

July 3, 1934.

W. A. KNOOP

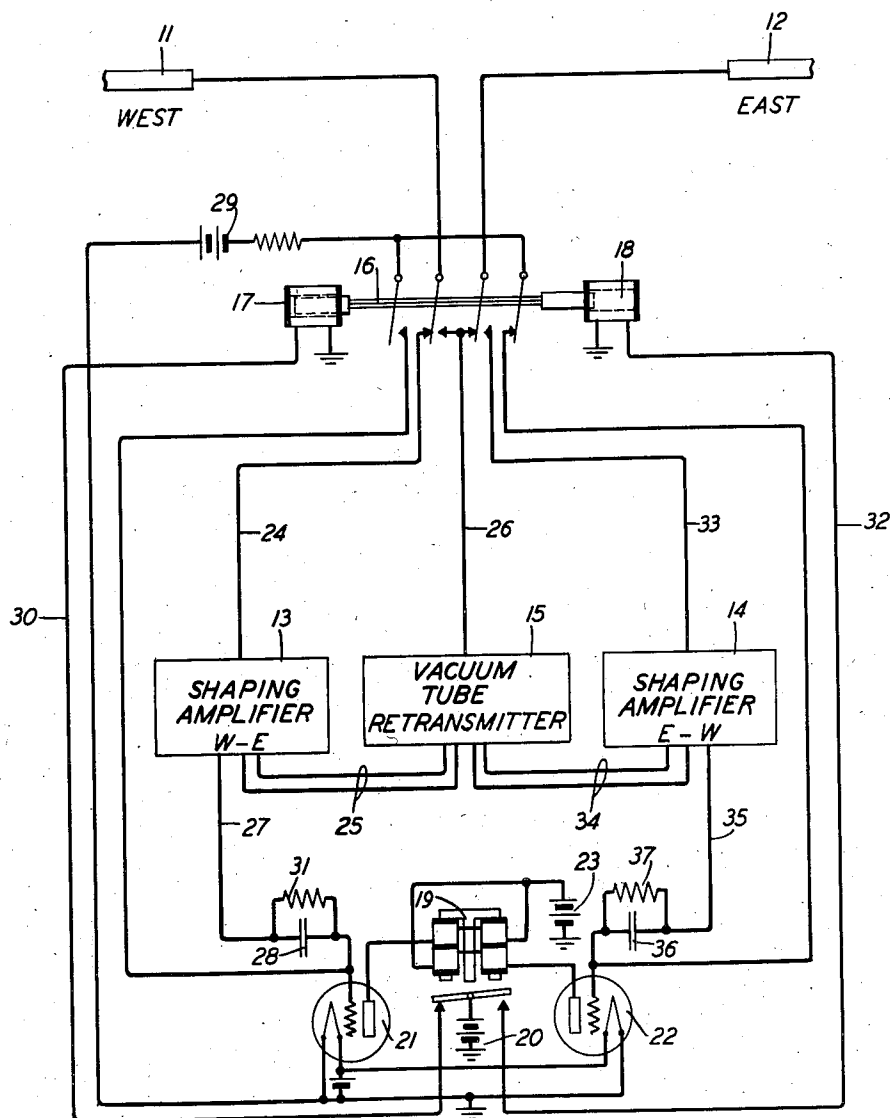
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DIRECTION CONTROL SWITCH FOR SIGNALING SYSTEMS

Filed April 28, 1931

2 Sheets-Sheet 1

FIG. 1



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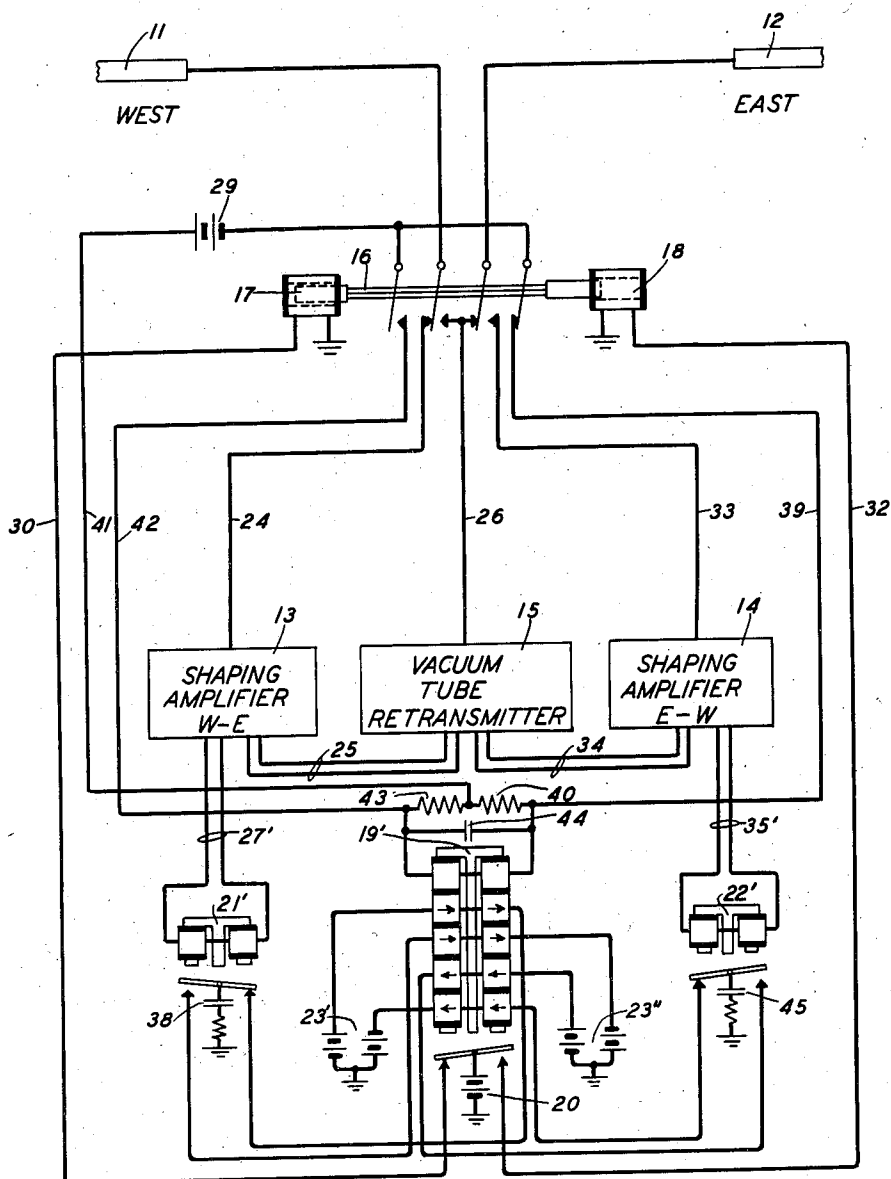
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FIG. 2



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DIRECTION CONTROL SWITCH FOR
SIGNALING SYSTEMS

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10 Claims. (Cl. 178—71)

This invention relates to impulse transmission systems and more particularly to switching devices employed with telegraph repeater equipments for automatic reversals of the direction of transmission.

An object of the invention is to automatically reverse the connections of repeater equipment in an expeditious and efficient manner.

Another object is to utilize the no-impulse intervals of an impulse transmission system for reversing the connections of a mid-cable or mid-line telegraph repeater.

A known type of telegraph system which has been employed chiefly for transmitting over long cables is one in which transmission is alternately in one direction or the other at intervals of a few minutes or such other intervals as may be desired. The reversals in direction may take place automatically or under manual control. The present invention relates to a repeater for use in such a system.

In accordance with the invention a repeater comes automatically under control for repeating signal impulses whenever signal impulses arrive at said repeater from either direction and remains under such control as long as the signal impulses continue to arrive. Upon cessation of the arrival of signals the repeater assumes a condition whereby it is free to be engaged by signal impulses arriving from either direction. Specifically, the repeater oscillates between two positions one of which is the position for repeating in one direction and the other of which is the position for repeating in the other direction. Usually an impulse or a small number of impulses is required to be transmitted to assure that the repeater is conditioned for repeating in the desired direction.

According to the present invention reversals in the direction of transmission are effected either at predetermined intervals, or at such times as the transmitter at the sending end runs out of messages to be transmitted, by utilizing the cessation of signals on a cable and the normal unbalance of two relaying or control devices to maintain a switch at the repeater point continuously vibrating between connections for transmission in either direction. In one embodiment of the invention this switching is accomplished by providing two vacuum tube rectifiers whereof the grid circuits are alternately arranged to receive signals from opposite directions and the plate circuits are respectively arranged to include windings of an unbiased polarized relay. The relay armature, which is connected to positive

battery, is in engageable relation with contacts respectively connected through the windings of two switch operating solenoids to negative battery. The switch arm, which is fixed at opposite ends to the solenoid cores, is arranged to interconnect the cable sections through the repeater equipment for transmission in either direction. The switch arm is also arranged to connect negative battery to the rectifier grid which is not receiving signals at the time. As long as signal impulses are being received from one cable section the space current in one rectifier is considerably less than that in the other and the current in the latter rectifier causes the relay armature to remain in engagement with one of its associated contacts thereby completing the operating circuit for one of the solenoids which holds the switch in the position desired to receive the signals from one cable section and to retransmit them over the other cable section. When the sending station stops sending current impulses the space current in the first rectifier increases in value above the value of the other or second rectifier because the grid of the latter rectifier is connected to negative battery at the time and, therefore, the relay armature moves into engagement with its opposite contact to energize and operate the other solenoid, whereby the switch arm moves to reverse the connection of both cable sections. If no signals are incoming from the opposite direction the above operation is repeated periodically to restore the switch to its original position. This operation is continued until signals are received from one or the other cable section.

In another embodiment the switching is accomplished in the same manner except that polar relays are used in place of the vacuum tube rectifiers.

An advantageous feature of the present system is that no special impulses of long duration need be transmitted from the terminal stations to control the repeater.

A better understanding of the invention will be had from the following detailed description and appended claims when taken in conjunction with the accompanying drawings of which:

Fig. 1 shows an embodiment of the invention wherein vacuum tube rectifiers are employed; and

Fig. 2 shows a modification of Fig. 1 wherein polar relays are used in place of the vacuum tube rectifiers.

Referring to Fig. 1 of the drawings, a relaying circuit comprising impulse repeating instrumen-

talities is shown interconnecting two long submarine cables 11 and 12. The repeating instrumentalities comprise two shaping amplifiers 13 and 14 for reshaping and amplifying signals incoming from opposite directions, respectively, and a vacuum tube retransmitter 15 which is adapted for repeating to the outgoing cable signals received from either of the shaping amplifiers. Each of the shaping amplifiers is equipped with two output circuits in the last stage and may be of the type disclosed in U. S. Patent 1,673,042, granted to A. M. Curtis on June 12, 1928. The vacuum tube retransmitter may be of the type disclosed in U. S. Patent 1,763,880 granted to E. T. Burton on June 17, 1930.

When no impulses are being received over either cable the repeater is arranged to connect itself first for repeating in one direction and then in the other direction and this action continues until impulses are received from one or the other cable. This continuous operation of reversing the position of the repeater during non-signal intervals is effected by means of a switch having a bar member 16 which is operated to alternately opposite positions by means of a pair of solenoids 17 and 18, the cores of which are respectively fixed to opposite ends of bar member 16. The alternate operation of the solenoids is effected by a single relaying device such as relay 19, the armature of which vibrates during non-signal intervals, between its associated contacts to connect grounded battery 20 to the windings of solenoids 17 and 18 alternately. The operation of the armature of relay 19 is effected by a pair of normally unbalanced rectifiers 21 and 22, the plate circuits of which are respectively connected in opposite directions through two windings of the relay to grounded positive battery 23.

Operation of the system shown in Fig. 1

Assuming that the switch bar 16 is in the position shown at the time polar signal impulses begin to come in over cable 11, the impulses will pass over the inner left-hand lever of switch bar 16, conductor 24, through the shaping amplifier 13, over conductors 25, through the vacuum tube retransmitter 15, conductor 26, inner right-hand lever of switch bar 16, to the cable 12.

As stated above each of the shaping amplifiers 13 and 14, has two output circuits in the last stage. One of the output circuits of amplifier 13 is connected to conductors 25 and the other is connected to a conductor 27.

The amplified signals which pass over conductor 27 are impressed on condenser 28 whereby the grid of rectifier 21 goes negative to a value lower than that of the grid of rectifier 22 which is connected at this time to the negative pole of battery 29 over the outer right-hand lever of switch bar 16. Consequently, the space current in rectifier 21 is reduced to a value lower than that flowing at the time in rectifier 22 and the space current of rectifier 22 predominates in energizing relay 19 to hold the relay armature in engagement with its left-hand contact. Battery 20 is thereby maintained in connection over conductor 30 to the winding of solenoid 17 which holds the switch bar 16 in the position shown as long as signal impulses are being received over cable 11. When signal impulses cease coming in over cable 11, the negative charge on condenser 28 in the input circuit of rectifier 21, leaks off through the resistance 31. The grid voltage of rectifier 21 becomes zero thereby causing the space current in rectifier 21 to rise to a value higher than that in

rectifier 22, the grid of which is still maintained at a negative potential by battery 29 being connected over the outer right-hand lever of switch bar 16. Consequently the higher space current now in rectifier 21 and flowing through the upper winding of relay 19 predominates to thereby operate the relay armature to its right-hand contact. The engagement of the relay armature with the right-hand contact closes over conductor 32 an energizing circuit for the solenoid 18. Solenoid 18 operates and draws the switch bar 16 into its alternate position so that the previously established connections for repeating signals from cable 11 to cable 12 are opened and the repeater is set for repeating signals in the opposite direction, that is from cable 12 to cable 11. At this time the grid of rectifier 22 is disconnected from and the grid of rectifier 21 is connected to, the negative pole of battery 29.

Should signal impulses be received from cable 12 at the time the switch bar 16 moves to its alternate position, they will be repeated over the circuit extending from cable 12, over the inner right-hand lever of switch bar 16, conductor 33, shaping amplifier 14, conductors 34, vacuum tube retransmitter 15, conductor 26, inner left-hand lever of switch bar 16, to cable 11. The output of shaping amplifier 14 will also be impressed over conductor 35 onto condenser 36, thereby causing the grid of rectifier 22 to again become negatively charged and to a value lower than that of the grid of rectifier 21. This results in the space current of rectifier 21 predominating in upper winding of relay 19 which holds the armature against the right-hand contact. The armature is maintained against the right-hand contact as long as signals continue to come in over cable 12.

As soon as the signal impulses cease coming in over cable 12, the condenser 36 discharges over its shunt resistance 37 thereby allowing the grid voltage of rectifier 22 to become zero. This permits the space current in rectifier 22 to rise to a higher value than that in rectifier 21 and the resultant current in the lower winding of relay 19 again predominates to actuate the relay armature to its left-hand contact.

It is readily seen that during periods wherein no signal impulses are being received from either cable, the space current in either of rectifiers 21 and 22 will become alternately higher and lower than the space current in the other, thereby causing the relay armature to vibrate between its contacts and the switch bar to move reciprocatingly between two positions.

A satisfactory duration of an interval wherein the cessation of signals is effective to operate the switch is a time interval almost equal to that of one revolution of the rotary distributor at the sending and receiving stations.

Description of circuit shown in Fig. 2

The circuit arrangement shown in Fig. 2 is the same as that shown in Fig. 1 except that polar relays are employed in place of the vacuum tube rectifiers and the polar relay which effects the operation of the solenoids, has a biasing winding in addition to its two vibrating windings. Like parts are designated by like reference characters and corresponding parts which are different in the two figures are designated in Fig. 2 by corresponding reference characters with the (') or (") mark attached.

Operation of the system shown in Fig. 2

Assuming that the switch bar 16' is in the position shown at the time polar signals begin to

come in over cable 11, the signals will pass as described above through shaping amplifier 13 and retransmitter 15 to cable 12. The amplified signals which pass over the circuit including conductors 27' and the winding of relay 21' will cause the armature of relay 21' to operate between its associated contacts. The contacts of relay 21' are respectively connected in circuits extending in opposite relation through the middle and the upper adjacent windings of relay 19' to the grounded positive battery 23' and grounded negative battery 23''. By connecting these circuits to the positive pole of battery 23' and to the negative pole of battery 23'' respectively, the currents received from both contacts of relay 21' pass through both windings of relay 19' in the one direction, as indicated by the arrows, so as to maintain the armature of the latter relay in one position, say, in engagement with its left-hand contact. The condenser 38 connected to the armature of relay 21', however, limits the duration of current flowing through the energized relay windings so that should the signals cease coming in over cable 11 for a predetermined interval, the current in the energized winding would stop and relay 19' would return to its normal unmagnetized state. Immediately upon the cessation of current in the middle or the upper adjacent winding of relay 19' the biasing current which is flowing in the uppermost or biasing winding of relay 19' at the time the switch bar 16 is in either of its two extreme positions, becomes effective to move the relay armature to its opposite position, say, at this time to its right-hand position. This biasing current is flowing in a circuit extending from battery 29', outer right-hand lever of switch bar 16', conductor 39, resistance 40, conductor 41, back to battery 29'. The potential drop across resistance 40 energizes the biasing winding sufficiently to operate the armature of relay 19' to its right-hand position when no current is flowing in either the middle or the upper adjacent winding of the relay.

If after the armature of relay 19' has reached its right-hand contact and the solenoid 18 is consequently energized to open the contact at the outer right-hand lever of switch bar 16' and to close the contact at the outer left-hand lever of the switch bar, a current will flow in the circuit extending from the battery 29', outer left-hand lever of switch bar 16', conductor 42, resistance 43, conductor 41, back to battery 29'. To prevent the current due to the potential drop across resistance 43 from energizing the relay 19' and moving the armature thereof back to its left-hand position before signals are received from cable 12, a condenser 44 is connected in shunt to the biasing winding of relay 19' whereby the energization of the relay is delayed sufficiently to permit signals incoming from cable 12 to become effective to hold the relay armature against its right-hand contact.

The signals incoming from cable 12 which are impressed on the conductors 35 cause the armature of relay 22' to operate in the same manner as described above for relay 21' whereby currents of opposite polarities pass through the two lowermost windings alternately of relay 19', as indicated by the arrows, to have a similar effect on the magnetic field of the relay and to thereby maintain the armature of the relay against its right-hand contact. The condenser 45 serves the same purpose as condenser 38 described above.

Should no signals be received from cable 12

for a predetermined interval after switch bar 16' completes its operation to its right-hand position, the biasing current produced by the potential drop across resistance 43 will become effective to actuate the armature of relay 19' to its left-hand contact. As long as no signals are received from either of cables 11 or 12, the armature of relay 19' will continue to vibrate between its contacts and switch bar 16' will consequently continue its reciprocating action under the influence of solenoids 17 and 18.

What is claimed is:

1. In an impulse repeating system, two transmission circuits, an impulse relaying circuit arranged to interconnect said transmission circuits for repeating message impulses in opposite directions, and switching means for automatically reversing the direction of transmission over said impulse relaying circuit at regular intervals when no message impulses are being received by said impulse relaying circuit from either of said transmission circuits and at irregular intervals when the message impulses are being received by said impulse relaying circuit from either of said transmission circuits, said means comprising two relaying devices, a single relaying device connected to be controlled by each of said relaying devices and a reversing device for interchanging the connections of said transmission circuits to said relaying circuit.

2. A system in accordance with claim 1, wherein circuits are provided for the two relaying devices and are adapted to control each other to continuously reverse the connections of said transmission circuits to said reversing device, and paths connected to each of said circuits respectively, whereby a signal impulse received over either path stops the reversal of said connections in position to repeat from the transmission circuit over which said impulse arrives, to the other transmission circuit.

3. In an impulse repeating system according to claim 1, wherein means are provided for biasing the single relaying device in either of two positions dependent on the direction of transmission of message impulses.

4. In an impulse repeating system according to claim 1, wherein means are employed for delaying the operation of said single relaying device to either of its two positions sufficiently long to allow incoming message impulses on one of said transmission circuits to maintain said single relaying device in the position in which it is at the time.

5. In an impulse repeating system according to claim 1, wherein impulse storing means are connected across said single relaying device for delaying the operation of said single relaying device to either of its two positions sufficiently long to allow incoming message impulses on one of said transmission circuits to maintain said single relaying device in the position in which it is at the time.

6. An impulse relaying system comprising impulse repeating instrumentalities, to two transmission lines, a device for rendering said instrumentalities effective to transmit from the first line to the second or alternatively from the second to the first, oscillatory means for continuously and periodically acting upon said device to cause it to change the direction in which said instrumentalities are effective to transmit characterized in that control elements alternately connected to said lines are also connected to said device whereby an impulse arriving over one of said lines when said instrumentalities are con-

nected to receive therefrom maintains said instrumentalities effective to transmit from said one line to the other.

7. In an impulse repeating system arranged to interconnect two transmission circuits, switching means for automatically reversing the direction of transmission between said circuits, comprising a pair of rectifying devices, a normally operated unbiased polar relay controlled by said rectifying devices, and a plurality of electromagnetic devices, said electromagnetic devices being alternately operated in continuous rotation over the contacts of said relay when no impulses are being received.

8. In an impulse repeating system arranged to interconnect two transmission circuits, switching means for automatically reversing the direction of transmission between said circuits, a source of negative voltage, a pair of rectifying devices arranged to be alternately charged by said source, a single electromagnetic relay arranged to be operated to alternately opposite positions in continuous rotation by said rectifying devices when no signals are being received, and a plurality of other electromagnetic devices arranged to operate alternately in response to the continuous operation of said single electromagnetic relay to thereby effect the automatic reversals of said switching means.

9. In an impulse repeating system according to claim 8, wherein a circuit including the rectifying devices comprises means for impressing a

negative charge of a definite value on the grid element of one device and for simultaneously discharging the grid element of the other rectifying device, and means for impressing incoming signals on the second mentioned rectifying device whereby the grid element thereof becomes charged negatively to a value exceeding that of the grid element of the first mentioned rectifying device to control the operation of the single electromagnetic relay in one position only.

10. A submarine cable signaling system wherein signals are transmitted from one station to another through a repeater station, comprising a cable divided into sections, transmitting and receiving mechanisms associated with said cable, equipment at said repeater station for repeating signals in either direction from one cable section to the other, a space discharge rectifying device responsive to signals received from one cable section, a second space discharge device responsive to signals received from the other cable section, a source of negative potential, a switching device, a pair of electromagnetic devices for moving said switching device in alternately opposite directions, whereby the source of negative potential is applied to said space discharge devices alternately and an unbiased polarized relay having contacts respectively arranged to complete operating circuits for said electromagnetic devices alternately when no signals are received from either cable section.

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