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START-STOP REGENERATIVE TELEGRAPH REPEATER

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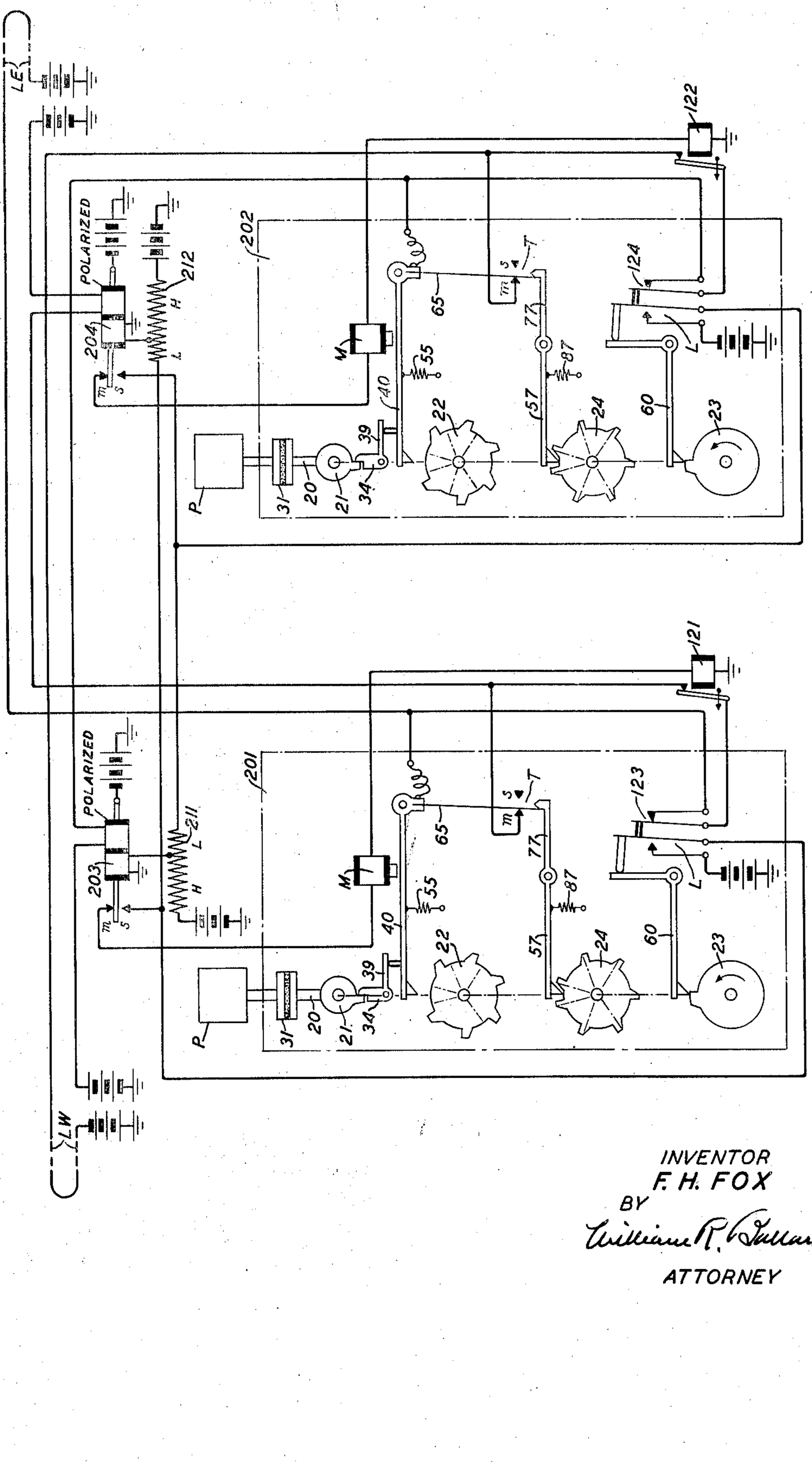


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## START-STOP REGENERATIVE TELEGRAPH REPEATER

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9 Claims. (Cl. 178—71)

This invention relates to improvements in start-stop regenerative telegraph repeaters and more particularly to arrangements for improving the operation of said repeaters in the presence of intefering impulses in the line circuit.

A mechanical type of start-stop regenerator unit has been in extensive use for some time in half-duplex telegraph repeaters, particularly in teletypewriter service. Two such regenerator units are used in a repeater, one for transmission in one direction and the other for transmission in the opposite direction. When the repeater is arranged for half-duplex operation, that is, for operation in one direction at a time, provision is made for locking the inactive side in its stop position by means of off-normal contacts in the unit operating in the active side so that all impulses of a signal series representing a character will be sent before the other unit is permitted to operate.

A regenerator unit of the type referred to is disclosed in U. S. Patent 2,105,173, issued to Zenner et al. on January 11, 1938, and reference may be had to this disclosure for details of its mechanism and operation.

The unit comprises a receiving magnet, responsive to incoming signals, and transmitting contacts for reproducing the received signals and retransmitting them into the outgoing line circuit. An intervening cam mechanism, motor-driven through a friction clutch and stopped once after each revolution, controls a plurality of operating levers and the arrangement is such that the magnet determines whether the regenerator contacts should be in marking or in spacing position and the rotating mechanism determines at which time the contacts should be moved from one position to the other. In this manner the outgoing pulses will have marking and spacing pulses in conformity with the incoming pulses and the outgoing pulses will be timed to be in synchronism with the incoming pulses, though somewhat delayed with respect to them.

As is well known, the start-stop signals comprise a stop and a start impulse and five, or sometimes six, character impulses. The stop pulse usually is a marking pulse and the start pulse is a spacing pulse.

For the purpose of maintaining successive outgoing signal series in isochronism with incoming signal series, the regenerator unit is equipped with a stop mechanism adapted to stop the cam mechanism during the stop pulse and to release it under control of the receiving magnet in response to the succeeding start pulse.

The two regenerator units operate between two sections of a single line circuit and each section may include a sensitive polar receiving relay for control of the associated receiving magnet. In a preferred form the locking arrangement referred to above is effective in preventing one receiving relay from starting its associated unit during the reception of a signal series by the other receiving relay and the locking circuit for the inactive relay includes the contacts of the active relay and the off-normal contacts of the active unit. These contacts cooperate in locking the inactive relay except for a portion of each stop pulse passing through the active side, thereby permitting the inactive side to respond to a signal, such as a break signal, from its line circuit during this unguarded period.

A circuit arrangement of this type has been disclosed in a copending application for U. S. Patent Serial No. 74,640, filed by W. V. K. Large on April 16, 1936, which has issued as Patent No. 2,243,215 on May 27, 1941, and reference may be had particularly to Fig. 2 of that disclosure.

As is well known, interfering impulses usually termed "hits" occur at varying intervals in telegraph circuits of this type and would be received in the repeater circuit as a spacing impulse. It is therefore general practice in commercial circuits to provide hit indicators that can be connected in each line section. These indicators may be of different types but have the common characteristics of responding separately in all impulses passing in each direction in the line circuit under observation and of giving an indication, which may be visual, for each response. Thus an observer will find one meter in the indicator actively responding to a message in a given direction and another associated meter remaining inactive during the transmission of the same message. Hits passing in the same direction as the message cannot be observed in this manner, whereas hits passing in the opposite direction will give readily observed indications on the inactive meter. In this manner too frequently occurring hits will be noted and it is possible to locate the line section on which they originate. Examples of hit indicator systems such as those just referred to are disclosed in U. S. Patents 1,861,553 issued to R. B. Shanck on June 7, 1932, and 1,982,022 issued to E. W. Reeve on November 27, 1934.

It has, however, been found that hits arriving in the same direction as the message at the repeater station and occurring during the unguarded portion of a stop pulse frequently give

erroneous indications on the hit indicator. Such a hit may cause the inactive receiving relay in the repeater circuit to start the inactive unit which then would send a spacing pulse back into the originating line circuit, thereby giving a false indication on the inactive hit meter. Thus the observer of the hit meters may be confused as to the origin of the hit.

Other provisions are made in the commercial circuits for supervision of long spacing conditions, such as break signals. For this purpose it is important that the open condition remain uninterrupted by the repeater circuit.

It is therefore an object of the invention to prevent the reflection into the originating line of hits arriving on that line by a start-stop regenerative repeater circuit, so that line trouble may more quickly be located.

It is a more specific object to guard the inactive side of a two-way repeater during the otherwise unguarded interval during the stop impulse to prevent false operation due to a hit.

It is another specific object to thus guard the inactive side substantially without interferring with the normal modes of operation of the regenerative repeater circuit.

In accordance with a feature of the invention the transmitting contacts of the regenerator unit are temporarily bridged by a by-pass while the regenerator is in stop position.

In accordance with a more specific feature of the invention the by-pass is established by contacts closed by an off-normal cam on the regenerator unit in stop position.

In accordance with another feature of the invention the by-pass is established during each stop impulse of successive signal impulse series transmitted with about the normal speed of operation and is made ineffective during a long open or spacing condition on the line circuit extending beyond the length of one or more signal impulse series.

In accordance with a still more specific feature of the invention a timed relay, such as a slow-releasing relay, is made responsive to marking impulses incoming at least once for each signal impulse series to keep its contacts closed for the completion of the by-pass so that during, for example, a break signal the contacts of the timing relay will open the by-pass after a predetermined period equal to the length of one, two or more signaling impulse series, thereupon maintaining the by-pass open and removing the artificial marking condition established by the by-pass for the line circuit into which the break signal is transmitted by the repeater and thus causing the break signal to be transmitted without interruption.

The invention will now be described more in detail as to its structure and operation when applied to a specific preferred embodiment. The following description should be read in combination with the attached drawing which shows a circuit diagram of a repeater station including two regenerator units of the general type shown in the Zenner et al. patent referred to above. The regenerator units are shown in diagrammatic form with elements corresponding to those of the device disclosed by Zenner et al. and numbered to correspond to the numerals identifying the elements in the Zenner et al. patent.

It should, of course, be understood that whereas the embodiment shown in the drawing includes mechanical regenerator units the invention may readily be adapted for operation with other types of start-stop regenerator units, such as the well-known type using segments and brush contacts. It should further be understood that whereas the disclosed embodiment includes a circuit arrangement similar to that of Fig. 2 in the copending application by Large referred to above, other circuit arrangements such as that shown in Fig. 1 or 3 of the Large disclosure may be used for the purposes of the invention.

Referring now to the circuit diagram shown in the drawing the system comprises a repeating station with relay equipment for half-duplex operation between two line sections LW and LE which may terminate in subscribers' loop circuits including the usual receiving and transmitting equipment at each subscriber's station. The repeating station comprises two regenerator units **201** and **202**, one for each direction of transmission. Two polar relays **203** and **204** having operating and biasing windings are associated with the regenerator units **201** and **202**, respectively. The loop circuits will normally be closed and the normal line current will act to operate relays **203** and **204** to marking. A spacing signal is transmitted by opening either one of the loop circuits which causes the relays **203** or **204** to be operated to spacing by their biasing windings which are normally connected to a predetermined potential through potentiometers **211** and **212**, respectively.

Each regenerator unit will be assumed to be of the type disclosed in the patent to Zenner et al. referred to above and comprises a receiving magnet M controlled by its associated receiving relay, transmitting contacts T controlled by the magnet M and by the cam mechanism of the unit for operation into marking or spacing positions, and off-normal or locking contacts L controlled by the cam mechanism.

The transmitting contacts T are included directly in the respective line circuits and thus repeat the signals directly into the subscribers' loops, the outgoing impulses passing through the operating winding of the receiving relay in the outgoing circuit and tending to operate that relay. The polar relays are, however, prevented from responding to outgoing signals, except for short intervals during each stop condition, by the application of a locking potential to the potentiometer connected to the biasing winding of the relay, the locking potential being applied either from the spacing contact of the active polar relay or from the locking contact of the active regenerator unit or both, this locking potential is of a polarity opposite to that permanently applied to the other end of the potentiometer.

Referring now particularly to the details of each regenerator unit, the cams **21**, **22**, **23**, **24** are mounted on a common cam sleeve **20** driven through a friction clutch **31** by any suitable power supply P. The stop cam **21** cooperates with a stop latch **34** for stopping the cam sleeve in stop position; the stop latch **34** is in turn controlled by armature **40** of magnet M so that when the armature **40** is released by magnet M the latch **34** will permit the stop cam **21** to rotate.

The armature **40** has a spring **55** for retracting the armature and the magnet M is not of a sufficient strength during a marking pulse to attract the armature, but is of sufficient strength to hold the armature attracted during the marking pulses. The armature **40** cooperates with a flutter cam **22** with projections properly distributed about its periphery for raising the armature **40**

against the spring 55 to present the armature to the magnet M. If at such time magnet M is energized, as during a marking pulse, the armature 40 remains attracted. If, however, the magnet is deenergized the armature will be retracted after the passing of the cam projection on cam 22. The armature 40 also carries a contact operating member 65, schematically shown as being flexible so that the member 65 may be locked against either the marking contact *m* or the spacing contact *s* by means of locking lever 77 while the armature 40 is in either position. Thus when the armature is attracted it will exert a force on the flexible arm 65 in the direction of the marking contact and when it is retracted it will exert a force on the arm 65 in the direction of a spacing contact. These forces exerted by the armature 40 will, however, not be effective until the arm 65 is released by the locking lever 77 which forms part of the lock arm 57. The lock arm 57 is normally in engagement with a lock cam 24 by means of a spring 87 and during rotation of the cam sleeve will be raised at predetermined intervals by the projections on the lock cam 24, thereby removing the locking lever 77 from engagement with the flexible contact arm 65 and permitting the latter to swing into engagement with either the marking or the spacing contact as determined by the position of the armature 40. The distribution of the projections on the flutter cam 22 and lock cam 24 is such that for any particular impulse of a signal impulse series the armature 40 will first be presented to the magnet M and will be held or dropped by the magnet, as the case may be, whereupon the lock arm 57 will be operated to permit the flexible contact arm 65 to, if necessary, change from one position to the other.

An off-normal cam 23 has a single projection which in stop position operates the locking lever 60 against the tension of a contact spring to open the locking contacts L, thereby opening the holding circuit for the polar relay connected in the output circuit of the unit.

For purposes of the invention a pair of contacts 123 and 124 are added to the locking contacts L of the respective units 201 and 202 and slow-releasing relays 121 and 122 have their windings connected in the operating circuit of the respective regenerator magnets M and have their contacts serially connected with the auxiliary contacts 123 and 124, respectively, in a by-pass for the transmitting contacts T of the regenerator, as shown in the drawing. Thus the slow-release relay 121, for example, will operate in response to the polar relay 203 in marking position and the slow-release action of relay 121 should be timed so that the relay contact will remain closed for an interval at least as long as the normal interval between two successive stop pulses. Thus under normal operation the slow relay in the active side will hold its contact closed, thereby preparing the by-pass for the transmitting contacts T.

Assuming that a message is to be transmitted from the line west LW to the line east LE, a start impulse is received over the line circuit LW through the operating winding of relay 203 and over the closed contacts T of the regenerator unit 202. Relay 203 responds by moving to spacing, thereby reducing the current in magnet M of the unit 201 and relay 121 to zero and also applying negative potential to the low resistance end of the potentiometer 212, the high resistance end of which is connected to positive potential, and thereby reversing the current in the biasing winding of relay 204 to hold this relay in marking position. The unit 201 will be started by the release of armature 40 and immediately thereafter the locking contacts L will be operated to their alternate position thereby applying negative potential to the potentiometer 212 and thus preventing relay 204 and unit 202 from operating until unit 201 again reaches its stop position.

After a short interval the lock arm 57 is elevated by the first projection on cam 24 to unlock the flexible contact arm 65 which quickly moves to spacing position due to the stored-up tension produced by the armature when the latter was dropped. The transmitting contacts T thus will be opened and will transmit a spacing signal into the loop LE without affecting relay 204.

The circuit will remain in this condition until a marking impulse is received over loop LY which will operate relay 203 to marking thereby energizing magnet M of unit 201. However, as the cam sleeve revolves the flutter cam 22 will raise the armature 40 once for each impulse period thereby presenting the armature to the magnet M for holding or dropping after each cam projection has passed. Cam 24 raises the lock arm 57 once for each impulse period shortly after the armature has been presented and has assumed its position in accordance with the characteristic of the pulse. Thus the transmitting contacts T are permitted to open or close the line circuit LE in accordance with the position of armature 40, thereby transmitting impulses from LW into the outgoing circuit LE.

When the stop impulse arrives, relay 203 moves to marking thereby energizing magnet M of unit 201 and relay 121. When the stop projection of cam 22 next presents the armature to the magnet the armature will be held attracted, thereby placing the stop latch 34 in the path of the cam 21 for stopping the unit. Shortly thereafter the stop projection on cam 24 releases the transmitting contacts T which then move to marking, or remain in marking as the case may be, for transmission of a stop pulse into the loop circuit LE. The contacts T will thereafter be locked while the unit moves to stop position and until the unit is again started, whereupon the start projection of cam 24 again will release the contacts T. The circuit is thus restored to normal condition as shown in the drawing.

It will be noted that the negative guard potential applied by relay 203 to potentiometer 212 is disconnected during the entire length of the incoming stop pulse and that the negative guard potential applied by locking contact L of unit 201 to the potentiometer 212 is disconnected by the off-normal cam 23 for an interval from about the beginning of the outgoing stop pulse until shortly after the next starting of the unit. Relay 204 therefore is permitted to operate to spacing from the moment off-normal cam 23 opens the locking contacts L until the moment when relay 203 operates to spacing in response to the next start pulse. This unguarded interval is provided to permit a break signal from line LE to start the regenerator unit 202 for placing a long opening on the line circuit LW, thereby notifying the transmitting subscriber that the other party wishes to cut in.

The auxiliary off-normal contacts 123 on the unit 201 are adjusted to close shortly before contacts L are opened by off-normal cam 23 and to again open shortly after the contacts L are closed

upon starting of the unit. With slow-releasing relay 121 holding its contacts closed during normal transmission, the by-pass for contacts T thus will be closed for an interval slightly longer than that in which the locking contacts are open during the stop pulse, and thus will be established during the entire unguarded period referred to above. The purpose of this provision will be explained below.

In the case of a break signal being transmitted from line west to the unit 201 this unit will be started and will keep on rotating so long as the spacing condition of the break signal is maintained and the slow relay 121 will open the by-pass after the absence of one or two stop impulses, dependent upon the timing adjustment of the relay, thereby removing the artificial marking condition imposed on the line LE by the by-pass each time the off-normal cam 23 closes the auxiliary contacts 123 and thus permitting a continuous break signal to be transmitted over line LE after the unit has revolved once or twice. The removal of the by-pass thus permits the proper operation of the supervisory equipment referred to above and the proper reception of the break signal in loop LE. As is well known, the break signal may be sent during transmission in the opposite direction as a request to the other station to stop sending, or a similar spacing signal may be sent over an idle line to call or start the other station.

When a hit occurs on line circuit LW during transmission from line LW to line LE, as described above, a spacing condition will be imposed on the incoming end of line circuit LW causing relay 203 to operate to spacing for the duration of the hit, and the magnet M of the rotating unit 201 will drop the armature each time it is presented during the hit and will cause corresponding spacing pulses to be transmitted into the line LE. Such hits may interfere with the message in line LE but cannot be observed on the hit meters for either the active or inactive direction. A hit on line LE occurring during transmission from line LW may also interfere with the reception of the message in line LE but can be properly observed on the inactive hit meter associated with the line circuit.

A special condition arises, however, when a hit occurs on the incoming circuit during a stop pulse and particularly when the hit is present at the time the transmitting contacts T are unlocked for operation to marking in response to the stop pulse.

Relay 203 thus will be operated to spacing by the hit on line LW thereby causing the magnet M to drop armature 40 after it has been presented by the stop projection on cam 22 with the result that the transmitting contacts T, when released by locking cam 24, will move to spacing instead of moving to marking as in the case of an uninterrupted incoming stop pulse. The unit 201 will thus fail to stop and the contacts T will remain in spacing during the subsequent start pulse and at least until the armature has been presented to magnet M by a projection on cam 22. If the hit be long enough to last into the incoming start pulse, the receiving relay 203 would remain in spacing and there would be no unguarded period for relay 204 which thus would remain locked by contacts L of unit 201 until the next stop pulse from line LW. However, if the hit should cease before the beginning of the incoming start pulse, the unguarded period for relay 204 may be as long as during normal operation.

In the absence of the by-pass, provided in accordance with the invention and described above, the opening, due to the hit, of the line circuit LE by contacts T of unit 201 during the unguarded interval of the stop period, i. e., after the passing of the hit when relay 203 has returned to marking would cause relay 204 to move to spacing and to start its associated regenerator unit 202. A guard potential would immediately be applied to potentiometer 211 for locking relay 203 in marking position during a revolution of unit 202, and when the transmitting contacts of unit 202 were released by the start projection on cam 24 a spacing pulse would be transmitted into line circuit LW. Since transmission from line LW would continue the spacing pulse from unit 202 against the prevailing direction of transmission would be indicated on the hit indicator as a hit originating in line circuit LE, which would be erroneous.

With the by-pass for transmitting contacts T provided in accordance with the invention, the erroneous hit indication under the special condition just described is prevented, and the location of line faults is expedited.

Thus when a hit occurs on line LW and is present when the transmitting contacts T of unit 201 are unlocked by the stop projection on cam 24 these contacts will be locked in spacing as described above, but the line circuit LE will remain closed over the by-pass including the auxiliary off-normal contacts 123 and the contacts of slow-release relay 121 in series. Since this by-pass, as already described, is closed during the entire unguarded interval of the stop pulse, relay 204 remains unaffected by the hit and a false start of the unit 202 is prevented; thus the inactive meter in the hit indicator remains unaffected by the hit in the active direction. However, since armature 40 of unit 201 remains retracted due to the hit, the cam sleeve will fail to stop and there may be some interference with the transmission of one or two characters to the loop circuit LE.

Inasmuch as the two generator units of the repeater station are similarly connected into the circuit, operation of the system during transmission from the line LE to the line LW will proceed in the same manner as described above for transmission in the opposite direction. Also the prevention of a false indication by the hit meters due to a hit on line LE during a stop impulse is accomplished in the same manner as described above for a similar hit on the line circuit LW.

Whereas the invention has been described above as being applied to a circuit arrangement in which the receiving relay in the inactive side is locked against operation except during the unguarded period, it should be understood that the invention is readily adaptable to a circuit arrangement in which the starting of the inactive unit is prevented, except during the unguarded period, by the application of a guard potential or other provision effective during the revolution of the active unit in locking the inactive magnet. Examples of such systems are shown in Figs. 1 and 3 in the application by Large referred to above.

What is claimed is:

1. A two-way start-stop telegraph repeater circuit connected between two line circuits and comprising a west and an east regenerative repeater alternately active and inactive one at a time to repeat start-stop code impulses incom-

ing from west and east into the east and west line circuits, respectively, each of said repeaters including receiving winding means, timed repeating contact means controlled as to code by said receiving winding means, off-normal guard contact means connected to lock the other of said repeaters against operation during the operating cycle of the active repeater except for an unguarded period during the stop condition of said active repeater, and auxiliary off-normal contact means connected to prevent the said other repeater from operating in response to a false start impulse by said repeating contact means of the active repeater during said unguarded period.

2. A repeater circuit in accordance with claim 1 in which said auxiliary off-normal contact means of each repeater is connected to short-circuit the associated said repeating contact means during the said unguarded period.

3. A repeater circuit in accordance with claim 1 in which each repeater further includes slow-acting relay means responsive to stop impulses for rendering said auxiliary contact means effective during substantially continuous character transmission by said repeater and for rendering said auxiliary contact means ineffective during intervals between stop impulses of substantially greater duration than that of a character impulse series.

4. A two-way start-stop telegraph repeater circuit comprising two regenerative repeaters alternately active and inactive for transmission in opposite directions one at a time, each of said repeaters including receiving winding means, timed repeating contacts controlled as to code by said receiving winding means, off-normal guard contacts connected to lock the inactive repeater against operation during the operating cycle of the active repeater except during an unguarded period during the stop condition of the active repeater, and auxiliary off-normal contacts connected to short-circuit the associated repeating contacts during substantially the total duration of said unguarded period.

5. A repeater circuit in accordance with claim 4 in which each of said repeaters further includes a slow releasing relay having contacts serially connected with said auxiliary contacts and being responsive to successive stop impulses transmitted at substantially normal intervals to close its contacts for completion of the said short circuit and to hold its contacts closed during said intervals and being timed to release during intervals between stop impulses substantially longer than normal to open its contacts for opening of said short circuit.

6. A two-way start-stop telegraph repeater circuit connected between two line circuits and comprising a west and an east regenerative repeater alternately active and inactive to one at a time repeat start-stop code impulses incoming from west and east into the east and west line circuits, respectively, each of said repeaters including receiving winding means, timed repeating contact means controlled as to code by said receiving winding means, off-normal guard contact means connected to lock the other of said repeaters against operation during the operating cycle of the active repeater except for an unguarded period during the stop condition of said active repeater, and circuit means including contact means normally closed during said stop condition and connected to said other repeater for, when closed, preventing the said other repeater from operating in response to a false start impulse by said repeating contact means of the active repeater during said unguarded period.

7. A two-way start-stop telegraph repeater circuit connected between two line circuits and comprising a west and an east regenerative repeater alternately active and inactive to one at a time repeat start-stop code impulses incoming from west and east into the east and west line circuits, respectively, each of said repeaters including receiving winding means, timed repeating contact means controlled as to code by said receiving winding means, guard contact means connected to lock the other of said repeaters against operation during the operating cycle of the active repeater except for an unguarded period during the stop condition of said active repeater, and circuit means including additional contact means and connected to said other repeater to lock said other repeater against operation during a starting impulse produced by said repeating contact means of the active repeater in the stop condition.

8. A two-way start-stop telegraph repeater circuit connected between two line circuits and comprising a west and an east regenerative repeater alternately active and inactive to one at a time repeat start-stop code impulses incoming from west and east into the east and west line circuits, respectively, each of said repeaters including receiving winding means, timed repeating contact means controlled as to code by said receiving winding means, guard contact means connected to lock the other of said repeaters against operation during the operating cycle of the active repeater except for an unguarded period during the stop condition of said active repeater, and circuit means including slow acting contact means and connected to said other repeater to lock said other repeater against operation during a start condition effected by said repeating contact means of the active repeater in stop condition and adjusted to after a predetermined interval restore said other repeater to normal operating condition.

9. A two-way start-stop telegraph repeater circuit connected between two line circuits and comprising a west and an east regenerative repeater alternately active and inactive to one at a time repeat start-stop code impulses incoming from west and east into the east and west line circuits, respectively, each of said repeaters having an operating circuit adapted to be opened for starting of said repeater in response to a starting impulse and further including receiving winding means, timed repeating contact means controlled as to code by said receiving winding means, guard contact means connected to lock the other of said repeaters against operation during the operating cycle of the active repeater except for an unguarded period during the stop condition of said active repeater, and circuit means including additional contact means connected to maintain closed the operating circuit for said other repeater during a start condition effected by said repeating contact means of the active repeater in the stop condition and adjusted to after a predetermined interval restore said operating circuit for normal starting of said other repeater.

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