

May 27, 1941.

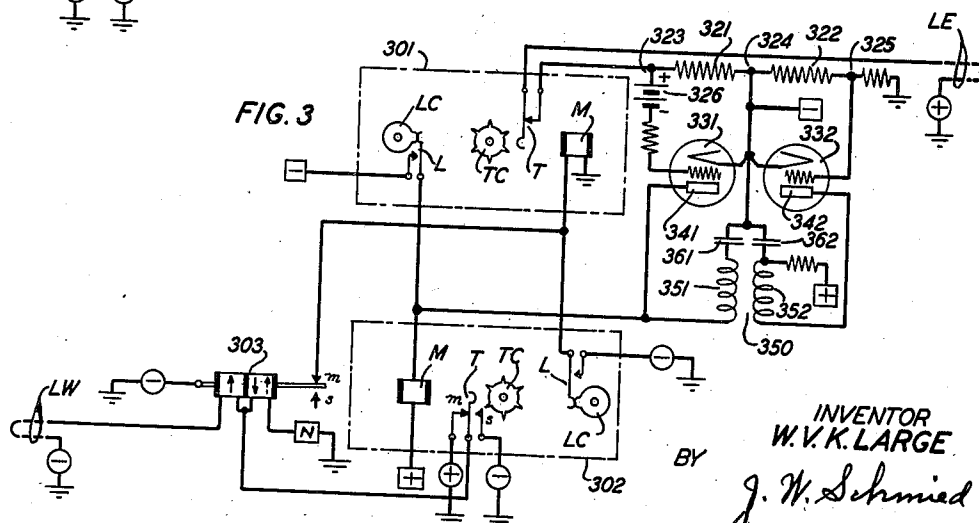
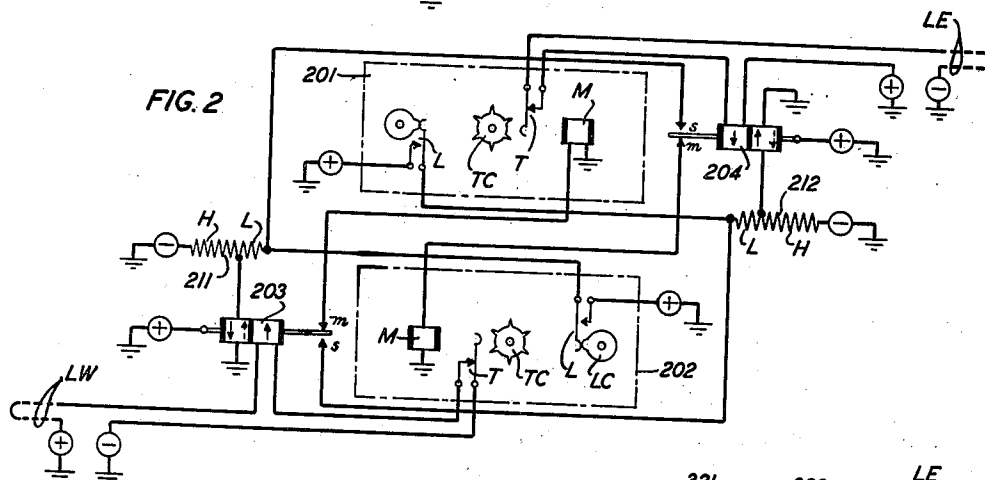
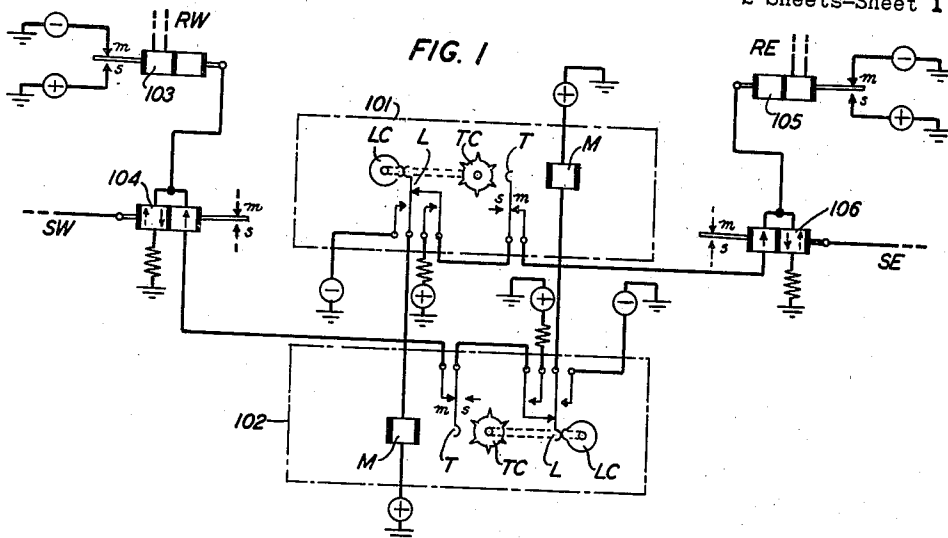
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2,243,215

REGENERATIVE IMPULSE REPEATER

Filed April 16, 1936

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 4

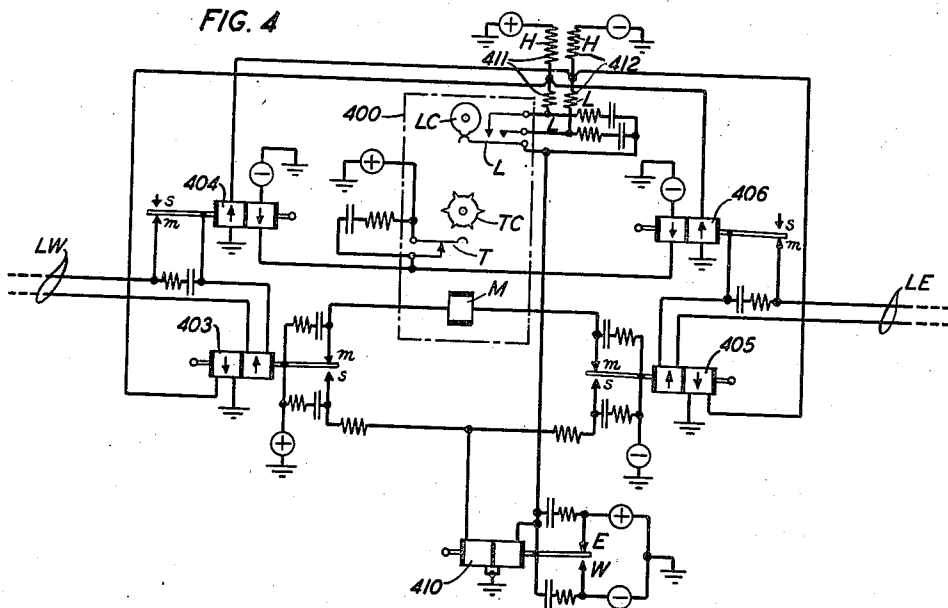
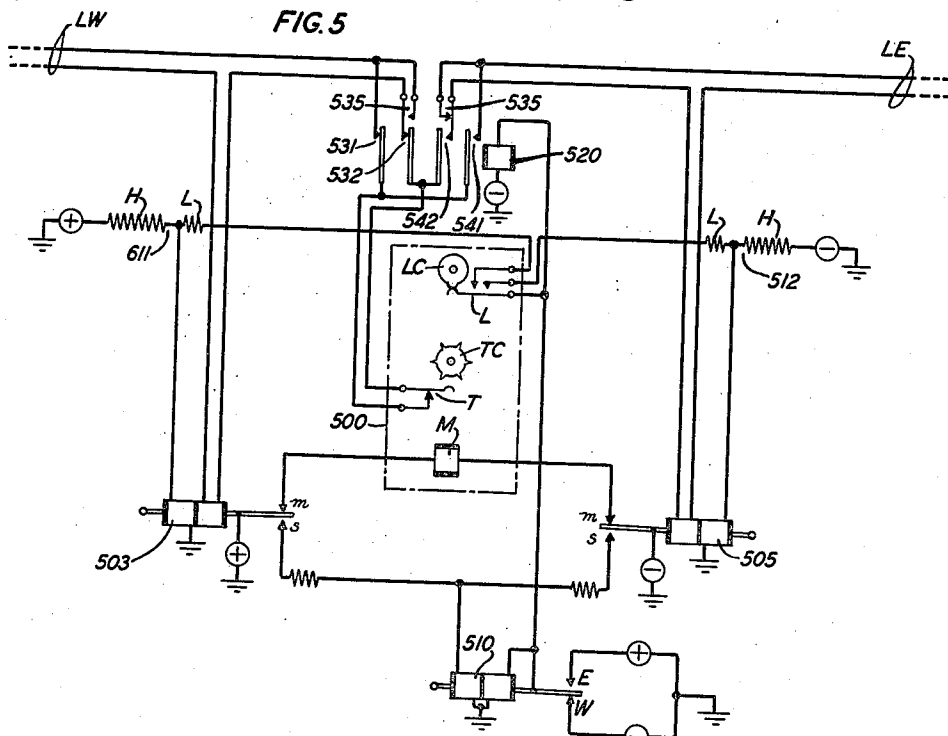


FIG. 5



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## UNITED STATES PATENT OFFICE

2,243,215

## REGENERATIVE IMPULSE REPEATER

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41 Claims. (Cl. 178—71)

This invention relates to regenerative impulse repeaters and, more particularly, to repeaters of this type adapted for use in start-stop telegraph systems.

An object of the invention is to provide a start-stop regenerative impulse repeater of simple construction and low cost.

Another object is to provide a regenerative repeater which will prevent transmission of signals back into the originating line.

A more specific object is to provide a switching arrangement for a regenerative repeater whereby a single impulse regenerating device may be used for both directions of transmission.

With the increasing speed of transmission in telegraph systems it has been found necessary to improve the shape of the impulses transmitted by the repeaters by the insertion of regenerative devices in the repeater circuits, so that the repeated impulses will be almost exact duplicates of the original impulses.

The regenerative device or unit may take different forms. Thus, it may be a mechanical device with cam-operated contacts and cooperating with one or more relays in the transmission of signals in a given direction, the principle of operation being that the contacts of the device are set in accordance with the character of the incoming impulses and their setting is timed by a motor driven cam device operating on the start-stop principle for purposes of synchronization. Such a device has been disclosed in Patent 1,956,704 issued to A. Weaver on May 1, 1934. A similar device is disclosed in a copending application for patent, Serial No. 712,461, filed on February 23, 1934, by W. J. Zenner and issued as Patent 2,104,251, on Jan. 4, 1938. Another arrangement would involve the use of the well-known type of distributor with segments and rotating contact wipers, cooperating with relays and capable of receiving distorted impulses by means of one relay and retransmitting perfected impulses by another relay in accordance with the character of the received impulses and at intervals timed by means of the distributor. Such an arrangement has been disclosed in U. S. Patent 1,771,453 issued to G. S. Vernam on July 29, 1930.

In accordance with the invention, a start-stop regenerative repeater for transmission in both directions may have one or two timing devices of the types referred to, each of which is provided with an off-normal set of contacts. This set of contacts may be a set of cam-operated springs having one position in the stop position

of the timing device and another position during the rotation of the device; or they may comprise segments on a rotary distributor for placing a circuit in one condition in the stop position of the distributor and in another condition during the rotation of the distributor. The off-normal contacts may be connected to prevent the inactive side of the repeater from operating during the period of retransmission by the active side of a complete series of impulses for a character of the start-stop codes. By this arrangement it is possible to eliminate two or more holding relays such as are generally used in repeaters of this type to prevent the line relay in the inactive side from kicking off.

In accordance with another specific feature of the invention, switching means are provided for switching a single regenerative device for transmission in either direction and the off-normal contacts are connected to lock the repeater in either switched position during the retransmission of a complete impulse series representing a character.

The objects and features of the invention will be better understood from the following detailed description thereof when read in connection with the accompanying drawings, in which:

Fig. 1 illustrates a start-stop telegraph repeater of conventional design arranged in accordance with this invention to cooperate with two regenerative devices for production of regenerated impulses; a locking arrangement prevents one device from operating during the operation of the other device;

Fig. 2 illustrates a single line repeater arranged in accordance with the invention to include two regenerative devices. The locking arrangement in this circuit prevents a line relay in one side from operating while the regenerative device in the other side of the repeater is operating;

Fig. 3 illustrates a two-element regenerative repeater controlled on one side by relay means and on the other side by an arrangement of ionic gas-filled tubes;

Fig. 4 shows a two-way regenerative repeater including a single regenerative device for transmission in both directions and also including switching means for alternating the direction of transmission. The switching in this embodiment is accomplished by locking the relays in one or the other side of the repeater against operation; and

Fig. 5 represents a single element regenerative

repeater similar to that shown in Fig. 4. In this embodiment the retransmitting contacts of the regenerative device are switched from one line circuit to the other in accordance with the direction of transmission.

As already stated, the regenerative unit or device suitable for use in circuits arranged in accordance with the invention may be any one of a number of different types, provided it has off-normal contact arrangements for controlling one or more circuits. For the sake of simplicity, the preferred forms of the invention illustrated in the various figures of the drawings will be assumed to include the mechanical regenerator disclosed by W. J. Zenner in his application, Serial No. 712,461. This device includes the usual receiving magnet and retransmitting contacts. The contacts are set in one or the other of two positions in accordance with impulses of two different characters received by the magnet, and their operation from one position to the other is timed by a cam shaft driven by a constantly running motor through a friction clutch. The cam shaft makes one revolution for each impulse series representing a character and is started by the release of the normally energized receiving magnet in response to the first or start impulse of each series. A set of cams fixed on the intermittently driven cam shaft has camming surfaces for the timed operation of the transmitting contacts once for each impulse of a series. For the purposes of this invention, an extra cam should be fixed to the intermittently driven cam shaft with a cam surface adapted to operate a set of off-normal contacts to be in one position when the shaft is in its stop position, and to be in their alternate position from a time shortly after starting to a time shortly before stopping of the cam shaft once for each revolution.

Referring now particularly to Fig. 1 of the drawings, this circuit represents a repeating station with relay equipment for half duplex operation between two line sections, and modified by the insertion between its two halves of two regenerative elements 101 and 102, one for each direction of transmission. Units 101 and 102 in reshaping the impulses on their passage through the repeater will make it possible either to increase the distance between the two stations or to increase the speed of transmission of the system. By means of the special locking arrangement associated with the regenerators 101 and 102, one of these devices is prevented from starting while the other one is rotating, so that the transmission will not be interfered with.

Each of the regenerators 101 and 102 comprises a receiving magnet M, transmitting contacts T operated in accordance with impulses through magnet M to marking or spacing position and timed by a timing cam TC, and off-normal or locking contacts L operated by a locking cam LC once for each impulse series.

The repeating circuit shown in Fig. 1 also comprises a polar relay 103 connected to receive impulses over a receiving circuit RW and to retransmit marking and spacing impulses to the magnet M of regenerator 101. Polar relay 104 is connected to receive impulses from transmitting contacts T of regenerator 102 and to retransmit marking and spacing impulses into a west sending circuit SW. The receiving circuit RW and sending circuit SW may be connected in any desirable manner to a line circuit extending west from the repeater station.

Relays 105 and 106 correspond to relays 103 and 104, respectively, and are connected to receive impulses over a receiving circuit RE and retransmit impulses into a sending circuit SE connected in any desirable manner to a line circuit extending east from the repeater station. Relay 105 impresses marking and spacing impulses upon magnet M of unit 102 and relay 106 receives impulses from the transmitting contacts T of unit 101.

Relays 104 and 106 are connected in a differential circuit so that they will not respond to impulses sent through their windings by the operation of relays 103 and 105, respectively.

The locking contacts L of the regenerator 101 normally complete the circuit from magnet M of unit 102 to the armature of receiving relay 105. As soon as unit 101 has been started, the locking contacts L will move to their alternate position thereby applying negative potential to the circuit of magnet M of unit 102 and positive potential to the operating winding of relay 106. Locking contacts L of unit 102 are similarly connected to the magnet M of unit 101 and to the operating winding of relay 104.

Assume now that a message is to be transmitted from the line West to the line East and that a start impulse is received over the circuit RW. Relay 103 responds by moving to spacing thereby reducing the current in magnet M of unit 101 to zero and also reversing the current in the biasing winding of relay 104 to hold this relay in marking position. The unit 101 will be started by the release of the armature of magnet M and immediately thereafter the locking contacts L are operated to their alternate position, thereby locking magnet M of unit 102 against operation and, without opening the transmitting circuit through transmitting contacts T, applying positive potential directly thereto. Shortly thereafter, transmitting contacts T will move to spacing position, the exact time being determined by the timing contacts TC. This reduces the current in the operating winding of relay 106 to zero, thereby operating this relay to spacing and causing a start impulse to be impressed upon the sending circuit SE.

Assuming now that the first character impulse received over the receiving circuit RW also is a spacing impulse, the entire circuit will remain in this condition. Assuming next that the second character impulse is a marking impulse, relay 103 will be operated to marking, in turn energizing M of unit 101. At the proper time determined by the timing cam TC, the transmitting contacts T of unit 101 will be operated to marking, thereby operating relay 106 to marking for retransmission of a marking impulse to the sending circuit SE. When the last or stop impulse, which always is a marking impulse, is received, the circuit will be in the position just described and shortly after the passage of the mid-point of the stop impulse, the unit 101 will come to a stop. Locking contacts L will then be operated to the position shown in the drawings and the entire circuit is restored to normal awaiting the arrival of the next start impulse. During this interval of waiting, a marking impulse will be applied by relay 106 to the sending circuit SE.

It is evident that it will not be possible to operate magnet M of unit 102 while unit 101 is in operation, and that, therefore, contacts T of unit 102 cannot interfere with the operation of magnet M of unit 101.

If a break signal should be received over receiving circuit RE by relay 105 while the unit 101 is rotated, relay 105 would be operated to spacing without affecting the operation of relay 106 and unit 101. This condition would be maintained until unit 101 arrived in stop position, at which time the spacing potential from relay 105 will immediately be extended to magnet M of unit 102 over the locking contacts L of unit 101 in normal position. Magnet M of unit 102 then deenergizes, starting up unit 102 and locking the magnet M of unit 101 by means of its locking contacts. Shortly thereafter the transmitting contacts T of unit 102 will operate to spacing, thereby transmitting a break signal to relay 104 which in turn sends it out over the sending circuit SW.

The circuit in Fig. 1 being symmetrical, it is evident that the operations for transmitting from east to west will take place exactly as described above for transmission of west to east.

The repeater circuit shown in Fig. 2 includes two regenerator units 201 and 202 in association with polar relays 203 and 204. The regenerator may be identical with those used in the circuit shown in Fig. 1. The repeater is connected for operation between line West LW and line East LE, which lines may be subscribers' loop circuits including the usual receiving and transmitting equipment at each subscriber's station. These 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 the loop circuits, in which case relays 203 and 204 are operated to spacing by their biasing windings, which are normally connected to negative potential through potentiometers 211 and 212, respectively.

The transmitting contacts T of the regenerators are included directly in the respective line circuits and thus repeat the signals directly into the subscribers' loops. The magnets M are operated by relays 203 and 204, respectively.

Assuming a signal to be transmitted from line LW through the repeater to line LE, the starting impulse will operate relay 203 to spacing, thereby opening the circuit for magnet M of unit 201 and applying positive potential to potentiometer 212. The resistances in potentiometer 212 are so proportioned that the current through the biasing winding of relay 204 now will be reversed, thereby preventing the operation of relay 204 at any time when relay 203 is in spacing position. Magnet M of unit 201 being deenergized, the unit will start up causing locking contacts L to apply positive potential to potentiometer 212, thereby preventing relay 204 and unit 202 from operating until unit 201 again reaches its stop position. At the proper time, transmitting contacts T of unit 201 will be opened, thereby transmitting 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 LW which will operate relay 203 to marking, thereby energizing magnet M of unit 201. At the proper time thereafter, transmitting contacts T will be closed for the transmission of a marking impulse into the loop circuit LE.

When unit 201 reaches its stop position, the locking circuit for relay 204 is again opened and transmitting contacts T will have been closed to transmit the stop signal into the loop LE and the entire circuit will be in its normal position as shown in the drawings.

A break signal transmitted from the loop LE at any time during the operation of unit 201 will have no effect. When unit 201 reaches its stop position, relay 204 will immediately operate, in turn releasing magnet M of unit 202 thereby causing unit 202 to transmit the break signal into the loop LW.

In the repeater circuit shown in Fig. 3, the regenerator units 301 and 302 are connected to operate between lines terminating in different manners. Thus the line West LW, which may be a subscriber's loop circuit, is connected through the line winding of polar relay 303 to the transmitting contacts T of unit 302 for normally operating relay 303 to marking; the windings of polar relay 303 are connected in a differential circuit so that the biasing winding tends to operate the relay to spacing with a magneto-motive force about equal to half that exerted by the line winding. The transmitting contacts T of unit 302 are connected to apply alternate potentials to the apex of the differential circuit, thereby producing current and no-current conditions in the loop LW and simultaneous current reversals in the biasing winding of polar relay 303, thereby holding this relay in marking position. Signals received over the loop LW will operate relay 303 which, in turn, will operate magnet M of unit 301 for the starting of this unit and for the control of the timing contacts T thereof.

The east line circuit LE is normally closed from a grounded source of positive potential through the loop LE over transmitting contacts T of unit 301 and through resistances 321 and 322 in series to ground. The potential drops over these resistances are utilized to control a pair of gas-filled electron discharge tubes 331 and 332 in accordance with current and no-current conditions in the loop LE and for corresponding control of the unit 302.

Tubes 331 and 332 are of the general type which includes a cathode, an anode connected to a source of potential, and a grid connected to a source of varying potential for control of the cathode-anode circuit. When the grid is at a predetermined negative potential, it will maintain a condition in the tube in which no current flows in the cathode-anode circuit. When the negative potential of the grid is caused to approach zero value, the gas in the tube is permitted to ionize and current flows in the cathode-anode circuit. To return the tube from this condition to its currentless condition, the negative grid potential must be restored and it is usually necessary to reduce the tube current to zero by other means, which may be used either to interrupt the main tube circuit or to apply an opposing potential to the main circuit for reducing the current to zero, after which time the currentless condition will be maintained by the grid element.

Tubes 331 and 332 shown in Fig. 3 have their input circuits controlled by the potential drops over resistances 321 and 322, as already mentioned. The current in the cathode-anode circuit of the tubes is supplied by an independent ungrounded source of potential, the negative and positive terminals of which are indicated by squares correspondingly marked in the drawing to differentiate from the grounded sources used in the other parts of the telegraph circuit, the positive and negative terminals of which are shown as circles correspondingly marked and connected to ground. Thus, the cathodes of tubes 331 and 332 are connected directly to ungrounded negative potential; the anode or plate 341 is

normally connected to positive ungrounded potential through magnet M of unit 302. The plate or anode 342 of tube 332 is connected through one winding of transformer 350 to positive ungrounded potential. The cathode elements of these tubes may be rendered emissive in any desired manner.

Tube 331 is provided to respond to marking impulses from loop LE and to hold the magnet M of unit 302 energized. Tube 332 is provided to respond to spacing impulses from the loop LE and to render the tube 331 currentless for the deenergization of magnet M of unit 302 during such spacing impulses. The arrangement including condensers 361 and 362 and transformer 350 is provided for interaction between tubes 331 and 332 to insure alternate operations of these tubes.

During the normal marking condition of the loop LE, the potential drop through resistance 321 will establish a positive potential at point 323 with respect to point 324 which may approximately counteract the normal negative potential on the grid of tube 331 established by the grid battery 326, so that this grid will be at about the same potential as the cathode, thereby permitting current to flow over the cathode-anode circuit through magnet M of unit 302. Due to the low potential drop in tube 331, condenser 361 will be practically completely discharged. The potential drop over resistance 322 during marking condition will establish a negative potential at point 325 with respect to point 324, thereby rendering the grid of tube 332 sufficiently negative to prevent ionization of this tube. Condenser 362 will thus have full potential applied and will be fully charged. When the loop circuit is opened, as in the case when a start impulse is transmitted from the distant station, the potential drops over resistances 321 and 322 disappear. The grid of tube 331 will assume its normal negative potential due to battery 326 and the grid of tube 332 will assume a potential equal to that of the cathode in this tube. Tube 332 breaks down and current is caused to flow from positive potential through winding 352 of transformer 350 and over the cathode-anode circuit of tube 332 to negative potential augmented by the discharge current from condenser 362. Due to this sudden rise of current in winding 352, a potential is induced in winding 351 which causes condenser 361 to become charged over the cathode-anode circuit of tube 331 by a current which is opposed to the cathode-anode current already flowing in this tube and quickly reducing this current to zero. With the grid of tube 331 at normal negative potential, this tube will thereafter remain currentless, causing magnet M of unit 302 to be deenergized.

When the loop LE is again closed to send a marking impulse, the potential drops over resistances 321 and 322 are reestablished. The tube 331 will break down, causing condenser 361 to discharge through winding 351. The sudden rise of current in winding 351 induces a potential in winding 352 which is applied to condenser 362 over the cathode-anode circuit of tube 332 in such a direction that the charging current will oppose the current already flowing in tube 332 and reduce it to zero, thereby rendering tube 332 currentless, which condition will be maintained by the negative potential applied to the grid due to the potential drop in resistance 322 during the marking condition of loop LE. The current now flowing in tube 331 causes the energization of magnet M of unit 302.

Assuming, first, that a signal series of impulses is to be transmitted from the line circuit LW to the line circuit LE, the start impulse will operate relay 303 to spacing, thereby deenergizing magnet M of unit 301. The unit 301 will start and lock contacts L in closing connect magnet M of unit 302 directly between positive and negative potential terminals of the ungrounded source, at the same time short-circuiting the cathode-anode circuit of tube 331 and rendering this tube currentless. At the proper time, the transmitting contacts T will open the line circuit LE for the transmission of a start impulse. This accidentally causes the tube 332 to spill over. When next a marking impulse is received, relay 303 goes to marking, thereby again energizing magnet M of unit 301. Transmitting contacts T then close the line circuit LE for transmission of a marking impulse.

Assuming this marking impulse to be the stop impulse, the unit 301 will come to a stop and the locking contacts L thereof will open. Under this condition, tube 331 will again spill over and cause the current in tube 332 to stop in the manner already described. The circuit is thus ready for transmission in either direction.

Assuming, now, that a start impulse is received from the line LE by the opening of the line circuit at the distant station, tube 332 will then spill over thereby stopping the current through tube 331 and through magnet M of unit 302. This unit starts up and closes the locking contacts L to lock magnet M in unit 301 against releasing. At the proper time, the transmitting contacts T of unit 302 are operated to spacing for transmission of a spacing signal into the line circuit LW without affecting relay 303. When line LE is again closed for the transmission of a marking impulse, tube 331 spills over thereby stopping the current in tube 332 and energizing magnet M of unit 302. Transmitting contacts T will then be operated to marking for transmission of a marking impulse to the line LW. When unit 302 returns to its normal position during the reception of the marking stop impulse, this circuit is returned to its normal condition for transmission in either direction.

The repeater circuit shown in Fig. 4 includes only one regenerator unit 400 which responds to signals from either direction and retransmits signals in either direction. The polar switching relay 410 is provided for determining the direction of transmission in response to the first start impulses arriving from either west or east.

The line circuit LW extends over contacts of the sending relay 404 and includes the line winding of receiving relay 403, holding the receiving relay to marking against the normally opposite, but smaller force of the biasing winding. Similarly, the line LE extends over the contacts of sending relay 406 and through the line winding of receiving relay 405, normally holding this relay in marking position.

The magnet M of unit 400 is connected to be normally energized over the marking contacts of both relays 403 and 405 in series. The operation of either of these relays to spacing will cause the magnet M to deenergize. The transmitting contacts T of unit 400 are connected to normally energize the operating windings of both sending relays 404 and 406 in multiple, thereby holding these relays in marking position against the normally opposite, but smaller force of the biasing windings. The opening of the transmitting contacts T will, therefore, cause

either of relays 404 and 406 to operate to spacing, thereby opening the corresponding line circuit for transmission of a spacing signal.

The biasing windings of relays 403 and 406 are normally connected through potentiometer 411 to a source of positive potential and the biasing windings of relays 404 and 405 are normally connected through potentiometer 412 to a source of negative potential. These pairs of relays also have their biasing windings connected to corresponding contacts L controlled by the locking cam LC of unit 400, the circuit from the locking contacts L further extending to the armature and contacts of relay 410 connected to plus and minus potentials for the purpose of locking one pair or the other of the relays against operation in accordance with the direction of transmission. The right holding winding of relay 410 will be connected to positive or negative potential depending upon the position of its armature for locking the relay in the position to which it was operated by the left operating winding. Thus, as shown in the drawings, the holding winding of relay 410 is connected directly to positive potential thereby holding the relay in position for transmission east by the repeater circuit.

Assuming, now, that a signal series representing a character is received over line LW by relay 403, the start impulse will cause relay 403 to operate to spacing, thereby connecting positive potential to the operating winding of relay 410, which will be aiding the holding winding in holding the armature in its east position. Magnet M, being deenergized, starts the regenerator 400. Immediately thereafter, the locking contacts L are closed, thereby applying positive potential from the E contact of relay 410 to the biasing windings of all of the relays 403, 404, 405 and 406. This positive potential will reverse the current in the biasing windings of relays 404 and 405 thereby locking these relays in marking position. The application of positive potential at the contacts of relay 410 over locking contacts L to the biasing windings of relays 403 and 406 will permit these relays to receive and transmit signals from west to east.

At the proper time determined by the timing cam TC, the transmitting contacts T will open, thereby causing relay 406 to be operated to spacing by its biasing winding in turn opening the line circuit LE for the transmission of a starting impulse.

When a marking impulse is received over the line LW, relay 403 is operated to marking, in turn energizing magnet M so that at the proper time the transmitting contacts T will close to again operate relay 406 to marking for the sending of a marking impulse over line LE.

When unit 400 reaches its stop position, relays 403 and 406 will be placed in marking position by their operating windings so that at the time the locking contacts open, all four relays will be in normal position and in condition to operate in response to impulses in either direction.

From the description of the locking arrangement just given, it is apparent that a break signal incoming over line LE during the operation of unit 400 in response to signals from line LW will be unable to operate relay 405 to spacing until the current in the biasing winding of relay 405 is reversed by the opening of the locking contacts when unit 400 returns to its stop position. Assuming this condition to exist, re-

lay 405 will operate to spacing, thereby applying negative potential to the operating winding of relay 410 and thus operating the relay to its west position where it will be locked by negative potential applied over contact W to its holding winding. The operation of relay 405 to spacing opens the energizing circuit for magnet M which thus starts unit 400 in operation. Shortly thereafter the locking contacts L are closed and connect negative potential from contact W of relay 410 to the biasing circuits of relays 403, 404, 405 and 406. This negative potential now reverses the current in the biasing windings of relays 403 and 406 thereby locking these relays in marking position, whereas relays 404 and 405 are conditioned for transmission in the direction east to west. Thus, when transmitting contacts T open, relay 404 operates to spacing thereby opening the line LW for the transmission of a break signal.

The circuit of Fig. 4 being symmetrical with respect to lines LW and LE, it is evident that the operations for transmission from east to west will be identical with those described above for transmission from west to east.

The repeater circuit shown in Fig. 5 is similar to that shown in Fig. 4 in that it uses only one regenerating unit 500 for transmission in both directions. In the arrangement shown in Fig. 5, transmitting contacts T of unit 500 are connected to be directly included in one or the other of line circuits LW and LE in accordance with the direction of transmission. For this purpose, relay 520, which may be of the neutral type, is provided and responds to the switching relay 510.

Assuming that a signal is to be transmitted from line LW to line LE, the start impulse, corresponding to the opening of line LW, will be received over the line circuit through the line winding of relay 503 over contacts 531 and 532 of relay 520 and transmitting contacts T. Relay 503 will be operated to spacing by its biasing winding thereby applying positive potential to the operating winding of relay 510. Relay 510 thus will be operated to its E position where it will be locked by its locking winding. Positive potential will then be applied over contact E of relay 510 to operate relay 520 which now closes line circuit LW directly over its contacts 535 and through the line winding of relay 503, and also completes the line circuit LE over contacts 541 and 542 of relay 520, transmitting contacts T, and through the line winding of relay 505.

When relay 503 operated to spacing, it opened the energizing circuit for magnet M, thereby starting unit 500 in operation and closing locking contacts L. Positive potential on contact E of relay 510 will now be applied over locking contacts L to the biasing winding of relays 503 and 505 thereby reversing the biasing potential on relay 505 and locking the relay in this position until unit 500 returns to its stop position. The application of positive potential from contact E of relay 510 to the biasing winding of relay 503 conditions this relay for operation in response to impulses over line circuit LW.

At the proper time, transmitting contacts T will be opened thereby opening the line circuit LE for the transmission of the start impulse. This condition will prevail until a marking impulse is received over line LW when relay 503 will operate to marking, again energizing magnet M. At the proper time, transmitting contacts T will close for repeating the marking impulse to the line circuit LE.



When unit 500 returns to normal, locking contacts L will open, thereby leaving relays 503 and 505 in readiness for reception of impulses in either direction and relay 520 will remain energized. If a spacing impulse is then received over line LE, relay 505 will operate to spacing causing relay 510 to operate to contact W, in turn releasing relay 520 so that the transmitting contacts T now will be included in line circuit LW. In this case, the negative potential from contact W of relay 510 will be applied over the locking contacts L to lock relay 503 against operation.

From the description given above of a number of different applications of the invention to circuits of widely differing characteristics, it is apparent that applicant's invention may be similarly applied to various other types of circuits and for different purposes other than those disclosed in the drawings and described above.

What is claimed is:

1. A regenerative signal repeating system comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by a line circuit to impress corresponding conditions upon another line circuit and having off-normal operating means, first signal receiving means for receiving said conditions from said first line circuit and impressing them upon said repeating means for transmission in one direction over said circuits, second signal receiving means for transmission in the opposite direction over said circuits, and auxiliary responsive means operative in response to said operating means upon starting of said repeating means whereby operation is prevented of said second receiving means until the return to normal of said repeating means.

2. A regenerative signaling repeating arrangement having an active side and an inactive side during transmission in one direction, each of said sides comprising start-stop regenerative repeating means responsive to spacing and marking conditions by a line circuit to impress corresponding conditions upon another line circuit and including an operating element having a stop position and off-normal positions, and auxiliary means responsive to said element upon starting of said repeating means and connected to prevent retransmission by the repeating means in the other side until the return to normal of said repeating means.

3. A regenerative signal system having an active side and an inactive side during transmission in one direction, each of said sides including repeating relay means, said system further comprising start-stop timing means having retransmission contact means for timing of impulses passing through said system and having also a receiving winding and auxiliary contact means, and circuit means connecting said auxiliary contact means to said repeating relay means, said auxiliary contact means being effective through said circuit means and upon starting of said timing means by the active side and until return to stop position of said timing means to render the other side inactive.

4. A start-stop regenerative repeater having an active side and an inactive side during transmission in one direction, each of said sides comprising a rotating transmitting device with a stop position for each impulse series and including retransmitting contacts, a receiving winding and cam-operated contact means adapted in all positions of said device except said stop position to render the other side of said repeater inactive.

5. A start-stop regenerative repeater having an active side and an inactive side during transmission in one direction, each of said sides comprising a rotating transmitting device having a stop position and including cam-controlled retransmitting contacts, a receiving winding, and off-normal contacts connected to the receiving winding of the other device whereby said other device is prevented from starting when the first-mentioned device is out of stop position.

6. A start-stop regenerative repeater having an active side and an inactive side during transmission in one direction, each of said sides comprising receiving relay means having marking contact means and spacing contact means, and a start-stop repeating device having a winding controlled by said marking contact means, and timed retransmitting contact means controlled by said winding and also having off-normal contact means connected to prevent starting of the repeating device in the other side during rotation of said repeating device, said spacing contact means being connected to prevent starting of the repeating device in the other side when closed.

7. A start-stop regenerative repeater having an active side and an inactive side during transmission in one direction, each of said sides comprising receiving relay means having marking contacts and spacing contacts, and a start-stop repeating device having retransmitting contacts, a winding for control of said retransmitting contacts in response to operations of said marking contacts, a rotating camming element for timing the operations of said retransmitting contacts, and off-normal contacts open in stop position of said element and closed by said element upon its starting and until its return to stop position to complete a locking circuit for the winding in the other side and prevent starting of the device in that other side during rotation of said element, said spacing contact being connected to close in response to a start impulse a locking circuit for the receiving relay means in the other side to prevent it from responding to a start impulse.

8. A start-stop regenerative repeater having an active and an inactive side during transmission in one direction, each of said sides comprising receiving relay means responsive to marking and spacing conditions imposed by a line circuit, and a start-stop rotating repeating device having a winding and timed retransmitting contact means controlled by said receiving relay means and having also off-normal contact means for locking the receiving relay means of the other side against operation when said repeating device leaves its stop position.

9. A regenerative signal repeating system comprising start-stop regenerative repeating means responsive to spacing and marking conditions to retransmit corresponding conditions and having auxiliary operating means effective except in stop position, first signal receiving means for receiving said conditions from a first line circuit and impressing them upon said repeating means, second signal receiving means for receiving said conditions from a second line circuit and impressing them upon said repeating means; and auxiliary responsive means operative in response to said operating means upon starting of said repeating means by one of said receiving means whereby operation is prevented of the other of said receiving means until the return to stop condition of said repeating means.

10. A regenerative signal repeating system



comprising first repeating relay means for retransmission in one direction, second repeating relay means for retransmission in the other direction, and start-stop timing means including main contact means for timing of impulses retransmitted by one of said relay means, start-stop synchronizing cam means for operation of said main contact means, and auxiliary contact means effective upon starting of said synchronizing means by said one relay means to prevent retransmission by the other of said relay means until the return to stop position of said synchronizing means.

11. A regenerative signal repeating system comprising first repeating relay means for transmission in one direction and second repeating relay means for transmission in the other direction over a line circuit, switching relay means connected to said repeating relay means for rendering one of said repeating relay means ineffective during transmission by the other of said repeating relay means, and start-stop rotary means having main contact means for timing the transmission of signal impulses by said repeating relay means and having off-normal contact means for locking the repeating system in the switched condition until the return to normal of said rotary means.

12. A regenerative signal repeating system comprising first receiving relay means and second receiving relay means, start-stop rotary means having timed retransmitting contacts controlled by both of said receiving relay means and having off-normal contacts, and switching relay means operated by the one of said receiving relay means first to receive a start impulse and having contacts connected through said off-normal contacts to maintain the other of said receiving relay means locked until return to stop position of said rotary means.

13. A regenerative signal repeating system comprising first repeating relay means for retransmission in one direction over a line circuit, second repeating relay means for retransmission in the other direction over said line circuit, a start-stop rotary device having timed retransmitting contacts controlled by said relay means and having off-normal contacts open only in stop position of said device, and switching relay means controlled by said repeating relay means for associating said retransmitting contacts alternately with one and the other line circuit, circuit means connected over said off-normal contacts to prevent operation of said switching relay means by said repeating relay means except when said rotary device is in stop position.

14. A regenerative signal repeating system comprising west receiving relay means and west transmitting relay means, east receiving relay means and east transmitting relay means, start-stop rotary means having timed retransmitting contacts controlled by said receiving relay means to operate accordingly said transmitting relay means, and said rotary means having off-normal contact means, and switching relay means operated by either one of said receiving relay means and having contact means connected through said off-normal contact means to lock one of said transmitting relay means against operation by said rotary means.

15. A regenerative signal repeating system comprising west receiving relay means and west transmitting relay means, east receiving relay means and east transmitting relay means, start-stop rotary means having timed retransmitting

contacts controlled by said receiving relay means to operate accordingly said transmitting relay means and having off-normal contacts, and switching relay means controlled by said receiving relay means and having contacts connected through said off-normal contacts to lock upon starting of said rotary means one of said receiving relay means and the opposite one of said transmitting relay means until return to normal position of said rotary means.

16. A regenerative signal repeating system comprising west receiving relay means having an operating winding in a west line circuit, east receiving relay means having an operating winding in an east line circuit, start-stop rotary means having timed retransmitting contacts controlled by said receiving relay means and having off-normal contacts closed except in normal position of said rotary means, and switching means operated into alternate positions by said east and west receiving relay means, respectively, to connect said retransmitting contacts for transmission alternately into the west and east line circuits, respectively, said receiving relay means being normally biased to spacing during marking condition, and said switching relay means having alternate contacts connected through said off-normal contacts to change the bias alternately of said west and east receiving relay means, respectively, to marking to prevent switching of the repeating system from the prevailing direction of transmission during substantially the entire time of the retransmission of a signal series of impulses.

17. A regenerative repeater system comprising one set of relays for transmitting east, another set of relays for transmitting west, start-stop regenerative timed means having retransmitting contacts and off-normal contacts, characterized in this that said off-normal contacts are connected to said sets of relays to prevent retransmission by one of said sets of relays upon starting of said timed means in response to the other set of relays and until return to stop position of said timed means.

18. A regenerative repeater system comprising one set of relays for transmitting east, another set of relays for transmitting west, start-stop regenerative timed means having transmitting contacts and off-normal contacts, characterized in this that said off-normal contacts are connected to said sets of relays to prevent retransmission by either one of said sets of relays upon starting of said timed means in response to the other set of relays and until return to stop position of said timed means.

19. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, and auxiliary means responsive to starting and stopping of said regenerative repeating means to continuously prevent operation of said other repeating means from the time of starting and until the return to normal of said regenerative repeating means.

20. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, and auxiliary means operated by

said regenerative repeating means in all its off-normal positions to prevent operation of said other repeating means except in stop position of said regenerative repeating means.

21. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, and auxiliary means having a normal condition and being connected with said regenerative repeating means to be operated thereby out of its normal condition during the entire period in which said regenerative repeating means is out of its stop position, said auxiliary means being connected to said other repeating means to continuously prevent operation thereof when operated out of its normal condition.

22. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, and auxiliary means having a normal and an operated condition and having a connection to said regenerative repeating means for operation thereby into said operated condition during the entire off-normal period of said regenerative repeating means and including connecting means to said other repeating means to continuously prevent operation thereof in the operated condition of said auxiliary means.

23. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, and auxiliary means connected with said regenerative repeating means to be placed in normal condition by said regenerative repeating means in stop position and to be placed in off-normal condition by said regenerative repeating means in all off-normal positions, said auxiliary means being connected to said other repeating means to prevent operation thereof in the off-normal condition of said auxiliary means and to again permit operation of said other repeating means in the normal condition of said auxiliary means.

24. A regenerative signal repeating arrangement comprising start-stop regenerative repeating means responsive to spacing and marking conditions imposed by an incoming circuit to impress corresponding conditions upon an outgoing circuit, other repeating means connected to one of said circuits, locking means connected to said other repeating means to control operation thereof and connecting means between said regenerative repeating means and said locking means to prevent operation of said other repeating means in response to starting and until stopping of said regenerative repeating means and to permit operation of said other repeating means in response to stopping of said regenerative repeating means.

25. In a telegraph repeating system, a line divided into two sections, a repeater unit intermediate said sections including a mechanical code signaling means of cyclic operation, a motor for said mechanical means, means responsive to receive signal impulses for setting said mechanical means into operation through power communi-

cated from said motor, contacts controlled by the operation of said mechanical means in accordance with the received signals for repeating corresponding impulses into the adjacent line section, and further contacts operated by said mechanical means and effective to prevent reflection of signal impulses into the line section on which the impulses were originally impressed.

26. In a telegraph repeating system, a line divided into two sections, a repeater unit intermediate said sections including a rotary repeating mechanism, a motor for driving said mechanism, means responsive to a starting signal of a code combination of impulses for causing said motor to drive said mechanism for one code cycle, contact means mechanically operated by said mechanism for repeating the code signals into the adjacent line section, and other contact means also mechanically operated by said mechanism for preventing reflection signals into the other line section.

27. In a telegraph repeating system, two line sections, a motor driven code signal repeater including mechanically operated elements, circuits for connecting said repeater to said line sections, contacts in said repeater for retransmitting impulses in one of said line sections, a reflection estoppel circuit, additional contacts in said repeater, and means operated by said mechanically operated elements for establishing, through said additional contacts the reflection estoppel circuit before operation of said other contacts and transmission of code signals in said one of said two line sections.

28. In a telegraph repeating system, two line sections, a line relay for each line section, an auxiliary relay for each line relay, a rotary repeating mechanism common to said line relays and operable by either of said line relays, and electrical contacts controlled by said rotary repeating mechanism when in off-normal condition to disable one or the other of said auxiliary relays.

29. In a telegraph repeating system, two line sections, two regenerative repeaters, one associated with each line sections to repeat impulses into the other line section, means to prevent concurrent operation of said two repeaters, and means to operate said means mechanically.

30. In a telegraph repeating system, two line sections, two regenerative repeaters, one associated with each line section to repeat impulses into the other line section, interlocking means between said two repeaters and effective to lock one repeater against operation when the other of two repeaters is out of normal position, and means to operate said interlocking means mechanically.

31. In a telegraph repeating system, two line sections, a line relay for each line section, an auxiliary relay for each line relay, operating windings and locking windings in said auxiliary relays, a rotary repeating mechanism common to said line relays and operable by either of said line relays, and electrical contacts controlled by said rotary repeating mechanism when in off-normal condition to disable said operating windings and to enable said locking windings.

32. In a telegraph repeating system, two line sections, a line relay for each line section, an auxiliary relay for each line relay, operating and locking windings in said auxiliary relays, a rotary repeating mechanism common to said line relays and operable by either of said line relays, a source of electrical energy, and electrical con-

tacts controlled by said rotary repeating mechanism when in off-normal condition to disconnect said operating windings from said source and to connect said locking windings to said source.

33. In a telegraph repeating system, two line sections, a single mechanically operated regenerative repeater mechanism associated with said line sections, means for controlling the connection of said mechanism therebetween to repeat into either of said line sections under control of signals received from the other of said line section, and means controlled by the starting signal impulse of a start-stop code of signalling conditions to determine the operation of said means and thus the connection of said mechanism between said two line sections.

34. In a telegraph repeating system, two line sections, a line relay for each line section, a rotary repeating mechanism common to said two line relays and operable by a first actuated one of said line relays, and means in said rotary repeater for locking the other of said two line relays.

35. In a telegraph repeating system, two line sections, a single rotary regenerative repeater mechanism initially responsive to a received signal in either of said two line sections and common to said two line sections, and retransmitting contacts controlled in regenerative manner by said rotary repeater mechanism and operable in response to signals received from either of said two line sections to repeat into the other of said two line sections.

36. In a telegraph repeating system, two line sections, two line relays, one for each of said two line sections, and a single rotary regenerative repeater mechanism initially responsive to either of said two line relays and common to said two line sections and operable in response to signals received by either of said two line relays to repeat into the line section of the other of said line relays.

37. In a telegraph repeating system, two line sections, a motor-driven, mechanical code signal repeater operated in a predetermined cycle, circuits connecting said repeater to said two line sections, mechanically operated means in said

repeater for retiming and retransmitting signals in one of said two line sections, a cyclic reflection estoppel means, and mechanical means in said repeater to establish said cyclic reflection estoppel means before beginning retransmitting of a signal in said one of said two line sections.

38. In a telegraph repeating system, two line sections, a motor-driven, mechanical signal repeater, circuits connecting said repeater to said two line sections, mechanically and cyclically operated code signal means for establishing a cyclic reflection estoppel condition in response to a received signal, and means subsequently operated in said repeater to begin retransmission of said signal.

39. In a telegraph repeating system, two line sections, two regenerative repeaters, one associated with each line section and each having an armature responsive to signals in its line section to repeat impulses into the other line section, and mechanical means associated with an armature of each of said repeaters to prevent concurrent operation of an armature of the other of said two repeaters.

40. In a telegraph repeater, a rotary repeating mechanism, means for starting said mechanism into operation for one code cycle by a signal impulse of a code combination of impulses, rotary timing means in said mechanism for timing the impulses retransmitted during said code cycle, means mechanically operated by said mechanism, and means controlled by said mechanical operated means to prevent reflection of signals.

41. In a single-line two-way telegraphic repeating system, the combination of a line divided into two sections, two motor-driven repeaters connected intermediate said sections either of which may be started into operation by a received signal condition, motor-operated contacts in said repeaters operated upon starting of one of said repeaters and effective during each received spacing signal condition to restrain the other of said repeaters against starting, and further motor-operated contacts operable in said started repeater and operating to repeat said spacing signal conditions from one line section to another.

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