Feb. 22, 1938. T. A. McCANN 2,109,026

TELEGRAPH REPEATING SYSTEM

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FIG. 1

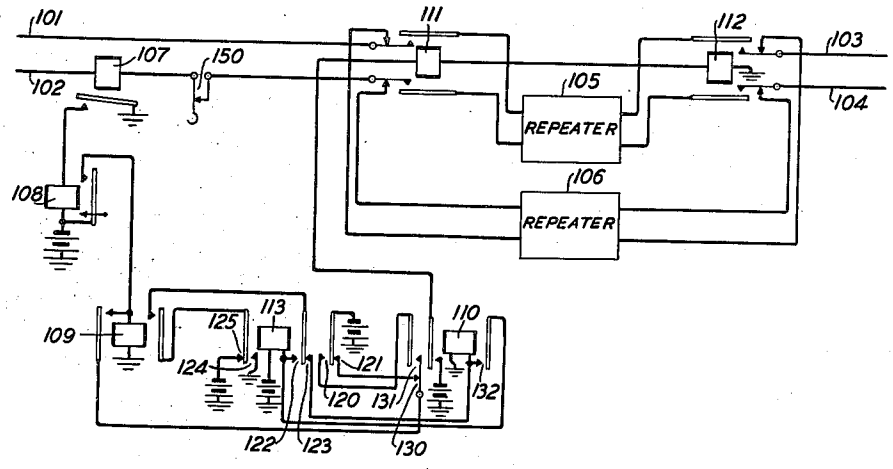
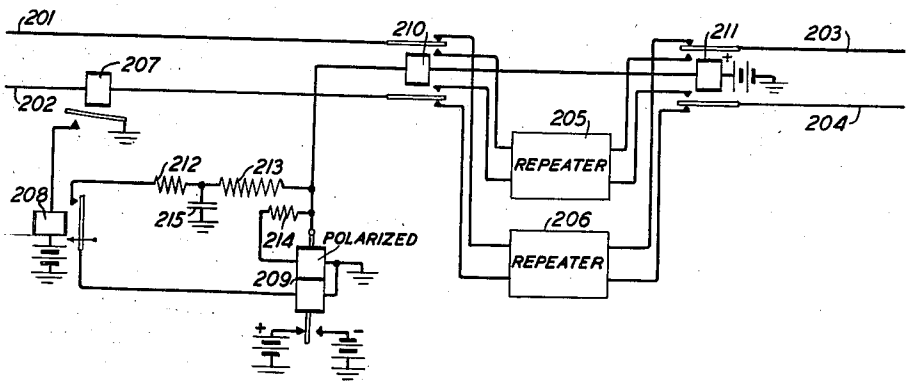


FIG. 2



INVENTOR
T. A. McCANN

BY

ATTORNEY

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FIG. 3

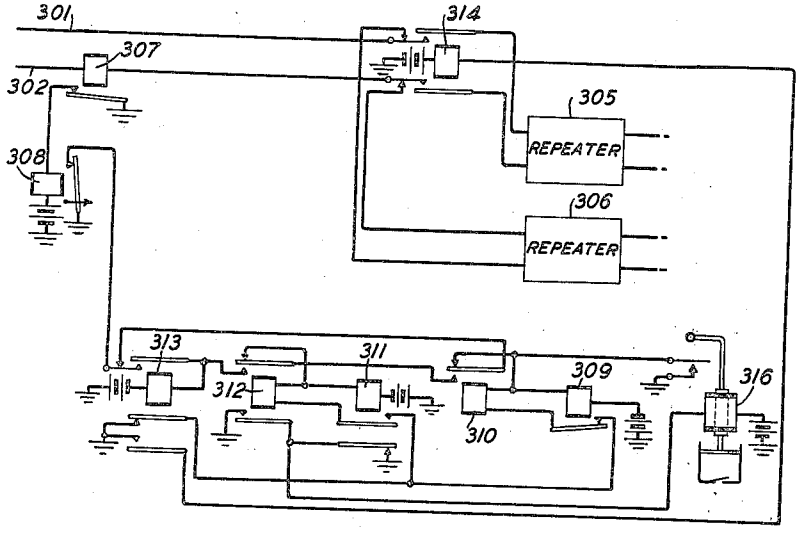
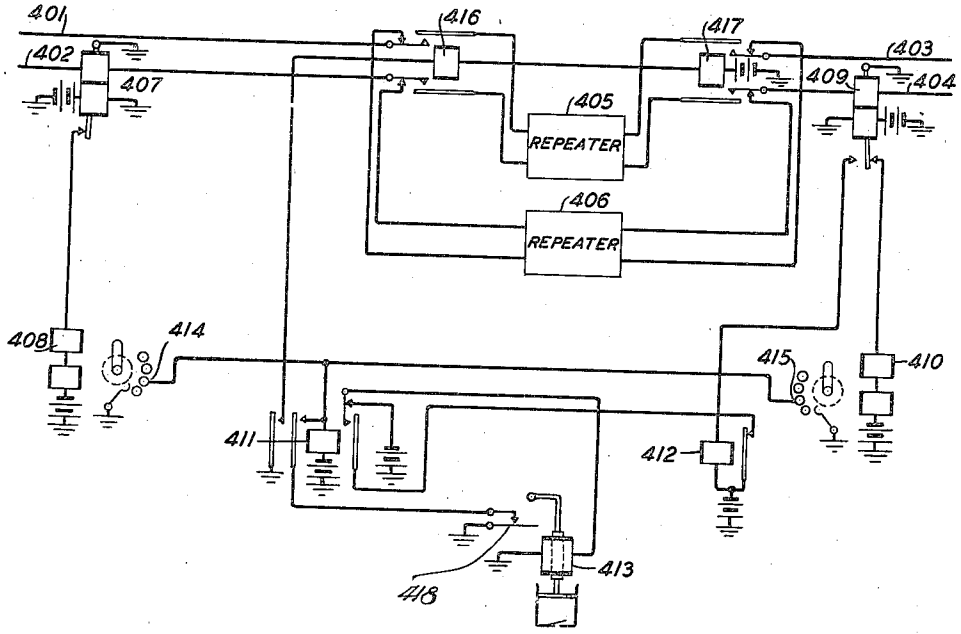


FIG. 4



INVENTOR
T. A. McCANN

BY

ATTORNEY

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TELEGRAPH REPEATING SYSTEM

Thomas A. McCann, East Orange, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

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14 Claims. (Cl. 178—71)

This invention relates to telegraph repeating systems, and more particularly to systems of this kind in which it is desired to change the line circuit at repeater stations by remote control.

In telegraph systems which ordinarily are operated on a code having impulses of unit lengths, such as the Baudot code or the well-known start-stop codes, it is often desired to transmit codes, such as the cable or the Morse code; thus, whereas the system may ordinarily be operated by mechanical transmitters such as keyboards, it is sometimes desirable to operate the system manually. Since, for mechanically transmitted and retransmitted signals synchronized equipment is required at both repeater and terminal stations, it is not possible to use such equipment for the manually transmitted signals which are of non-uniform length, both as to the individual impulses and as to the total series combination.

An object of the invention, therefore, is to provide a telegraph repeater which may be adjusted at will from a remote station for transmission of either synchronized signals or non-synchronized signals.

Another object of the invention is to provide simple selective means responsive to special adjusting signals for adjusting the repeater from one condition to the other and vice versa.

A further object is to provide a system of this type which may be controlled by signals incoming from either direction to the repeater.

In accordance with the invention the repeater station may be arranged for one-direction or two-direction transmission and has one equipment particularly suited for regeneration of synchronized impulses, other equipment particularly suited for repeating of manual or Morse impulses, relay means for switching one or the other equipment into the circuit, and selective means particularly responsive to special switching signals for controlling the switching from one mode of operation to the other.

In a preferred form the repeater station includes a line relay which is unaffected by the switching operation and is responsive to signals transmitted in both directions. The relay is used to control special equipment which may be of different types, such as slow-acting relays, counting relays, selecting mechanisms or combinations thereof, which operate in response to special line impulses, such as one or more long break impulses for control of one or more switching relays. The switching relays are provided with a sufficient number of contacts for switching the line through one equipment or the other as the case may be.

The invention may be successfully utilized in the general type of repeater system, since it is desirable to arrange for communication between attendants at different stations for lining up of the synchronized repeaters along a line circuit, without the need of a separate monitoring line circuit. Thus the attendant, say at a terminal station, may switch all repeater stations along the line to equipment suitable for transmission of Morse signals and issue instructions to the repeater attendants for lining up of the circuit and thereafter switch all repeater stations back to the regenerative equipment. Also, in case of trouble in the regenerative equipment at any one station communication may still be established at any time through the Morse equipment for passing of reports between the attendants, and restoration of service may thus be facilitated.

The invention will be more readily understood by reference to the drawings, in which

Fig. 1 shows an arrangement for substituting another type of telegraph repeater for the repeater normally included in the line circuit, the substitution taking place in response to a long break period or open circuit on the line, the circuit being returned to its original condition upon the receipt of a second long break period;

Fig. 2 shows an alternative method of accomplishing the same result as in Fig. 1;

Fig. 3 shows a circuit in which the switching operation is effected upon the receipt of two long break periods, the circuit being returned to its original condition upon the receipt of a single long break period; and

Fig. 4 shows a method of accomplishing the same result by the use of a selective device responsive to a special code. The circuit is returned to its original condition upon the receipt of a long break period.

Referring now particularly to Fig. 1, an arrangement is shown which switches a regenerative repeater 106 out of the line circuit and substitutes a single line repeater 105 therefor upon the receipt of a long break signal on the line. With the relays in their normal position as shown, the regenerative repeater 106 is in use and the transmission circuit may be traced from conductors 101 and 102 through the winding of relay 107, over the back contacts of switching relay 111, through regenerative repeater 106, over the back contacts of switching relay 112 to conductors 103 and 104.

When it is desired to send manual telegraph

or similar signals, the operator at the transmitting station at the distant end of line 101, 102 or of line 103, 104 or at any intermediate station on the line, operates the break key for a comparatively long interval, say for 3 seconds. The break key may, of course, be inserted at any point in the whole line circuit, and thus may be a key 150 inserted in conductor 102 of the repeater station as shown. The operation of the key will cause the simultaneous switching of all repeater stations as well as of the terminal stations from one condition to another as desired. The opening of the line in the present instance releases relay 107 which through its back contacts closes a circuit through the winding of relay 108, operating it. Relay 108 is of the slow-to-operate type and does not operate when relay 107 releases in response to the short telegraph impulses. The operation of relay 108 in response to a break signal of sufficient duration causes the operation of relay 109, which locks in a path traced from battery over the back contacts 121 of relay 113, back contact 130 of relay 110, the left-hand contacts and winding of relay 109 to ground. Relay 109, operated, causes the operation of relay 110 in a circuit traced from battery over the back contact 125 of relay 113, right-hand contact of relay 109, back contact 123 of relay 113 to ground through the winding of relay 110. The operation of relay 110 opens the locking circuit for relay 109 just described and causes the operation of the switching relays 111 and 112 in series. When relay 107 reoperates after the long break period, relays 108 and 109 release, the latter relay opening the operating path of relay 110 just described. Relay 110 in operating prepared a holding circuit for itself which may be traced from battery through the winding of relay 113 over contact 132 and winding of relay 110 to ground. Relay 113 operates in this circuit as soon as relay 109 releases and opens the short circuit therefor; relay 113 does not perform any useful function at this time, and relay 110 remains energized in series therewith.

The operation of relays 111 and 112 removes regenerative repeater 106 from the transmission line and substitutes a single line repeater 105 therefor. The transmission line may now be traced from conductors 101 and 102, through the winding of relay 107, over the front contacts of relay 111 through single line repeater 105, over the front contacts of relay 112 to conductors 103 and 104. The circuit is now conditioned to receive and retransmit manual or other non-synchronized telegraph signals.

When it is desired to return the transmission line to its original condition, the break key at any station included in the line circuit is operated to again produce a long open interval on the line. Relay 107 again releases, operating relay 108 which in turn operates relay 109. Relay 109 now locks in a circuit traced from battery over contact 120 of relay 113, contact 131 of relay 110 to ground through the left-hand contact and the winding of relay 109. Relay 109, operated, now holds relay 113 operated and shunts down relay 110. The circuit for this function is traced from ground over contact 124 of relay 113, right-hand contact of relay 109, front contact 122 of relay 113 at which point one branch leads to battery through the winding of relay 113 and another branch over contact 132 of relay 110 to the right-hand winding terminal of relay 110. The release of relay 110 causes the release of relays 111 and 112 which, in turn, switch single line repeater 105 out of the line and substitute regenerative repeater 106 therefor. When relay 107 reoperates, relays 108, 109 and 113 release, returning the equipment to its original condition.

Fig. 2 shows an alternative method of accomplishing the same result as Fig. 1, in which a single polarized relay and a condenser are used to effect the switching. With polarized relay 209 on its left-hand contacts as shown, condenser 215 is charged through high resistance 213 to a positive potential, relay 209 being maintained on its left-hand contacts in a circuit traced from ground through its upper, holding winding and resistance 214 to positive battery through its left-hand contact. When relay 207 releases on a long break interval, it operates slow-to-operate relay 208. Relay 208, operated, closes a circuit from condenser 215, through low resistance 212 to ground through the lower, operating winding of relay 209. Condenser 215 discharges and the flux produced in the armature of relay 209 by the discharge current is sufficient to overcome the flux produced by the holding current through the upper winding and relay 209 opens its left-hand contact and closes its right-hand contact. The current through the holding winding is now reversed and the armature of relay 209 will therefore now be maintained on its right-hand contact. The current through high resistance 213, low resistance 212, the contacts of relay 208 and the operating winding of relay 209 is insufficient to alter this condition after the condenser has become discharged. With relay 209 operated to its right-hand contact, a circuit is closed from negative battery to positive battery through the windings of relays 210 and 211 in series. Relays 210 and 211 operate and remove regenerative repeater 206 from the transmission line 201, 202 and 203, 204 and substitute single line repeater 205 therefor. When relay 207 reoperates after the long break interval, relay 208 releases and condenser 215 is charged through resistance 213 to a negative potential.

When it is desired to return this circuit to its original condition, the break key is again operated producing a long open circuit on the line. Relay 207 again releases operating relay 208. Relay 208, operated, connects condenser 215 through resistance 212 and the lower winding of relay 209 to ground, discharging condenser 215 in the opposite direction of before and thus operating the armature of relay 209 to its left-hand contact. The operation of relay 209 to its left-hand contacts places positive battery at both ends of the operating circuit of relays 210 and 211, releasing them and restoring the line to its original condition. When relay 207 again operates, relay 208 is released and condenser 215 is charged to a positive potential as before.

In Fig. 3 an arrangement is shown in which the regenerative repeater is switched out of the circuit and the single line repeater is switched into the circuit upon the receipt of two long break signals, the circuit being returned to its original condition upon the receipt of a single break signal. By this method the chances of switching a repeater in the opposite direction of the other repeaters included in the same transmission line will be greatly reduced.

Under normal conditions relay 307 is in an operated condition in series with the line and relay 308 is held operated through the contacts of relay 307. Relay 309 also remains operated under this condition in a circuit traced from ground through

the contacts of relay 308, upper back contacts of relay 313, back contacts of relay 310 to battery through the winding of relay 309. When relay 307 releases on the first long break interval, relay 308, which is of the slow-to-release type, releases also. The release of relay 308 causes the operation of relay 310 in series with relay 309, holding the latter operated. This circuit is traced from ground through the lower inner contacts of relay 313, lower contacts of relay 309 to battery through the windings of relay 310 and 309 in series.

At the completion of the first break signal, relay 307 operates, operating relay 308. Relay 311 now operates in a circuit traced from ground through the contacts of relay 308, contact of relay 313, front contact of relay 310, upper back contacts of relay 312 to battery through the winding of relay 311. When relay 307 releases on the second long open period, relay 308 releases as before. The release of relay 308 now causes the operation of relay 312 in series with relay 311 holding the latter relay operated. This circuit is traced from ground through the lower inner contacts of relay 313, front contacts of relay 311 to battery through the windings of relays 312 and 311 in series. At the completion of the second break interval, relays 307 and 308 again operate. The operation of relay 308 closes a circuit through its contacts from ground through the upper back contacts of relay 313, front contacts of relay 310, upper front contacts of relay 312 to battery through the winding of relay 313. Relay 313 operates in this circuit and locks through its upper front contacts to ground through the contacts of relay 308. The operation of relay 313 opens at its lower back contacts the holding paths of relays 309, 310, 311 and 312, releasing these relays, and closes at its lower front contact a circuit for the operation of relay 314, which on operating switches transmission line 301, 302 from regenerative repeater 306 to single line repeater 305. The circuit is now conditioned for transmission of manual telegraph signals.

As previously stated, the circuit is restored to the original condition by a single operation of the break key. Relay 307 releases on the open circuit caused by the operation of this key, releasing relay 308. The release of relay 308 opens the locking circuit of relay 313, releasing this relay. The release of relay 313 opens the operating circuit of relay 314, releasing this relay and restoring the line circuit to its original condition with regenerative repeater 306 in the line.

Provision is made in the arrangement shown in Fig. 3 whereby a single accidental break period is rendered ineffective while the regenerative repeater is in use. This is accomplished by the use of slow-to-release relay 316 which may be of the dashpot type. Relay 316 is normally held operated through the lower outer contacts of relay 311. If a single break interval should be received, relays 310 and 311 operate as previously described. The operation of relay 311 opens the operating circuit of relay 316. If a second break signal should not be received before dashpot relay 316 fully releases and closes its contacts, relay 310 will be shunted down and relay 311 released, thus restoring the circuit to its original condition. If, however, a second break signal should be regularly received, i. e., before relay 316 closes its contacts, relay 312 will operate closing a circuit through the winding of relay 316 to prevent it from releasing.

From the description given above of the circuit shown in Fig. 3, it will be apparent that relays 309 and 310 form what may be termed a first pair of counting relays responding to the first break signal and extending the counting circuit from the contact of slow release relay 308 to the second pair of counting relays 311 and 312, which in turn count the second break signal and perform the switching operation. It is evident that the second pair of counting relays may extend the counting circuit to a third similar pair of counting relays which would count a third break signal and in response thereto would perform the switching operation instead of the second pair. Any number of pairs of counting relays may thus be added as desired in accordance with the principles illustrated by the circuit shown in Fig. 3.

The principle of the invention may thus in certain cases be extended to provide a selective arrangement whereby for special purposes one or more of a plurality of repeater stations along the line may be selected for switching, while the rest of the stations remain unswitched, as by using different numbers of counting relays at different stations. Thus with the circuit shown in Fig. 3 used at a plurality of stations on a line, the switching relay 314 at certain stations may be operated by relay 313 after the arrival of two break signals, and at other stations the switching relay 314 may be operated by relay 311 after the arrival of only one break signal. For the restoration of the whole line circuit other break signals must be sent to all stations. For this example, it is assumed that the dashpot relay 316 is not provided.

Arrangements such as shown in Fig. 3, in which the switching of the repeaters into one condition takes place in response to a code or set of impulses which is different from that which causes the switching into the alternate condition, have the advantages that all repeaters on the line will always be switched in the same manner and that the operator, say at a terminal station, transmitting the switching code, will know definitely the condition of all remote stations along the line.

In Fig. 4 the same result is accomplished as in Fig. 3 by the use of a mechanical selective device such as the well-known Gill selector. These selectors are adjustable to be responsive only to a definite signal code, for example, 323, the impulses of the code being considerably longer than ordinary printing telegraph impulses and being usually transmitted by a special code key, as is well known. Since the fast operating regenerative repeater cannot transmit Gill selector signals without mutilating them, telegraph relays and Gill selectors have been shown in both the incoming and outgoing ends of the circuit to provide for switching control from either line circuit. Under ordinary conditions, incoming line 401, 402 is connected through the back contacts of relay 416 to regenerative repeater 406 and the outgoing line 403, 404 is connected to regenerative repeater 406 through the back contacts of relay 417. If the code to which Gill selectors 408 and 410 are responsive is transmitted from either side of the line, either one of the polarized relays 407 and 409 will operate to advance one or the other of the selectors to terminal 414 or 415. When this occurs, ground is connected to the winding of relay 411, operating this relay. Relay 411 locks in a circuit traced from ground through contacts 418 of normally energized slow-to-release relay 413 to battery over the left-hand inner contacts and winding of relay 411. The operation of relay 411 causes the operation of relays 416 and 417 in series,

which disconnect regenerative repeater 406 from the line and substitute single line repeater 405 therefor. The operation of relay 411 also disconnects battery at its right-hand back contacts from the winding of relay 413 and substitutes therefor at its right-hand front contact the battery at the back contact of relay 412. Relay 413 is thus held operated keeping contacts 418 closed under control of relay 409, which upon completion of the special code signal again holds its armature against the right-hand contact as during idle periods.

The circuit is restored to its original condition by operation of the usual break key which causes the operation of relay 409 to its left-hand contact and causes relay 407 to open its left-hand contact. Relay 409 causes the operation of relay 412 which opens the operating circuit of relay 413 initiating its release. If the open circuit on the line should be of sufficient duration, relay 413 will fully release and break the holding circuit of relay 411 at contacts 418. Relay 411 will thereupon release, releasing relays 416 and 417, substituting regenerative repeater 406 for single line repeater 405 and restoring the circuit to its original condition. The Gill selectors being too slow to respond to any impulse or combination of impulses of the printing telegraph code or of the manual code, the selectors 408 and 410 will in the present instance remain in selected position until the break signal arrives, when relays 407 and 409 will open their contacts long enough to cause the selectors to return to normal position ready for the next special code signal. A selecting device of this general type is disclosed in Patent 1,343,256, issued to J. C. Field on June 15, 1920; and for a disclosure of a special code transmitting key for operation of the selecting device, reference may be had to Patent 1,306,054, issued to J. C. Field on June 10, 1919.

In the description of the various circuit arrangements shown in the drawings it has been assumed that the repeaters are two-way repeaters, so that the break signals may be transmitted from any station on the line to switch all the stations. It is, however, possible to use one-way repeaters in the circuits shown in Figs. 1, 2, and 3 and thus place the control of the switching entirely at the transmitting terminal station. If in this latter case another similar line circuit be provided for transmission in the opposite direction through either of two types of repeaters similar to those in the circuit shown in the drawings, the switching of this latter line may either be controlled from its transmitting terminal station by counting relays and switching relays similar to those illustrated, or the control may be from the first-mentioned transmitting station through the common set of counting relays for operation of switching relays in both line circuits.

Various other modifications of the invention are, of course, possible. Thus the repeater for manual operation may be eliminated and the two line sections directly interconnected by a pair of conductors in one position of the switching relays; or a monitoring set may be cut into the line circuit in one position of the switching relays. It is, of course, also possible to arrange for one repeater to remain in the line circuit in both switching positions and to add a special circuit or a branch circuit in one of the switching positions.

What is claimed is:

1. A telegraph repeater station connected between two line sections and comprising a line relay responsive to signals from both line sections, switching relay means for changing said repeater station alternately from one to the other of two transmission conditions, and relay means responsive to the reception of special switching signals by said line relay to operate said switching relay means.

2. A repeater station in accordance with claim 1 in which said line relay is associated with both line sections independently of said switching relay means.

3. A telegraph repeater station connected between two line sections and comprising a line relay responsive to signals from both line sections, switching relay means for changing the circuit of said repeater station alternately for transmission of one and another type of signals, and relay means responsive to the reception by said line relay of selected signals from both line sections to operate said switching relay means.

4. A telegraph repeater station connected to a line circuit normally carrying current, said repeater comprising a circuit for one mode of transmission and another circuit for a different mode of transmission of signals by said station, selective switching relay means responsive to selected no-current switching signals from the line circuit to alternately switch one and the other circuit into operation without affecting the connection between the relay means and the line circuit.

5. A telegraph repeater in accordance with claim 4 in which said selective switching relay means includes counting means.

6. A telegraph repeater in accordance with claim 4 in which said selective switching relay means includes permutation counting means.

7. A telegraph repeater in accordance with claim 4 in which said selective switching relay means includes slow acting relay means and relay means for counting the operations of said slow acting relay means.

8. A signal repeating system including a line circuit synchronized impulse repeating means, non-synchronized impulse repeating means, line relay means permanently connected to said line circuit and responsive to incoming signals, switching relay means for connecting said line circuit through either one of said repeating means, and selective means connected to said line relay means for operating said switching relay means in response to selected switching signals.

9. A telegraph repeating system adjustable for repeating of machine transmitted signals and alternately for repeating of manually transmitted signals by selective relay means continuously responsive to incoming signals of either type and in response to selected adjusting signals.

10. A two-way telegraph repeating system connected between two line sections and adapted for alternate repeating of synchronized signals and non-synchronized signals, switching relay means for changing the repeating system alternately from one of said repeating conditions to the other, and selective relay means for operation of said switching relay means in response to selected switching signals incoming over either line section.

11. A two-way telegraph repeating system connected between two line sections and having equipment adapting said system for repeating of synchronized signals and other equipment adapting said system for repeating non-synchronized signals, switching relay means for alternately

switching one or the other of said equipments into operation and selective relay means for operation of said switching relay means in response to special line signals.

12. A two-direction telegraph repeating system comprising selective relay means and switching relay means controlled by said selective relay means for automatically adapting said repeating systems for repeating unit length impulses upon reception by said selective relay means of predetermined switching signals from either direction and for automatically adapting said repeating system for repeating variable length impulses upon reception by said selective relay means of predetermined switching signals from either direction.

13. A telegraph repeating system in accordance with claim 12 in which said system includes a line circuit and said selective relay means includes a line relay having a winding continuously connected in said line circuit during reception of said predetermined switching signals.

14. A telegraph repeater station connected to an incoming line section comprising a circuit for one mode of transmission and another circuit for a different mode of transmission of signals by said station, selective switching relay means responsive to a selected signal from said incoming line section to switch one of said circuits into operation and responsive to another selected signal from said incoming line section to switch the other of said circuits into operation without affecting the connection between said relay means and the line section by either switching operation.

THOMAS A. McCANN.