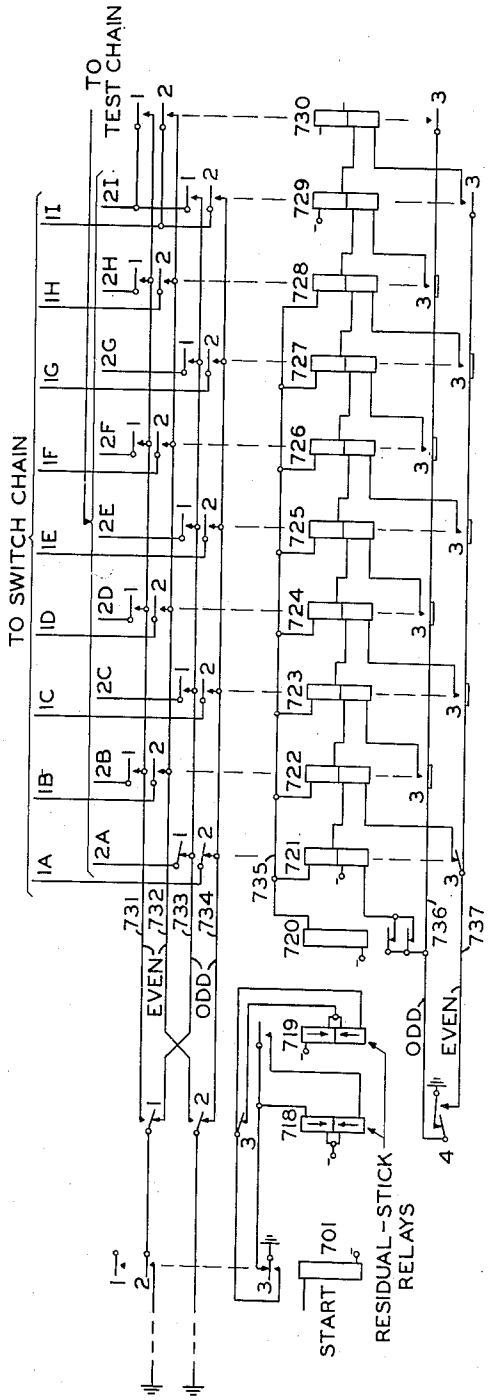
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ENDLESS CHAIN OF COUNTING RELAYS

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ENDLESS CHAIN OF COUNTING RELAYS

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5 Claims. (Cl. 175—320)

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This invention relates to an endless chain of counting relays. Its principal object is to provide a new and improved circuit arrangement for such a chain of relays, employing a minimum of contacts and insuring positive and reliable operation.

This application is a division of my prior application for Selector Switching Systems, Serial No. 649,595, filed February 23, 1946, now Patent No. 2,559,702.

GENERAL DESCRIPTION

In the parent application each of a number of group controllers employs the endless counting chain of this application as a choice allotter. Any such allotter is arranged to equalize the offered traffic among equivalent subgroups of connection paths by shifting from one choice combination to the next succeeding one after each use of the group controller.

An endless counting chain according to the present invention is so arranged that the counting relays operate from first to last in a progressive wave-like motion wherein the relay immediately preceding any newly operated one is held operated and the one immediately preceding it is released. Upon operation of the last counting relay, the first one is rendered reoperable for the next cycle.

One feature concerns a pair of even and odd driver relays, common to the counting relays of the chain, which are held operated by residual magnetism and restored by reversed magnetic force to simplify their arrangement of control contacts.

A feature of the counting chain herein disclosed resides in the arrangement whereby any relay preceding the last is held operated when the next succeeding relay is operated, thereby maintaining the operating circuit of such succeeding relay instact. A special feature of the invention is that any such relay is held operated within the operating circuit of the next succeeding relay to promote general contact-pair economy.

Another feature of the disclosed counting chain resides in the provision of a recycling or cutoff relay for the first counting relay to render unnecessary the usual back-contact chain through contacts of the remaining counting relays. Related special features of the invention include (1) controlling the cutoff relay through contacts of concerned counting relays, and (2) avoiding use of additional contacts for this purpose by including the winding of the cutoff relay within the operating circuit of concerned ones of the counting relays.

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Other objects and features of the invention will become apparent as the description progresses.

The drawings

The accompanying drawing comprises a schematic circuit diagram of a preferred embodiment of the improved endless chain of counting relays.

The counting relays **721** to **730** include double-wound coils, employing one of the windings as a locking circuit rather than having additional locking contacts.

The cutoff relay **720** is in the battery-supply circuit of all counting relays preceding the last, rather than being controlled by its own separate circuit contacts.

The driver relays **718** and **719** are residual-stick relays which provide the desired sequential operation with a minimum of contacts.

Detailed description

The invention having been described generally, a detailed description will now be given.

Endless chain of counting relays

The endless counting chain comprising the thirteen relays **718** to **730** includes counting relays **721** to **730** arranged to count the operations of start relay **701** in cycle groups of ten. As used in the parent application, its purpose as previously noted, is to shift first choice among secondary subgroups, being the ones to which wires 1A to 2I extend.

The counting relays **721** to **730** are controlled by driver relays **718** and **719**. Cutoff relay **720** is employed to disconnect relay **721** after it operates and to hold it disconnected until a new cycle of counting operations is about to begin.

The counting chain is illustrated in the first of its ten positions, position A. In that position the first counting relay **721** stands operated and all other counting relays are restored.

Control relays

Each of the driver relays **718** and **719** is a residual-stick relay which, upon being open-circuited after operation by current flow through its operating winding, retains sufficient residual magnetism to hold it operated against its spring load until the residual magnetism is neutralized. Each such relay may have tandem-wound coils, differentially connected as shown. The uppermost winding is assumed to be adjacent to the armature (not shown).

As described in my noted parent application,

start relay 701 operates responsive to the associated group controller being seized to control the extension of a connection, and releases responsive to the termination of such seizure.

With the relays in their respective illustrated positions (all restored except relays 718 and 721), an operating circuit exists for the upper winding of relay 718 through back contact 3 of start relay 701. The lower winding of relay 718 is not energized at this time because relay 719 is in restored condition.

When the operation of start relay 701 occurs, armature 3 thereof open-circuits the upper winding of relay 718 and closes a circuit for relay 719. Because of its residual holding construction (as by being supplied with a hard-steel armature instead of one of soft iron), relay 718 remains in operated condition after the circuit of its upper winding is opened. Accordingly, the lower winding of relay 719 remains short-circuited at contacts 3 of relay 718, resulting in the energization of the upper winding of relay 719, alone. The upper winding being energized alone, relay 719 operates and connects the lower winding of relay 718 in parallel with the upper winding thereof, in preparation for its restoration.

When start relay 701 next restores, it open-circuits relay 719 and again closes a circuit for relay 718. Residual relay 719 remains operated, however, for reasons given in connection with relay 718. With relay 719 operated, both windings of relay 718 are energized at the same time. The two windings of this relay are differentially connected, as indicated. Moreover, the lower winding of relay 718 is slightly more powerful than the upper winding thereof, resulting in a mild reversed magnetomotive force. This reversed magnetomotive force is sufficient to overcome the residual magnetization of the relay, whereby relay 718 now restores, but the reversed magnetization is insufficient to cause reoperation of relay 718.

Upon the next ensuing operation of start relay 701, relay 718 is open-circuited and remains in restored condition.

With relay 718 in restored condition, and with start relay 701 in operated condition, the two windings of relay 719 are energized in series with each other. Under this condition, the upper winding somewhat more than over-balances the lower winding, causing a mild reversed magnetization sufficient to restore the relay, but insufficient to reoperate it. Relay 719 accordingly now restores. Relays 718 and 719 are thus both now in restored condition.

When start relay 701 again restores, the upper winding of relay 718 is again energized alone, causing reoperation of relay 718.

As succeeding operations and restorations of start relay 701 occur, driver relays 718 and 719 operate successively and restore successively in successive cycles of two start relay operations each. Relay 718 accordingly assumes its illustrated operated position in the interval preceding each odd-numbered operation of the start relay, and assumes its restored condition in the interval preceding each even-numbered operation of the start relay.

Counting-relay operation

Driver relay 718, through the medium of conductors 736 and 737, causes relays 721 to 730 to operate successively in recurring cycles as will now be explained.

Choice position A

With relay 720 in its restored condition, as it is at the beginning of each cycle of operations of counting relays 721 to 730, and with relay 718 in its illustrated operated condition, the lower winding of relay 721 is energized over odd conductor 736, and through contacts of the unoperated relay 720. Relay 721 thereupon assumes its illustrated operated condition. At its contacts 1 and 2, it allots first choice to the hereinbefore noted associated secondary subgroup A by connecting conductors 733 and 734 respectively to wires 2A and 1A, odd conductors 733 and 734 being currently connected to the common test and switch conductors through the front contacts of armatures 1 and 2 respectively of relays 718, while even conductors 731 and 732 stand open at the back contacts of these armatures.

At its armature 3, relay 721 prepares an operating circuit for relay 722 and a holding circuit for itself, subject to the restoration of relay 718.

Choice position B

When relay 718 next restores, it disconnects ground from odd conductor 736 and applies ground to even conductors 737. At the same time it disconnects odd conductors 733 and 734, and substitutes even conductors 731 and 732.

Armature 4 of relay 718 and its associated contacts comprise a make-before-break arrangement whereby there is a slight overlap interval during which conductors 736 and 737 are both grounded when relay 718 restores or operates. Accordingly, while the ungrounding of conductors 736 open-circuits the lower winding of relay 721, the grounding of conductor 737 previously closes a holding circuit for the upper winding thereof, which circuit includes contacts 3 of the operated relay 721, the lower (or operating) winding of relay 722, and the winding of relay 720. Relay 721 is held operated over this circuit to maintain the circuit of relay 722 intact. Relay 720 operates over this circuit, and as will subsequently appear, remains operated thereafter until near the end of the cycle of operations of relay 721 to 730. Relay 720 disconnects the operate winding of relay 721 from odd conductor 736 so as to prevent further energization thereof until a new allotting cycle begins.

Relay 722 now operates, through its lower winding, and relay 721 remains temporarily operated. With relay 718 restored to substitute even conductors 731 and 732 for odd conductors 733 and 734, relay 722 allots first choice to the secondary subgroup B associated with wires 1B and 2B, which condition remains unchanged until start relay 701 is released and is again operated. At its contacts 3, relay 722 prepares a holding circuit for itself and relay 720, and an operating circuit for the next succeeding relay 723.

Choice position C

When relay 718 next reoperates, relay 723 operates as explained for relay 722 to allot first choice (over conductors 733 and 734) to the secondary subgroup associated with wires 2C and 1C. Relays 722 and 720 remain operated over the new operating circuit, which includes odd conductor 736.

Relay 721 now restores, responsive to the removal of ground potential from conductor 737, opening its associated connections (wires 1A and

2A) to the odd allotting conductors 733 and 734.

Succeeding choice positions

As start relay 701 operates and releases, a new one of the relays 721 to 730 operates responsive to each release of relay 701; the immediately preceding relay remains operated; and the relay preceding that restores, whereby first choice is allotted successively to the succeeding subgroups.

Choice position I

The allotting operation continues in the manner indicated up to the operation of the ninth allotter relay 729 to allot first choice to the secondary subgroup associated with wires 1I and 2I, at which time the eighth allotter relay 728 remains operated, and the seventh allotter relay 727 restores. Relay 720 is at this time maintained operated in the operating circuit of the lower winding of relay 729, and in series with the upper winding of the preceding relay 728.

Final choice position

When relay 718 next restores responsive to the release of start relay 701, the resultant grounding of even conductor 736 operates relay 730, and holds relay 729, through contacts 3 of the latter relay. At the same time, relay 728 is open-circuited and restored. Relay 720 restores at this point since operating current for relay 730, and holding current for relay 729, is supplied directly to relay 729 rather than over conductor 735 and through the winding of relay 720. Circuit connections are thus prepared for the reoperation of relay 721 to begin a new cycle. It will be observed that relay 730 has its armatures 1 and 2 connected respectively with armatures 1 and 2 of relay 729, whereby the first-choice allotment of the subgroup A associated with the last wires 1I and 2I remains during the tenth operation of the group controller. This arrangement is employed because there are an odd number of secondary subgroups. When there is an even number, such as ten, the final relay, such as 730, initially allots first choice to the final secondary subgroup rather than reallotting first choice thereto.

With relay 730 operated and relays 718 and 720 restored, the next reoperation of relay 718 begins a new cycle. At this time relay 730 restores and relay 721 reoperates through contacts of the restored relay 720 to begin a new cycle of choice-allotting operations.

I claim:

1. In combination, a pair of electromagnetic relays, each having an operating winding and a restoring winding, means for energizing the operating windings alternately, each relay being operable responsive to an energization of its operating winding and being arranged to remain operated by residual magnetism after its operating winding is deenergized, the second relay having contacts operable therewith for placing the restoring winding of the first relay in parallel with the operating winding thereof, the first relay having contacts operable with a restoration thereof for placing the restoring winding of the second relay effectively in series with the operating winding thereof, each restoring winding opposing its associated operating winding and being of a power sufficient to cause restoration of the concerned relay when both windings are energized together, but insufficient to cause reoperation thereof.

2. In combination, a pair of electromagnetic relays, each having an operating winding and a restoring winding, means for energizing the operating windings alternately to operate the relays alternately, each relay being arranged to remain operated by residual magnetism after its operating winding is deenergized, each relay having contacts for placing the restoring winding of the other relay in circuit with the operating winding thereof, each restoring winding opposing its associated operating winding and being of a power sufficient to cause restoration of the concerned relay when both windings are energized together, but insufficient to cause reoperation thereof.

3. In a cyclic control circuit, first and second relays each including an electromagnet and contacts controlled thereby, each relay requiring an effective flow of operating current through its electromagnet to operate its contacts and requiring an effective flow of restoring current through its electromagnet to restore them, first and second control wires and means for energizing them alternately in succession, means responsive to any said energization of the first control wire subject to the contacts of the second relay being in a restored condition for applying an effective operating current to the first relay, means responsive to any said energization of the second control wire subject to the contacts of the first relay being in an operated condition for applying an effective operating current to the second relay, means responsive to any said energization of the first control wire subject to the contacts of the second relay being operated for applying an effective restoring current to the first relay, and means responsive to any said energization of the second control wire subject to the contacts of the first relay being in a restored condition for applying an effective restoring current to the second relay.

4. In combination, a repeatedly operable device, a series of relays each including an electromagnet and contacts operable responsive to an energization thereof and requiring holding current through the electromagnet to maintain them operated, said series including a normally connected first relay and normally disconnected succeeding relays, means for supplying operating current to the relays successively in cycles during any one of which a separate relay of the series receives operating current responsive to each operation of the device, said means including contacts operable with each said relay preceding the last for preparing an operating circuit for the next succeeding one, means effective during each cycle for restoring the relays successively beginning with the operation of the third one, and ending with the reoperation of the first relay at the start of the next succeeding cycle, at which time the final two relays are restored, the last named means including means external to the series of relays for disconnecting the first relay coincidental with the operation of the second relay and for maintaining it disconnected until a new cycle is about to start, and including means for holding any relay except the last operated in the operating circuit of the next succeeding one.

5. In combination, a repeatedly operable device, a series of relays each including an electromagnet and contacts controlled thereby, each relay including a normally connected first relay and normally disconnected succeeding relays, each relay having an operate winding and each relay preceding the last having a hold winding,

means for energizing the operate windings for operating the relays successively in cycles during any one of which a separate relay operates responsive to each operation of the device, said means including contacts operable with each said relay preceding the last for connecting the next succeeding one, means effective coincidental with the operation of each relay succeeding the first for deenergizing the operate winding of the immediately preceding relay, any said hold winding being included in circuit with the operate winding of the next succeeding relay whereby the concerned relay is held operated until the second succeeding relay is operated whereupon it restores.

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