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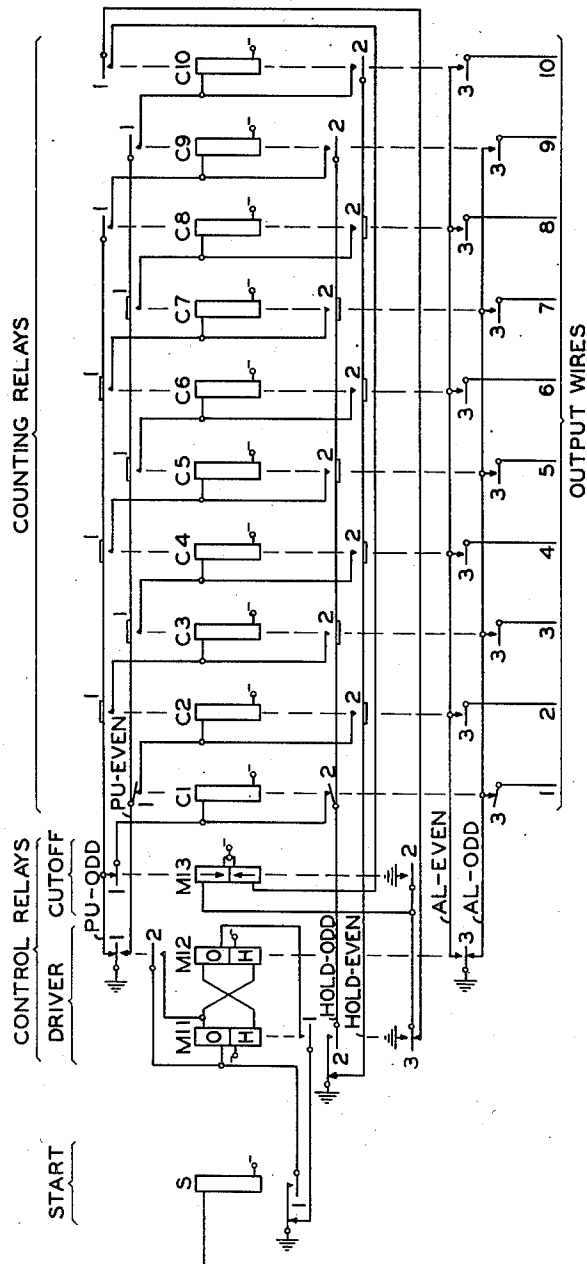
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ENDLESS CHAIN OF COUNTING RELAYS

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2 SHEETS—SHEET 1

FIG. 1



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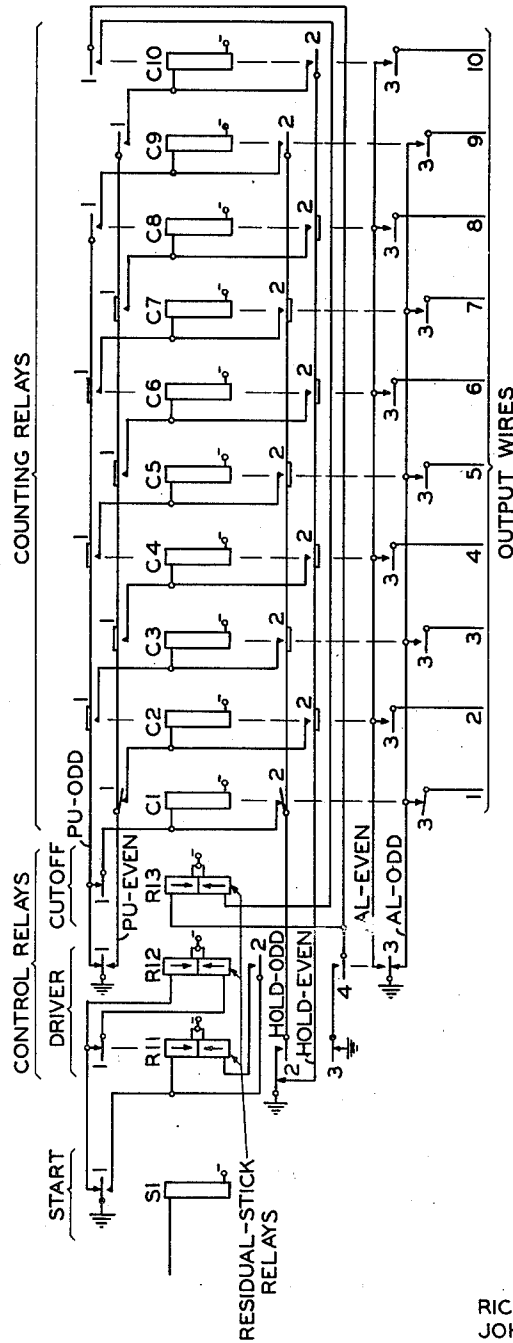
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2 SHEETS—SHEET 2

FIG. 2



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ENDLESS CHAIN OF COUNTING RELAYS

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8 Claims. (Cl. 177-353)

1

This invention relates to an endless chain of counting relays, and the principal object is to provide a new and improved circuit arrangement for such a chain of relays, employing a minimum of relays and relay windings consistent with reliable operation.

GENERAL DESCRIPTION

This invention is a direct improvement on the counting chain employed as an allotter in the pending application of Bellamy for Selector Switching Systems, Serial No. 649,595 filed February 23, 1946, now Patent No. 2,559,702, issued July 10, 1951.

The endless counting chain is so arranged that the counting relays operate in a progressive wave-like motion wherein the last preceding counting relay is held operated along with a newly operated one, and the second preceding counting relay is released. The counting relays upon operation, assume respective allotting positions successively in a cycle.

A feature of the invention resides in an arrangement whereby the re-cycling or cutoff, relay is controlled by a circuit independent of the windings of the counting relays.

Another feature resides in the arrangement whereby the counting relay windings are permitted to be single-wound coils instead of double-wound coils previously required for counting circuits of this character. This feature includes "even" and "odd" locking circuits for holding the counting relays as required.

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

The drawings

Referring to the accompanying drawings, Figs. 1 and 2 are schematic circuit diagrams of a preferred embodiment and a desirable modification, respectively.

In each embodiment, the counting relays C1 to C10 are each single-wound relays, employing even and odd locking circuits rather than a second winding.

In each embodiment the cutoff relay (M13 or R13) is controlled through its own separate circuit, rather than being in the battery-supply circuit of certain of the counting relays as heretofore, thereby lowering the power requirements of the concerned counting-relay circuits and rendering all of them uniform.

In each embodiment, a differential winding is employed to restore the cutoff relay. In the first embodiment, a self-locking circuit is employed

2

to hold the cutoff relay operated after its operating circuit is opened, while the second embodiment employs a residual-stick cutoff relay to render the noted self-locking circuit unnecessary.

In the first embodiment (Fig. 1), a new driver-relay circuit (relays M11 and M12) is disclosed which avoids the necessity for residual-stick relays without increasing the required number of windings or of contacts.

DETAILED DESCRIPTION

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

Hereinafter, for convenience, the disclosed counting chains will be described as allotters (as in the cited pending application), but it will be understood that the counting chains are suitable for any one of a number of other well-known uses.

Preferred embodiment (Fig. 1)

The endless counting chain of Fig. 1, comprising the thirteen relays C1 to C10 and M11 to M13, is a specialized counting chain suitable, for example, to designate first choice where groups of circuits may be simultaneously available for seizure.

The counting chain relays C1 to C10 are controlled by driver relays M11 and M12. Relay M12 controls the operate paths of the counting chain relays over odd and even operate or pickup wires, PU-Odd and PU-Even, while relay M11 controls their release over odd and even hold wires, Hold-Odd and Hold-Even. Cutoff relay M13 is employed to disconnect relay C1 after it operates, and to hold it disconnected until a new cycle of operations is about to begin, thereby avoiding the necessity of a back-contact chain on the counting relays as explained in the previously noted prior application.

The counting chain is illustrated in the first of its ten positions, position 1. In that position, the first counting relay C1 stands operated through closed contacts on relays M12 and M13, and all other relays are restored.

Driver circuit

The driver circuit comprises relays M11 and M12. Driver relays M11 and M12 consist of a pair of tandem-wound relays, with the operate winding O of either in series with the holding winding H, of the other. The number of turns of the windings O and H are so related that while

either winding H will hold the relay operated it will not operate the relay when the winding O of the other relay is in series therewith.

Driver relays M11 and M12 are controlled primarily by start relay S which is operated at the initiation of each operation requiring the allotting action and is restored when such operation is completed. This arrangement provides for the advance of the endless counting chain (from one position to the next) incidental to the completion of the noted operation between successive allotting uses of the chain.

With start relay S restored, and with both driver relays M11 and M12 in their illustrated restored condition, operate winding O of relay M11 and hold winding H of relay M12 stand open at contact 1 of relay S, and the alternative windings of relays M11 and M12 stand open at contact 1 of relay M11. Driver relays M12 and M11 are now in position 1, both restored.

The initiation of allotting action causes start relay S to operate, which at its make contact 1 energizes operate winding O of relay M11 in series with hold winding H of relay M12. Relay M11 now operates, but relay M12 does not now operate because of the small number of turns of its hold winding. Driver relays M11 and M12 are now in position 1.5, relay M11 being operated alone.

On completion of the noted allotting action, start relay S is released. Break contact 1 of relay S extends ground through contact 1 of relay M11 to winding O of relay M12 which operates in series with winding H of relay M11. The operate ground of relay M11 is removed at make contact 1 of relay S but relay M11 remains operated by the noted energization of its hold winding H in series with winding O of relay M12. Driver relays M11 and M12 are now in position 2, both relays operated.

When start relay S operates the next time, its contact 1 extends ground to one side of the operate coil of relay M11 and through contact 2 of relay M12 to the other side of its operate winding, which is also the hold winding of relay M12. Contact 1 of relay S removes the ground from the operate winding of relay M12 which deenergizes the hold winding of relay M11. Ground on both sides of the operate winding of relay M11 and its hold winding deenergized, relay M11 releases. The ground shunting the operate winding of relay M11, maintains the hold winding of relay M12 energized and prevents the release of relay M12. Driver relays M11 and M12 are now in position 2.5, relay M12 being operated alone.

When start relay S restores, incidental to the completion of the allotting action, contact 1 of relay S removes ground from the hold winding of relay M12. The operate winding of relay M12 is open at contact 1 of relay M11 and relay M12 releases. Relays M11 and M12 are now again in position 1 (both relays restored), at the beginning point of a new cycle of driver action.

In summary, considering driver relays M11 and M12 in position 1 (both restored), (1) relay M11 first operates to bring them into position 1.5; (2) relay M12 later operates to bring them into position 2 (both operated); (3) relay M11 releases to bring them into position 2.5 (relay M12 operated alone); and (4) relay M12 releases to bring them back into position 1 (both restored).

The function of cutoff relay M13 is to disconnect counting relay C1 from the operating circuit after it has operated at the start of a counting cycle of operations of counting relays C1 to

C10, and to maintain it disconnected until a new cycle of counting operations is about to start.

Starting with the relays in the respective positions shown in Fig. 1, when driver relays M11 and M12 next assume position 1.5, wherein relay M11 is operated alone, cutoff relay M13 operates from ground at make contact 3 of relay M11. Cutoff relay M13 locks through its own contact 2, and at contact 1 disconnects the operate winding of counting relay C1. Prior to this, however, relay C1 has been locked operated as later described. Cutoff relay M13 remains locked operated until its opposing lower winding is energized. Following the operation (hereinafter described) both driver relays M11 and M12 operated, driver relay M11 restores and connects the lower winding of the locked cutoff relay M13 in parallel with the energized upper winding through contact 1 of counting relay C10. The consequent energization of the lower winding of relay M13 overpowers the upper winding, causing the relay to release as the net flux passes through zero. Contact 2 of the relay opens both windings, leaving the relay restored. Contact 1 of cutoff relay M13 reconnects the winding of counting relay C1 in preparation for another cycle of counting chain operations.

Counting relay action

The counting or allotting relays of Fig. 1 comprise relays C1 to C10. All allotting relays have coils with one winding and operate directly from battery and ground.

With the endless counting chain of Fig. 1 in its illustrated first position, all relays thereof are restored except the first relay C1. Relay C1 is operated from ground through closed contact 1 of relay M12, conductor PU-Odd, closed contact 1 of relay M13 and through the winding of relay C1 to battery.

With driver relay M12 unoperated, the allotting ground extends through its back contact 3 to odd-allotting wire AL-Odd connected to contacts 3 of all odd-numbered allotter relays. With the allotter in its illustrated first position, output wire 1 is thus grounded through contact 3 of relay C1.

When the driver relays M11 and M12 advance to position 1.5 by operation of relay M11 alone, ground from contact 3 is placed on the upper winding of cutoff relay M13 causing it to operate. Relay M11 locks to ground through its contact 2. Contact 2 of relay M11 places a holding ground on the coil of relay C1 before contact 1 of relay M13 opens the operate path of relay C1. When the driver relays advance to position 2 by the operation of relay M12, ground is placed on the coil of relay 2 operating it. Contact 3 of relay M12 transfers the allotting ground from conductor AL-Odd to conductor AL-Even. Output wire 1 is ineffective and output wire 2 is now grounded from contact 3 of relay C2 and conductor AL-Even. The allotter is now in position 2 (relays C1 and C2 operated).

The next ensuing allotting operation releases relay M11 which at its contact 2 releases relay C1 and locks relay C2 operated. The driver relays are now in position 2.5.

When relay M12 releases, its contact 1 extends ground through contact 1 of relay C2 to the coil of relay C3 and at its contacts 3, transfers ground to the odd allotting conductor AL-Odd. Ground is removed from output wire 2 and placed on output wire 3. The allotter is now in position 3 (relay C2 and C3 operated).

5

From this point, the allotter action proceeds in the progressive wave-like motion previously described. Accordingly, except for a momentary half-step (transition) interval, only two allotting relays (C1 to C10) are in operated condition at any one time, but only the last-operated one closes effective allotting circuits because of the action of driver relay M12 in shifting the allotting ground back and forth between the odd and even allotting branches.

When the counting chain reaches its ninth position, the ninth allotting relay C9 stands operated from ground at contact 1 of relay M12, contact 1 of the operated eighth allotting relay C8, and the winding of relay C9 to battery. When driver relays M11 and M12 are operated, the tenth (and final) allotting relay C10 is operated from ground at contact 1 of relay M12, contact 1 of relay C9 and the winding of relay C10 to battery. The allotting ground is transferred from output wire 9 to output wire 10, and the counting chain is now in position 10 (relays C9 and C10 operated).

When relay M11 restores, relay C9 releases at contact 2 of relay M11. Ground from contact 2 of relay M13 is placed through break contact 3 of relay M11 and contact 1 of relay C10 to battery through the lower winding of relay M13. With the upper winding of relay M13 energized by ground at its contact 2 and the lower winding energized through contact 1 of relay C10, the flow of flux from each winding is in opposition, causing the relay to release.

Relay M12 releases and at its contact 1 places ground on the coil of relay C1 through contact 1 of relay M13. Contact 3 transfers the allotting ground from output wire 10 to output wire 1. At this time the driver relays are in position 1 (relays M11 and M12 operated) and the counting chain is in its effective allotting position 1 (output wire 1 grounded). The next allotting action will start a new cycle of operation.

From the foregoing it is clear that the allotting ground is applied successively to the ten output wires, thereby shifting first choice from the first output wire to the tenth.

Second embodiment (Fig. 2)

The second embodiment of the invention, shown in Fig. 2, provides an arrangement wherein the driver relays R11 and R12, and cutoff relay R13, while performing the same respective functions as relays M11 to M13, Fig. 1, are residual-stick relays rather than relays requiring holding current. The counting relays C1 to C10 and their circuits are the same in Fig. 2 as in Fig. 1.

Any residual-stick relay R11 to R13, upon being open-circuited after operation by current flow through its operate winding, retains sufficient residual magnetism to hold the relay operated against its spring load until the residual magnetism is neutralized. Each such relay may have a tandem-wound coil with the windings differentially connected, as shown. The uppermost winding is assumed to be adjacent to the armature (not shown).

Start relay S1 of Fig. 2 is similar to start relay S of Fig. 1, except that its contacts are not required to be of the make-before break type shown for relay S.

With relays S1, R11 and R12 restored, as shown, both windings of relay R11 stand open, but both windings of relay R12 stand closed. With its two windings energized in opposition, as indicated, relay R12 remains unoperated.

6

Control relays R11 and R12 are now in position 1, both restored.

When relay S next operates, it disconnects ground from both windings of relay R12 (leaving it unoperated) and transfers ground to the circuit of relay R11. With relay R12 unoperated, only the upper winding of relay R11 is energized, the lower winding thereof being disconnected. Relay R11 is now operated by its upper winding, energized alone. Upon operating, it disconnects the lower winding of relay R12 from in parallel with the upper winding thereof preparatory to the subsequent operation of relay R12. Relays R11 and R12 are now in position 1.5, relay R11 being operated alone.

When relay S1 next restores, it transfers ground back from the circuit of relay R11 to the circuit of relay R12. Relay R11 remains operated by residual magnetism, and relay R12 is operated by its upper winding, energized alone. The control relays R11 and R12 are now in position 2, both relays operated.

When start relay S1 next reoperates to transfer ground from the circuit of relay R12 to the circuit of relay R11, relay R12 remains operated by residual magnetism, but relay R11 restores since its lower winding overpowers the upper winding to reverse the flow of flux. The release occurs when the flux approaches zero value during reversal. Having released, the relay does not reoperate so long as the two differentially connected windings are both energized. Relays R11 and R12 are now in position 2.5, relay R12 being operated alone.

When relay S next restores, the lower winding of relay R12 is energized in parallel with the upper winding thereof causing relay R12 to restore and remain restored for reasons given in connection with relay R11. Relays R11 and R12 are now again in position 1 (being both restored), at the beginning point of a new cycle.

It will be observed that driver relays R11 and R12 are related to control wires PU-Odd, PU-Even; Hold-Odd, Hold-Even; and AL-Odd, AL-Even in the same way as are the previously described driver relays M11 and M12 of Fig. 1. Therefore, subject to suitable control of cutoff relay R13, the relays C1 to C10 in Fig. 2 respond precisely as described for Fig. 1; more specifically, relay C1 operates in position 1 of the driver relays, locks over wire Hold-Odd in position 1.5, releasing in position 2.5 of the driver relays, following the operation of relay C2 in position 2 of the driver relays. In position 2.5, coincidental with the unlocking and release of the first counting relay C1, cutoff relay R13 is operated through contacts 3 and 4 of relays R11 and R12 to disconnect relay C1 to withhold it from further operation until the beginning of a new cycle of operations of relays C1 to C10.

When the driver relays R11 and R12 pass from position 2.5 back to position 1, the operate circuit of relay R13 is opened (at contacts 4 of relay R12), but relay R13 remains operated by residual magnetism until later restored by demagnetization.

When the counting relays C1 to C10 arrive in their tenth position as described for the first embodiment (operation of relay C10), the lower winding of relay R13 is connected in parallel with the upper winding thereof at contact 1 of relay C10. This occurs when the driver relays R11 and R12 arrive in position 2 (both operated).

When the driver relays assume position 2.5, a circuit is again closed for relay R13. With both

windings connected in parallel, the relay releases and remains restored as described for relays R11 and R12.

When driver relays assume position 1, a circuit is closed for the first counting relay C1. The counting chain is prepared to start another cycle of operations.

We claim:

1. In combination, a first and a second electromagnetic relay each having one winding for operating it and another winding for holding it operated, a first circuit branch including a first control wire, the operating winding of the first relay, and the holding winding of the second relay in series, a second circuit branch including a second control wire, the operating winding of the second relay, and the holding winding of the first relay in series, the holding winding of the second relay being incapable of operating such relay when energized in series with the operating winding of the first relay, means for energizing said control wires alternately to bring about the operation of said relays in succession and the restoration thereof in the same succession cyclically, and means for securing said cyclic operation including normally open contacts on the first relay serially related in the second said circuit branch and normally open contacts on the second relay connected in shunt of the said operating winding in the first circuit branch.

2. In combination, a first and a second electromagnetic relay, each having one winding for operating it and another winding for holding it operated, a first circuit branch including a first control wire, the operating winding of the first relay, and the holding winding of the second relay, a second circuit branch including a second control wire, the operating winding of the second relay, and the holding winding of the first relay, the holding winding of the second relay being of insufficient power to operate such relay, means for energizing said control wires alternately to bring about the operation of said relays in succession and the restoration thereof in the same succession cyclically, and means for securing said cyclic operation including contacts on the first relay for placing the operating winding of the second relay and the holding winding of the first relay effectively in circuit, and contacts on the second relay for effectively removing the operating winding of the first relay from circuit.

3. In combination, a first and a second electromagnetic relay, each having one winding for operating it and another winding for holding it operated, a first circuit branch including a first control wire, the operating winding of the first relay, and the holding winding of the second relay, a second circuit branch including a second control wire, the operating winding of the second relay, and the holding winding of the first relay, the holding winding of either relay being of insufficient power to operate such relay, means for energizing said control wires alternately to bring about the operation of said relays in succession and the restoration thereof in the same succession cyclically, and means for securing said cyclic operation including contacts on the first relay for placing the operating winding of the second relay effectively in circuit, and contacts on the second relay for effectively removing the operating winding of the first relay from circuit.

4. In a cyclic relay control circuit, first and second relays each requiring a flow of current to operate it and requiring a continued flow of current to hold it operated, first and second con-

trol wires and means for energizing them one at a time in succession, means responsive to a said energization of the first control wire and subject to both relays being restored for operating the first relay alone, means responsive to a said energization of the second control wire and subject to the first relay being operated alone for operating the second relay and for holding the first relay operated, means responsive to a subsequent said energization of the first wire for restoring the first relay and for holding the second relay operated, and means responsive to a later said energization of the second wire for restoring the second relay and for maintaining both restored until a said energization of the first wire again occurs to start a new cycle.

5. In combination, a series of relays including a normally connected first relay and normally disconnected succeeding relays, means for operating said series of relays successively in cycles, said means including contacts operable with each said relay preceding the last for connecting the next succeeding relay, a cutoff relay, said cutoff relay when operated disconnecting the said first relay and when restored reconnecting the said first relay, means following the operation of the said first relay for operating the said cutoff relay, and means responsive to the operation of the last relay of said series for restoring said cutoff relay.

6. In combination, a first and a second control device operable in succession and thereafter restorable in the same succession, a series of counting relays, means controlled by the second control device jointly with said relays for supplying operating current to them successively, a separate relay being thereby operated responsive to each operation and to each restoration of the second control device, means controlled by the first control device jointly with operated ones of said relays for supplying holding current to them in the same succession in which they are operated, any relay being supplied with holding current before the operating current is transferred to the next succeeding relay and releasing upon being deprived of holding current when the holding current is transferred to the next succeeding relay.

7. In combination, a series of counting relays comprising alternate odd relays and alternate succeeding even relays, odd and even operate wires associated respectively with the odd and even relays, respectively corresponding odd and even hold wires, associated respectively with the odd and even relays, first and second control devices operable in succession and thereafter restorable in the same succession, one said control device energizing one operate wire when restored and energizing the other operate wire when operated, the other control device when restored energizing the hold wire corresponding to the operate wire energized by the said one control device when operated, said other control device when operated energizing the other hold wire, means connecting the first said odd relay to the odd operate wire when a counting operation is about to begin and for disconnecting it from such wire after it has been operated thereover incidental to such counting operation, first contacts on each counting relay preceding the last one of the series, for connecting the next succeeding counting relay to its corresponding operate wire, and second contacts on each said counting relay for connecting such relay to its corresponding hold wire.

8. In combination, a series of counting relays, a first and a second control device, odd and even operate wires and odd and even hold wires controlled by said control devices and associated with respective odd and even counting relays, 5 each of said counting relays preceding the last including contacts operable therewith for connecting the next succeeding relay to its corresponding operate wire, and each of said relays including contacts operable therewith for connecting it to its corresponding hold wire. 10

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