

Oct. 11, 1949.

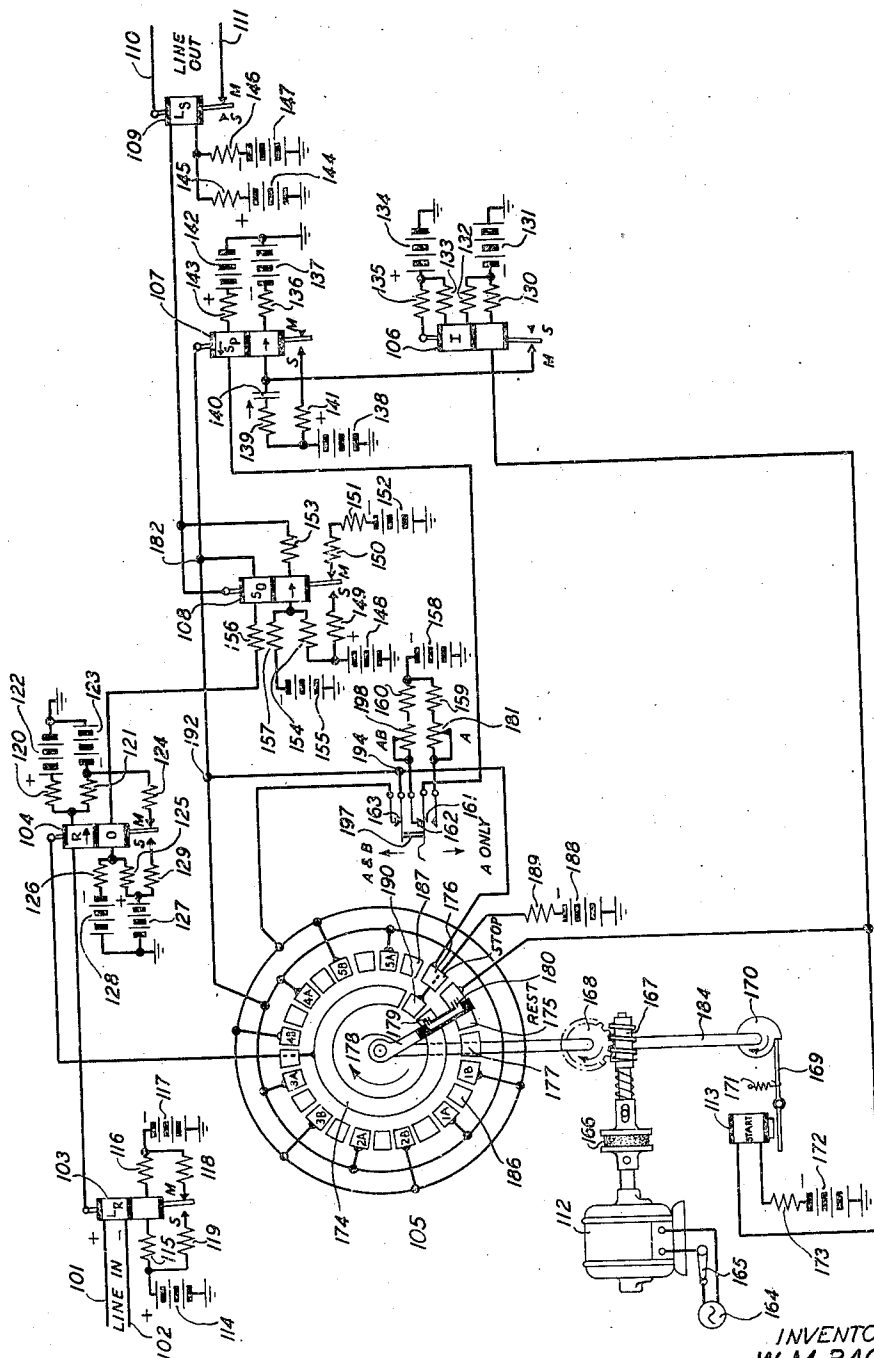
W. M. BACON
REGENERATIVE TELEGRAPH REPEATER, ONE OR MORE
CODE COMBINATIONS PER START-STOP CYCLE

2,484,066

Filed Oct. 24, 1945

2 Sheets-Sheet 1

FIG. 1



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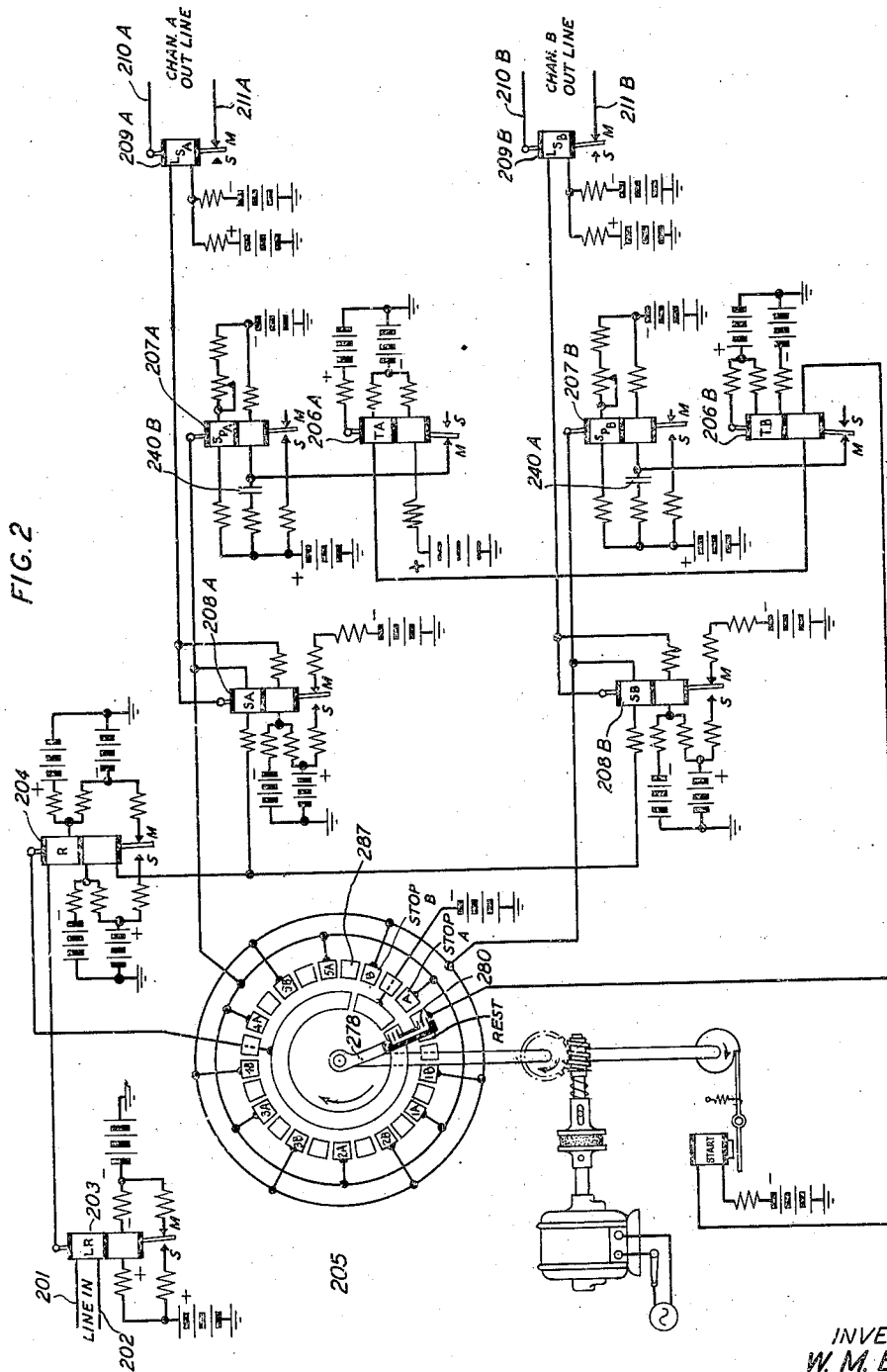
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FIG. 2



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UNITED STATES PATENT OFFICE

2,484,066

REGENERATIVE TELEGRAPH REPEATER,
ONE OR MORE CODE COMBINATIONS PER
START-STOP CYCLEWalter M. Bacon, New York, N. Y., assignor to
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Application October 24, 1945, Serial No. 624,291

9 Claims. (Cl. 178-70)

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This invention relates to regenerative repeaters for multiplex telegraph systems. More particularly, this invention is a regenerative repeater for use in a start-stop multielement permutation code telegraph system wherein the usual signal elements of the multielement permutation code signaling system have been shortened so that during an interval corresponding to the duration of a single element of normal length, two signal elements are transmitted for two different channels. Such systems have been found useful, particularly when weather conditions permit, for application on long radio channels to increase the capacity of such facilities. They are employed also on the connected land lines and the problem of regeneration arises, particularly when the double-channel single start-stop arrangement is extended over land lines. When the weather conditions are adverse, it is necessary to revert to single-channel transmission. Since the cooperating receiving teletypewriters are adjusted to respond to signal elements displaced from their normal position, the reversion to single-channel operation requires that the signals for single-channel operation be adapted to the adjustment of the teletypewriter in the particular single channel which is to continue in operation if the delay involved in the readjustment in the teletypewriter to normal conditions is to be avoided. This complicates the problem of regeneration.

In such multiplex systems as presently arranged, a single start pulse, which serves for both channels, is followed by the first signal element of the multielement permutation code combination for the first channel and then the first signal element for the second channel. Thereafter the second signal element for the first channel is transmitted followed by the second signal element for the second channel and so on until, in the case of a five-element permutation code, five signal elements, each equal in length to one-half the duration of a single normal character-forming signal element have been transmitted for each channel. Thereafter a single stop pulse will be transmitted to serve both channels. The total duration of the whole cycle is the same as the duration of a start-stop cycle for a single multielement permutation code combination having character-forming signal elements of normal duration. Systems operating as described in the foregoing are disclosed in E. F. Watson Patent 2,231,375, granted February 11, 1941 and in E. F. Watson Patent No. 2,416,723, March 4, 1947. In the improved system of Patent No. 2,416,723, a

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single telegraph transmitting unit is arranged in such manner that it can be operated to transmit either signal elements of normal length for a single channel or signal elements of half normal length for two channels by the operation of a single switch associated with the improved telegraph transmitting apparatus. The arrangement of the present invention will cooperate with the arrangements of the above-mentioned patent and application.

It is necessary to make adjustments in the receiving apparatus which may for instance be a teletypewriter receiver such as disclosed in Patent 1,904,164, Morton et al., April 18, 1933, to function with the two-channel system. This is done by properly orienting the receiving cams on the cooperating receiving units so that they will respond to the respective permutation code signal elements intended for each. The present invention provides a regenerative repeater arranged to cooperate with such systems.

It is an object of the present invention to provide an improved regenerative telegraph repeater for use with single start-stop multiplex telegraph systems. It is a further object of the present invention to provide a regenerative repeater to function with single start-stop multiplex permutation code signal systems in which the duration of the normal multielement permutation code character-forming signal elements has been shortened so that a signal element for each of two different channels is transmitted during the interval normally allocated for the transmission of a single signal element for a single channel.

It is a further object of the present invention to provide a regenerative repeater for a single start-stop multiplex system arranged to impress the regenerative signals either on a single channel or on a separate channel for each of the component multielement permutation groups in the multiplex system.

The foregoing objects as well as the features of the present invention may be more readily understood from the following description when read with reference to the attached drawings in which Fig. 1 shows an exemplary transmission system incorporating a typical embodiment of the arrangement wherein the two combinations of signals regenerated in each cycle of operation of the regenerator are impressed on a single outgoing channel and Fig. 2 is an exemplary transmission system incorporating a typical embodiment of the invention wherein each of the two combinations of signals regenerated in each cycle of operation of the regenerator is impressed on an

individual one of two separate outgoing channels directly.

Refer now to Fig. 1. Before proceeding with the detailed description of operation of the system per Fig. 1, its operation will be described in general.

It will be assumed that conductors 101 and 102 are incoming either from the output of a radio receiver, telegraph transmitter, or from a distant telegraph repeater station. The incoming signals are impressed on the line receiving relay 103. The line receiving relay 103 in turn impresses the signals on the regenerative repeater receiving relay 104. The regenerative repeater receiving relay 104 impresses the signals through the transmitting-distributor 105 and on the delay circuit comprising relays 106 and 107 and the circuit of condenser 140. This circuit introduces a delay equal to one-half of the duration of one of the signal elements comprising one of the two character-forming combinations of a cycle, before the start signal is impressed on relay 108. Regenerative repeater sending relay 109 impresses the regenerated signals on the line sending relay 109 which retransmits them to the outgoing channel formed by conductors 110 and 111. Relays 106 and 107 are involved only in the transmission of the start signal and their primary function is to delay the beginning of the start signal and then to pass it on to sending relay 108 which transmits it to the outgoing line 110, 111 through relay 109.

The system per Fig. 1, as hereinbefore mentioned, is intended to impress regenerative signals for two separate multi-element permutation codes on the single outgoing line formed by conductors 110 and 111.

The start signal element impressed on distributor 105 starts arm 173 in rotation. After the start signal has been transmitted, the control of relay 108 is assumed by distributor 105 directly, without the intervention of the delay circuit. The elements of the two multielement code combinations are transmitted alternately as the arm 178 continues to rotate. The transmission of each signal element is displaced so that its proper nature may be determined by sensing the middle portion of the incoming signal. This is cared for automatically by the introduction of the delay before the start signal is transmitted, after which a normal full length start signal is transmitted.

When arm 178 has rotated to a position such that brush 180 engages segment 176, a marking signal is transmitted as a stop signal from positive battery 188 which is permanently connected to segment 190 to relay 108.

It was also mentioned above that at times it is desirable to arrange the system so that instead of transmitting two permutation groups, each having signals of one-half the normal length, single permutation code groups of signals of normal length are transmitted. In order to arrange the system for such operation, key 197 is provided. When this key is in the normal position indicated in Fig. 1, the system is arranged to transmit the signal elements of two permutation code combinations alternately. When the key 197 is operated to its lower position, the system per Fig. 1 is arranged to transmit a single permutation code combination having signal elements of the usual normal length.

The detailed operation of Fig. 1 will now be described. First, the condition of the various units of the system per Fig. 1, while it is in the normal idle condition awaiting the reception of signals, will be described.

The path extending through conductor 101, the top winding of relay 103 and conductor 102 is closed by means not shown so that current flows through the top winding of relay 103. The effect of this current is tending to actuate the armature of relay 103 to engage with its right-hand or marking contact. A circuit may be traced from positive battery 114 through resistance 115, bottom winding of relay 103 and resistance 116 to negative battery 117. The effect of current flowing in this path tends to actuate the armature of relay 103 toward the left to engage with its spacing contact. However, the effect of the current flowing in the top winding when the circuit through conductors 101 and 102 is closed is dominant and the armature of relay 103 is maintained in engagement with its right-hand or marking contact for the idle and marking conditions. While the armature of relay 103 is in engagement with its right-hand or marking contact, a circuit may be traced from negative battery 117 through resistance 118, marking contact and armature of relay 103 and the top winding of relay 104 to the junction between resistances 120 and 121 which connect to grounded positive battery 122 and to grounded negative battery 123, respectively. The path through the bottom winding of relay 104 extends from the junction between resistances 125 and 126, which connect to grounded positive and negative battery, respectively, through resistance 156 and the top winding of relay 108 to junction point 182. From junction point 182 one branch extends through the armature of relay 107 to the marking contact of relay 107 which is open. A second branch extends to junction point 192 from which point one branch extends directly to segments 1A to 5A and a second branch extends to junction point 194. From junction point 194 one branch extends through contact 163 of key 113 to segments 1B to 5B. A second branch extends to segment 176. While arm 178 is in the stop position, each of the segments to which the path through the bottom winding of relay 104 extends is open. Therefore, the bottom winding of relay 104 and the top winding of relay 108 are deenergized for the idle condition. The effect of current flowing in the top winding of relay 104 maintains its armature in engagement with its right-hand or marking contact. While the armature of relay 104 is in engagement with its right-hand or marking contact, a circuit may be traced from negative battery 123 through resistance 124, right-hand or marking contact and armature of relay 104, inner ring 174 of transmitting-distributor 105, brush 179 which connects internally to brush 180, and rest segment 175 to parallel branches. One branch extends through the winding of the stop magnet 113 and resistance 173 to negative battery 172. The other branch extends through the bottom winding of timing relay 106 and resistance 130 to negative battery 131. Attention is called to the fact that negative battery 123, at one end of the circuit last traced, connects to negative battery 172 in one of the parallel branches and to negative battery 131 in the other of the parallel branches. No current flows in this circuit under this condition. Stop magnet 113 is deenergized. Spring 171 maintains the right-hand end of lever 169 in the path of the shoulder of cam 170 so that the rotatable arm 178 of distributor 105 is at rest in the position shown. A circuit may be traced from negative battery 131 through resistance 132, top winding of relay 106 and resistance 133 to positive battery 134. The effect of the current flow-

ing in this path tends to actuate the armature of relay 106 to engage with its left-hand or marking contact and since it is unopposed the armature of relay 106 will be maintained in engagement with its left-hand or marking contact for this condition. When the armature of relay 106 is in engagement with its left-hand or marking contact, a circuit may be traced from positive battery 134 through resistance 135, armature and left-hand or marking contact of relay 106 to the junction of a parallel circuit. One branch of the parallel circuit extends through the bottom winding of relay 107 and resistance 136 to negative battery 137. The other branch extends through condenser 140 and resistance 139 to positive battery 138. The effect of the current flowing through the bottom winding of relay 107 tends to actuate the armature of relay 107 towards its right-hand or marking contact. A circuit may also be traced from positive battery 142 through resistance 143, top winding of relay 107 and, assuming that the key 197 is in the position indicated through contact 162, potentiometer 198 and resistance 160 to negative battery 158. The effect of the current flowing in this circuit tends to actuate the armature of relay 107 toward its left-hand or spacing contact. The effect of the current flowing through the bottom winding of relay 107 for this condition is dominant over the effect of the current flowing in the top winding of relay 107 and the armature of relay 107 is maintained in engagement with its right-hand or marking contact. It was shown above that no current flows through the top winding of relay 108 for the idle condition. The armature of relay 108 is shown locked in its right-hand or marking position. It is actuated to this position under the influence of current flowing in its top or operating winding as brushes 179 and 180 traversed stop segments 190 and 176, respectively, at the end of the last preceding cycle at which time negative battery 188 through resistance 189 was in series with the top winding of relay 108 to actuate the armature of relay 108 to its right-hand or marking position. The armature of relay 108 is locked in this position by the effect of current flowing from negative battery 152 through resistances 151 and 150, marking contact and armature of relay 108 and resistance 153 to the junction between resistances 154 and 157 which connect to grounded positive and negative battery, respectively. To anticipate, it is pointed out that the armature of relay 108 is locked in whatever position it assumes by the effect of current flowing either from positive or negative battery connected to its marking and spacing contacts, respectively. This maintains the particular signaling condition last received from the distributor for an interval until the relay is actuated to the opposite position. The effect of the current in the top winding of relay 108 when flowing and when of opposite effect to the locking current, dominates the effect of the current in the locking circuit. A circuit may be traced from negative battery 152 through resistance 151, resistance 150, right-hand or marking contact and armature of relay 108 through the winding of relay 109 to the junction between resistances 145 and 146 which connect to grounded positive battery 144 and grounded negative battery 147, respectively. The current flowing in this path for the idle or marking condition maintains the armature of relay 109 actuated to the right-hand position to engage its marking contact and maintains the path through conductors 110 and 111 in the outgoing line closed.

Power source 164 is connected through closed switch 165 to motor 112. Motor 112 is coupled through friction clutch 166, worm gear 167 and pinion 168 to shaft 184. As mentioned heretofore, the arm 178 is prevented from rotation by lever 169 which engages the shoulder of cam 170, which is rigidly secured to shaft 184, when arm 178 is in the rest position. The speed of rotation of arm 178 is fixed so that it makes a single rotation in an interval which is slightly less than the time required for the transmission of a normal single cycle of five-element permutation code start-stop signals. The difference is compensated by arresting arm 178 during a portion of the stop signal. It is to be understood, however, that the present invention is not limited to service in a five-element system. The number of elements comprising the code may be varied and the time of transmission of a start-stop cycle may be varied so long as the number of segments in the regenerator 105 and the time of a regenerating cycle conform to the number of elements in the code as transmitted and the duration of a cycle as transmitted from the originating source minus the compensating interval.

From the foregoing the condition of the various apparatus elements of Fig. 1 for the idle or stop condition, which is a marking condition, while awaiting the reception of a two-combination single start-stop signal train should be understood. The manner in which the circuit per Fig. 1 responds to the reception of a signal train will now be described.

The first signal element which is received from line 101, 102 is a no-current or starting signal element of normal length. In response to this the top winding of relay 103 will be deenergized and the armature of relay 103 will be actuated to engage with its left-hand or spacing contact. Positive battery will be connected through resistance 119 and the spacing contact of relay 103 through the path which has heretofore been traced through the top winding of relay 104. In response to this the armature of relay 104 will be actuated to engage with its left-hand or spacing contact. Positive battery 127 will be connected through resistance 129 and the spacing contact of relay 104 through the path which has heretofore been traced through the armature of relay 106. Stop magnet 113 will be energized. The armature lever 169 will be rotated clockwise around its fixed center against the influence of spring 171 and its right-hand portion will disengage from the shoulder on the periphery of cam 170 permitting rotatable arm 178 to start in rotation clockwise. Simultaneously, the armature of relay 106 will be actuated to the right to engage with its spacing contact, disconnecting positive battery 134 from the circuit which has heretofore been traced through the bottom winding of relay 107. Relay 107 will not release instantly, however. When positive battery 134 is disconnected from the right-hand terminal of condenser 140, positive battery 138 will flow through resistance 139 and condenser 140 for an interval until the condenser 140 is charged. The capacity of condenser 140 and the magnitude of the other elements in this circuit are so chosen that the armature of relay 107 will be maintained in engagement with its right-hand or marking contact for an interval. At the termination of this interval the armature of relay 107 will be actuated to the left to engage with its spacing contact. This connects positive battery through resistance 141 and

the spacing contact and armature of relay 107 to the circuit which has heretofore been traced through the upper winding of relay 108 and the bottom winding of relay 104. In response to this the armature of relay 108 will be actuated to engage with its left-hand or spacing contact and the armature of relay 104 will be locked in engagement with its left-hand or spacing contact. Meanwhile, arm 178 continues to rotate. The constants of the circuit including condenser 140 are so chosen that after the armature of relay 107 engages with its left-hand or spacing contact, an interval of 22 milliseconds, which is equal to the duration of a normal start pulse, will elapse before arm 178 has rotated into such position that brush 180 will begin to make contact with segment 1B of distributor 105. When the armature of relay 108 engages with its spacing contact positive battery 148 will be connected through resistance 149 and the spacing contact and armature of relay 108 and through the circuits which have been traced through the winding of relay 109 and the bottom winding of relay 108. The armature of relay 109 will be actuated to its left-hand or spacing contact, opening the circuit through conductors 110 and 111, to transmit a spacing signal out over the line and the armature of relay 108 will be locked in engagement with its left-hand or spacing contact by the effect of the current flowing through its bottom winding. While the armature of relay 104 is locked in the spacing condition, it will not respond to any signal received by relay 103 from the incoming line. When arm 178 has rotated into such position that brush 180 disengages from rest segment 175, the circuit through the bottom winding of relay 106 will be opened. The armature of relay 106 will be actuated under the influence of the current in its upper winding to reengage with its left-hand or marking contact. This will reclose the circuit through the bottom winding of relay 107 and the armature of relay 107 will again be actuated to reengage with its right-hand or marking contact. This in turn opens the path through the top winding of relay 108 and the bottom winding of relay 104. Relay 108 will remain locked with its armature in the spacing position since its locking circuit which is local to the relay remains closed. Relay 104, however, will be unlocked and can respond to incoming signals. However, attention is called to the fact that segment 177 which succeeds the rest segment is not connected to any external circuit and therefore any portion of a signal which may be received by ring segment 174 from relay 104 while brush 180 is traversing, segment 177 will be ineffective.

After an interval of 22 milliseconds, which is equal to a full starting signal element, plus the delay interval introduced by the delay circuit, has elapsed, brush 180 will start to engage segment 1B of distributor 105. In the meantime, the succeeding signal element of the signal train which is the first signal element for channel B will have been received by relay 103 and impressed on relay 104. Relay 104 will have in turn impressed the signal element on the solid conducting ring segment 174 of distributor 105. Brush 180 will engage segment 1B just as the middle portion of the signal element is being received and the signal element will be impressed through segment 1B and a circuit which has been traced in the reverse direction through contact 163 of key 197 and the top and bottom windings of relays 108 and 104, respectively. In the event

that the signal element is a marking signal element, negative battery 123 will be impressed on this path, and in the event that it is a spacing signal element, positive battery 127 will be impressed on this path. In response to this the armature of relay 108 will be actuated either to its marking or spacing contact and the armature of relay 109 will be actuated to either open or close the path through conductors 110 and 111. Arm 178 will engage each succeeding active segment 1A, 2B, 2A, etc., as the middle portion of the corresponding signal element is being received. Relays 108 and 109 will follow these signal elements and transmit them to line 110, 111. Attention is called to the fact that all B segments are connected in parallel through contact 163 to the top winding of relay 108 and all A segments are connected in parallel and extend directly through the top winding of relay 108. When key 197 is in the position shown, the regenerative repeater per Fig. 1 will regenerate two separate multielement permutation code combinations for each cycle of operation. When key 197 is actuated to its down position, contact 163 is opened. All of the B segments will be disconnected from the top winding of relay 108. All of the A segments, however, will be unaffected by the operation of the key. As a result of this, the signals corresponding to a single combination only, namely, the A combination will be transmitted. The armature of relay 108 will then be locked in whichever position it assumes for an interval such that the total duration of a signal element is equal to the duration of a full signal element of normal length rather than to half a signal element.

The operation of key 197 to its lower position by opening contact 162 and closing contact 161 substitutes potentiometer 181 and resistance 159 for potentiometer 198 and resistance 159 in the circuit which extends through the top winding of relay 107. This is necessary in order to change the current flowing through the top winding of relay 107 for the two conditions so as to insure the proper timing of the operation of relay 107.

It is emphasized that corresponding signal elements as received from line 101, 102 and as retransmitted after regeneration to line 110, 111 are slightly displaced in time in relation to each other. In the arrangement per Fig. 1, the start signal received from the line is impressed on the regenerative repeater circuit, immediately upon its reception, through relay 104 and distributor 105. However, relays 106 and 107 and the circuit of condenser 140 introduce a delay interval before relay 108 is permitted to retransmit the regenerated start signal through relay 109 to the outgoing line. The interval of the delay is equal to the duration of one-quarter of a normal full length character-forming signal element of a five-element permutation code or to one-half of a shortened character-forming signal element when the system is arranged, as herein, to transmit two character-forming code combinations in the interval in which a single five-element code combination is normally transmitted.

The position of the rotatable arm 178 is orientable. Its stop position and speed of rotation are arranged so that brush 180 arrives at the right-hand end of segment 1B at the instant that the center of the first character-forming signal element of the two code combinations is being received. During the interval from the start of rotation of arm 178 until brush 180 engages seg-

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 ment 1B, an interval elapses which is equal to the interval required for the delay, which corresponds to one-half of the interval required for the reception of a single one of the five character-forming signal elements in either of the two code combinations, plus a full normal start signal element of 22 milliseconds. Brush 180 will sweep off rest segment 175 at the end of 22 milliseconds corresponding to the end of the received start signal and will be traversing inactive segment 177 during the interval while the first half of signal element 1B is being received. But the beginning of transmission of the outgoing start signal by relay 109 will be delayed by the interaction of relays 106 and 107 and the circuit of condenser 140 for an interval equal to the interval required for the traversal of segment 177 by brush 180. During the interval while brush 180 is traversing segment 1B, which corresponds to the interval required for the reception of the latter half of the first character-forming element of the B code combination, relay 108 will be under direct control of segment 1B for the transmission of a portion of a marking or spacing signal element. Then during an interval while the first half of signal element 1A is being received by relays 103 and 104 and while brush 180 is traversing inactive segment 186, relay 108 will be locked by its own local circuit in whatever position it had assumed while under the influence of segment 1B. As a result of this the duration of the character-forming signal elements transmitted to the line 110, 111 will comprise two portions. The first represents an interval while the brush 180 traverses a segment such as 1B corresponding to the interval of the latter half of the signal element received from line 101, 102, and the second represents an interval while brush 180 traverses a succeeding inactive segment such as 186 while the first half of the succeeding signal element is being received from the line 101, 102 during which interval sending relay 108 is locked with the proper sending signal element stored therein.

The latter half of the fifth or last character-forming signal element of combination A is transmitted by locked relay 108, while brush 180 traverses inactive segment 187. Then brush 180 sweeps onto the active stop segment 176. Positive battery 183 is permanently connected through resistance 189 to segment 190. When brushes 179 and 180 bridge segments 190 and 176, a circuit is extended through the top winding of relay 108. The effect of current in this circuit transmits a marking signal as a stop signal through lines 110, 111. The length of the active stop segment 176 is short and the segment is traversed in less time than the actual duration of a stop signal. The function of active stop segment 176 is to transmit a marking signal to relay 108 and to permit relay 108 to lock in the marking position. Then brush 180 sweeps off the active stop segments 176 and brushes 179 and 180 sweep onto large conducting ring segment 174 and rest segment 175, respectively.

Attention is called to the fact that the actual reception of the last character-forming element 5A of the A combination from line 101, 102 terminates and the reception of the stop signal element from line 101, 102 starts as brush 180 sweeps off segment 5A and engages segment 187. However, segment 187 is inactive. During the interval while the first portion of the stop signal element is actually being received from line 101, 102, brush 180 is traversing segment 187 and the

second half of signal element 5A which is stored in relay 108 is being transmitted. The time of traverse by brush 180 of active stop signal segment 176 as mentioned above, is actually considerably shorter than a normal stop signal element. The brush 180 sweeps off active stop segment 176 and onto rest segment 175 where it arrives at the stop position shortly before the end of reception from line 101, 102 of a stop interval of normal length.

The period of rotation of arm 178 is slightly less in duration than the period of transmission of one cycle of standard five-element start-stop permutation code telegraph signals. The duration of a cycle of the shortened element double code combination including the start-stop signal elements is the same as the duration of the normal five-element permutation code start-stop cycle. Brush 180 traverses segments 187, 176 and the portion of segment 175 up to the stop position, where arm 178 is arrested by the released lever 169, during an interval slightly less than the duration of a normal stop signal and arm 178 and brush 180 are arrested in the stop position during the remainder of the interval while the normal stop signal is actually being received from line 101, 102. But only during a portion of this normal stop signal interval, namely, while brush 180 engages segment 176, after the second half of signal element 5A has been transmitted, while brush 180 was traversing segment 187, will the distributor 105 actually be transmitting a stop signal to relay 108. During the interval while brush 180 traverses the portion of segment 175 up to the stop position and during the interval while brush 180 is arrested, the stop signal will be locked in relay 108. The arm 178 makes one revolution and then is stopped. The transmission of the last portion of the normal stop signal from relay 108 will occur after the rotation of arm 178 stops while relay 108 remains locked. In other words, at the instant when the stop arm 178 reaches the stop position, a stop signal of normal length will not have been transmitted. The transmission of the stop signal is completed during the interval while the stop arm remains at rest.

Refer now to Fig. 2. In the arrangement per Fig. 2 the operation is essentially the same as in Fig. 1 except that separate outgoing channels are provided for the two combinations. Relays 206A, 207A, 208A and 209A are assigned to channel A and relays 206B, 207B, 208B and 209B are assigned to channel B the relays in each channel correspond in their function and in their detailed operation to relays 106, 107, 108 and 109 in Fig. 1. Channel A is controlled by the A segments on transmitter-distributor 205 and channel B is controlled by the B segment on the distributor. In the arrangement per Fig. 2 no key corresponding to key 197 is provided since none is required when separate outgoing channels are employed as in Fig. 2.

In Fig. 2, the operating windings of relays 206A and 206B which correspond to relay 106 in Fig. 1 are connected in series and separate stop segments have been provided on the distributor for both the A and B channels which control the respective relays 208A and 208B for the particular channel. The actual reception of a stop signal from line 201, 202 starts when brush 280 sweeps off segment 5A of distributor 205. The actual transmission of the stop signal for channel B does not start until brush 280 engages stop segment B. The

actual transmission of the stop signal for channel A will not start until brush 280 engages stop segment A. Arm 278 is arrested at the stop position and the stop interval for each channel persists after the brush stops. The stop interval for channel A will include an interval determined by the circuit of condenser 240B when continuous signals are coming in. During these intervals the armatures of relays 207B and 207A for the respective channels will be maintained in their respective marking positions as shown in Fig. 2. After these respective intervals elapse the armatures of relays 207B and 207A will be actuated to their respective spacing positions to permit the actual transmission of the start signals through relays 208B and 208A and relays 209B and 209A to the B and A channels at the respective proper instants. Thereafter, spacing signals of durations equal to full length start signals of 22 milliseconds will be transmitted over the B and A channels while brush 280 is traveling to the 1B and 1A segments, respectively.

What is claimed is:

1. In a telegraph system, an incoming telegraph circuit, an outgoing telegraph circuit, a regenerative repeater intermediate said circuits, means in said incoming circuit for receiving at a first time a train of telegraph signal elements consisting of a start signal element of normal duration followed by two complete individual code combinations of multielement permutation code character forming or functional signal elements and a stop signal element of normal duration, each of said character forming or functional signal elements in each of said two combinations being one-half normal duration and arranged alternately, each signal element of one combination followed consecutively by a correspondingly numbered signal element of the other combination, means for impressing all of said signals on said regenerative repeater, means in said repeater for regenerating said signals, means in said repeater for impressing said regenerated signals on said outgoing circuit, means in said circuit for receiving at a second time a single start-stop multielement permutation code signal combination, means for regenerating said single combination and means for impressing said single regenerated combination on said outgoing circuit, said regenerating means for said train of elements and for said single combination comprising a single transmitting device of substantially constant speed of operation per cycle and arranged to regenerate said train of elements and said single combination in equal intervals.

2. In a telegraph system, a regenerative telegraph repeater, means in said repeater for receiving at a first time a train of telegraph signal elements consisting of a single start signal element, a single stop signal element, each of said elements of normal duration and a plurality of complete character forming multielement permutation code signal combinations during the interval normally allotted for the reception of a single start stop multielement permutation code signal combination having the same number of elements, means in said repeater for arranging signal elements in correspondingly numbered positions in each of said plurality of combinations in an ordered sequence, means in said repeater for regenerating said train of signals, means in said repeater for receiving at a second time a single start-stop multielement permutation code signal combination, and means for regenerating said single combination, said regenerating means

for said train of elements and for said single combination comprising a single transmitting device of substantially constant speed of operation per cycle and arranged to regenerate said train of elements and said single combination in equal intervals.

3. In a telegraph system, a regenerative repeater, means connected to said repeater for transmitting through said repeater, at a first time, a first train of telegraph signal elements consisting in sequence of a start signal element, a single multielement permutation code signal combination and a stop signal element, means in said regenerator for regenerating said train in a time interval t equal to $(t_1 + t_2 + t_3)$, wherein t_1 is the duration of said start signal element, t_2 is the total duration of all of said elements in said multielement combination combined and t_3 is the duration of said stop signal element, means connected to said repeater for transmitting through said repeater, at a second time, a second train of telegraph signal elements consisting in sequence of a start signal element, a plurality of multielement permutation code signal combinations and a stop signal element, means in said regenerator for regenerating said second train in said same time interval t equal to said same $(t_1 + t_2 + t_3)$ wherein said t_1 is the duration of the start signal element of said second train, said t_2 is the total duration of all of said elements of said plurality of multielement combinations in said second train combined and said t_3 is the duration of said stop signal element of said second train.

4. A system in accordance with claim 3 in which said plurality of multielement combinations are two combinations and in which each pair of the signal elements in correspondingly numbered positions in said two combinations is arranged in numerical sequence in said second train, and means in said regenerator for regenerating each of said pairs of elements in said second train in the time of regeneration of a single element of a combination of said first train.

5. A system in accordance with claim 3 and means in said regenerator for delaying the regeneration of the first signal element of the first of said plurality of multielement combinations for an interval so as to insure the detection of its proper nature.

6. A system in accordance with claim 3 and means in said regenerator for delaying the regeneration of all of the signal elements of all of said plurality of multielement combinations for an interval so as to insure the detection of its proper nature.

7. A system in accordance with claim 3, a rotary transmitting distributor in said regenerative repeater, means on said distributor for delaying the regeneration of the first character-forming signal element of the first combination of said plurality of combinations for an interval until the nature of said element may be accurately determined, a relay circuit in said repeater, a delay circuit connected to said relay circuit for delaying the operation of said relay circuit, a transmitter connected to said relay circuit and means interconnecting said transmitter and said relay circuit, responsive to said delay circuit, for preventing the operating of said transmitter until after the delay interval introduced by said distributor has elapsed.

8. In a multichannel start-stop multiplex telegraph system in which the pulses of the respective channels are intermingled with each other, a regenerative repeater comprising a single ring of distributor segments, a receiving relay, a trans-

mitting relay, circuit connections between said relays and said distributor for locking said receiving relay during the time said sending relay is positioned under control of said receiving relay and a retarded delay operated under control of said receiving relay for initiating the transmission of a regenerated start pulse.

9. In a regenerative repeater, a transmitting distributor, a rotatable contact on said distributor, a start segment on said distributor, a segment on said distributor corresponding to the latter half of the first element of a character-forming multi-element permutation code combination, an inactive segment on said distributor separating said segments, a delay relay circuit in said repeater, a relay transmitting circuit connected to said distributor in said repeater, a circuit interconnecting said delay circuit and said transmitting circuit,

means in said repeater responsive to the reception of a start signal impulse by said repeater for activating said delay circuit, and means responsive to said activation for delaying the transmission of said start signal impulse by said transmitting circuit for an interval equal to the time of traverse of said inactive segment by said contact.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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