

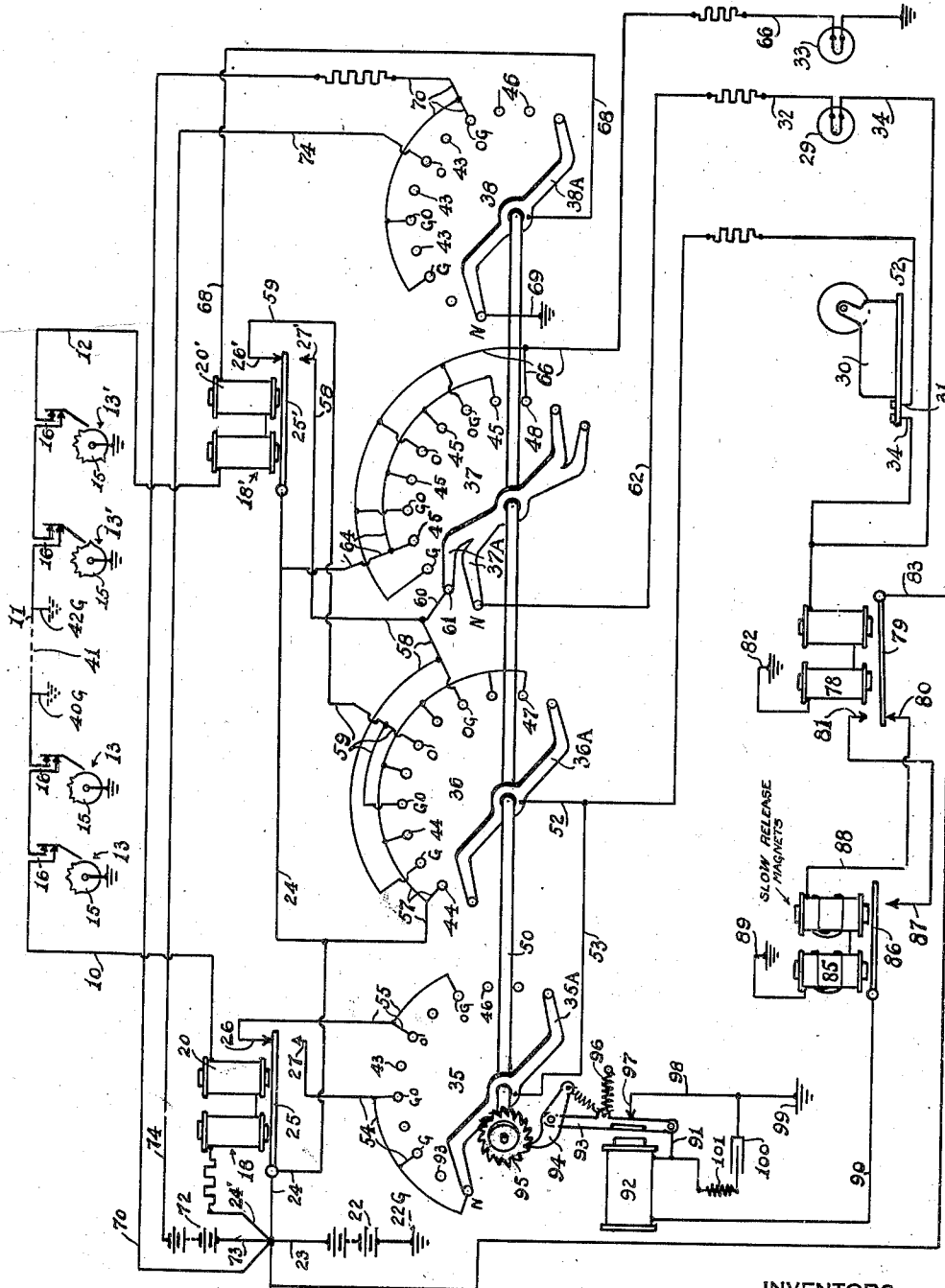
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AUTOMATIC ELECTRIC SIGNAL CIRCUIT

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INVENTORS
Richard M. Hopkins
Herbert M. LaFord

By *Harold D. Penny*, ATTORNEY.

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AUTOMATIC ELECTRIC SIGNAL CIRCUIT

Richard M. Hopkins, Rutherford, N. J., and Herbert M. Laford, New York, N. Y., assignors to American District Telegraph Company, New York, N. Y., a corporation of New Jersey

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This invention relates to electric signal systems and to systems including the McCulloh circuit, and more particularly to automatic means for adjusting the signal system to variations from normal in the line condition, though it is noted that in some of the claims the invention is not limited to the McCulloh circuit nor to automatic means.

The main object of the invention is to provide, in an apparatus or circuit of this kind, automatic means for adjusting the circuit to various line conditions.

Another object of the invention is to provide an adjusting means of this kind which includes rotary switches for effecting adjustments.

Another object of the invention is to provide an automatic adjusting device which is not responsive to intermittent signal impulses, but is responsive to longer impulses.

Other objects of the invention are to improve generally the simplicity and efficiency of such apparatus and to provide an apparatus of this kind which is reliable in operation, and economical to construct.

Still other objects of the invention will appear as the description proceeds; and while herein details of the invention are described and claimed, the invention is not limited to these, since many and various changes may be made without departing from the scope of the invention as claimed in the broader claims.

The inventive features for the accomplishment of these and other objects are shown herein in connection with an automatic McCulloh circuit which, briefly stated, includes a McCulloh signal system including a line loop having transmitters therein and connected in series between respective magnets of relays of a receiver having a recorder. Each relay is provided with a pair of members which, when signals are not being transmitted, are respectively continuously charged and uncharged during normal line condition, one or both of which pairs may be respectively uncharged and continuously charged during abnormal line conditions, the uncharged member being always intermittently charged during signal sending.

Motor means, uninfluenced by signal impulses and operative by longer impulses operate suitable switch means associated with said relays respectively and operable for connecting the recorder and the motor with one member at a time of each relay, for receiving signals and for causing the motor to operate when a member with

which the motor is connected becomes the continuously charged member.

Operative connections are provided between said motor and the switch means for operating said switch to disconnect the motor from a continuously charged member and connect it with uncharged members whenever the motor is operated.

In the accompanying drawing showing, by way of example, one of many possible embodiments of the invention, the figure is a diagrammatic view of the automatic system.

Brief description of principal features

The principal features only of the apparatus will first be very briefly indicated, and later described in detail. The apparatus is shown in connection with a McCulloh system having a line loop 10, 11, 12, an "out" relay 18, an "in" relay 18', a grounded main current source 22, a recorder 30, and normally engaged and disengaged contacts 26, 27, 26', 27' for the respective relays.

The automatic control mechanism includes a pilot lamp 29, an out-signal switch 35, an in-signal switch 36, a pilot switch 37 and a ground switch 38, each including operation contacts N, G, GO, O, OG (corresponding to different operating conditions) and contact arms 35A, 36A, 37A, 38A respectively.

Retarded motor means 50, 78 to 101, uninfluenced by signal impulses and operative by longer impulses, is disposed in circuit with said lamp 29 and recorder 30 and is adapted to drive all of said arms in unison successively to positions to engage said operation contacts.

Conductors 52, 53, 54, 55, 58, 59 associated with said contacts and arms of the switches 35, 36 serve for connecting the recorder 30 to relay contacts 26, 27, 26', 27' which are normally disengaged during conditions of operation corresponding to the respective operating positions of the switch arms. Conductors 58, 60, 62 associated with the pilot switch arm and contacts connect the pilot lamp with the normally disengaged in-relay contact 27' during normal operation; and conductors 24, 64, 66 connect the trouble lamp 33 with the main source in the remaining positions of operation.

Conductors 68, 69, 70 associated with the ground switch 38 connect the in-magnet 20' in circuit with the ground or with said source in the positions of the arm 35A that correspond to operating conditions that require it.

Conductors 74, 68 associated with the ground switch 38 connect the auxiliary source in circuit

with relay magnet 20' for certain operations during open-circuit condition.

During signal sending, the relay armatures 25 or 25' vibrate, and as will be explained, cause intermittent current to pass to the recorder 30, and the magnet 78; but this intermittent current does not influence the operation of the stepping or motor means 78 to 95. This motor means is only operated when changing line conditions causes a shifting of the armatures 25 or 25' in a way to cause the passage of continuous current to the magnet 78. Then the motor means operates as will be explained to cause the switch arms to revolve until the revolving switches make the required connection for operation of the line condition, whereupon said continuous current ceases, and the apparatus remains in this condition until repair or other line condition change, causes another automatic action. This operation will be fully explained hereinafter. Now the various parts of the apparatus will be described in detail.

The McCulloh system

This invention is shown in combination with the well known McCulloh signal system. This system comprises a line loop 10, 11, 12 having in series therein the usual pull boxes or transmitters 13, 13' comprising each a rotary grounded toothed code-signal wheel 15, and a normally closed switch 16 interposed in the line and normally out of contact with the wheel 15 and adapted to be engaged by the teeth of the grounded wheel when rotating, thereby, once for each tooth, to ground both legs 10, 12 of the loop and also to break the loop.

The receiver includes an "out" relay 18 and "in" relay 18', having magnets 20 and 20' respectively. The loop 10, 11, 12 is connected between and in series with the magnets 20, 20'. The receiver also includes a grounded main source of current 22 having an ungrounded terminal 23 connected by a conductor 24' to the out magnet 20, the other terminal of the in-magnet 20' being, as will be explained, normally grounded and at times connected to said ungrounded terminal 23.

The out-relay 18 comprises a normally attracted armature 25 carrying or comprising a movable switch element, and a normally engaged contact 26 normally engaged by the movable element during normally closed circuit line-condition and intermittently engaged for signal sending during open circuit in the adjacent leg 10 of the loop, and a normally disengaged contact 27 intermittently engaged by the movable member for signal sending during normally closed circuit working and constantly engaged (when there is no signal) during open circuit condition in the adjacent leg.

The in-relay 18' comprises corresponding parts 25', 26', 27', the contact 27' being constantly engaged during open circuit of the adjacent leg 12. The switch elements 25, 25' are connected by the conductor 24 to the ungrounded terminal 23.

As is usual, the receiver also includes a pilot lamp 29 and a recorder 30 having respective terminals 31, 32 adapted for connection with one of said contacts 26, 27, 26', 27' as is true of the usual McCulloh system, but in the present invention they are connected in a different manner as will be explained.

The usual McCulloh systems have manual switches for connecting the various contacts 26, 27, 26', 27' with the recorder 30 to suit the various line conditions. Such a system is shown in the U. S. Patent No. 1,640,325, issued Aug. 23,

1927, to G. W. Janson. The main object of the present invention is to perform the above operations automatically by automatic means such as a means, now to be described.

The automatic control mechanism

In addition to the usual McCulloh structure just described, the present invention provides a trouble lamp 33 having one terminal grounded, and also provides a grounded retarded stepping or motor means 78 to 101 uninfluenced by signal impulses but operated by longer impulses and having an ungrounded terminal connected to the other terminals 34 of said pilot lamp 29 and recorder so that when the recorder or pilot lamp is energized continuously the motor means should operate. Said motor means drives an automatic means for automatically connecting said lamps and recorder to the proper contacts of said relays to meet the various operating conditions for operating during line defects somewhat after the manner of the manual operation heretofore usual of McCulloh systems. Said automatic means will now be described.

The revolving switches

Said automatic mechanism comprises revolving switches 35, 36, 37, 38. These include an out-signal switch 35, an in-signal switch 36, a pilot switch 37 and a ground switch 38. Each switch comprises a semi-circular bank of contacts equal angles apart, each bank including fixed contacts N, G, GO, O, OG respectively for normal operation (as when the loop 10, 11, 12 is complete) grounded closed circuit operation (as when the loop 11 is unbroken and grounded), grounded out-leg of an open circuit (as when the circuit is grounded as at 40G and open as at 41), open circuit without ground (as when the circuit is open at 41), grounded in-leg of an open circuit (as when the circuit is open as at 41 and is grounded as at 42G), intermediate contacts 43, 44, 45 between the above named contacts, and additional contacts 46, 47, 48 completing the semi-circle.

Said switches also comprise a rotatable shaft 50 coaxial with all of said banks carrying insulated pairs of contact arms 35A, 36A, 37A, 38A, two pairs 37A for the signal bank and one pair for each other bank, all fast on said shaft and engageable with the associated fixed contacts respectively. The contact arms 37A are electrically connected and constitute a bridge, bridging adjacent fixed contacts.

Signal switch connections

Conductors 52, 53 connect the first named terminal 31 of said recorder with the contact arms of the signal switches 35, 36. Conductors 54, connect the normal operation fixed contact N, the grounded closed circuit operation contact G and the grounded out-leg open circuit contact GO of the out-signal-switch 35 with the normally disengaged contact 27, to permit normal signal operation when one of said fixed contacts is engaged by a contact arm 35A, and to permit the supplying, to the recorder, of a current of sufficient duration to operate the stepping means, should damage to the line cause the movable member 25 to come to rest on the normally disengaged contact 27.

Conductors 55 connect the open circuit contact O and the grounded in-leg open circuit contact OG of the switch 35 to the normally engaged contact 26, whereby when the condition of

damage to the line requires the armature to rest on the normally disengaged contact 27, current for signals to be recorded may be received from the normally engaged contact 26, and current of sufficient duration to operate the stepping means, caused by change of such condition, will cause the stepping means to step the contact arm 35A from such contacts O and OG.

Conductors 24, 57 connect each intermediate and final contacts 44, 47 of the in-signal-switch 36 with said ungrounded terminal 23, whereby when the contact arm 36A engages such contact, current passes through the conductor 52 and the stepping means will be operated and the contact arms stepped to the next contact of the respective banks. Thus it is seen that the arms 35A, 36A and 38A will never remain on contacts 43, 44, 46, 47. This feature will not be described again.

Conductors 58 connect the grounded closed circuit operation contact G and the grounded in-leg open circuit contact OG of the in-signal-switch 36 with the normally disengaged contact 27', to allow signal operation when one of said contacts G or OG is engaged by a contact arm 36A, and to permit the supplying to the recorder a current of sufficient duration to operate the stepping means, should damage to the line cause the armature to come to rest on the normally disengaged contact 27'.

Conductors 59 connect the open circuit contact O and the grounded out-leg open circuit contact GO to the normally engaged contact 26', whereby when the condition of damage to the line requires the armature to rest on the normally disengaged contact, current for signals to be recorded may be received from the normally engaged contact, and current of sufficient duration to operate the stepping means, caused by change of such condition, will cause the stepping means to step the contact arm from such contact O or GO.

Pilot switch connections

Conductor 62 connects the first named terminal 32 of said pilot lamp 29 with the normal operation contact N of the pilot switch 37; and conductors 58, 60 connect the first intermediate contact 61 with the normally disengaged contact 27' of the in-relay, whereby normal closed circuit signals cause current in conductor 62 and flashes of the pilot lamp, and any continued low position of the in-armature switch element 25' causes continued light from the pilot lamp, to indicate that the apparatus is not working as it should.

Conductors 24, 64 connect the remaining intermediate contacts 45 of the pilot switch 37 with the source of current, while contacts, G, GO, O, OG and 48 are connected by conductors 66 with the trouble lamp, whereby when the condition of damage to the line causes said arms to move to the abnormal operation contacts, the double arm 37A will bridge adjacent contacts and current will be supplied to the trouble lamp, thus indicating abnormal operation.

Ground switch connections

A conductor 68 connects the in-magnet 18' to the contact arm 38A of the ground switch 38; and a conductor 69 connects the normal operation contact N of the ground switch to the ground, thus adapting the system for closed circuit operation, as is usual with McCulloh systems.

Conductors 70 connect the grounded closed

circuit contact G, the grounded out-leg and grounded in-leg open circuit operation contacts GO, OG to the ungrounded terminal 43 of said source, whereby when grounded open and closed circuits of the line require that the current pass out through the in-magnet, the in-magnet will be connected to said terminal 23 of the source.

The auxiliary current source

For a purpose which will be explained, an auxiliary source 72 of current is connected by conductors 73, 74 in series between the main source and the open circuit operation contact O of the ground switch 38 for energizing the in-magnet during open circuit operation signaling, and for causing the in-armature 25' to rise when the open circuit has been repaired, thereby to energize open circuit contact O of the in-signal switch 36, to start the motor to start the switches to rotating.

The automatic stepping or motor means

Said retarded stepping means includes a pilot relay 78, 79, 80, 81 having its magnet coils 78 interposed between a ground 82 and said recorder 30 and pilot lamp 29. Said relay comprises a normally unattracted armature 79 carrying or constituting a movable switch element connected by a conductor 83 to the ungrounded terminal 23 of the main source. The relay also comprises normally engaged and disengaged fixed contacts 80, 81 respectively normally engaged and disengaged by the movable contact 79.

A timed relay 85, 86, 87 comprises a slow release retarded magnet 85 connected by a conductor 89 between said normally engaged contact 80 and a ground 89, whereby the magnet is normally energized.

The release of said magnet is insufficiently rapid to release on signal impulses, but is sufficient to release on longer impulses. The timed relay includes a normally open switch 86, 87 normally held open by the retarded magnet 85 and having one element 87 connected to the normally disengaged element 81 of the pilot relay.

The motor magnet

Conductors 90, 91, connect the coil of a motor magnet 92 in series between the other element 86 of the timed relay switch and to a switch element 93 carried or constituted by a pivoted armature attracted by said magnet 92 and forming an operating arm carrying a pivoted pawl 94 engaging a ratchet 95 carried by the shaft 50, whereby said contact arms 35A, 36A, 37A, 38A are moved from one contact to the next each time said magnet is energized.

A switch contact 97 normally engaged by said arm is connected by a conductor 98 with the ground 99, whereby the armature 93 vibrates with an electric bell action and said pawl rotates said ratchet and revolves said arms, step by step, so long as the timed relay armature 86 is released.

A condenser 100 and an inductance 101 are connected in series and with each other between the switch elements 93 and 97 to avoid sparking.

Operation of the stepping means

When no current passes through the conductors 53 or 62 and the magnet 78, the armature 79 remains lowered, and current passes through the terminal 23, conductor 83, armature 79, contact 80, 88 slow release magnet 85, ground 89, thus holding the armature 86 from the contact

87; and no current can pass from the conductor 83 to the ground 99.

When signal current passes through the conductors 53 or 62, the magnet 78 and ground 82, the armature 79 is vibrated, thus intermittently breaking the current through conductor 88, slow release magnet 85 and ground 89. But as the magnet 85 is a slow release magnet, it does not drop the armature 86, and still no current passes through the contact 87, armature 86, motor magnet 92 and ground 99.

However, when continuous current passes through conductors 52 or 34 and the magnet 78, the armature 79 is continuously raised, and no current passes through contact 80, 88, slow release magnet 85 and ground 89; and the armature 86 remains in lowered position against the contact 87.

This permits current to pass through conductor 83, armature 79, contacts 81, 87, armature 86, conductor 90 motor magnet 92, conductor 91, armature 93, contact 97 conductor 98 and a ground 99. This attracts the armature 93 against the action of the spring 96, which breaks the circuit at the contact 97 and allows the spring 96 to retract the armature, thus vibrating the armature 93 with an electric bell action, causing the pawl 94 to vibrate upon the ratchet wheel 95, rotating the shaft 50 and stepping the switch arms from one contact to the next for each vibration, so long as continuous current is supplied to the magnet 78.

The operation of the apparatus

In operation the movable contacts 25, 25' respectively rest upon one of the fixed contacts 26, 27 or 26', 27' to suit the line condition, as in the known McCulloch system; and a change of condition in the line causes the present system to automatically change the receiver with relation to said elements to adapt them to the line conditions. The operation will now be described relative to line conditions.

Normal operation

The transmitter switches 16 are normally closed, and current normally passes from the main source 22 through magnets 20, the switches 16, magnets 20', the conductor 68, the switch arms 38A, conductor 69, to ground and then to the grounded side of the battery 15. Thus the circuit is a closed circuit. When a signal is sent from a station, the wheel 15 of that station rotates and opens the switch 16 sending code signal in accordance with the teeth of that wheel. This intermittently breaks the circuit, intermittently deenergizing magnets 20 and 20' permitting the armatures 25, 25' to drop, intermittently closing the local circuit through the source 22, conductor 24, elements 25, 25', conductors 54, 58, contacts N, arms 35A, 36A, conductors 52, 53, the recording receiver 30, magnet 78 to ground 82, thus recording the signal. Current also passes from conductor 58, through conductor 60, contact 61, arms 37A, contact N, conductor 62, and pilot lamp 29.

It will be noted that the wheel 15 is grounded but normally does not touch the spring member of the switch 16.

As the intermittent signal, causes only intermittent current in the magnet coils 78, intermittently breaking the contact between elements 79 and 80, the slow release magnets 85 do not release the armature 86, the motor 92, 93 is not operated and the shaft 50 and the arms thereon are not moved.

When the intermittent signal current is being sent to the recorder through the contacts N, intermittent current also passes through contacts 61 and N of switch 37, thus flashing the lamp 29; but while the arms 36A, 37A are on contacts N, the contact G of switch 37 is not engaged, and no current passes to the trouble lamp 33.

Automatic switching for closed circuit grounded line

With the parts still as shown, suppose a ground as at 40G should then occur. Current would pass direct from the ground 40G to the ground 22G, thus short-circuiting the line leg 12 and magnets 20', deenergizing the magnet 20' dropping the armature 25', causing continuous current to pass from the source 22, through conductors 24, 58, 60, 62, pilot lamp 29 and magnets 78 to the ground 82, thus deenergizing the slow release magnet 85, energizing the magnet 92, rotating the ratchet wheel 95 until the arms come into contact with the first intermediate contact 44, causing current through conductors 24, 57, 52 and movement of the arms into contact with the contacts G of all of the switches 35, 36, 37, 38.

If when the elements 25, 25' dropped to the contacts 27, 27', the stepping means had, through accident or the like, failed to rotate the shaft, arms 37A would have remained on the contacts 61 and N, causing continuous lighting of the lamp 29, calling attention to the failure of operation.

As soon as any arm 37A reaches the contact G or subsequent contacts, the arms bridge adjacent contacts, thus connecting conductors 64 and 66 and carry current from the source 22 and conductor 24 to the trouble lamp 33 indicating line trouble.

Closed-circuit grounded-line operation

As soon as the arms have been as above noted moved to contacts G, current may pass from the source 22, through conductors 70, contact G of switch 38, arm 38A, conductor 68, magnet 20', leg 12 to ground 40G, thus raising armature 25'. At the same time current passes from source 22, through the magnet 20 and leg 10 to ground 40G thus raising armature 25.

Now if a wheel 15 on either side of the ground 40G be rotated in sending the signal, the circuit through the adjacent leg 10 or 12 and magnet 20 or 21' will be broken, the armature 25 or 25' will be dropped, and signal current will pass through conductors 54 or 58 and arm 35A or 36A and a signal recorded at the recorder 30.

If the signal is sent from the signal box 13 to the left of the ground 40G, the left hand magnet 20 will be operated and vice versa.

Restoring apparatus after repair

While the arms are thus resting on contacts G, current passes through conductors 24, 64, arms 37A, conductors 66 and trouble lamp 33, indicating that repair men should be sent out to repair the line. As soon as the line is restored to normal, no current will pass, since both ends are then connected to the terminal 23, and there is no connection with the ground 69. This will cause the dropping of both armatures 25, 25', so that continuous current will pass through conductor 24 and 54, 57 or 58 in any abnormal position of the arm except at contact O, and therefore through conductors 53, 52 or 62 and magnet 78, causing the stepping means to step the arms around from these positions until the arms again engage the

normal contacts N. In being thus stepped around, when the arms reach the contact O, current passes through source 72, conductor 74, arm 38A, conductor 68, magnet 20', the line loop 12, 10, magnet 20 and conductor 73, thus raising the armatures 25, 25' and causing current to pass through conductors 24, 55, 59, contacts O of switches 35, 36, arms 35A, 36A, conductors 53, 52 and magnet 78, thus stepping the arms from contact O, and then finally to normal as above noted.

If there should develop a simple ungrounded break, as at 41, in the ungrounded line, the arms would be stepped around to engage and stop on contacts O. In this position, both legs 10 and 12 must, for proper operation, be ungrounded and connected to the same (the ungrounded) terminal of the source 22, as in usual McCulloch operation. If in this position (supposing the source 72 be not provided), the break should be repaired, both legs would still be simply connected to the same single ungrounded terminal 23 and no current would pass, the armatures 25, 25' would not rise, and the motor would not operate to step the arms to normal. Therefore, the source 72 is provided, so that when the break is repaired, a circuit will be established from source 72, through conductor 24', magnet 20, line 10, 11, 12, magnet 20', conductor 68, arm 38A, conductor 74 to source 72, thus energizing the magnets 20, 20', raising the armatures, causing the motor to step the arms to normal.

The operation of restoring the apparatus from any line position to normal after repair is included in the preceding description, and need not be repeated hereinafter.

Ground-open operation

Should it happen that the circuit operating as shown should develop both a ground 40G and an open 41 the right hand magnet 20' would be de-energized, the right hand armature 25' would drop. This would cause continuous current to find a path through conductors 24, 58, arms 37A, conductors 62, 34, causing the stepping means to move the arm 36A to charged contact 44 and then to contact G of switch 36, which is charged by conductor 58, causing current through the arm 36A, conductors 52, 34, causing the stepping means to rotate the arm to another charged contact 44 and then to contact GO. During this movement the arm 38A passes the contact G of switch 38 and reaches contact GO, and in both cases the magnet 20' is connected to the main source through conductor 68, arm 38A and conductors 70; but no current passes because of the open at 41 and the armature 25' remains lowered.

In this position, a closed circuit is formed through the leg 10 and ground 40G; and if a station 13 to the left of the ground-open 40G, 41 be operated, the leg 10 will be intermittently broken, the armature 25 will be intermittently dropped, and intermittent current will pass through conductors 24, 54, 53, 52, and the recorder will operate.

In this condition, no current can pass the magnets 20' because of the open 41, but the leg 12 is charged; and when a station 13' is operated current passes through conductor 70, arm 38A, conductors 68 and 12 and the ground of station 13', thus intermittently raising the armature 25', sending intermittent current through conductors 24, 59, arm 36A, conductors 52 and the recorder.

Open-line operation

If when the parts are as in the figure, there

should occur an accidental break in the line as at 41, the circuit through the line 10, 11, 12 would be broken, magnets 20 and 20' would be deenergized, armatures 25 and 25' would drop, close the circuit through conductors 54, 58, 60 and light up the pilot lamp 29 warning the attendant that a break had occurred. Continuous current would then pass through conductors 52, 53, and the magnet 78 causing the stepping means to step the switch arms from the position N, to the intermediate contacts and then to the position G and GO. As no current can pass the open 41, and therefore the magnets 20, 20', the armatures must stay down, and current must pass through conductors 24, 54, 58, 53, 52 and magnet 78 and the stepping means will step the arms to the contacts O.

In this position, the leg 10 is still connected to the main source; and the leg 12 is connected through magnet 20', conductor 68, arm 38A, conductor 74, source 72, terminal 23 to the main source thus both legs and both sides of the open 41 will be charged, and if either transmitter 13 or 13' be operated, current would pass from the source 22 through one of the magnets 20 or 20' to a switch 16. The tooth of the wheel 15 touches the switch 16 before it opens the switch, and current would pass through the tooth, the wheel 15, the ground of the station, the ground 22G to the source 22. This would cause the armatures 25 or 25' to intermittently rise, and the signal current would pass through conductors 55 or 59, arms 35A or 36A and conductor 52 and be recorded at 30. Thus it is seen that the circuit could operate even with an open as at 41.

Open-grounded operation

Suppose the parts are as in the figure, and a break 41 and a ground 42G should develop. When this happens, no current can pass through the magnet 20 and the armature 25 drops from the position of figure into contact with the contact 27, thus causing continuous current to pass through conductors 24, 54, arm 35A, conductors 53, 52 the recorder and magnet 78. This will cause the stepping means to move the switch arm 36A to the first contact 44, causing steady current to pass through conductors 24, 57, arm 36A, conductors 52, 34 and magnet 78, causing the stepping means to step the arms to the contacts G.

When the contacts G are thus engaged steady current will still pass through conductor 54, and the stepping means will step the arms to contacts GO as above described, and past GO because current still passes through conductor 54.

In time the arms reach contacts O, whereupon no current will pass through conductors 54; but current will pass through sources 22 and 73, conductor 74, arm 38A, conductor 68, magnet 20', leg 12 and ground 42G, thus raising the armature 25', causing current through conductors 24, 58, contact O of switch 36, arm 36A and conductors 52, 34, thus causing the stepping means to step the arms to the next intermediate contacts and then to contacts OG.

In this position with the arms on contacts OG, the armature 25 is down, because no current passes the open 41; but the armature 25' is up, because current passes through conductors 70, arm 38A, conductor 68, magnet 20', leg 12 and ground 42G. Then if a signal be sent from station 13, current passes through the magnet 20, leg 10 and the ground of station 13, thus intermittently raising the armature 25, sending cur-

rent through conductors 55, contact OG, arm 35A, conductors 53, 52 to the recorder. If station 13' be operated, the circuit in leg 12 is thereby broken, armature 25' intermittently drops, and intermittent current passes through conductors 58, arms 36A, conductor 52 and the recorder.

Operation from one abnormal line condition to another abnormal line condition

Should the apparatus be set for any abnormal condition, such as a grounded closed circuit, and then the line condition change to a condition corresponding to a subsequent switch position, such as an open-ground position, the switch arms would obviously be stepped forward from the first abnormal position to the subsequent position just as if the first condition had not existed. Thus this operation requires no further explanation.

If however, an abnormal condition such as open-ground, having a later switch position, as at the contact OG, should become changed to a condition corresponding to a preceding switch position, such as the position at contacts G, GO or O, the apparatus would take care of this operation also.

Suppose, for instance, that there be the open-ground condition, with the circuit broken at 41 and grounded at 42G, switch arms on contacts OG and the armature 25 down and the armature 25' up. Then if the break 41 should close, and there be only a ground, current would pass through the magnet 20, the armature 25 would rise, and current would pass through conductor 55, contact OG, arm 35A, and the arm would be stepped around.

If instead, the open-ground condition, the loop should lose its ground and become an open position, the armature 25' would drop, current would pass through conductor 58 and contact OG, and the arms would be stepped around.

If instead, the open-ground condition be changed to a ground-open condition, that is, the ground pass from 42G to 40G, then the armature 25 would drop, the armature 25' would rise, and current would pass through conductors 55 and 58, and the arms would be stepped around.

Suppose, that there be only the open 41, the arms being on contacts O, both armatures 25, 25' being down. Then if a ground, for instance the ground 42G, should develop, current would pass through source 73, conductors 74, 68, magnet 20', then the armature 25' would rise current would pass through conductors 59, 52, and the arms would be stepped around.

Thus it is now seen, that for every operating position, the arms 35A, 36A are connected to one uncharged associated relay contact, and that every line change changes the position of at least one armature charging a previously uncharged relay contact, causing the arms to be stepped around until it finds their proper position.

We claim as our invention:

1. In a signal system, for changeable conditions, having a pair of members normally respectively continuously charged and uncharged during one condition, and abnormally respectively uncharged and continuously charged during another condition, the normally uncharged member being intermittently charged during signal sending, the combination of a motive means, uninfluenced by signal impulses and operative by longer impulses; circuit control means connected with said members and motive means and nor-

mally connecting the motive means to the normally uncharged member, and operable for connecting the motive means with said members one at a time for causing the motive means to operate when the member with which the motive means is connected is the continuously charged member; and operative connections between said motive means and the circuit control means for operating said control means to disconnect the motive means from a continuously charged member and connect it with uncharged member when the motive means is operated.

2. In a McCulloh system having an "out" relay, an "in" relay, a grounded main current source, a recorder, and a normally engaged and disengaged contact for each relay, control mechanism including an out-signal switch, an in-signal switch and a ground switch each including contacts and a contact arm; a retarded motor means, uninfluenced by signal impulses and operative by longer impulses, disposed in circuit with said recorder, means driven by said motor means for driving all of said arms in unison to successive positions engaging contacts corresponding to different line conditions; conductors associated with said contacts and arms of the switches for connecting the recorder to relay contacts which are normally disengaged during conditions of operation corresponding to said contacts; and conductors associated with the ground switch for connecting the magnet of the in-relay in circuit with the ground or with said source in the arm positions that correspond to conditions that require it.

3. In a system as in claim 2, an auxiliary current source; and conductors cooperating with the ground switch, auxiliary source, and relay magnets for connecting the auxiliary source in circuit with the relay magnets when the arms are in open circuit operation positions.

4. In a system as in claim 1, said control means comprising a bank of contacts including contacts respectively for normal and abnormal operations and a contact arm driven by the motive means and successively engageable with adjacent contacts, conductors connecting said motive means to the arm of the switch; conductors connecting the respective operation contacts of the switch with the corresponding relay contacts which are normally disengaged during such operation.

5. In a McCulloh system having a grounded main current source, an "out" relay, an "in" relay, a line loop therebetween and a recorder, each relay having a movable switch element connected to said source, and a normally engaged contact and a normally disengaged contact, control mechanism including a retarded motor means in circuit with said recorder; an out-signal switch; an in-signal switch; each switch including operation contacts respectively for normal and abnormal conditions, intermediate contacts therebetween, and a contact arm engaging one contact only at a time; means driven by the motor means when energized for causing said arms to advance and simultaneously engage corresponding contacts; conductors connecting said recorder in circuit with the arms of the signal switches; conductors connecting the respective operation contacts of the signal switches with the corresponding relay contacts which are normally disengaged during conditions corresponding to such contacts; and conductors connecting the intermediate contacts of one of the signal switches to the main source.

6. In a McCulloh system having an "out" re-

lay, an "in" relay, a grounded main current source, a recorder, and a normally engaged and disengaged contact for each relay, control mechanism including an out-signal switch, an in-signal switch and a pilot switch, each including contacts and a contact arm; a retarded motor means, uninfluenced by signal impulses and operative by longer impulses, disposed in circuit with said recorder and adapted to drive all of said arms in unison successively to positions engaging contacts corresponding to different line conditions; conductors associated with said contacts and arms of the switches for connecting the recorder to relay contacts which are normally disengaged during conditions of operation corresponding to said contacts; an indicating means; the pilot switch arm being adapted to bridge adjacent contacts and conductors connected with the pilot switch contacts for connecting the indicating means with one or more normally disengaged relay contacts during one or more positions of operation of the switch arms.

7. In a McCulloh system having a grounded current source, an "out" relay, an "in" relay, a line loop therebetween and a recorder, each relay having a movable switch element connected to said source, and a normally engaged contact and a normally disengaged contact, control mechanism including a retarded motor means in circuit with said recorder; a trouble lamp; an out-signal switch; an in-signal switch; a pilot switch; each switch including operation contacts respectively for normal and abnormal conditions, intermediate contacts therebetween, and a contact arm, the arm of the pilot switch bridging adjacent contacts, the other arms engaging one contact only at a time; means driven by the motor means when energized for causing said arms to advance and simultaneously engage corresponding contacts; conductors connecting said recorder in circuit with the arms of the signal switches; conductors connecting the respective operation contacts of the signal switches with the corresponding relay contacts which are normally disengaged during conditions corresponding to such contacts; the intermediate contacts of one of the signal switches being connected to the main source; conductors connecting the remaining alternate pilot switch contacts with the trouble lamp and the source respectively.

8. In a McCulloh system having a grounded current source, an "out" relay, an "in" relay, a line loop therebetween and a recorder, each relay having a movable switch element connected to said source, and a normally engaged contact and a normally disengaged contact, control mechanism including a retarded motor means in circuit with said recorder; an out-signal switch; an in-signal switch; and a ground switch; each switch including operation contacts respectively for normal condition, open circuit line condition and other abnormal conditions, and a contact arm engaging one contact only at a time; means driven by the motor means when energized for causing said arms to advance and simultaneously engage corresponding contacts; conductors connecting said recorder in circuit with the arms of the signal switches; conductors connecting the respective operation contacts of the signal switches with the corresponding relay contacts which are normally disengaged during conditions corresponding to such contacts; conductors connecting the in-magnet in circuit with the contact arm of the ground switch and grounding the nor-

mal operation contact of the ground switch; and conductors connecting the ground switch contacts with said source at the arm positions that are thus operated.

9. In a system as in claim 8, an auxiliary current source connected in circuit between the main source and the open-circuit contact of the ground switch.

10. In a system as in claim 1, said motive means comprising a motor; a retarded relay including a normally energized slow release magnet and means released by said magnet to put said motor in an electric circuit; and means connected to said control means and operated by movement of the control means to deenergize said slow release magnet.

11. In combination, an apparatus including a line subject to change from one condition to one or more different grounded conditions and back to the first named condition, said apparatus being caused by any one of said changes of condition to change the type of signal transmitted; and means influenced by each signal change from a certain type of signal to automatically adjust the apparatus to transmit said certain type after the apparatus is thus adjusted; thereby causing said means to automatically adjust the apparatus to send said certain type of signal after the apparatus has been subjected to a succession of said changes of condition.

12. In combination, an apparatus including a line subject to change from one ungrounded condition to another grounded condition and back to the first named condition said apparatus being caused by either of said changes to change the type of signal transmitted; and means influenced by each signal change from said certain type to adjust the apparatus to transmit said certain type, thereby automatically causing said means to adjust the apparatus to transmit said certain type of signal whenever the apparatus is subjected to a change back to said first named condition.

13. In combination, an apparatus including a line subject to change from normal condition to one or more different grounded conditions of defect, said apparatus being caused by any one of said changes to change the type of signal transmitted from short impulses to a long impulse; and means influenced by each and every signal change from short to long impulses to automatically adjust the apparatus to transmit said short impulses after the apparatus is thus adjusted; thereby causing said means to automatically adjust the apparatus to transmit said short impulses after the apparatus has been subjected to a succession of said changes.

14. In combination, an apparatus subject to change from normal condition to one or more different conditions of defect and then back to the normal condition, and caused by any one of said changes to change the type of signal transmitted from short impulses to a long impulse; and means influenced by each signal change from short to long impulses to automatically adjust the apparatus to transmit said short impulses after the apparatus is thus adjusted; thereby causing said means to automatically adjust the apparatus to transmit said short impulses as soon as said apparatus has been repaired to said normal condition.

15. A signal system, for changeable conditions, comprising a line capable of conducting long impulses; means in the line for causing in-

termittent impulses therein; a pair of conducting members; means controlled by the line whereby the members are normally respectively continuously charged and uncharged during one line condition, and abnormally respectively uncharged and continuously charged during another line condition, the normally uncharged member being intermittently charged during signal sending; a motive means, uninfluenced by signal impulses and operative by longer impulses; circuit control means connected with said members and motive means and normally connecting the motive means to the normally uncharged member, and operable for connecting the motive means with said members one at a time for causing the motive means to operate when the member with which the motive means is connected is the continuously charged member; and operative connections between said motive means and the circuit control means for operating said control means to disconnect the motive means from a continuously charged member and connect it with uncharged member when the motive means is operated.

16. In a McCulloh system having a grounded main current source, an "out" relay, an "in" relay, a line loop therebetween and a recorder, each relay having an electrically charged movable switch element, and a normally engaged and disengaged contact; control mechanism including an out-signal switch; an in-signal switch; each signal switch separate from the other switch and including a bank of operation contacts respectively for normal and a plurality of abnormal conditions, and a contact arm individual to such bank and engaging said contacts; means for simultaneously advancing the arms and adapted to engage corresponding contacts one at a time; conductors permanently connected to said arms and connecting said recorder in circuit with said arms; and conductors connecting the respective operation contacts with the corresponding relay contacts which are normally disengaged during conditions corresponding to such contacts; each arm engaging one contact only at a time.

17. In a McCulloh system having a grounded main current source, an "out" relay an "in" relay, a line loop therebetween and a recorder, each relay having an electrically charged movable switch element, and a normally engaged and disengaged contact; control mechanism including an out-signal switch; an in-signal switch and a ground switch; each signal switch being separate from the other switches and including an individual bank of operation contacts respectively for normal and a plurality of abnormal broken circuit and grounded conditions, and a contact arm individual to such bank and engageable with said contacts one at a time; means for simultaneously advancing the arms to engage corresponding contacts one at a time; conductors permanently connected to said in-switch and out-switch arms and connecting said recorder in circuit with said arms; conductors connecting the in-leg of the loop to the ground, and the other ground switch contacts to said source; and conductors connecting the respective operation contacts of the other switches to corresponding relay contacts which are normally disengaged during conditions corresponding to such contacts; each of the three separate arms engaging one contact only at a time, thereby to accommodate itself to individual wear of each contact and uneven height of different individual

contacts; said arms and banks being exactly alike, thereby reducing manufacturing costs.

18. In combination, a signalling system subject to different loop conditions and having constantly charged and uncharged contacts changeable by said conditions; a receiver adapted to receive code when connected to an uncharged contact; a motor means uninfluenced by code signal current and operable by constant current; a control switch means movable by said motor to different positions to connect said receiver to an uncharged contact as required by different loop conditions, and to connect said motor means to a continuously charged contact only whenever the control means is in a position unsuited for the loop condition at the time, thereby to operate the motor to move said control switch means to move said motor means and the receiver until both are connected to uncharged contacts.

19. In combination, an intermittent-code signal system having relays each having front and back contacts adapted respectively to be uncharged or to be constantly charged pending upon external line conditions of the system; a receiver; a motor means operable by constant current and inoperable by the intermittent code signal current; and control switch means movable by said motor means successively to different operative positions to connect said receiver to uncharged contacts as required by different external conditions of the line, and to connect said motor means to a continuously charged contact only whenever the control means is in a position unsuited for the external condition at the time.

20. In a McCulloh signalling system having relays, each having front and back contacts each adapted to be uncharged or constantly charged depending upon loop conditions and a receiver adapted to receive code when connected to an uncharged contact, a motor means uninfluenced by code signal current and operable by constant current; a control switch means movable by said motor means successively to different positions to connect the motor means and receiver to the same contacts and to connect said receiver to uncharged contacts as required by different external conditions, and to connect said motor means to a continuously charged contact only whenever the control means is in a position unsuited for the loop condition at the time, thereby to operate the motor to move said control switch means to move said motor means and the receiver until both are connected to uncharged contacts.

21. In combination, a current source having one terminal grounded; a normally closed line loop extending from the ungrounded terminal of said source and having its other end connected to a ground; code signal transmitters in said loop having means for intermittently breaking and grounding the loop; relays at the ends of said loop, each having front and back contacts adapted respectively to be uncharged or constantly charged depending upon loop conditions; a receiver; a motor means operable by constant current and inoperable by code signal current; and control switch means movable by said motor means successively to different operative positions to connect said outer end to said ground or ungrounded terminal and to connect said receiver to such of said contacts as is required by different conditions of the line, and to connect said motor means to a continuously charged contact only whenever the control means is in a position unsuited for the loop condition at the time.

22. In combination, a current source having one terminal grounded; a normally closed line loop extending from the ungrounded terminal of said source and having its other end connected to a ground; code signal transmitters in said loop having means for intermittently breaking and grounding the loop; relays at the ends of said loops, each having front and back contacts adapted respectively to be uncharged or constantly charged depending upon loop conditions; a receiver adapted to receive code when connected to an uncharged contact; a control switch means movable successively to different positions to connect said outer end to said ground or ungrounded terminal and to connect said receiver to uncharged contacts as required by different loop conditions; a motor means adapted to move said control switch means and uninfluenced by code signal current and operable by constant current and connected to receive current from the receiver, whereby whenever the control means connects the receiver to a charged contact, the motor will move said control switch means to move said motor means and the receiver until they are connected to uncharged contacts.

23. In a signal system, for changeable conditions, having a recorder, and a pair of relays, each relay comprising a pair of members respectively continuously charged and uncharged during normal line condition, one or both of which pairs of members may be respectively uncharged and continuously charged during abnormal line condition, the uncharged member being intermittently charged during signal sending, the

combination of a motor means, uninfluenced by signal impulses and operative by longer impulses; circuit control means connected with said relays respectively and the motor means and operable for connecting the recorder and the motor means with one member at a time of each relay, for causing the motor means to operate when the member with which the motor means is connected becomes the continuously charged member; and operative connections between said motor means and the circuit control means for operating said control means to disconnect the motor means from a continuously charged member and connecting it with uncharged members whenever the motor means is operated; said control means comprising a pair of switches associated with said relays respectively, each switch comprising a bank of contacts, each bank including operation contacts respectively corresponding to various line conditions; a rotatable shaft associated with said banks carrying a ratchet; insulated contact arms fast on said shaft and associated with the banks respectively, and movable to successively engage said contacts; conductors connecting said recorder to the arms of the signal switches; conductors connecting the respective operation contacts of the signal switches with the corresponding relay members normally disengaged during operation corresponding to said contacts; said motor means including a vibratory pawl engaging said ratchet.

RICHARD M. HOPKINS.
HERBERT M. LAFORD.