

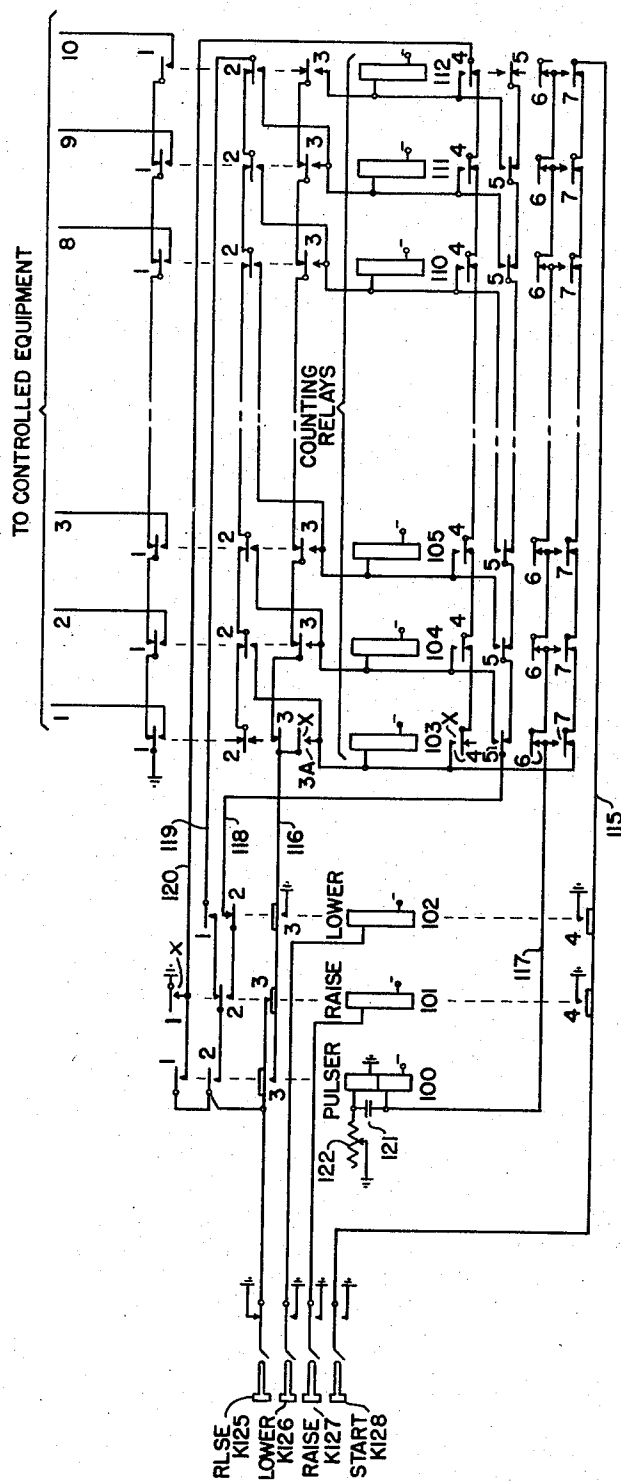
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BI-DIRECTIONAL CHAIN OF COUNTING RELAYS

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BI-DIRECTIONAL CHAIN OF COUNTING RELAYS

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This invention relates in general to a bi-directional chain of counting relays. Its principal object is to provide an economical and simple counting chain arrangement which counts forward or backwards from any position to reach any desired other position.

General description

The bi-directional chain of counting relays according to the present invention is so arranged that the counting relays may be operated from first towards last and then may be operated in the reverse direction to another position, this procedure being repeated as desired. The forward and backward operation of the chain being such that each newly operated relay restores the immediately preceding one. Such an arrangement is desirable in telephone computer systems or motor-control systems, for example.

Heretofore, bi-directional counting chains usually employed relays having two or more windings, such chains effectively comprising two separate one-direction chains. The contact arrangements for controlling such chains necessarily required numerous contact elements and became quite complex.

According to the present invention, single-wound counting chain relays are employed which are controlled by circuit arrangements requiring a minimum of contact elements so arranged to insure positive and reliable operation. This arrangement is such that the operating, locking, and releasing circuits for controlling the chain in one direction are similar to such circuits for controlling the chain in the other direction, thereby providing each operated relay with control circuits for operating the next succeeding relay or the immediately preceding one, as desired.

A feature of the counting chain here employed resides in a control circuit arrangement wherein a variable-speed pulser is controlled by two conductors to either raise or lower the counting chain positions. An additional control conductor is provided for releasing any operated chain relay to restore the chain to normal unoperated position without any time-consuming backward counting operation.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood, by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing wherein a chain of ten counting relays 103 to 112 is shown, together with the associated control relays 100 to 102 and control keys K125 to K127.

The bi-directional chain of counting relays comprising the ten chain relays 103 to 112 are arranged to count the pulse operations of pulser relay 100 in a forward direction from beginning to last in the event the raise relay 101 is operated and to count such operations in the reverse direction in the event the lower relay 102 is operated.

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As previously pointed out, each relay upon becoming operated after the operation of the first relay of the chain, restores the immediately preceding one. In this manner, the control wires extending to controlled equipment (not shown) are energized on a one-at-a-time basis.

The ten chain relays have ten respective positions, position 1 corresponding to relay 103 being in its operated position and the control wire 1 being energized, position 2 corresponding to relay 104 being operated, and so forth.

The counting chain relays are caused to count operations of pulser relay in the forward direction responsive to pulses of ground appearing on conductor 118 and are caused to count in the reverse direction by ground appearing on conductor 119. The ground normally appearing on conductor 116 extending to contacts 3 of each of the relays locks any operated counting chain relay in its last operated position until the operation of a succeeding or preceding relay. Conductor 116 is controlled by release key K125, operation of which removes ground from conductor 116 to return the chain to normal condition by immediately restoring the operated relay.

Pulser relay 100 is controlled by conductor 117, such conductor being controlled to operate and restore relay 100 according to a predetermined pulse frequency. The release time of relay 100 is controlled by the value of the coil resistance of the ground-connected winding in parallel with current-limiting resistor 122 and condenser 121, the operation of such relay being described in detail hereinafter.

Raise relay 101 is controlled by raise key K127 and contacts of such relay control the application of ground pulses to wire 118 to control the operation of the chain in the forward direction.

Lower relay 102 is controlled by lower control key K126 and contacts of relay 102 control the deliverance of ground pulses to conductor 119, such conductor controlling the operation of the chain in a reverse direction to a lower-numbered position than the currently-operated position.

In the normal illustrated position, ground appearing on one terminal of condenser 121 and the battery potential appearing on the other terminal thereof through the lower winding of pulser relay 100, maintains condenser 121 in a charged condition. Responsive to the appearance of ground on wire 117, relay 100 operates through its lower winding, such relay remaining operated as long as ground appears on wire 117. At such time condenser 121 is short-circuited, and discharged.

Responsive to the removal of relay 100 operating ground from wire 117, the short-circuit across condenser 121 is removed. At such time condenser 121 recharges from current flow through the ground-connected upper winding of relay 100 in parallel with ground-connected current-limiting resistor 122 and the battery-connected winding of relay 100, such condenser charging current delaying the release of relay 100. Responsive to condenser 121 becoming charged, current flow through the windings of relay 100 cease, permitting pulser relay 100 to restore.

Since the time required for condenser 121 to become charged is dependent on the resistance in the series circuit, control potentiometer 122 is provided in parallel with the ground-connected winding of relay 100 to vary the resistance in the charging circuit, thereby providing a wide range of release characteristics, such potentiometer being adjusted to provide the desired speed according to the application for which the counting chain is employed.

In the event the counting chain is used to control a circuit requiring a pre-warming interval or the like, a start key K128 is provided, which upon being operated, causes the first chain relay 103 to operate and energize

control wire 1, relay 103 locking operated to ground on wire 116. At any desired time interval thereafter, operation of raise key K127 causes pulser 101 to operate and restore to cause the counting chain to advance.

The counting chain may be advanced beyond its desired position, as the counting chain relays continually operate in succession towards the chain end as long as the raise key is operated. In the event it is desired to cause the counting chain to count in the reverse direction thereafter, lower key K126 is operated causing the next preceding lower-numbered relay to operate and restore the immediately preceding one to return the chain to any desired lower-numbered position.

In the event a fast release of the operated chain is desired, release key K125 is provided, which when operated, removes locking ground from any operated counting chain relay, permitting such relay to restore immediately without the normal backward counting operation.

Assuming it is desirable to energize control wire 1 for a predetermined interval of time and to thereafter energize control wire 9 by successively energizing the intermediate control wires 2 to 8, start key K128 is depressed. Ground from make contacts thereon appears on wire 115 and is extended through break contacts 7 of each of the counting relays to the battery-connected winding of relay 103.

Relay 103 operates and at its make contacts 7 extend such operating ground to wire 117 extending to the battery-connected winding of pulser relay 100. Make contacts 1 of relay 103 ground control wire 1 thereby placing the controlled equipment in a standby position. Relay 103 locks operated through the make-first contacts 3A to the ground on wire 116 from the release key K125 and break contacts 3 of raise relay 101; its make contacts 4 prepare an additional locking circuit to wire 120 and its make contacts 5 prepare an operate circuit for the next preceding relay 104.

Pulser relay 100 operates and short-circuits condenser 121 as noted. Its make contacts 1 ground wire 120 and its make contacts 3 close another path to maintain wire 116 grounded, but no further chain relays are operated.

Responsive to the release of start key K128 ground is removed from wire 115 and a short time thereafter pulser relay 100 restores, relay 103 being maintained operated.

After any desired delay interval, raise key K127 is operated, thereby extending operating ground to the battery-connected winding of raise relay 101.

Raise relay 101 operates and at its make-first contacts 1 grounds wire 120; its make contacts 2 prepare a circuit for grounding wire 118; its break contacts 3 remove the ground from wire 116, and its make contacts 4 ground wire 115.

Responsive to ground appearing on wire 115, ground potential is extended through make contacts 7 of all unoperated chain relays and through make contacts 7 of operated relay 103 to wire 117, operating pulser relay 100. At such time, the ground from release key K125 is extended through make contacts 2 of pulser relay 100 and make contacts 2 of raise relay 101 to wire 118 extending to the battery-connected winding of relay 104 through make contacts 5 of relay 103, operating relay 104. Relay 103 is at this time locked operated through its make contacts 3A only as break contacts 4 of relay 104 opened the other locking circuit.

At such time both relays 103 and 104 are operated, and contacts 6 on relay 103 and make contacts 7 of relay 104 open the operate circuit of pulser relay 100 by removing ground from wire 117.

Pulse relay 100 restores after its slow-release time interval, and responsive to the restoration thereof, ground is removed from wire 116, thereby permitting relay 103 to restore.

Responsive to the restoration of relay 103 and the operation of relay 104, relay 104 at such time being locked operated to the ground on wire 120, an operate

circuit is again closed for pulser relay 100 at contacts 6 of relay 103 and make contacts 7 of relay 104.

Pulser relay 100 operates and grounds wire 118 as previously noted to extend ground potential through break contacts 5 of chain relay 103 and make contacts 5 of chain relay 104 to energize the winding of the third counting chain relay, relay 105.

Relay 105 operates and locks through its make contacts 4. Its contacts 7 and contacts 6 of relay 104 restore relay 100. Locking ground is thereby removed from relay 104, which restores a short time later, leaving relay 105 the only relay operated.

The continued operation of the counting chain relays in the forward direction to the desired position 9 is similar to that above described, control wires 1 to 9 becoming successively energized.

Assuming that ground was removed from wire 115 one chain relay operation too late, by the late release of the raise key, relay 112 operated and restored relay 111, one position beyond the desired position. In such event, lower key K126 is operated, operating lower relay 102, which at its contacts 4 ground wire 115 to operate the pulser as hereinbefore noted and at its make contacts 1 and 2 transfer the operating ground for the chain from wire 118 to wire 119.

Responsive to the appearance of ground on wire 119, an energizing circuit for relay 111 is closed through make contacts 2 of operated chain relay 112.

Relay 111 operates and locks through its make contacts 3 to the ground on wire 116 and at its contacts 6 open-circuits the operate path of pulser relay 100.

Pulser relay 100 restores and at its make contacts 1 removes ground from wire 120, such ground maintaining relay 112 operated. Relay 112 restores, and in the event the lower key K126 is released and no more ground pulses appear on wire 115, the counting chain is left in position 9, control wire 9 being energized.

In the above described manner, the counting chain can be advanced to any desired position, and in the event the desired position is exceeded, the chain may be controlled in the reverse direction to reach such position.

Responsive to a continued operation of lower key K126, ground is maintained on wire 115 causing pulser relay 100 to continually operate and release, thereby delivering pulses of ground to wire 119 to operate the chain relay in the reverse direction to any desired lower-numbered position. At the time relay 103 is operated from the reverse direction, the continued operation of lower key K126 is ineffective.

In the event the counting chain is positioned on position 9 and is desired to deenergize such wire and immediately return the counting chain to normal position with no relays operated, release key K125 is operated. Break contacts thereon remove ground from wire 116, such ground being the locking ground for each operated relay.

When the counting chain is forcibly released by such operation of release key K125, the hereinbefore described operation may be repeated.

The chain may be advanced to any desired position and then thereafter operated to a still higher position or to a lower position as desired, thereby providing any successive energizations of conductors 1 to 10. Further, the ground at contacts 1 of relay 103 may be controlled by a separate key or contacts on the control relays so that a control wire would become energized only after each counting operation has ceased.

Start key K128, as noted, functions only to operate the first relay of the chain by delivering one stepping pulse to pulser 100. It is to be observed that such key could be eliminated if desired, as the contacts 4 of the raise and lower relays 101 and 102 duplicate the operational procedure of the start key. Likewise, release key K125 is not necessary in the event no serious consequences arise from restoring the relays in succession to start position 1.

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While I have described the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

I claim:

1. In combination, a series of bi-directional counting relays each having a winding and being of the normally restored type which requires energization of its winding to operate the relay and requires continued energization of the winding to maintain the relay operated, external circuit conductors, each of the relays having contact sets of which the first set is connected to the external conductors to exercise a control thereover, counting-control conductors extending to the relays comprising a forward-pulse, a forward-lock, a rearward-pulse, and a rearward-lock conductor, (a) a forward-pulse chain extending forwardly through the second contact set of all relays preceding the last for connecting the forward-pulse conductor to the winding of any relay succeeding the first subject to the immediately preceding relay being operated and further subject to all other preceding relays being restored, (b) a forward-lock chain extending rearwardly through the third contact set of all relays for connecting the forward-lock conductor to the winding of any relay subject to that relay being operated and further subject to all succeeding relays being restored, (c) a rearward-pulse chain extending rearwardly through the fourth contact set of all relays succeeding the first for connecting the rearward-pulse conductor to the winding of any relay preceding the last subject to the immediately preceding relay being operated and further subject to all other succeeding relays being restored, (d) a rearward-lock chain extending forwardly through the fifth contact set of all relays for connecting the rearward-lock conductor to the winding of any relay subject to that relay being operated and further subject to all preceding relays being restored; a forward and a rearward control means and means for operating and restoring them selectively; means responsive to the operation of the forward control means with the rearward control means restored, (1) for extending energizing potential to the winding of the first relay subject to all

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other relays being restored, (2) for depriving the rearward-pulse conductor of energizing potential, (3) for supplying energizing potential continuously to the forward-lock conductor, and (4) for supplying successive pulses of energizing potential to the forward-pulse conductor and contemporaneously to the rearward-lock conductor; and means responsive to the operation of the rearward control means with the forward control means restored, (1) for supplying energizing potential continuously to the rearward-lock conductor, (2) for depriving the forward-pulse conductor of energizing potential, and (3) for supplying successive pulses of energizing potential to the rearward-pulse conductor and contemporaneously to the forward-lock conductor, whereby the relays may be pulsed selectively in a forward wave-like progression of the relays succeeding the first and in a rearward wave-like progression of the relays preceding the last, wherein the pulse operation of any relay of the progression currently in use depends upon the immediately preceding relay being already operated, and wherein the last said relay is held operated until the instant operating pulse is terminated.

2. In a combination according to claim 1, means responsive to a restoration of the said forward control means with the rearward-control means restored for de-energizing the said forward-lock conductor and for contemporaneously energizing the said rearward-lock conductor to maintain the last operated one of the relays.

3. A combination according to claim 1, wherein the said rearward-lock conductor is maintained energized with both of the said control means restored, to maintain the last operated one of the said relays.

4. In a combination according to claim 3, release means operable at will, and means responsive to an operation of the release means with the said rearward control means restored for deenergizing the said rearward lock conductor to restore the last operated one of the said relays.

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