April 9, 1929. R. B. SHANCK 1,707,997

TELEGRAPH SYSTEM

Filed Aug. 23, 1927

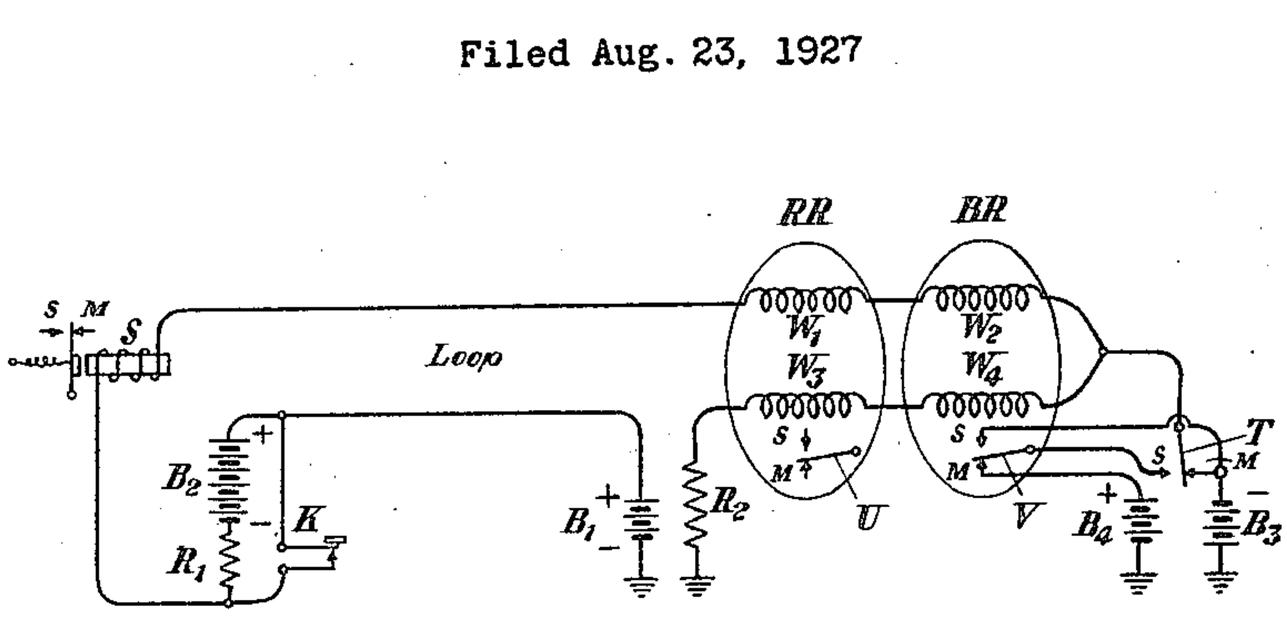
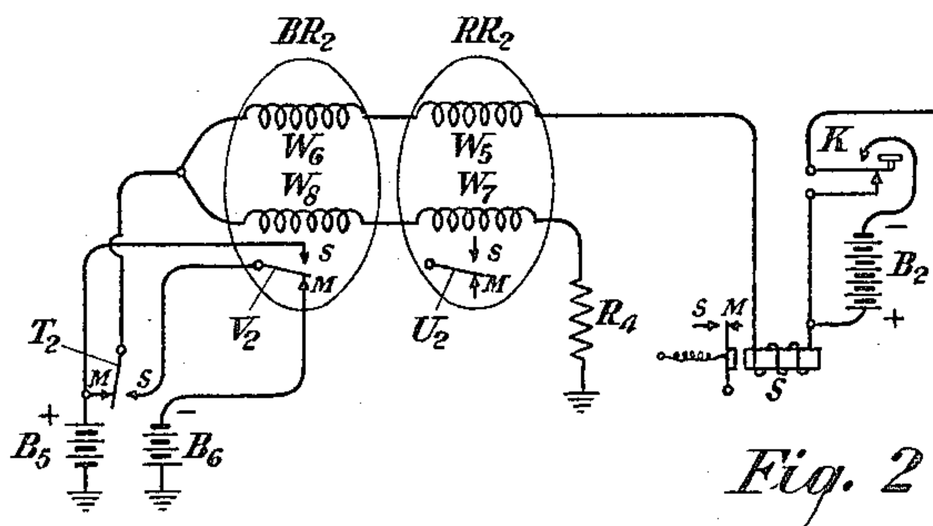


Fig. 1



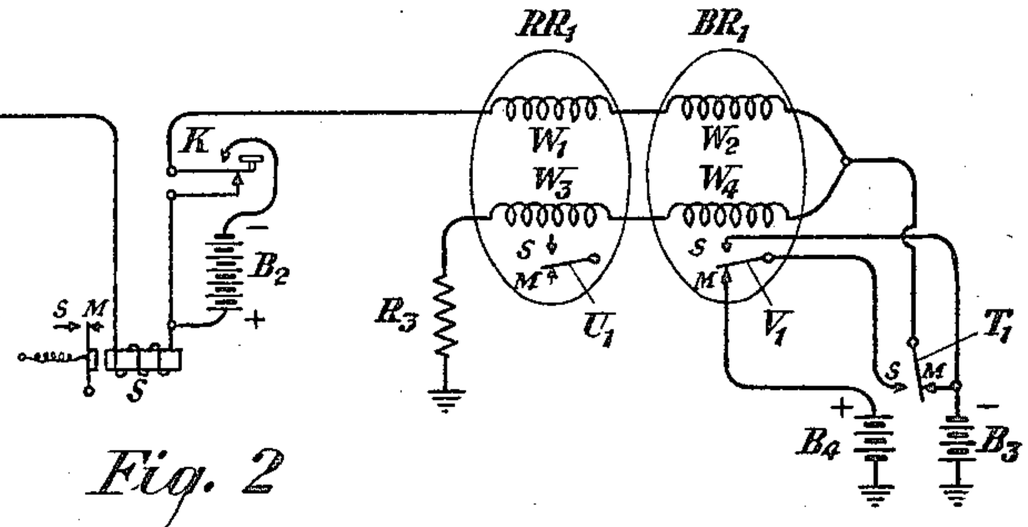


Fig. 2

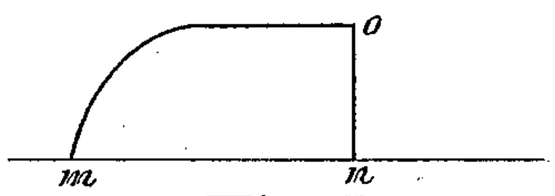


Fig. 3

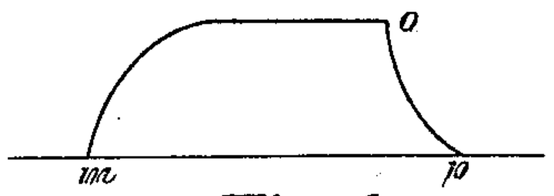


Fig. 4

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Patented Apr. 9, 1929. 1,707,997

UNITED STATES PATENT OFFICE.

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TELEGRAPH SYSTEM.

Application filed August 23, 1927. Serial No. 214,905.

This invention relates to telegraph signaling systems, and particularly to the application of counter-electromotive forces to such systems in order to maintain a fixed relationship between the durations of the marking and of the spacing impulses in order to reduce or minimize distortion.

In this invention, counter-electromotive forces will be provided at telegraph subscribers' stations for the purpose of improving the transmission in order to overcome the objectionable distortion of signals due to the inequality of the durations of the marking and spacing impulses. In former telegraph systems, considerable distortion of the signals is experienced in operating the local telegraph circuits by what is known as the open-and-close method. In the latter method of operation, the current at closing, i. e., at the marking impulse, usually builds up to a steady value exponentially, the time required for the current to reach the steady value depending upon the time constant of the circuit. The time constant may be looked upon as a measure of the slowness or fastness with which the current reaches its steady value. The greater the number of sounders or relays or other electromagnetic devices in a circuit, the slower the circuit usually becomes for signal transmission and, therefore, the more gradual is the increase in current when the circuit is closed. However, when the circuit is opened, the current drops immediately to zero. Accordingly, there is a tendency toward the shortening of the marking impulse at the telegraph receiving instrument. Thus, the spacing signal may be considerably longer than the marking signal.

The objects and features of this invention will become apparent from the following detailed description thereof, when read in connection with the accompanying drawing, in which Figure 1 represents a portion of a telegraph system in which counter-electromotive force cells are connected across a transmitting key therein; Fig. 2 represents a similar telegraph arrangement which avoids short-circuiting the source of counter-electromotive force, and Figs. 3 and 4 represent curves characteristic of the current flowing through the winding of a telegraph sounder.

Referring to Fig. 1 of the drawing, a telegraph sounder S is shown, having an armature which may move between marking and spacing contacts as the current through its winding changes from one value to another. The winding of sounder S is connected in series relationship with a battery B_1 through a parallel circuit comprising a battery B_2 and a resistance R_1 as one of the branches, and a key K as the other of the branches. The winding of the sounder S is also in series with the upper windings W_1 and W_2 of a receiving relay RR and of a break relay BR, respectively. Windings W_1 and W_2 are also serially connected to an armature T of a transmitting relay (the winding or windings of which are not shown). As the armature T of the transmitting relay moves back and forth between its contacts M and S, either battery B_3 or battery B_4, of opposite polarities, may be connected thereto. Lower windings W_3 and W_4 of the receiving relay RR and of the break relay BR, respectively, are also connected in a series circuit with a resistance R_2 and with the armature T of the transmitting relay.

The magnetizations of windings W_1 and W_3 and of windings W_2 and W_4 control the movements of the armatures U and V between the marking and spacing contacts M and S in the receiving relay RR and in the break relay BR, respectively, the armature of the receiving relay RR operating a receiving circuit (not shown). The windings W_1 and W_3 and the windings W_2 and W_4 are preferably alike in all respects and are energized by similar currents so that armatures U and V of these relays may move back and forth in synchronism. It is to be observed that when the armature V closes its spacing contact S, marking battery B_3 will be connected to windings W_1 and W_2 and to windings W_3 and W_4, even though the armature T of the transmitting relay may close its associated spacing contact S. This is so except, however, when this armature, i. e., armature T, is traveling between its contacts. The effect upon the system due to armature T not touching either of its contacts is negligible for practical purposes.

Marking and spacing signals may be transmitted over the loop to the sounder S by the operation of armature T of the transmitting relay. When armature T closes its marking contact M, key K at the other end of the loop remaining closed, current will then flow through windings W_3 and W_4 from battery

B_3, these windings being so poled as to produce spacing effects upon their respective armatures. At the same time, battery B_1 will be in series with battery B_3, and accordingly, a comparatively large current will flow through windings W_1 and W_2 of the receiving relay RR and of the break relay BR, respectively. Under these operating conditions, the magnitude of the current through windings W_1 and W_2 may be substantially twice as great as the magnitude of the current through windings W_3 and W_4, and the former current will sufficiently energize windings W_1 and W_2 so as to overcome the spacing effect produced by windings W_3 and W_4. Therefore, armatures U and V of the receiving and break relays, respectively, will close their marking contacts M. A marking signal will also be noted at the sounder S.

When the armature T of the transmitting relay closes its spacing contact S, the current through windings W_3 and W_4 will be of a magnitude the same as heretofore, but will be oppositely directed due to the connection of the oppositely poled battery B_4. Accordingly, the connection of battery B_4 to windings W_3 and W_4 will produce marking effects on the respective armatures. Moreover, battery B_1 will be connetced in series with battery B_4 through the winding of the sounder S and through the windings W_1 and W_2 of the relays RR and BR, respectively. Since batteries B_1 and B_4 are of substantially equal potentials and of opposite polarity, no current will flow through the latter windings. Accordingly, armatures U and V of the relays RR and BR, respectively, will remain in their positions against their marking contacts M, while a spacing signal will be noted at sounder S. Thus, as armature T moves back and forth between its contacts M and S, marking and spacing signals are noted at the sounder S, while the armatures U and V of relays RR and BR, respectively, remain biased against their marking contacts.

Telegraph key K may be operated to transmit marking and spacing signals over the loop circuit to relays RR and BR. It is to be particularly noted that battery B_2 and resistance R_1 shunt key. Also, when key K is open, battery B_2 is in series with battery B_1 as well as with the winding of sounder S. During the transmission of marking and spacing signals over the loop circuit by the operation of key K, the armature T of the transmitting relay will ordinarily be maintained against its marking contact M. If battery B_2 be considered a battery having a potential substantially twice that of battery B_1, then when key K is opened, substantially no current will flow through windings W_1 and W_2 of the relays RR and BR, respectively, while a normal current will flow through windings W_3 and W_4 of these relays from battery B_3, the latter windings being so poled as to produce spacing effects upon the armatures of the respective relays. Therefore, armatures U and V will close their spacing contacts S. When key K becomes closed, the effect of battery B_2 is eliminated, and battery B_1 is then connected in series with battery B_3 and aids battery B_3 in sending a comparatively large current through windings W_1 and W_2. Clearly, the joint effect of the currents through windings W_1 and W_2 and windings W_3 and W_4 will move armatures U and V of the respective relays to their marking contacts M. Thus, it will be apparent that as key K is opened and closed, spacing and marking signals will be noted at the sounder S, while the armatures U and V of relays RR and BR, respectively, will alternately move between their spacing and marking contacts.

Fig. 1 illustrates the principles of the invention as applied to a terminal telegraph repeater system employing an "upset polar" loop circuit. Fig. 2 shows the principles of this invention applied to two terminal type repeaters connected so as to form an intermediate repeater in which a loop circuit also is used. The arrangement shown in Fig. 1 discloses a group of counter-electromotive force cells B_2 which are connected across the transmitting key K, and the electromotive force of these cells is just sufficient to bring the current through the winding of the sounder S as well as through windings W_1 and W_2 to zero when key K is open. Yet, when key K is closed, battery B_2 is short-circuited which may be undesirable in practice. In Fig. 2, battery B_2 is connected in series with the sounder S when key K is opened, thereby preventing the source of counter-electromotive force from being short-circuited.

In Fig. 2, armatures T_1 and T_2 may move back and forth between marking and spacing batteries M and S, batteries B_3 and B_5 being normally connected to the marking contacts M, while batteries B_4 and B_6 are connected to spacing contacts S. The winding of sounder S is connected in a series circuit with windings W_1 and W_2 of the receiving relay RR_1 and of the break relay BR_1 respectively, and is also connected in the same series circuit with windings W_5 and W_6 of the receiving and break relays RR_2 and BR_2, respectively. Windings W_3 and W_4 are connected in series with a resistance R_3 and the armature T_1 of the transmitting relay, while windings W_7 and W_8 are connected in series with resistance R_4 and the armature T_2 of a similar transmitting relay.

Marking and spacing signals may be transmitted by armature T_1 through the sounder S as well as through the relays RR_2 and BR_2. If key K is closed and if the armature T_2 of the transmitting relay remains closed against

its marking contact, then the closure by armature T_1 of its marking contact will cause a marking signal to be transmitted through the sounder S, and, at the same time, armatures U_2 and V_2 will synchronously move to their marking contacts. Armatures U_1 and V_1 will remain biased against their marking contacts. When the armature T_1 closes its spacing contact S, a spacing signal will be noted at the sounder S, and armatures U_2 and V_2 of relays RR_2 and BR_2, respectively, will move synchronously to their spacing contacts S, armatures U_1 and V_1 of relays RR_1 and BR_1, respectively, still remaining biased against their marking contacts, and so on. Similar effects are produced when the armature T_2 is moved back and forth between its marking and spacing contacts while key K remains closed and armature T_1 remains biased against its marking contacts.

Key K may be operated to transmit marking and spacing signals to both receiving relays as well as both break relays, assuming, of course, that armatures T_1 and T_2 are held against their marking contacts. When key K is opened, battery B_2, which may be of a potential substantially twice that of battery B_3 or battery B_5, these batteries being of substantially the same potential, and is poled oppositely with respect to these batteries, will be in series with windings W_1 and W_2 as well as with windings W_5 and W_6, so that substantially no current may flow therethrough. Yet, the current which normally flows through windings W_3 and W_4 due to the series connection of battery B_3 and the current which normally flows through windings W_7 and W_8 due to the series connection of battery B_5 are both so directed by these windings as to produce spacing effects on their corresponding armatures so that these armatures, namely, U_1 and V_1 and U_2 and V_2, will be moved synchronously to their spacing contacts. When key K becomes closed, battery B_2 is disconnected from the circuit so that comparatively large marking currents flow through windings W_1 and W_2 as well as through windings W_5 and W_6, and these marking currents produce marking effects upon their armatures which overcome the spacing effects produced by the flow of currents through windings W_3 and W_4 and W_7 and W_8. Accordingly, armatures U_1 and V_1 and U_2 and V_2 will move to their marking contacts, and so it continues.

Fig. 3 shows a curve characteristic of the current that flows through the winding of a telegraph sounder when the associated transmitting key is operated, in systems not employing the principles of this invention. If it be assumed that the telegraph key is opened and closed at time intervals which are substantially equal, each time interval being, for example, represented by the abscissæ "*mn*," and if it be assumed that the magnetization of the sounder attracted its armature when the current value was substantially equal to one-half of the current value at a steady state, i. e., at a value of one-half of the ordinate "*no*," "*no*" being the ordinate corresponding to the current magnitude at the steady state, then it will be clear from the characteristic curve that the length of the marking signals will be substantially decreased, while the length of the spacing signals will therefore be correspondingly increased.

Fig. 4 shows the characteristic curve of current through the winding of a sounder connected in a telegraph system based upon the principles of this invention. Here, when the key is closed, the current increases to its steady value exponentially, as heretofore, and, when the key is open, the current decreases to its negligible value exponentially, also. It will be clear that if the magnetization required to operate the sounder were one-half of the total magnetization during the steady state, then the length of the marking and spacing signals will be substantially equal to each other, and the distortion present in former systems will be practically eliminated.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be obvious that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In the subscriber's loop of a telegraph system, the combination of a sounder, a source of potential in series with the winding of said sounder, a key, and a second source of potential, the said second source of potential being shunted by the said key when said key is closed, said second source of potential being connected in series with the winding of said sounder upon the opening of the key.

2. In a telegraph system, the combination of a sounder, a source of potential in series with the winding of said sounder, a key also in series with the winding of said sounder when said key is closed, and a second source of potential, said second source of potential being shunted by said key and being ineffective when said key is closed, said second source of potential being effectively connected in series with the winding of said sounder when said key is opened, said key being employed to cause the production of marking and spacing signals by the sounder.

3. In a telegraph system, the combination of a sounder, a battery in series with the winding of the sounder, a key similarly in series with the winding of the sounder when said key is closed, and a second battery, said second battery being connected to the series

circuit by the opening of said key, the operation of the key at a normal rate causing the operation of the sounder to produce marking and spacing signals without distortion.

4. A telegraph system comprising a line, a key, a sounder, a break relay having two windings and an armature, a transmitting relay having an armature which may operate to connect marking or spacing battery thereto, the line being serially connected to the key, the winding of the sounder, one winding of the break relay and the armature of the transmitting relay when the key is closed, the other winding of the break relay being connected between the armature of the transmitting relay and ground through resistance of a definite magnitude, and a source of counter electromotive force which may be effectively connected to, or disconnected from, the series circuit by the respective opening or closing of said key.

5. In a telegraph system, the combination of a sounder, a relay having an armature which may vibrate to cause the sounder to produce marking and spacing signals, a telegraph key which is closed when the armature of said relay vibrates, said telegraph key being operated to produce marking and spacing signals at the sounder if the armature of said relay remains stationary, and a source of direct current potential which may be connected to, or disconnected from, said sounder by the operation of said telegraph key.

In testimony whereof, I have signed my name to this specification this 18th day of August, 1927.

ROY B. SHANCK.