Sept. 12, 1944. W. B. MARTIN 2,357,840

REGENERATIVE TELEGRAPH REPEATER

Filed Feb. 25, 1941

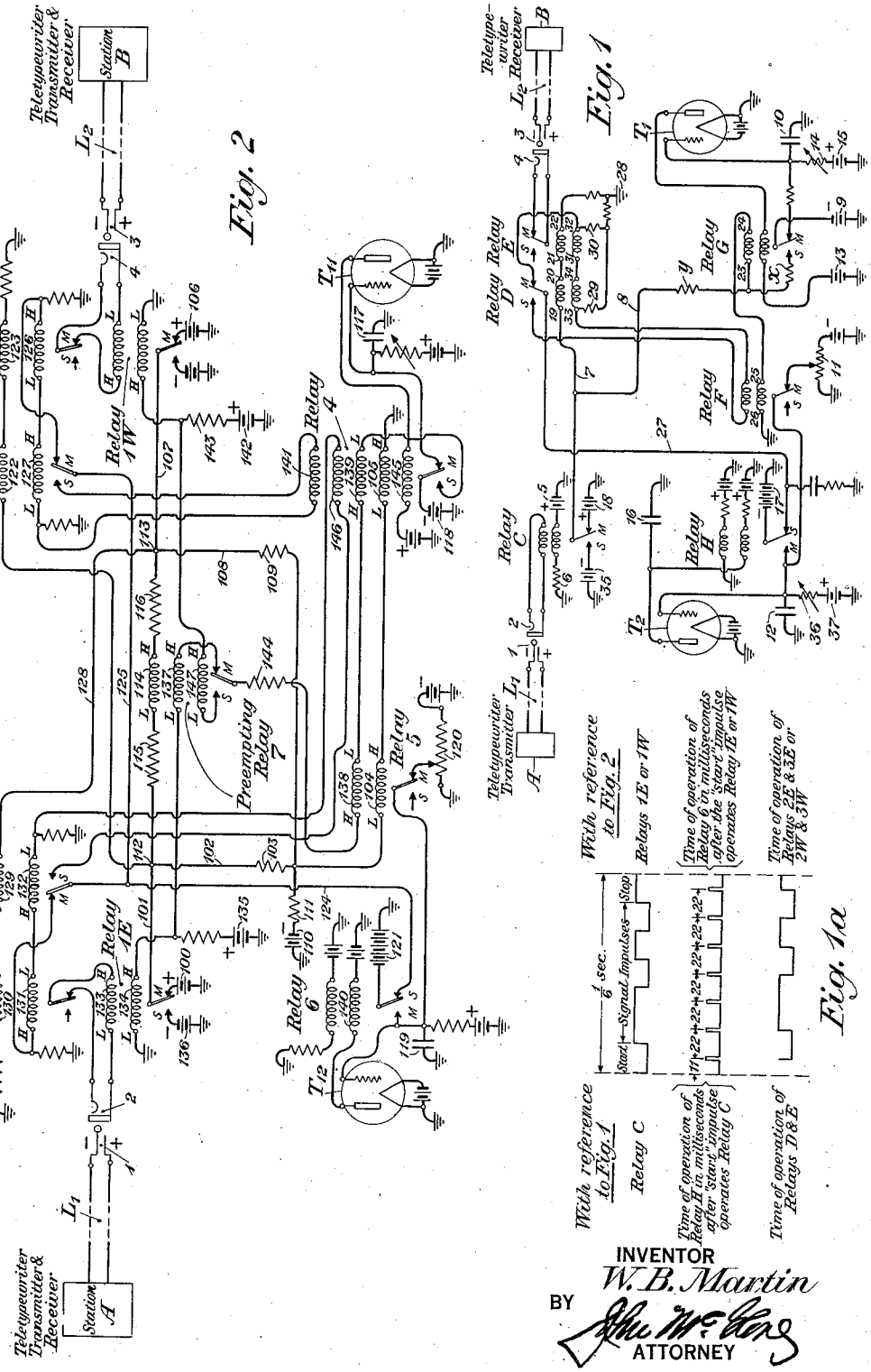


Fig. 2

Fig. 1

Fig. 1a

INVENTOR
W. B. Martin
BY
ATTORNEY

Patented Sept. 12, 1944 2,357,840

UNITED STATES PATENT OFFICE

2,357,840

REGENERATIVE TELEGRAPH REPEATER

Wade B. Martin, Westwood, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application February 25, 1941, Serial No. 380,440

5 Claims. (Cl. 178—71)

This invention relates to telegraph systems and particularly to an improved type of regenerative telegraph repeater.

Regenerative repeaters of the type heretofore employed have been characterized by the use of distributors for re-spacing the received signal impulses prior to retransmitting them over the line. Not only are the first cost and the maintenance charges of such distributors fairly high but also they are subject to the limitation that they can be used for only one transmission speed and a fixed number of pulses per signal combination.

I have found that by replacing such distributors by an arrangement of vacuum tubes it is possible not only to materially reduce the first cost and the charges upon such repeaters, but also to readily adapt the repeater to any desired speed, and any desired number of pulses per signal combination.

This invention resides in such a repeater characterized by the use of two vacuum tubes one of which, together with its associated relay, serves as a character length timer; and the other vacuum tube, together with its relay, serves to control the spacing of the several impulses embraced within the signal character. In this repeater the receiving relay, upon the receipt of the spacing impulse constituting the first impulse of the signal character, operates two other relays, one of which removes the grid biasing voltage from the vacuum tube that forms part of the character-length timing device; and the other relay removes the grid biasing voltage from the vacuum tube that forms part of the pulsing circuit. The pulsing circuit continues to operate until seven pulses have been created whereupon its operation is stopped as the result of the flow of space current through the vacuum tube that forms part of the character-length timing circuit. Those pulses serve to operate a locking relay which, in turn, controls the sending relay of the repeater and thereby insures the retransmission of the signal character free from distortion.

This invention will be clearly understood from the following description, when read in connection with the attached drawing of which Figure 1 shows schematically the embodiment of the invention in a circuit for transmitting the signals in one direction; Fig. 1*a* is a graph indicating the relative time of operation of the several relays; and Fig. 2 shows the circuit arrangement for two-way transmission between stations.

In Fig. 1, A represents a teletypewriter station adapted to transmit teletypewriter signal characters over the line L_1 to a distant station B (represented at the right-hand side of the figure) which is adapted to receive those signal characters and to translate them into printed messages in a manner that is well understood by those familiar with the art. The transmitting and receiving apparatus may be of any well known type such as that disclosed in Pender's "Electrical Engineer's Handbook," vol. V, 3rd ed., section 11, pages 23 and 24 (published John Wiley & Sons 1936). Between those stations is a regenerative repeater, the purpose of which is to receive the impulses, representing a signal character, to properly space and amplify those impulses and to retransmit them to the distant receiving station. The line L_1 is adapted to be connected to the repeater by inserting the plug 1 in the jack 2. In like manner the line L_2, extending to the distant receiving station B, is connected to the repeater by inserting the plug 3 in the jack 4. The jack 2 is connected to the upper winding of relay C. The lower winding, which is the biasing winding of the relay, has connected thereto a battery 5 and a suitable resistance 6. The tongue of relay C is connected by conductor 7 to the upper winding of relays D and E and is also connected by conductor 8 with the upper winding of relay G and the lower winding of relay F. The upper windings of relays D and E are the operating windings of those relays and the lower windings are the locking windings that serve to prevent the movement of the tongues of those relays until certain timing operations have taken place, which will later be more fully described. The tongue of relay G has connected therewith a battery 9 that serves to charge the condenser 10 when the tongue is upon its marking contact; and to lock relays F and G when the tongue is upon its spacing contact. The tongue of relay F serves to connect the potentiometer 11 to the condenser 12 when the armature of F is upon its marking contact. The lower winding of relay G is connected between the battery 13 and the plate of the vacuum tube T_1. The grid of that tube is connected to the condenser 10 and also to the battery 9, the voltage of which is such that when applied to the grid it will prevent the flow of current through the space in the tube. When the battery 9 is disconnected from the condenser 10 the latter will discharge through the resistance 14 and the battery 15, which are so proportioned as to fix the time of discharge at a definite figure which is the optimum time of transmission of one character at the selected speed, all of which will be more fully described herein-

after. The tube T_1 and relay G serve as the character length timer of the repeater. The tube T_2 has its grid connected to the condenser 12 the voltage of which is capable of preventing the passage of a current through the tube. Associated with the tube is a relay H, the upper winding of which is a biasing winding. The lower winding of that relay, which is its operating winding, is connected to the plate of T_2 and also to the condenser 16. The tongue of that relay is connected to the battery 17. When that tongue moves to its marking contact it will charge the condenser 12 and when it moves to its spacing contact it will serve to cause a flow of current through the locking windings of relays D, E and F for the purpose of controlling the action of those relays.

The manner in which this circuit functions for the re-spacing and re-transmission of the impulses that go to make up a teletypewriter character is as follows:

Let it be assumed that the tongues of the various relays are in the postions shown in the figure. Current will flow from the positive terminal of battery 18, associated with the marking contact of relay C, thence over conductor 7 and through the upper windings of relays D and E to ground at 26. The windings of those relays, and of all the relays of this drawing are so poled that when the positive pole of a battery is connected to the lower numbered terminal of a winding, the tongue of the relay will either move or tend to move toward or remain upon the marking contact of that relay. If the negative pole of a battery is connected to the lower numbered terminal, the tongue will move or tend to move toward or remain upon the spacing contact of the relay. Since the positive pole of battery 18 is so connected that current will flow in the direction from the lower numbered terminals to the higher numbered terminals of the upper windings of relays D and E, the tongues of those relays will remain on the marking contacts.

Current from battery 18 will also flow over conductor 8 and through the upper winding of relay G and the lower winding of relay F to ground. Since the direction of flow is from the lower numbered to the higher numbered terminal of each winding, the tongues of those relays will remain on their marking contacts. Considering relay G, battery 9 will apply a voltage to the condenser 10 the magnitude of which is such as to prevent the flow of current from the plate to the filament of the tube T_1 to the grid of which the condenser is connected. Accordingly no current will flow through the lower winding of relay G which is connected to the plate of the tube T_1. Considering relay F, the voltage of the potentiometer 11 will be applied to the condenser 12, the magnitude of which will depend upon the setting of the potentiometer. That voltage may be of the order of 30 volts and it is sufficient, when applied to the grid of T_2, to prevent transmission of current between the plate and the filament of that tube. Consequently, no current will flow through the lower winding of relay H, which is connected to the plate of T_2, and the tongue of that relay will remain upon its spacing contact, under the influence of the biasing winding. Accordingly, current will flow from battery 17 over conductor 27 to the tongue of relay D, thence to the marking contact of that relay, and through the lower windings of relays E and D, shunted by the resistances 29 and 30, to ground at 28. This current is of higher value than that flowing in the upper windings. Since the negative pole is connected to the higher numbered terminal of those lower windings of relays D and E the tongues of these relays will thereby be locked in the position shown upon the marking contacts.

Let it be assumed that the next impulse of the signal character transmitted over the line L_1 is an open or spacing impulse. That will cause the tongue of relay C to move to its spacing contact and that, in turn, will connect the negative pole of battery 35 to the conductors 7 and 8 and a current will flow through the windings connected to those conductors in a direction opposite to that previously described. Since the negative pole of battery 35 is connected to the lower numbered terminals 19 and 21 of the upper windings of relays D and E, the tongues of those relays would move to their spacing contacts if they were free to do so but they are prevented for the time being by the effect of the current from battery 17 that flows through the lower windings of relays D and E. Current from the negative pole of battery 35 will also flow through the upper winding of relay G and the lower winding of relay F. Since the lower numbered terminals of those windings are connected to a negative pole, the tongues of the relays will be moved to their spacing contacts. Considering relay G, the movement of its tongue disconnects the battery 9 from the condenser 10 which thereupon begins to discharge through the circuit of 14 and 15. The rate of discharge depends upon the circuit constants, which are varied to values dependent upon the selected optimum speed of transmission of the system. If the rate of transmission be assumed to be 60 words per minute, the time of discharge of the condenser would be one-sixth of a second. During that period of time one teletypewriter character consisting of a start impulse, five code signal impulses, and a stop impulse, would be transmitted through the repeater and during the course of such transmission those impulses would be subjected to the control mechanism of the repeater so that when retransmitting to station B they would be properly spaced to effect the correct result in the teletypewriter receiver at that station.

Considering relay F, the flow of current from battery 35 through its lower winding causes its tongue to move to the spacing position and both relays, F and G, would be locked in that position by current from battery 9. Resistances x and y are so proportioned that the current in the locking windings of relays F and G will remain in a spacing direction regardless of the position of the armature of relay C but the value of the current will be twice as great, when relay C's armature is on its spacing contact than when it is on its marking contact. This is to prevent the operation of relay G while relay C is on its spacing contact. The movement of the tongue of relay F to its spacing position disconnects the potentiometer 11 from the condenser 12 and permits that condenser to discharge. By proper proportioning of its circuit that condenser will discharge in 11 milliseconds and thereupon current will flow through the lower winding of relay H which is connected to the plate of the tube T_2. The direction of flow through that winding is such as to cause the tongue of the relay to move to its marking contact. That operation connects battery 17 to the condenser 12 and since the magnitude of the voltage of that battery is very much greater than that of the potentiometer 11, being of the order of 130 volts, the condenser 12 will take an appreciably great-

er charge. In fact, condenser 16 has been provided in order that condenser 12 may acquire its full charge. As soon as that has occurred, the flow of current through the tube T_2 and consequently through the lower winding of relay H ceases, and the tongue of that relay drops back to its spacing contact.

When the tongue was off its spacing contact current ceased to flow through the locking windings of relays D and E and consequently the tongues of those relays were permitted to move to their spacing contacts. Upon the return of the tongue of relay H to its spacing contact current will flow from battery 17 over conductor 27 and through the upper winding of relay F and the lower, locking windings of relays D and E. The polarity of the battery and the direction of flow of current through those windings is such as to hold the tongue of each relay upon its spacing contact. It is to be noted that the movement of the tongues of relays D and E to their spacing contacts occurs 11 milliseconds after the movement of the tongue of relay C to its spacing contact, under the influence of the spacing impulse received from station A. Furthermore, it is to be noted that the tongues of relays D and E will stay upon their spacing contacts until they are released after a predetermined length of time by the movement of the tongue of relay H from its spacing contact. Relay H will operate seven times during the interval of time of one-sixth of a second in which relays F and G remain locked by the current from the battery 9 while the tongue of G is on its spacing contact and, as shown in Fig. 1*a*, each operation of relay H occurs at an interval of 22 milliseconds. The movement of the tongue of relay H from its spacing contact disconnects the battery 17 from the circuit of the locking windings of relays D and E once in each 22 milliseconds and permits the tongues of those relays to move at those instants of time (and at those instants only) to that contact toward which they are influenced by the current in the operating windings. By means of this arrangement the effect of distortion of an incoming signal upon the outgoing signal from such a repeater is entirely removed unless such distortion was of such magnitude as to be equal to or greater than one and one-half times the length of a normal impulse. In such abnormal instances it is essential to take other steps to remove the cause of such distortion from the line.

At the end of the period of one-sixth of a second condenser 10, associated with tube T_1, will have completely discharged and current will flow through the lower winding of relay G and through the electron path of the tube. Relay C should have reached its marking contact, thus reducing the current in the upper windings of relay G to a lower value than that in the lower windings. The instant the tongue of relay G leaves its spacing contact the current in the upper winding of G and the lower winding of F changes from spacing to marking. The magnitude of that current is such as to cause the tongue of relay G to move to its marking contact. That will not only charge the condenser 10 and cut off a further flow of current through the tube but it will also unlock relay F by cutting off current through its lower winding. If the tongue of relay D is on its marking contact, the tongue of relay F will accordingly fall back to its marking position. If the tongue of relay D is on its spacing contact, relay F will remain locked to spacing by current through its upper winding until it is unlocked by the next operation of relay H. The circuit is then in condition to receive the next signal character and to properly re-space its impulses.

The arrangement of the repeater for handling traffic in both directions is shown in Fig. 2. In view of the two-way character of this repeater it is necessary to have receiving, locking and sending relays at each end and also a preempting relay to give control of the repeater to that station which first begins transmitting a signal character through the repeater. With the tongue of relay 1E upon its marking contact, current will flow from battery 100, through a circuit which includes conductors 101, 102, resistance 103, winding 104 of relay 5, and winding 105 of relay 4 to ground. At the same instant the tongue of relay 1W is upon its marking contact and current will flow from the battery 106 over a circuit that includes conductors 107, 108, resistance 109 and the windings 104 and 105 to ground. Those circuits, just traced, have a portion in common, namely, that which includes the windings 104 and 105. At the junction point of those circuits is connected a battery 110 in series with a resistance 111. Resistances 103, 109 and 111 are of equal value. The direction of the current flowing through windings 104 and 105 will depend upon the poling of the batteries 100, 106 and 110. Since the poling of battery 110 remains fixed, the effect upon relays 4 and 5 of the current flowing through windings 104 and 105 will depend upon the position of the tongues of relays 1E and 1W. With both tongues upon their marking contacts current will flow through windings 104 and 105 from a lower numbered to a higher numbered terminal (indicated upon the drawing by L and H, respectively), which will cause the tongues of relays 5 and 4 to move to or remain upon their marking contacts, as indicated. Since the junction points 112 and 113 are at the same potential, no current will flow through the circuit connecting those points which includes the winding 114 of relay 7 and resistances 115 and 116. Since no current is flowing in any winding of relay 7, its armature may rest on either contact. With the tongue of relay 4 on its marking contact, condenser 117, associated with the tube T_{11}, will be charged by the flow of current from the battery 118 through the marking contact of the relay. The voltage of that battery is sufficient, when applied to the grid of T_{11}, to cut off electron emission through the tube. At the same time the condenser 119, associated with the tube T_{12}, will receive a charge from the potentiometer 120 through the marking contact of relay 5. The voltage on that potentiometer is relatively lower than that of the battery 121 so that the charge received by the condenser 119 will be less than that received from battery 121.

Current from the marking battery 100 of relay 1E will also flow through the operating windings 122 and 123 of relays 2W and 3W, and since the positive pole is connected to a lower numbered terminal of each relay (indicated by L), the armatures will be upon their marking contacts. At the same time current will flow from battery 121 of relay 6 through its spacing contact and thence over the circuit that includes conductors 124, 125, the marking contact of relay 2W and the windings 126 and 127 to ground. Since the negative pole of battery 121 is connected to the higher

numbered terminal of relays 3W and 2W, the tongues of those relays will be locked upon their marking contacts.

At the same time current will flow from the marking battery 106 of relay 1W over conductors 107 and 128 and through windings 129 and 130 of relays 2E and 3E to ground. Since the positive pole of that battery is connected to the lower numbered terminals of windings 129 and 130, the tongues of those relays will be held upon their marking contacts and will be locked there by the flow of current from battery 121 of relay 6 over conductor 124, the marking contact of relay 2E and windings 131 and 132 to ground. Relays 2E and 3E are thus locked to marking by current from contacts of relay 6.

Now, let it be assumed that an open impulse is transmitted from station A. That will open the circuit of winding 133 of relay 1E and the tongue of that relay will move to its spacing contact under the influence of current through winding 134. A circuit is established from battery 136, through resistances 115 and 116 and winding 114 of relay 7 causing its armature to move to or remain on its spacing contact. Also under this condition there will be two negatively poled batteries, namely, 110 and 136, connected to the lower numbered terminals of windings 104 and 105 of relays 5 and 4, and only one positively poled battery, namely, 106. The current through those windings will be reversed in direction and the tongues of those relays will move to their spacing contacts. Current will thereupon flow from battery 142 (associated with relay 1W) through resistance 143, winding 147 and the left-hand contact of relay 7, through resistance 144, windings 138 and 139 of relays 5 and 4, respectively, and the spacing contact and battery 118 to ground. Resistances 143 and 144 are proportioned so that the direction of current through the lower winding of relay 1W is reversed, locking it to marking, thus preventing transmission in a W to E direction until the armature of relay 4 returns to its marking contact, as is described hereinafter. The direction of flow of the current through those windings is such as to lock them upon their spacing contacts. Condenser 117 will thereupon begin to discharge and its rate of discharge will be assumed to be the same as in Fig. 1, namely, one-sixth of a second. That time is sufficient to permit the repeater to translate an entire teletypewriter signal character. At the same time condenser 119 begins to discharge and at the end of 11 milliseconds such discharge will be complete. Thereupon current will flow through the tube and the tongue of relay 6 will move to its marking contact under the influence of the current through the winding 140. That will connect the negatively poled battery 121 to the condenser 119, giving the latter a much higher charge than that given to it by the potentiometer 120.

When the tongue of relay 1E moves to its spacing contact the current through the operating windings 122 and 123 of relays 2W and 3W is reversed, thereby tending to move the tongues of those relays to their spacing contacts. Such movement is at that instant prevented by the current in the locking windings 126 and 127. However, when the tongue of relay 6 moves away from its spacing contact, the current ceases to flow through the locking windings 126 and 127 and the tongues of those relays are caused to move to the spacing contacts by virtue of the current in the operating windings. Then, as soon as the tongue of relay 6 returns to its spacing contact the tongues of relays 2W and 3W are locked in their spacing positions by the flow of current over a circuit that includes conductors 124 and 125, spacing contact of relay 2W, winding 141 of relay 4 and windings 127 and 126 of relays 2W and 3W. The spacing impulse is thereupon sent over the line L_2 to station B.

In the manner that has been described fully in connection with Fig. 1, condenser 119, associated with the tube T_{12}, will continue to receive a charge and to discharge at intervals of 22 milliseconds throughout the period of one-sixth of a second. Accordingly, the circuits of the locking windings 126 and 127 of relays 2W and 3W will be closed and opened at 22 millisecond intervals, thereby insuring the proper spacing of the signal impulses being relayed from the repeater to the station B.

Approximately 1/6 second after the start was received by relays 1E, 4 and 5, condenser 117 completes its discharge and tube T_{11} becomes conductive. A current flows in winding 145 which is in a marking direction and of sufficient magnitude to overcome the spacing current in winding 139 providing, (*a*) the current in winding 105 is in a marking direction, and (*b*) that no current is flowing in a spacing direction in winding 146. If the 5th pulse (6th in the order of transmission) is marking, relay 4 will operate to marking when tube T_{11} becomes conductive. The sequence of operations after the operation of relay 4 to marking has been described hereinbefore.

Assuming the 5th pulse to be spacing: Current will flow from battery 121, through the spacing contact of relay 6, conductors 124 and 125, the spacing contacts of relay 2W and in a spacing direction through winding 141 of relay 4 and similarly through windings 126 and 127 of relays 3W and 2W and their associated bridge resistors to ground, locking relays 4 and 2W and 3W to spacing until they are released by the momentary operation of relay 6 to marking.

When the stop pulse, which is marking, is received, the current in windings 145 and 105 of relay 4 is in the marking direction and of sufficient value to overcome the effect of the current in winding 139 but not sufficient to overcome the combined effects of the currents in windings 139 and 146. Therefore relay 4 will remain on its spacing contact until the next operation of relay 6 which reduces the current of winding 146 of relay 4 to zero and allows it to operate to marking.

As soon as the tongue of relay 4 leaves its spacing contact current in windings 139, 138, and 147 of relays 4, 5 and 7 is reduced to zero. Relay 7 is completely deenergized. The negative potential through resistance 144 is removed from the lower winding of relay 1W and the current in the winding is changed from marking to spacing. The current in windings 104 and 105 now control relays 5 and 4 and they are held on their marking contacts until the balance of potentials on the resistances 103, 109, and 111 are upset by the operation of either relay 1E or 1W at some future time.

The operation of relay 5 connects the voltage of the potentiometer to condenser 119 and the grid of T_{12} causing the operations of the tube T_{12} and associated relay 6 to stop until relay 5 is again operated to spacing.

The repeater is now closed and waiting for the next transmission. If, before the reception of the next start pulse from the line L_1, L_2 wishes

to send, an open is transmitted to the line which will cause the operation of relay 1W to spacing. This will upset the balance of voltages through resistances 103, 109, and 111 and operate relays 4 and 5. Relay 7 will also be moved to its marking contact and relay 1E will be locked to marking through paths corresponding to those which locked relay 1W. Transmission of an open will ensue, the mechanics of which may be understood from the previous description.

Relay 7 preempts the distributor for transmission in the direction from which the first open starting impulse is received and retains it until the tongue of relay 4 returns to its marking contact at the expiration of the period of time of one-sixth of a second hereinbefore described. It will be seen that relays 7 and 4 also lock relay 1E or 1W in the direction opposite to that from which the open impulse comes and such locking is continued for the entire period of each signal character except the stop impulse. For example, in transmitting from east to west, after a start impulse is received by relay 1E, relay 7 is moved to or remains on the contact which will allow relay 1W to be locked to its marking contact as long as relay 4 is on its spacing contact. All "breaking" to get control of the repeater must be done during the transmission of the stop impulse.

The transmission of signal characters from station B to station A through the repeater would be carried out in a manner similar to that described hereinbefore in which transmission took place from station A to station B.

Although a speed of 60, and a 7 unit code has been assumed and referred to in the foregoing description, my invention is not limited to that particular speed and code, but may be readily adapted to other speeds and to codes involving other than 7 units. For example, by varying the resistances 11, 14 and 36 of Fig. 1 the speed may be made as high as the practical operation of the relays permits, or as low as desired; and the code units may be varied from one to any desired multiple of 1.

The purpose of the batteries 15 and 37, shown in Fig. 1, is to ensure the operation of the tubes T_1 and T_2 within relatively narrow time limits. As mentioned, hereinbefore, the suppression of the space current in those tubes is accomplished by raising the voltage on condensers 10 and 12 to a negative value above ground potential. As the grid approaches ground potential current begins to flow and its value depends to a degree on the potential of condensers 10 and 12. Batteries 15 and 37 cause the charges on the condensers to sweep rapidly across the zero to ground potential and thereby ensures the operation of the tubes within relatively narrow time limits.

While this invention has been described as embodied in particular forms, it is obviously capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a telegraph repeater, the combination with a receiving relay connected to an incoming line and responsive to signaling impulses thereon a sending relay controlled in part by the said receiving relay and connected to an outgoing line for the transmission of amplified and undistorted signals thereover, a locking relay associated with the sending relay to release the latter relay at prefixed time intervals, the said receiving relay being connected to a winding of the said sending relay to operate the latter relay in accordance with the received signaling impulses whenever the said sending relay is released upon the operation of the locking relay at each prefixed interval of time thereby permitting the sending relay to transmit a signal impulse of the same polarity, namely marking or spacing, as that received by the said receiving relay, a pulsing relay adapted to operate the said locking relay at the said prefixed intervals, an electronic timing circuit adapted to cause the pulsing relay to operate at the said time intervals, and a second electronic timing circuit to limit the number of operations of the said pulsing relay.

2. In a telegraph repeater, the combination with a receiving relay responsive to signaling impulses impressed thereon, of a sending relay controlled, in part, by the said receiving relay and adapted to impress amplified and undistorted signals upon an outgoing line, a locking relay associated with the sending relay to prevent the operation of the latter relay by the receiving relay except at prefixed time intervals, a pulsing relay having an electronic vacuum tube associated therewith to effect the operation of the said pulsing relay upon each occurrence of an electron discharge within the said tube, the said pulsing relay being arranged to disconnect a source of energy from a winding of the locking relay and the sending relay upon each occurrence of the said discharge whereby the locking relay and the sending relay may be released and permitted to operate under the control of the said receiving relay, a condenser connected to said vacuum tube and adapted to permit the said discharge to occur at the said prefixed intervals, and timing means, having a vacuum tube associated therewith to limit the number of oscillations of the said pulsing relay.

3. In a telegraph repeater, the combination with a receiving relay connected to an incoming line of a sending relay connected to an outgoing line, a locking relay associated with the sending relay, and a pulsing relay having means associated therewith to cause it to operate a prefixed number of times at prefixed intervals during the time of reception of the impulses constituting a teletypewriter signal, the said locking relay and sending relay each having a plurality of windings, one winding of each relay being connected in series to the armature of the receiving relay, and another winding of the said locking and sending relays being connected in series with a contact of the pulsing relay, the said pulsing relay having means to connect a source of current to the locking and sending relays whereby those relays may be prevented from operating and also to disconnect the said source from the locking and sending relays at prefixed intervals to permit the operation of the latter relays in accordance with the impulses of the received signal.

4. In a telegraph repeater adapted for two-way repetition of signals between an east station and a west station, the combination with an east receiving relay responsive to signals received from the east station, a west receiving relay responsive to signals received from the west station, a pulsing relay having means associated therewith to cause it to operate a prefixed number of times at prefixed intervals during the time of reception of the impulses of a teletypewriter signal, a sending relay associated with

the east receiving relay but controlled by the west receiving relay to repeat the signal characters from the west station to the east station, the said sending relay having associated therewith a locking relay arranged to be released upon each operation of the said pulsing relay to permit the operation of the sending relay at the said prefixed intervals of time only, another sending relay associated with the west station to repeat the signal characters from the east station to the west station, the said other sending relay having another locking relay associated therewith also arranged to be released upon each operation of the said pulsing relay to permit the operation of the said other sending relay at the said prefixed intervals of time only, and a preempting device responsive to the open starting impulse of a signal character adapted to give control of the repeater to that station from which the first open starting impulse comes to the repeater.

5. The invention defined by claim 4 further characterized by the inclusion of a character-length control circuit including a relay, a vacuum tube and a timing circuit connected to the grid of the tube, the said timing circuit being so proportioned as to reduce the negative charge upon the grid of the said vacuum tube and thus permit its discharge at the end of a period of time corresponding to the time-length of an undistorted teletypewriter character, the said control circuit being arranged to stop the operation of the said pulsing relay upon the completion of the transmission of each teletypewriter character.

WADE B. MARTIN.