March 1, 1949. W. M. BACON 2,463,236

SECRET TELEGRAPH SYSTEM

Filed March 9, 1946 2 Sheets-Sheet 1

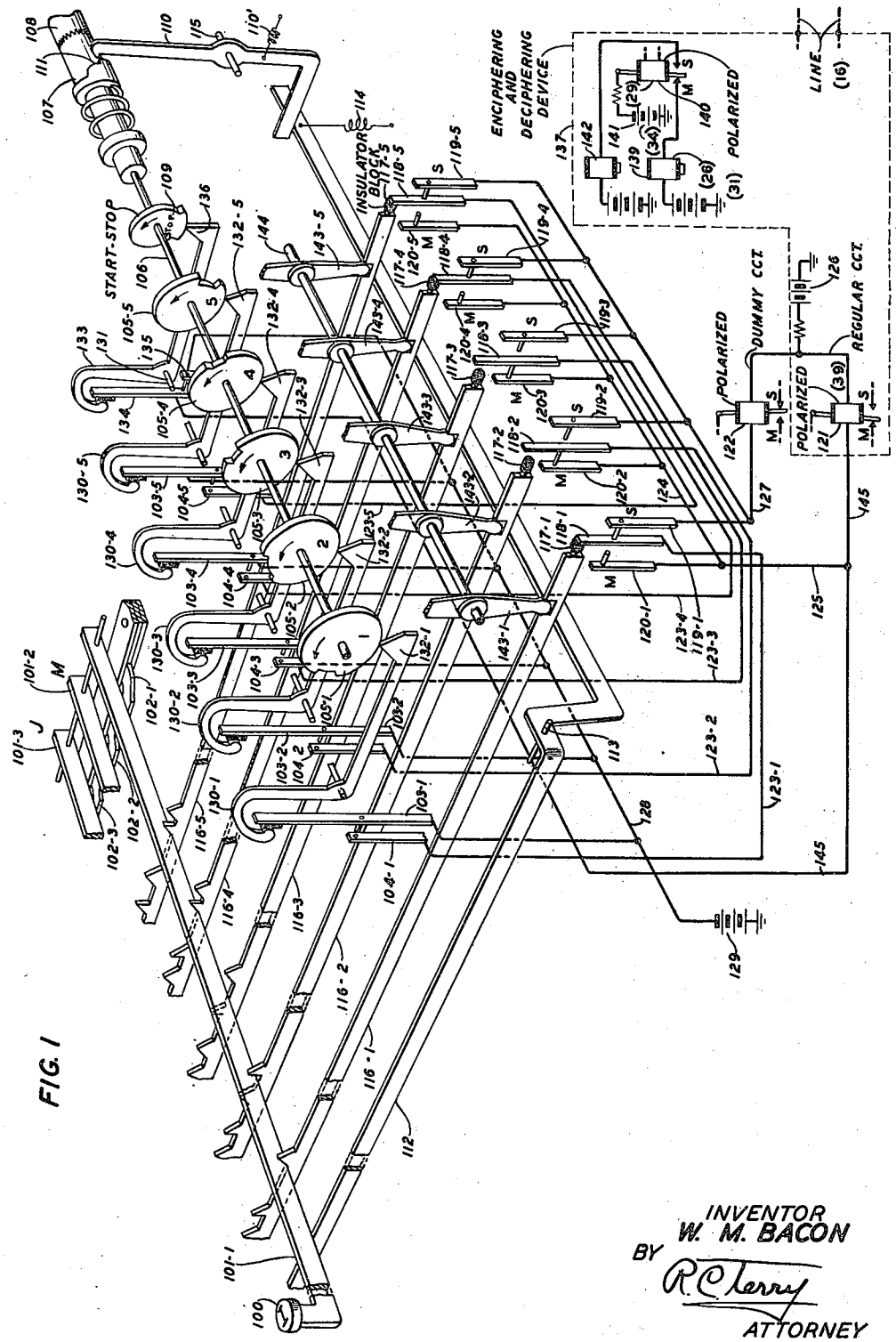

FIG. 1

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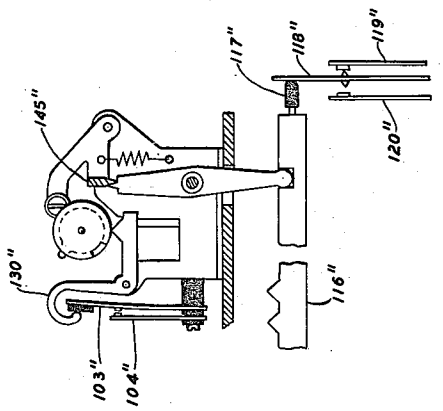

FIG. 1B

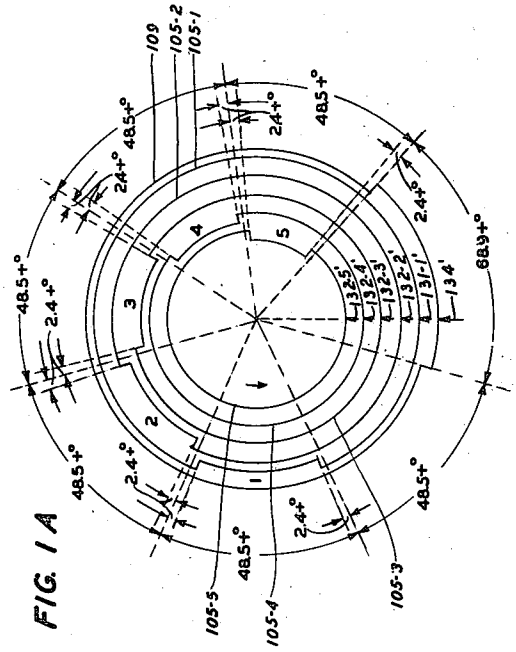

FIG. 1A

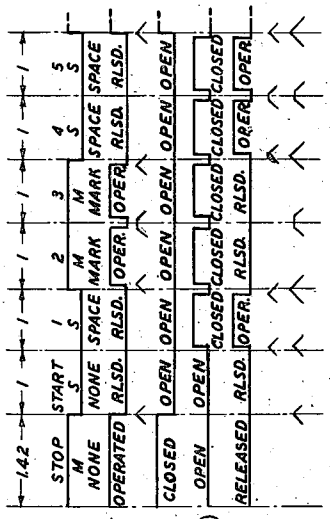

FIG. 1C

(a) RELATIVE DURATION OF PULSES OF START-STOP FIVE UNIT PERMUTATION CODE SIGNALS
(b) SIGNAL WAVE OF CHARACTER (LETTER I) IN PLAIN TEXT (MESSAGE)
(c) CONTACTS CONTROLLED BY CODE BARS 116-1 TO 116-5
(d) CURRENT IN AND CONDITION OF SELECTOR MAGNET 121
(e) PLAIN TEXT "PICK-UP".
(f) CURRENT WAVE IN SELECTOR MAGNET 121 DUE TO CONTACTS CONTROLLED BY STOP CAM 109
(g) CURRENT WAVE DUE TO CONTACTS CLOSURES BY CAMS 105-1 TO 105-5 (CLOSURE 90% OF DOT OF UNIT PULSE)
(h) CURRENT IN AND CONDITION OF DUMMY MAGNET 122
(i) MASKING "PICK-UP"
(j) COMBINED "PICK-UP" (e AND i)

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2,463,236

SECRET TELEGRAPH SYSTEM

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6 Claims. (Cl. 178—22)

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This invention relates to telegraph systems and more particularly to secret telegraph systems.

In telegraph systems, messages are transmitted and received in any well-known code and when intercepted in this condition, during the course of transmission, are intelligible to anyone skilled in the art. However, in secret telegraph systems the message signals are altered for transmission over the line and when intercepted in their altered form are unintelligible.

At the transmitting end of a secret system, these intelligible messages prepared at the transmitter are, before being impressed on the line, enciphered by means of other signals of what is generally known as a key code and the enciphered messages with their altered signals are transmitted over a line so that any interception on the line will cause to be received by the interceptor unintelligible messages. At the final receiving end these unintelligible messages are deciphered by means of other signals identical with those of the key code at the transmitting end and the deciphered messages are recorded to produce the messages as originally prepared.

Heretofore in secret telegraph systems difficulties were experienced in developing a completely shielded device for transmitting messages to the enciphering set or for receiving messages from the deciphering set for recordation. At the sending end where the transmitting device may be a keyboard or an automatic tape transmitter or a transmitting relay of a sending teletypewriter, or at the receiving end where the receiving device may be a line relay or a repeating relay or the selector magnet of a receiving teletypewriter, it has been found that each device upon the "make" or "break" of its operating contacts radiates a short, sharp voltage pulse. These pulses when radiated in a location which is comparatively free from other electrical disturbances and in which a ciphering or deciphering set is operated, may be surreptitiously or otherwise received, or picked up, by a radio receiving device located in an adjacent room or within some other short distance or at a much greater distance along a power or signal wire which is connected to or passed close by the set, and recorded as pulses by an oscillograph. From these pulses appearing on an oscillogram can be constructed the signals of the complete message as originally prepared.

An object of the present invention is to protect a secret message from detection at any point between the point of transmission and its

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associated enciphering set and at any point between a deciphering set and its associated receiving teletypewriter by masking short, sharp voltage pulses picked up from a transmitted message with other pulses so as to produce on an oscillogram, a pattern of voltage pulses that is uniform for all code combinations in the transmitted message.

According to the present invention an arrangement is provided in connection with a transmitting or a receiving teletypewriter for masking the short, sharp voltage pulses which are radiated from the circuit of the message signal repeating, or relaying, element at times corresponding to the transitions of the plain text signals constituting the secret message, by adding other short, sharp voltage pulses radiated from a similar element in a dummy circuit controlled by the plain text signal and having the same electrical characteristics as the circuit of the message signal repeating element. The pulses radiated from both circuits, if received by a radio receiving set located in proximity to the teletypewriter for producing an oscillogram of the combined voltage pulses radiated by both circuits will be arranged in a pattern that is uniform for all code combinations.

A feature of the invention is the provision of means for producing a series of voltage pulses, one for each of the possible transitions in a transmitted signal code combination so as to show on an oscillogram a uniform pattern for all the code combinations of a transmitted message.

Another feature is the provision of means for closing either the plain text signal circuit or the dummy circuit at each of the possible transitions in each of the message signal combinations to produce an oscillogram showing a pattern of voltage pulses that is uniform for all code combinations, that is, each series of pulses will have the same pattern for all signal combinations in the start-stop permutation code.

Another feature is the provision at the sending and/or the receiving end of the system, of a dummy circuit having electrical characteristics identical with those of the plain text signal circuit, the dummy circuit including a repeating relay or operating magnet identical with that of the plain text signal circuit, and two groups of contact sets which jointly function to operate either of the corresponding relays or magnets in response to each of the selecting pulses of each signal combination transmitted or received. The contact sets of one group are respectively oper-

ated by the code bars to either their marking or spacing positions in correspondence with the positions of those bars. The contact sets of the other group are controlled by the cams on the transmitting cam shaft. One contact set of the group controlled by the cams on the transmitting cam shaft is normally closed but arranged to open as soon as the cam shaft rotates out of its stop, or normal, position and remain open until the cam shaft again reaches its stop position at the end of a revolution. The other contact sets of the group controlled by the cams, which respectively correspond to the selecting pulses, are normally open, but are arranged to momentarily close successively once during each revolution of the cam shaft. The printer selector magnet is normally operated inasmuch as it is under the sole control of the contact set which is always closed when the cam shaft is in its stop position and is arranged to release as soon as the cam shaft rotates out of its stop position. It will operate only at such other times during a revolution of the cam shaft as the normally open contact sets corresponding to the selecting pulses and controlled by the cam shaft, are closed and their respectively associated code bar contact sets are in their marking positions. The other magnet, which is in the dummy circuit, is normally in a released condition and is operated only at such times during a revolution of the shaft, as the above-mentioned normally open contact sets are closed and their respectively associated code bar contact sets are in their spacing positions.

Another feature is the provision on a teletypewriter of a rotatable cam shaft having cams arranged to successively close the contact sets respectively corresponding to the selecting pulses of a signal combination. Certain of these closed sets may, depending on the signal combination being transmitted, be included in the operating circuit of the selector magnet to effect its operation in response to each marking pulse and the others may be included in the operating circuit of the dummy magnet to effect the operation of the dummy magnet in response to each spacing pulse, the interval of closure of each pair of contacts being approximately 90 per cent of the duration of the regular interval of a selecting pulse.

The invention will be better understood by reference to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 shows the invention in connection with the transmitting end of a teletypewriter system wherein the teletypewriter is provided with transmitting contact sets arranged to close an operating circuit for the printer selector magnet or transmitting relay in response to each marking selecting pulse of a signal combination to be transmitted from the teletypewriter and to close an operating circuit of a dummy magnet or relay for each spacing selecting pulse, the operating circuit for the dummy magnet having electrical characteristics identical with those of the printer selector magnet circuit. The teletypewriter is shown as a part of a schematic circuit instead of as a part of the actual apparatus.

Fig. 1A represents a superimposed arrangement of the cams on a start-stop rotatable shaft replacing the regular transmitting cam shaft of a teletypewriter for the purposes of the present invention.

Fig. 1B shows an end elevation view of a rotatable transmitting cam shaft assembly as modified in accordance with the present invention.

Fig. 1C is a diagrammatic showing of a plain text signal wave for the letter I in start-stop five-unit permutation code and its effect on both the plain text signal circuit and the dummy circuit of the circuit arrangement illustrated in Fig. 1.

The present invention will be described as applied to the transmitting end of a secret teletypewriter system, it being understood that the invention adapted for operation at the receiving end, will be obvious from the description herein given.

The signal code used herein for transmission is the start-stop, five-unit permutation code which comprises five selecting pulses used in various combinations of "current" and "no current" intervals, namely, "mark" and "space," depending upon the signal transmitted. Each group of five selecting pulses is preceded by a start, or space, pulse and followed by a stop, or mark, pulse, the latter being used to maintain synchronism between the stations in the system. The mark pulses operate the printer selector magnet of a teletypewriter and are known as "marking," and the space or non-operative pulses which cause it to release, are known as "spacing."

The use of reference characters has been kept to a definite plan. Like parts have corresponding reference characters with the addition of primary and secondary symbols in Figs. 1A and 1B respectively.

Referring to Fig. 1, the teletypewriter keyboard transmitter comprises a set of keys represented by key **100**, key levers represented by levers **101—1**, **101—2**, and **101—3**, etc. which are maintained in normal position by springs **102—1**, **102—2** and **102—3**, etc., a bank of contact springs **103—1**, **103—2**, **103—3**, **103—4** and **103—5** in engageable relation with fixed terminals **104—1**, **104—2**, **104—3**, **104—4**, **104—5**, respectively. Cams **105—1**, **105—2**, **105—3**, **105—4**, and **105—5** fixedly mounted on rotatable shaft **106**. Shaft **106** is arranged to be driven by driven clutch member **107** and driving clutch member **108** connected through a set of gears (not shown) to the main shaft of the printer unit which, in turn, is driven by a motor (also not shown). The teletypewriter employed herein may, with certain modifications hereinafter described, be of the type disclosed in U. S. Reissue Patent 20,330, granted to S. Morton on April 13, 1937. For example, what is referred to herein as a printer selector magnet **121** may actually be a repeating relay, such as relay **(39)**, of an enciphering and deciphering device **137** disclosed in K. E. Fitch et al. U. S. Patent 2,405,571, dated Aug. 13, 1946. Other reference characters in parentheses shown in the drawings of the present application represent corresponding elements in K. E. Fitch et al. U. S. Patent 2,405,571. The cams together with start-stop cam **109** mounted on shaft **106** are normally held stationary because clutch members **107** and **108** are held apart by latch member **110** which is normally in engagement with throw-out cam **111**.

When a key, such as key **100**, is momentarily depressed, universal bar **112** which is pivotally supported at each end by a pin, such as pin **113**, and extends beneath all the key levers, is momentarily operated in a counter-clockwise direction around pin **113** to move the free end of latch member **110** in a clockwise direction around pin **115** and against the tension of coil spring **110'**. Latch member **110**, upon being rotated around pin **115** disengages at its free end throw-out cam **111** thereby permitting the driven clutch member **107** to mesh with the driving clutch member

108 to cause cam shaft 106 to rotate about its axis. At the end of one revolution of cam shaft 106, driven clutch member 107 is disengaged from the driving clutch member 108 by the throw-out cam 111 again engaging latch member 110 and the cams on shaft 106 are brought to a stop and remain stationary until the keyboard is again operated. Beneath the key levers 101—1, 101—2, 101—3, etc. are five selector, or code, bars 116—1, 116—2, 116—3, 116—4 and 116—5, and the front portion of the universal bar 112, which extends across the width of the keyboard. The selector, or code, bars are provided with saw-toothed shaped notches arranged according to the requirements of the signal code. These bars rest on rollers (not shown) and are guided at each end so that they may be easily moved endwise. When a key is depressed, the key lever, striking the slanting sides of certain of these notches, will operate one or more of these bars either to the left or to the right depending upon whether the corresponding pulses of the signal combination are to be marking or spacing pulses as described in S. Morton U. S. Reissue Patent 20,330, supra.

Each of the selector, or code, bars has connected to its right end a bumper 117 of insulative material. When each of the code bars 116—1 to 116—5 is moved toward the right it causes its corresponding bumper of bumpers 117—1 to 117—5 to actuate a contact spring member of those designated 118—1 to 118—5 into engagement with a contact member of those designated 119—1 to 119—5, and when moved toward the left withdraws its corresponding bumper to permit its associated spring member 118 to engage its respectively associated contact member of those designated 120—1 to 120—5. The contact spring members 119 are in either of two positions, namely, in engagement with their respectively associated contact members 119 or 120. When the contact spring members 118—1 to 118—5 are in engagement with their respectively associated contact members 120 each is prepared to send a mark pulse to selecting magnet 121 and when in engagement with their respectively associated contact members 119—1 to 119—5 each is prepared to send a space pulse to operate dummy magnet 122.

In connection with Fig. 1B reference may be had to H. L. Krum U. S. Patent 1,595,472, granted August 10, 1926, Fig. 2, for a detailed description of the arrangement for locking code bars 116'' in their set positions until the transmitting cam shaft 106 completes a revolution after each teletypewriter key is operated. None of the keys except the one depressed can be operated until locking bar 145'' is raised. Fig. 1B is substantially similar to Fig. 2 of S. Morton U. S. Reissue Patent 20,330, supra, except that the switch shifters 130'' do not latch during the time that transmitting cam shaft 106 is rotating through a revolution. The reference characters in Figs. 1 and 1B designate like parts.

Each of conductors 123—1 to 123—5 is connected at one end to its respective contact spring member of those designated 118—1 to 118—5 and at the opposite end to its respective terminal member of those designated 104—1 to 104—5. The marking contact members 120—1 to 120—5 are connected to a path extending over conductors 124, 125 and 145, through the winding of selector magnet 121 to grounded positive battery 126. Spacing contact members 119—1 to 119—5 are connected to a path extending over conductor 127, through the winding of dummy magnet 122, to grounded positive battery 126. The contact spring members 103—1 to 103—5 which are engageable with terminals 104—1 to 104—5, respectively, are connected to conductor 128 which extends to the grounded negative battery 129. Contact spring members 103—1 to 103—5 are normally restrained from engaging terminals 104—1 to 104—5, respectively, by means of gooseneck-shaped switch shifters 130—1 to 130—5, respectively, the latter being pivotally supported on rod 131. Switch shifters 130—1 to 130—5, through their respective peak portions 132—1 to 132—5, are at all times in engagement as shown with cams 105—1 to 105—5, respectively. These peak portions may be considered as idlers in continuous engagement with cams 105.

Cams 105—1 to 105—5 have peripheral indents of the same angular distance, spirally arranged with respect to each other so as to follow successively, during the revolution of cam shaft 106, in passing the alignment of points on peak portions 132 whereat the cam indentations are successively engaged. The indentation on each of cams 105—1 to 105—5 subtends an angle about 10 per cent less than the angle subtended by an indentation on each of the selecting cams of a regular transmitting cam shaft of a teletypewriter such as shown in Morton's Reissue Patent 20,330, supra, so that each of the successive closures between contact members 103 and terminals 104 is of a duration slightly less by 10 per cent than the closure of a selecting pulse of the usual start-stop, five-unit permutation code. In other words, the circuit controlled by cams 105 is, during each revolution of shaft 106, opened for the usual "start" pulse and then successively closed for 90 per cent of the duration of each of the next five pulses and closed again for the "stop" pulse.

In accordance with the above, start-stop cam 109 controls in a manner similar to that of cams 105—1 to 105—5 the restraint of gooseneck-shaped switch shifter 133 over contact spring member 134 which is normally in engagement with terminal 135. Peak portion 136 of switch shifter 133 is at all times in engagement with start-stop cam 109 and normally maintains the contact between contact spring member 134 and terminal 135 closed in a circuit traceable from grounded negative battery 129, conductor 128, terminal 135, contact spring member 134, conductor 145, through the winding of selector magnet 121, to grounded positive battery 126, and therefore when the start-stop cam shaft 106 is stationary, the operating circuit for selector magnet 121 is closed to maintain the magnet operated. However, the normally closed contact between contact spring 134 and terminal 135 is opened at the beginning of each revolution of cam shaft 106 to thereby open the operating circuit for selector magnet 121 to send thereto a start, or spacing, signal and the magnet releases. Then cams 105—1 to 105—5, in turn, condition the operating circuit for the five selecting pulses of the signal combination. After the circuit is conditioned for the fifth selecting pulse, contacts of contact spring 134 and terminal 135 are again closed by start-stop cam 109 to close the circuit for the stop, or mark, pulse. The contact between contact spring member 134 and terminal 135 will remain closed until the keyboard is again operated, at which time the clutch driven member 107 will again be permitted to mesh with clutch driving member 108 to start cam shaft 106 through another revolution

thereby conditioning the circuit for another signal.

In the start-stop, five unit permutation code the pulses of each signal are arranged so that the start pulse and each of the selecting pulses Nos. 1 to 5 are of equal duration, that is, unity, and the stop pulse is 1.42 times longer. This would mean that each of the sectors respectively corresponding to the start pulse and the five selecting pulses would have an angular width of 48.5+ degrees and the sector corresponding to the stop pulse would have an angular width of 68.9— degrees as shown in Fig. 1A. However, in order to satisfy the requirements of the present invention, special cams are provided in place of the regular selecting cams on the transmitting cam shaft 106. As hereinbefore stated each of the selecting cams 105—1 to 105—5 has an indentation which is approximately 90 per cent in angular width of those provided on the selecting cams of the ordinary teletypewriter, the indentations provided on cams 105—1 to 105—5 having an angular distance of 48.5+ degrees minus 4.8+ degrees, or 43.7— degrees which is 90 per cent of the angular width of the indentation on the regular selecting cams. This difference of 10 per cent is divided into equal parts for application at the beginning and the ending of each indentation so that all contacts controlled by cams 105—1 to 105—5, as well as cam 109 as hereinbefore stated, are open at the beginning and the ending of each selecting pulse of every signal combination. The reason for decreasing the angular width of the indentations on cams 105—1 to 105—5 is to provide for the release of either the selector magnet 121 after each pulse of a continuous series of marking pulses or the dummy magnet after each pulse of a continuous series of spacing pulses.

The contact spring members 118 are actuated by their respective code bars 116 into engagement with their respectively associated contacts 119 and 120 depending on whether the corresponding selecting pulse of the signal combination is spacing or marking, and remain in such position until the keyboard is again operated. The cam shaft 116 in making one revolution will successively close the operating circuit for selector magnet 121 or dummy magnet 122, the operating circuit selected for closure depending upon the position of the corresponding contact spring member 118 at the time the closure is effected by the corresponding cam but the closure of the particular circuit will be for a duration of only 90 per cent of that of the regular selecting pulse.

As hereinbefore stated, selector magnet 121 may serve as the regular printer selector magnet of a teletypewriter, or as a sending or a repeater relay for transmitting the plain text signals to code ciphering set of device 137 wherein the signals of a key code are superimposed on the plain text signal for transmitting unintelligible signals over the line. With respect to the selecting pulses of each code combination, selector magnet 121 is arranged to operate and release in response to each marking selecting pulse and dummy magnet 122 is arranged to operate and release in response to each spacing selecting pulse of each signal combination, whereby a short voltage pulse is radiated by either magnet at every possible transition and each signal combination radiates a series of pulses that forms a uniform pattern for every signal character that is originally prepared.

The method of operation

The method of operation will now be described with particular reference to Fig. 1—C wherein a start-stop, five-unit permutation code signal representing the letter I is shown in diagrammatic form in line *b* and the relative duration of the regular pulses of each of the signal combinations is indicated in line *a*, the start and each of the five selecting pulses being represented by unity and the stop pulse being represented as 1.42 times longer. When key 100 representing the letter I on the keyboard of the sending teletypewriter is operated, key lever 101—1 is momentarily depressed against the tension of spring member 102—1, to move selector, or code, bars 116—2 and 116—3 toward the left, and selector bars 116—1, 116—4 and 116—5 toward the right unless these bars are already in their respective desired positions. The selector bars 116—1, 116—4 and 116—5 move toward the right to cause their respectively associated contact spring members 118, such as members 118—1, 118—4 and 118—5 to engage "space" contacts 119—1, 119—4 and 119—5, respectively. The selector bars 116—2 and 116—3 move toward the left to cause their respectively associated contact spring members 118, such as members 118—2 and 118—3, to engage their "mark" contacts 120—2 and 120—3, respectively.

The depression of key lever 101—1 or any other key lever of the keyboard, causes universal bar 112 to rotate in a counter-clockwise direction around pin 113 and the free end of the universal bar moves upwardly against the tension of coil spring 114 to cause latch member 110 to disengage throw-out cam 111. When latch member 110 moves out of engagement with throw-out cam 111, driven clutch member 107 is permitted to mesh with driving clutch member 108 and cam shaft 106 is started on a revolution through a single cycle. Should there be no further operation of the keyboard following the operation of a key, such as key 100, latch member 110 having immediately returned to normal under the influence of coil spring 110', would engage throw-out cam 111 at the end of the cycle of cam shaft 106 and the cam shaft would again be locked in its normal position, selector magnet 121 would be maintained operated in its marking position and dummy magnet 122 would be maintained released in its spacing position.

In transmitting the start-stop, five-unit permutation code signal corresponding to the letter I, the space and mark pulses constituting the signal are established by the joint operation of the group of contact sets controlled by cam shaft 106 and the group of contact sets controlled by code bars 116, during a revolution of the shaft 106. The operation resulting from the transmission of the signal may be described in the following manner:

(1) The contact between contact spring member 134 and terminal 135 is opened at the beginning of the start pulse, or first interval, and remains opened for the duration of the five selecting pulses of the signal combination. A start, or space, pulse is sent to the operating circuit for selector magnet 121, and selector magnet 121 having been previously energized, releases in response to the space pulse, the opening of the contact between spring contact member 134 and terminal 135 being due to the removal of the restraint on switch shifter 133 when the stop segment of start-stop cam 109 leaves the peak

portion 136 of shifter 133. The start, or first, interval sector of the cam, now of reduced diameter engages the peak portion 136. The dummy magnet 122 which is normally in a released condition, remains in a released condition.

(2) At the end of the start, or first interval, peak portion 132—1 of switch shifter 130—1 continues on the cam 105—1 of normal diameter for a short distance, say about 2.4+ degrees as indicated in Fig. 1—A or about 5 per cent of the unit interval of a selecting pulse, and then engages the indentation on cam 105—1 to remove the restraint on switch shifter 130—1. This permits the contact between contact spring member 103—1 and terminal 104—1 to close during the second interval that is, for 90 per cent of the unit interval of a selecting pulse, whereby a shortened pulse for the first selecting pulse is transmitted in a circuit extending from grounded negative battery 129, contact spring member 103—1, terminal 104—1, conductor 123—1, contact spring member 118—1 and "space" contact 119—1, conductor 127, through the winding of dummy magnet 122, to grounded positive battery 126 to operate dummy magnet 122 in place of selector magnet 121. Selector magnet 121 is not responsive to a space pulse and therefore remains released.

(3) Near the end of the second interval, peak portion 132—1 of switch shifter 130—1 leaves the indentation of cam 105—1 at a point about 2.4+ degrees, in angular distance, before the beginning of the third interval and continues on cam 105—1 of normal diameter but peak portion 132—2 of switch shifter 130—2 reaches a point, say 2.4+ degrees, in angular distance, beyond the beginning of the third interval where it engages the indentation of cam 105—2 to close the contact between contact spring member 103—2 and terminal 104—2 during the third interval, that is, for 90 per cent of the unit interval. A shortened pulse for the second selecting pulse is therefore transmitted over the circuit traceable from grounded negative battery 129, conductor 128, contact spring member 103—2, terminal 104—2, conductor 123—2, contact spring member 118—2, "mark" contact 120—2, conductors 124, 125 and 145, through the winding of selector magnet 121 to grounded positive battery 126. Selector magnet 121 operates in response to the shortened second selecting pulse which is marking, and dummy magnet 122 was released when peak portion 132—1 left the indentation of cam 105—1 as stated above.

(4) Near the end of the third interval peak portion 132—2 of switch shifter 130—2 leaves the indentation of cam 105—2 at a point about 2.4+ degrees, in angular distance, before the beginning of the fourth interval and continues on cam 105—2 of normal diameter but peak portion 132—3 of switch shifter 130—3 reaches a point about 2.4+ degrees, in angular distance, beyond the beginning of the fourth interval where it engages the indentation on cam 105—3 to close the contact between the contact spring member 103—3 and terminal 104—3 during the fourth interval, that is, for 90 per cent of the unit interval. A shortened third selecting pulse is therefore transmitted over the circuit traceable from grounded negative battery 129, conductor 128, contact spring member 103—3, terminal 104—3, conductor 123—3, contact member 118—3, "mark" contact 120—3, conductors 124, 125 and 145, through the winding of selector magnet 121, to grounded positive battery 126. Selector magnet 121 again operates in response to the modified third selecting pulse which is also marking, and dummy magnet 122 remains released.

(5) Near the end of the fourth interval peak portion 132—3 of switch shifter 130—3 leaves the indentation of cam 105—3 at a point about 2.4+ degrees, in angular distance, before the beginning of the fifth interval and continues on cam 105—3 of normal diameter but peak portion 132—4 of switch shifter 130—4 reaches a point about 2.4+ degrees, in angular distance, beyond the beginning of the fifth interval where it engages the indentation on cam 105—4 to close the contact between contact spring member 103—4 and terminal 104—4 during the fifth interval, that is, for 90 degrees of the unit interval. A shortened fourth selecting pulse is therefore transmitted over the circuit traceable from grounded positive battery 129, conductor 128, contact spring member 103—4, terminal 104—4, conductor 123—4, contact spring member 118—4, "space" contact 119—4, conductor 127, through the winding of dummy magnet 122 to grounded positive battery 126. Dummy magnet 122 operates in response to the shortened fourth selecting pulse while selector magnet 121 which released when peak portion 132—3 left the indentation of cam 105—3, remains released to send the fourth selecting pulse which is spacing.

(6) Near the end of the fifth interval peak portion 132—4 of switch shifter 130—4 leaves the indentation of cam 105—4 at a point about 2.4+ degrees, in angular distance, from the beginning of the sixth interval and continues on cam 105—4 of normal diameter but peak portion 132—5 of switch shifter 130—5 reaches a point about 2.4+ degrees, in angular distance, beyond the beginning of the sixth interval where it engages the indentation on cam 105—5 to close the contact between the contact spring member 103—5 and terminal 104—5 during the sixth interval, that is, for 90 per cent of the unit interval. A shortened fifth selecting pulse is transmitted over the circuit traceable from grounded negative battery 129, conductor 128, contact spring member 103—5, terminal 104—5, conductor 123—5, contact spring member 118—5, space contacts 119—5, conductor 127, through the winding of dummy magnet 122 to grounded positive battery 126. Dummy magnet 122 again operates, but now in response to the shortened fifth selecting pulse, while selector magnet 121 remains in a released condition to transmit the fifth selecting impulse which is also spacing.

(7) Near the end of the sixth interval peak portion 132—5 of switch shifter 130—5 leaves the indentation of cam 105—5 at a point about 2.4+ degrees, in angular distance, from the beginning of the seventh interval and continues on cam 105—5 of normal diameter but peak portion 136 of switch shifter 133 reaches a point where it again engages the stop segment of start-stop cam 109 to again close the contact between contact spring member 134 and terminal 135 during the seventh and last interval. A stop pulse which is always marking, is therefore transmitted over the circuit traceable from grounded negative battery 129, conductor 128, terminal 135, contact spring member 134, conductor 145, through the winding of selector magnet 121, to grounded positive battery 126. Selector magnet 121 is operated by the stop pulse and dummy magnet 112 released when peak portion 132—5 left the indentation of cam 105—5 as stated above. Magnet 121 remains operated until the keyboard is again operated.

These seven pulses of the start-stop signal for letter I, as stated above, are shown on line (b) of Fig. 1C.

In line *c* is designated the operated positions of the contact spring members 118—1 to 118—5 when the code bars 116—1 to 116—5 are operated to transmit the letter I. It is noted that in the first two intervals respectively corresponding to the "stop" and "start" pulses, there are no contacts but for the next five intervals which correspond to selecting pulses Nos. 1 to 5, the contact spring members 118—1 to 118—5 are respectively positioned in engagement with "space" contact 119—1, "mark" contact 120—2, "mark" contact 120—3, "space" contact 119—4 and "space" contact 119—5.

In line *d* is indicated the current in and the condition of selector magnet 121 during the transmission of the signal combination for letter I. During the stop, or normal, interval shown in line *b*, selector magnet 121 is operated. During the intervals respectively corresponding to the start pulse and the first selecting pulse, magnet 121 is released. During the intervals respectively corresponding to the second and third selecting pulse magnet 121 operates for 90 per cent of the duration of the interval of each of these pulses. During the intervals of the fourth and fifth selecting pulses, magnet 121 is released and at the end of the interval corresponding to the fifth selecting pulse, magnet 121 is again operated and remains operated until the keyboard is again operated.

Line *e* indicates the letter I signal "pick-up" which would appear on an oscillogram in the form of short, sharp voltage pulses, as they are radiated by the operation and release of selector magnet 121, received by a nearby radio receiving set and recorded by an oscillograph (both of which are not shown). It will be noted that when two or more marking pulses occur in consecutive order as shown for selecting pulses 2 and 3 in the signal wave of line *b*, a short, sharp voltage pulse appears at each possible transition in the continuous marking pulse of two or more selecting pulses and therefore a short voltage pulse occurs in the plain text pick-up at the point between selecting pulse No. 2 and selecting pulse No. 3. Also, a voltage pulse occurs when the selector magnet responds to an actual signal transition from marking to spacing or spacing to marking.

Line *f* indicates the current wave due to the contacts controlled by start-stop cam 109. In other words, when cam shaft 106 is in its normal position, contact spring member 134 and terminal 135 are interconnected during the idle period of the teletypewriter or the time lapsing between the operation of keys at the keyboard. Inasmuch as the contact between contact spring member 134 and terminal 135 opens at the beginning of the start pulse and remains open for the duration of the five following selecting pulses, the next six intervals, representing the start and selecting pulses Nos. 1, 2, 3, 4 and 5, are indicated as open intervals of contact spring members 134 and 135 and therefore no current flows through these contacts in the operating circuit of either selecting magnet 121 or dummy magnet 122 during these intervals.

Line *g* indicates the current wave due to the closures of the contacts associated with cams 105—1 to 105—5. Since contact spring members 118—1 to 118—5 have prepared circuits from the contacts controlled by the cams, a conductive circuit, either to selector magnet 121 or dummy magnet 122, is closed and reopened by each of the cams, and the closures are for 90 per cent of the normal interval for each of the selecting pulses Nos. 1, 2, 3, 4 and 5 as provided for by the special cuttings, or indentations, on cams 105—1 to 105—5 shown in Fig. 1A.

Line *h* shows the current in and condition of dummy magnet 122. Dummy magnet 122 is released during the stop and the start pulses of a signal combination but with respect to the particular combination for letter I the first selecting pulse is spacing to cause magnet 122 to operate. Second and third selecting pulses are marking to cause magnet 122 to release, the fourth and fifth selecting pulses are spacing to cause magnet 122 to operate. Should the selecting pulses be of unit duration magnet 122 would remain operated for the duration of the fourth and fifth selecting pulses but inasmuch as the indentation on the cams have an angular distance of 90 per cent of that of a unit length, or normal, selecting pulse interval, magnet 122, having been operated, will release at every possible transition of each signal combination.

Line *i* indicates the masking pick-up, as it would appear on an oscillogram, in the form of short, sharp voltage pulses radiated by the operation and release of dummy magnet 122, received by the nearby radio receiving set (not shown) and recorded by the oscillograph (not shown).

Line *j* indicates the combined pick-up, that is, the pick-up indicated in line *e* added to the pick-up indicated in line *i* which would appear on the oscillogram in the form of a uniform pattern of short, sharp voltage pulses as they are radiated by the operation and release of both selecting magnet 121 and dummy magnet 122. This pattern would be the same for all character signals transmitted from the keyboard.

The deciphering set of device 137 utilizes repeating relay (29) and selector magnet (26) for receiving deciphered signals incoming over line (16). Selector magnet (26), upon operating, is effective to control in a receiving printer a cam shaft of the type shown in S. Morton et al. U. S. Patent 1,904,164, issued April 18, 1933, selector magnet (26) designated 139 in the present application, being responsive to marking pulses repeated by repeating relay (29) designated 140 herein and dummy magnet 142 being responsive to the spacing pulses.

What is claimed is:

1. At a telegraph station, a work circuit path including a signal responsive device having the inherent characteristic of radiating electrical impulses incident to the signal responsive operation thereof, a dummy circuit path having electrical characteristics identical with those of said work circuit path and adapted to radiate like electrical impulses, and means for closing a circuit through said work circuit path for marking pulses and through said dummy circuit path for spacing pulses in non-overlapping time relation for successive like or unlike pulses whereby the patterns of energy radiated from said station for like numbers of pulses in any combination of marking and spacing pulses are identical.

2. In a telegraph transmitter, a plurality of marking contacts, a plurality of spacing contacts, a work circuit path connected to said marking contacts including a signal responsive device having the inherent characteristic of radiating electrical impulses incident to the signal responsive operation thereof, a dummy circuit path con-

nected to said spacing contacts and having electrical characteristics identical with those of said work circuit path and adapted to radiate like electrical impulses, a plurality of contact tongues selectively positionable in engagement with said marking or spacing contacts, and a distributor for completing circuits through said contact tongues and said work circuit path or said dummy circuit path in non-overlapping relation whereby the pattern of energy radiated from said transmitter includes like components of energy from both paths and is uniform for all signal combinations.

3. In an impulse transmission system, means for causing to be generated different groups of different kinds of unit length signaling pulses, a plurality of transmission channels, selectably operable contacts, successively operable contacts, means under the joint control of said selectably operable contacts and said successively operable contacts for selecting in response to the operation of said first-mentioned means one or the other of said channels, as desired, a signaling pulse responsive device in each of said channels having the inherent characteristic of radiating electrical impulses incident to the signal responsive operation thereof, one of said devices being operated and released in response to each of a certain kind of said signaling pulses transmitted from said selecting means and the other being operated and released in response to each of the other kind of said signaling pulses, said devices, when operated and released, radiating energy components that are alike and therefore indistinguishable to detect which of the energy components were radiated by either one of said devices.

4. In a telegraph system, means for selecting different groups of unit length signaling pulses of different types to be transmitted, a transmission channel including an operable device arranged to operate and release in response to each of the pulses of one type and having the inherent characteristic of radiating electrical impulses incident to the signal responsive operation and release thereof, another transmission channel including an operable device arranged to operate and release in response to each of the pulses of another type and having a like inherent characteristic, selectably operable contacts for conditioning both of said operable devices for operation, and successively operable contacts cooperating with said selectably operable contacts in response to the operation of said selecting means for operating and releasing one of said devices in response to each of the pulses of one type and the other of said devices in response to each of the pulses of another type, whereby said devices radiate an energy component at each possible change from one type of pulse to another, said components of all groups of signaling pulses being alike and therefore the components of one group being indistinguishable from those of any other group.

5. At a telegraph station, a circuit comprising a work path having the inherent characteristic of radiating electrical impulses incident to the operation thereof, and a dummy path having electrical characteristics identical with those of said work path and adapted to radiate identical electrical impulses, a telegraph instrumentality for transmitting permutation code signals, and having operable bars arranged to be automatically positioned in accordance with the impulses of different types in each of said signals, a pair of terminals and a movable contact member therebetween controlled by each of said bars and arranged to condition either of said paths depending on the type of the corresponding impulse of each of said signals, cams fixedly mounted on a start-stop rotatable shaft arranged to rotate through one revolution in response to each of said signals and contacts respectively controlled by said cams and arranged to close and then open in successive order whereby, in response to each impulse of each of said signals, one or the other of said paths depending upon which is conditioned for operation at the time, is closed, the closings of said paths producing patterns of energy radiated from said station for like numbers of impulses in any signal combination, which patterns are identical for all said signals.

6. At a telegraph station, a circuit comprising a work path having the inherent characteristic of radiating electrical impulses incident to the operation thereof and a dummy path and adapted to radiate identical electrical impulses, and a teletypewriter for transmitting permutation code signals of marking and spacing impulses, said teletypewriter having means for effectively closing and effectively reopening said circuit through said work path during each marking impulse and through said dummy path during each spacing impulse of the permutation code telegraph signals, whereby each of the patterns of energy radiated from said station includes like components of energy from both said paths and said patterns are uniform for all signal combinations.

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