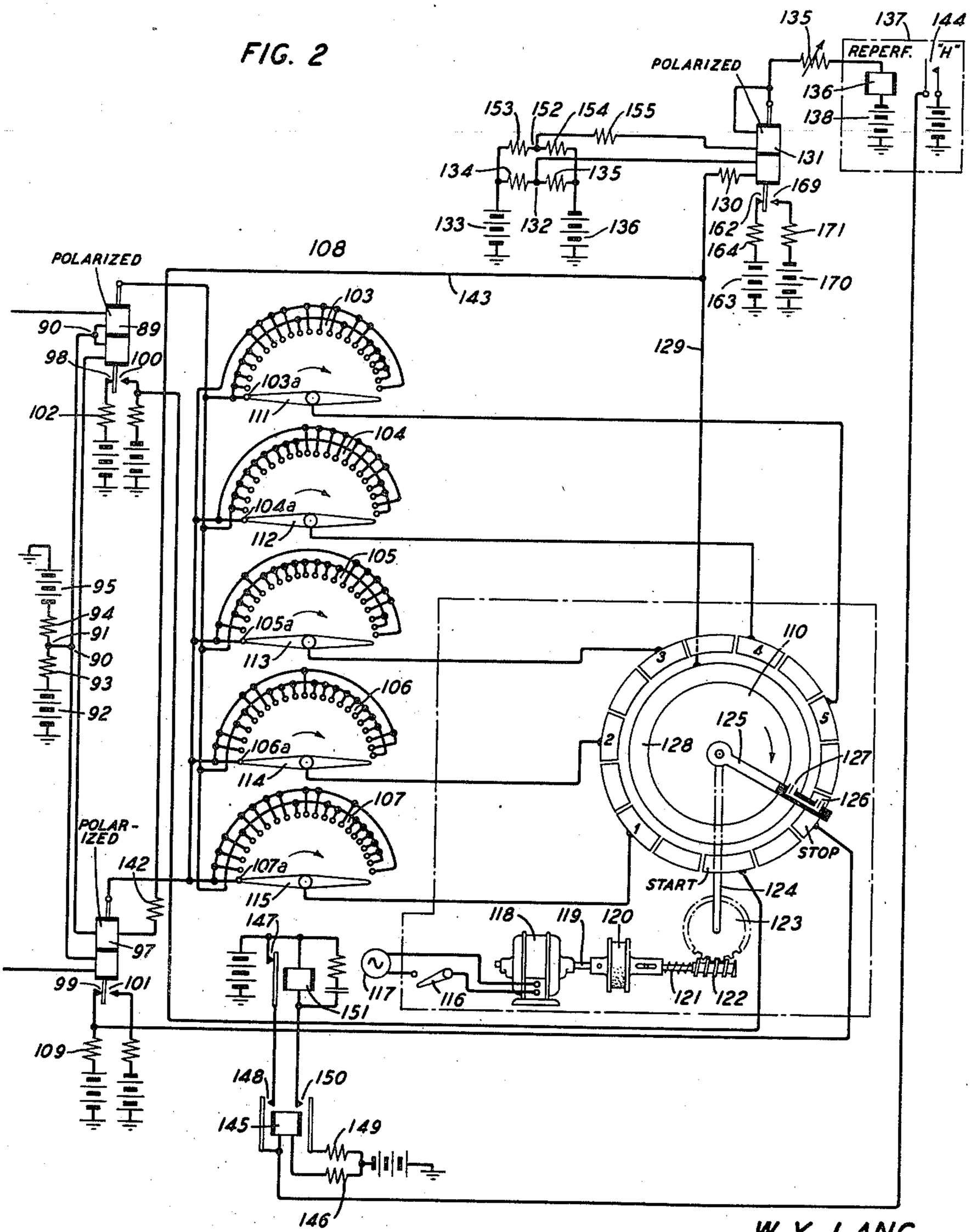
FIG. 2



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TELEGRAPH SIGNAL ENCIPHERING MECHANISM

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10 Claims. (Cl. 178—22)

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This invention relates to enciphering systems for permutation code telegraph signals. More particularly, this invention relates to the full mechanical preparation of random key tape for use in enciphering and deciphering such signals.

There are presently available a number of devices for preparing ciphering key tapes. The present invention has the advantage of employing apparatus used in well-known telegraph systems. No special apparatus is required. The characters in key tapes produced by this method have been found by actual count of frequency and sequence to closely approach perfect random. Further, the device is a full mechanical arrangement. It requires no manual manipulation and a minimum of adjustment.

It is an object of this invention to provide a full mechanical device employing telegraph system apparatus for producing random key tape for an automatic enciphering and deciphering system.

The invention may be understood from the following description when read with reference to the associated drawings in which:

Fig. 1 shows two transmitting distributors to each of which signal elements are supplied from two different sources and in which the signal elements supplied from the two sources are combined so that the output from the distributors is relatively random. One source of signal element supply for each distributor, as shown is an individual punched tape which is produced, as indicated, in an individual keyboard perforator associated with each distributor. This tape is preferably one containing all possible combinations in the code an equal number of times but with the characters punched in random sequence. The tapes in the two transmitters may be in the forms of long repeating loops, but if so they should be of different length. The second source of signal element supply for each distributor is a single vibrating relay which serves both distributors. The trains of signal elements as transmitted by each of the two distributors represent the combination of the signal elements impressed on the distributor by the key tape and the signal elements impressed on the distributor by the vibrating relay. The random signals resulting from the combination of these two signals in each distributor are transmitted through an individual output circuit from each distributor; and

Fig. 2 shows two polar relays each of which receives and repeats the signal supplied by each of the two distributors of Fig. 1. It shows also a five-bank selector in which the signal elements repeated by the two relays are combined and which is arranged to be stepped at intervals to scramble the output from the two polar relays in different manners in response to the production of a specific symbol in the output of the scrambling mechanism. It shows also a distributor in

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which the scrambled signal elements from the selector are selected before they are in turn impressed on an individual polar relay which controls the reperforator.

Refer now to Fig. 1. Switches 14, 15, 25 and 26 are closed. Keyboard perforators 1 and 2 have keys such as 3 and 4. As the keys are depressed, tapes 5 and 6 are perforated in a well-known manner. When sufficient tape has been punched, switch controls 7 and 8 are lowered closing contacts 9 and 10. When contacts 9 and 10 are closed, a circuit is established which may be traced from battery 11 through the winding of magnet 12, winding of magnet 13, contact 9, switch 14, contact 10, and switch 15, to ground 16. Magnets 12 and 13 attract their respective armatures 17 and 18. The armatures are rotated in a clockwise direction around fixed pins 19 and 20, respectively. The right-hand end of each armature is withdrawn from its position against shoulders 21 and 22 of cams 23 and 24. Power is supplied when switches 25 and 26 are closed from source 27 to motors 28 and 29 which rotate shafts 30 and 31. Shafts 30 and 31 are coupled through clutches 32 and 33 to the driven shafts 34 and 35. The driven shafts are coupled through worms 36 and 37 and gears 38 and 39 to the distributor shafts 40 and 41. When the right-hand end of the armatures 17 and 18 are withdrawn from engagement with the shoulders 21 and 22, shafts 40 and 41 are rotated driving the rotary arms 42 and 43 of the distributors 44 and 45.

Depending upon whether a corresponding position in tapes 5 and 6 is punched or unpunched, armatures 46, 47, 48, 49 and 50 associated with tape 5 and armatures 51, 52, 53, 54 and 55 associated with tape 6 will be in engagement with their respective upper contacts 56, 57, 58, 59, 60, 61, 62, 63, 64 and 65 or their respective lower contacts 66, 67, 68, 69, 70, 71, 72, 73, 74 and 75. Each of the armatures 46 to 55 which is in engagement with its upper contact will supply positive battery from source 76 to a particular segment of the group numbered 1 to 5 on the outer ring of distributor 44 or 45. Each of armatures 46 to 55 which is in engagement with its lower contact will supply negative battery from source 77 to a particular segment of the group numbered 1 to 5 on the outer ring of distributor 44 or 45. It is pointed out that armatures 46 to 50 are connected to segments 1 to 5 of distributor 45 and that armatures 51 to 55 are connected to segments 1 to 5 of distributor 44. The armature of relay 73 is driven from a source of 20-cycle current 79 between its contacts 80 and 81 by the effect of current flowing through its left-hand winding from the 20-cycle source. When the armature of relay 73 engages its upper contact, a circuit may be traced from positive battery 76 through contact 81 and the armature of relay 73 to parallel

branches. The upper branch extends to what are normally the stop segment and the start segment of distributor 45 which are connected in parallel. The lower branch extends to what are normally the stop and start segments of distributor 44 which are connected in parallel. When the armature of relay 78 is in engagement with its lower contact 80, a circuit may be traced from negative battery 77 through contact 80 and the armature of relay 78 to the same segments of the two distributors.

As long as there is sufficient slack in tapes 5 and 6 contacts 9 and 10 will remain closed. Magnets 12 and 13 will remain energized. Rotary arms 42 and 43 will continue to rotate. As brush 82 sweeps over each segment of distributor 45 positive or negative battery depending upon which is connected to the segment at the instant will be conducted through brush 83 to solid ring 86. Correspondingly, positive or negative battery momentarily on the segments of distributor 44 will be connected through brushes 84 and 85 to solid continuous ring 87. From the solid ring 86, conductor 88 extends to the top winding of relay 89 and the circuit extends through junction point 90 to the mid-point 91 of the potentiometer comprised of the circuit which extends from ground to positive battery 92, resistance 93, resistance 94 and negative battery 95 to ground. Similarly, conductor 96 extends from the solid ring 87 of distributor 44 through the bottom winding of relay 97 to the mid-point 91 of the potentiometer.

When negative battery is applied through a segment of either distributor to conductors 88 and 96 the armatures of relays 89 and 97 will be actuated to the left to engage their left-hand contacts 98 and 99, respectively. When positive battery is connected through the distributors to conductors 88 and 96, the armatures of relays 89 and 97 will be actuated to the right to engage their respective contacts 100 and 101. The circuit through the bottom winding of relay 89 and through the top winding of relay 97 is used to lock the armature in the position which it has assumed. The manner in which this is performed will be described hereinafter.

When the armature of relay 89 is in engagement with contact 98 a circuit may be traced from positive battery through resistance 102, contact 98 and the armature of relay 89 to terminals on the five banks 103, 104, 105, 106 and 107 of the multibank selector 108. Correspondingly, when the armature of relay 97 is in engagement with its left-hand contact 99, a circuit is established from positive battery through resistance 109, contact 99 and the armature of relay 97 to terminals on banks 103 to 107 of selector 108. It may be observed that, in the case of the bottom left-hand row of terminals of selector banks 103 to 107 designated 103*a* to 107*a*, the armature of relay 89 is connected to terminal 103*a*. The armature of relay 97 is connected to terminals 104*a*, 105*a*, 106*a* and 107*a*. The rotating brushes associated with banks 103 to 107 of selector 108 are connected to five segments, numbered 1 to 5, of rotary distributor 110. Thus, brush 111 connects to segment 5, brush 112 connects to segment 4, brush 113 connects to segment 3, brush 114 connects to segment 2 and brush 115 connects to segment 1. The positive battery connected through resistance 102 and contact 98 to the armature of relay 89 will be impressed through terminal 103*a* of bank 103 and rotary brush 111 on segment 5 of rotary distributor 110. Positive battery connected through resistance 109, contact 99 and the armature of relay 97 will be impressed through terminal 104*a* and rotary brush 112 on segment 4 of distributor 110. Similarly, this same positive battery will be impressed through terminal 105*a* and brush 113 on segment 3, through terminal 106*a* and rotary brush 114 on segment 2 and through terminal 107*a* and rotary brush 115 on segment 1.

When switch 116 is closed, power is supplied from power source 117 to motor 118, driving shaft 119, clutch 120, shaft 121, worm 122, gear 123, shaft 124 and rotary arm 125 of distributor 110. When arm 125 has rotated into the position so that brush 126 engages segment 1, positive battery will be connected through brushes 126 and 127, solid continuous ring 128 of distributor 110, conductor 129, resistance 130 and the bottom winding of relay 131 to mid-point 132 of a potentiometer. The potentiometer comprises positive battery 133, resistance 134, resistance 135 and negative battery 136. As the rotary brush 125 of distributor 110 sweeps over segments 2, 3, 4 and 5 it impresses whatever battery condition is found on the bank terminals of the selector on the bottom winding of relay 131. When positive battery is connected to the left-hand terminal of the bottom winding of relay 131, the armature of relay 131 will be actuated to the left. When negative battery is connected to the left-hand terminal of the bottom winding of relay 131, the armature of relay 131 will be actuated to the right.

When the armature of relay 131 engages its left-hand contact 162, a circuit is established from positive battery 163 through resistance 164, contact 162, armature of relay 131, variable resistance 135 and the winding of magnet 136 of the reperforator 137 to negative battery 138 energizing the winding of the reperforator. When the armature of relay 131 engages contact 169, negative battery 170 is connected through resistance 171 and contact 169 to the circuit which extends through the winding of magnet 136. Negative battery is thus connected to both terminals of magnet 136 and the magnet will be deenergized. As the magnet is energized and deenergized, a tape is perforated in one of its five transverse positions or remains unperforated in a well-known manner.

It was pointed out above that the armatures of relays 89 and 97 were locked in position. The manner in which this is performed will now be explained. A circuit may be traced from the mid-point 91 of the potentiometer associated with relays 89 and 97 through the bottom winding of relay 89, top winding of relay 97, resistance 142, conductor 143, conductor 129, solid ring 128 of distributor 110 and brush 127 to brush 126. As brush 126 engages segments 1 to 5 in successsion, the circuit will be extended in turn through the corresponding selector switch brushes and the particular terminal with which the particular brush is engaged, through the armature of relay 89 or 97, depending upon which of these armatures is connected to the particular bank terminal, to positive or negative battery through contact 98, 99, 100 or 101 depending upon the particular armature and the particular contact with which the armature is in engagement. The bottom winding of relay 89 and the top winding of relay 97 are arranged so that, in response to the connection of the particular battery with which the armature of either relay is in engagement at the moment, the arma-

ture will be maintained in the position which it has assumed during the interval while rotary arm 125 traverses a corresponding segment of distributor 110. If it is assumed, for instance, that the armature of relay 97 has been actuated to the left to engage contact 99 when rotary arm 125 is in position so that brush 126 engages segment 1, the circuit from solid ring 128 will be extended through brush 127, brush 126, segment 1, selector arm 115, terminal 107*a* of selector bank 107, armature of relay 97, contact 99 and resistance 109 to positive battery. The effect of current flowing in this path through the top winding of relay 97 will lock the armature of relay 97 in engagement with contact 99 during the interval that brush 126 is traversing segment 1 of distributor 110. As brush 126 traverses segment 2, the armature of relay 97 which is impressing battery on contact 106*a* will be locked in whatever position it has assumed by the effect of current flowing through its top winding. Correspondingly, when brush 126 of distributor 110 engages segment 3, the locking circuit for the top winding of relay 97 is extended through selector brush 113 and contact 105*a* to the armature of relay 97. When brush 126 traverses segment 4, the locking circuit for the top winding of relay 97 will be extended through brush 112, terminal 104*a* of bank 104 and the armature of relay 97. Depending upon which position the armature of relay 97 has assumed, positive or negative battery will be supplied to the relay armature, through the locking winding on the same relay, while brush 126 traverses the corresponding segments to lock the armature of relay 97 in the assumed position. When brush 126 traverses segment 5, the locking circuit is extended through selector brush 111, terminal 102*a* of selector bank 103, armature of relay 89 and through contact 98 or 100 to positive or negative battery depending upon the position assumed by the armature of relay 89. The armature of relay 89 will be locked in the position which it has assumed by the effect of the current flowing from positive or negative battery through the locking winding of relay 89 while brush 126 traverses segment 5.

It is pointed out that selector brushes 111 to 115 are arranged to step so as to engage terminals in corresponding positions on their respective terminal banks simultaneously. The brushes remain in engagement with a particular terminal for an interval. When the symbol for the letter H or other designated character is produced by the reperforator in the perforated tape, contact 144 is closed in a well-known manner. This establishes a circuit from positive battery through contact 144, winding of relay 145 and resistance 146 to negative battery operating relay 145. When relay 145 operates it locks over a path from positive battery through contact 147, contact 148, winding of relay 145 and resistance 146 to negative battery. The operation of relay 145 also establishes a circuit from negative battery through resistance 149, contact 150 and the winding of the multibank selector stepping magnet 151 to positive battery energizing the stepping magnet. Switch arms 111 to 115 of the multibank selectors are stepped one position to engage the next terminal on their respective terminal banks. The direction of rotation is indicated by the arrow. As the brushes are stepped forward one position, contact 147 is opened. This opens the locking path of relay 145. Relay 145 releases opening contacts 148 and 150. Rotary brushes 111 to 115 will remain in engagement with the second terminal

on their respective terminal banks for an interval until the symbol for the letter H reappears in the punched tape, when the operation will be repeated and brushes 111 to 115 will be stepped so as to engage their respective third terminals, etc.

Attention is called to the fact that the different terminals on terminal banks 103 to 107 are connected to the armatures of relays 89 and 97 in different manners. This has the effect of further scrambling the signals and prevents their recurrence in any decipherable pattern.

Relay 131 is also provided with a locking circuit. This circuit may be traced from the midpoint 152 of the potentiometer, comprising positive battery 133, resistance 153, resistance 154 and negative battery 136, through resistance 155, top winding of relay 131 to the armature of relay 131. Depending upon which contact the armature of relay 131 engages, the locking circuit will extend either through contact 162 and resistance 164 to positive battery 163 or through contact 169 and resistance 171 to negative battery 170.

Attention is directed to the fact that the conducting segments on distributor 110 are separated by insulating gaps. The conducting segments of distributor 110 subtend smaller radial angles than is usually the case in a distributor arranged for the transmission of five-element permutation code telegraph signals. The insulating gaps separating the conducting segments are considerably longer than usual. It was shown above that the armatures of relays 89 and 97 are locked in position during the interval while brush 126 of distributor 110 is sweeping over a particular conducting segment. Since the armature of each of these relays is locked during this interval, time must be allowed to permit each of these armatures to assume a new position in response to a battery pulse of a different polarity if supplied from distributors 43 or 44. For this reason, the insulating gaps separating the conducting segments of distributor 110 are long enough so that the time required for brush 126 to sweep over each of them is sufficient to permit the armature of relay 89 or 97 to assume a new position if required.

It was pointed out also above that the armature of relay 131 was locked in whatever position the armature of relay 131 assumed. While brush 126 is sweeping across a particular conducting segment of distributor 110, the armature of relay 131 will be actuated so as to engage contact 162 or contact 169 depending upon the polarity of the battery supplied from the particular conducting segment. As soon as the armature of relay 131 engages with contact 162 or contact 169, the armature of relay 131 is locked in the position it has assumed by the effect of current flowing from that contact through its top winding. When brush 126 sweeps off a conducting segment, although current is no longer being supplied to the bottom winding of relay 131 through rotary distributor 110 since brush 126 is in engagement with an insulating segment, the locking circuit through the top winding of relay 131 remains effective to maintain the armature in engagement with the contact determined by the polarity of the battery supplied from the conducting segment last engaged by brush 126. The armature of relay 131 will remain locked in position while brush 126 sweeps over the succeeding insulating segment. When brush 126 engages the succeeding conducting segment of distributor 110, current will again be supplied through conductor 129 to the bottom winding of relay 131. If the

polarity of this current is different from that of the current supplied from the last segment engaged by brush 126, the armature of relay 131 will be operated so as to engage its opposite contact since the effect of the current flowing through the bottom winding is dominant over the effect of the current flowing through the top or locking winding of relay 131.

Attention is called to the fact that whereas insulating segments of greater than normal length must be provided on distributor 110 to permit the armatures of relays 89 and 97 to respond to the polarity of the current supplied from distributors 43 and 44 during the interval while brush 126 is sweeping over an insulating segment, provision is made to supply a signal impulse of normal duration to the perforator mechanism. This is of longer duration than would be supplied by the shortened conduction agent on the distributor 110 acting alone. This is accomplished by means of the locking arrangement for relay 131 described above. Its function, as is doubtless apparent, is to maintain the armature of relay 131 in engagement with the contact it has last engaged during the interval while brush 126 sweeps over the succeeding insulating segment.

Positive and negative battery, respectively, are permanently supplied to the stop and start segments of rotary distributor 110 over obvious circuits. The pulses supplied to the bottom winding of relay 131 as brush 126 sweeps across the stop and start segments are, therefore, not varied. A positive pulse is supplied to the bottom winding of relay 131 by the stop segment of distributor 110, operating the armature of relay 131 so as to engage contact 162 and supply positive battery invariably to reperforator magnet 136 energizing the magnet for this condition. A negative pulse is supplied to the bottom winding of relay 131 by the start segment of distributor 110, operating the armature of relay 131 so as to engage contact 169 and supply negative battery invariably to the winding of reperforator magnet 136 deenergizing the magnet for this condition.

Attention is called to the fact that the distributors shown are run at different and unrelated speeds to add to the secrecy.

What is claimed is:

1. A mechanism for producing key tape for a permutation code telegraph system comprising a permutation code signal scrambling device, a key tape perforator controlled by said device and means connected to said perforator for changing the setting of said device in response to the production of a single particular permutation code signal combination defining a particular key character in said perforator, so as to scramble the signal elements comprising the key characters in a different manner, to promote secrecy.

2. A mechanism in accordance with claim 1 which includes a multibank selecting switch having brushes connected in said scrambling device, and means for stepping said brushes to new positions in response to said production of said combination defining said particular key character in said perforator.

3. A mechanism for producing key tape for a permutation code telegraph system comprising a first and a second punched tape, a pattern of punched and unpunched areas in each representing a symbol in a multielement permutation signal telegraph code, and means for combining elements forming part of one of said symbols in each tape into a single pattern of punched and unpunched areas in a single key tape to form a single enciphering symbol.

4. A mechanism for producing key tape for a multielement permutation code telegraph system comprising a tape, punched and unpunched areas in said tape representing a permutation code telegraph symbol, a switch, means for operating said switch to generate telegraph signal elements, and means for combining signal elements forming part of said symbol produced by said tape with signal elements produced by said switch to form in a key tape a single enciphering symbol in a permutation telegraph code.

5. In a telegraph system, a telegraph circuit extending from a point on a potentiometer through a winding on each of two polar relays, through a rotary distributor to a plurality of circuits extending through a plurality of switching devices to an armature on each of said relays and opposed contacts on each of said relays connected to batteries of opposite polarities.

6. In a mechanism for producing key tape for a permutation code telegraph system, a first source of permutation code signal elements connected to a first rotary distributor, a second source of permutation code signal elements connected to a second rotary distributor, a third rotary distributor and means for combining signal elements transmitted from said first and second distributor in said third distributor to form signal elements in the same permutation code for ciphering purposes.

7. A mechanism in accordance with claim 6 including a signal element scrambling device intermediate the signal element output of one distributor and the signal element input of another distributor.

8. A mechanism in accordance with claim 6 including a signal element scrambling device intermediate the signal element output of one distributor and the signal element input of another distributor, and means responsive to the production of a particular character by said mechanism for operating said scrambling device to promote secrecy.

9. In an enciphering system for a permutation code telegraph system, means for producing duplicate enciphering and deciphering key tapes, said means comprising a multibank selector, and means in said producing means for modifying the settings of said selector in response to the production in said key tapes of a particular symbol by said producing means.

10. A system for producing a key tape for enciphering or deciphering permutation code telegraph signals, a first means for producing multielement permutation code telegraph signals in said key tape and a second means, comprising a multibank selector, for altering the signals which would normally be generated by said first means in response to the production of a particular multielement permutation code signal in said key tape so as to produce different signals in said key tape.

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