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COUNTING RELAY SYSTEM

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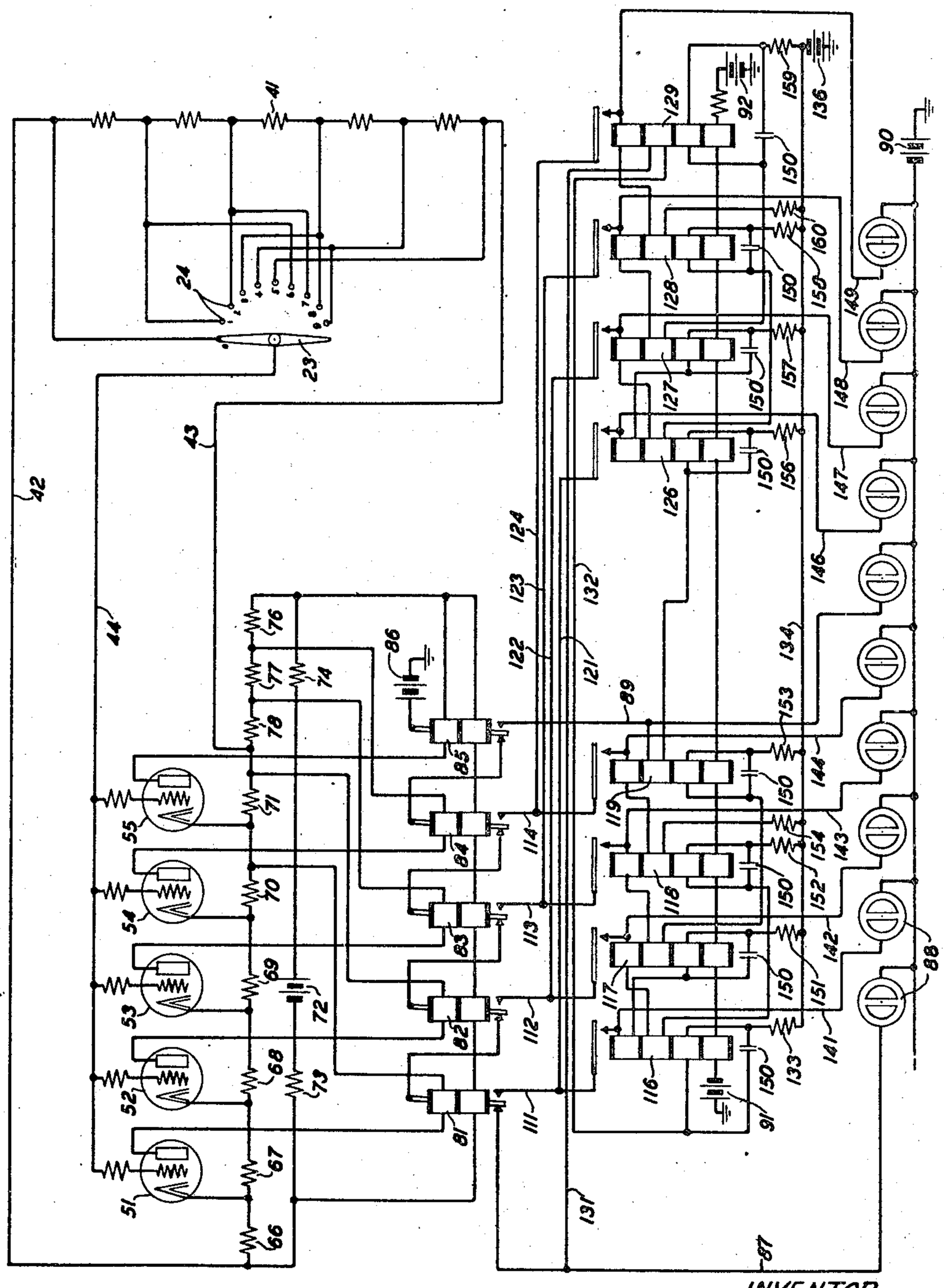

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COUNTING RELAY SYSTEM

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16 Claims. (Cl. 177—353)

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This invention relates to relay systems and particularly to counting relay chains.

This application is a division of copending application Serial No. 464,846, filed November 7, 1942, by F. S. Kinkead and G. A. Locke, which has issued as Patent 2,407,286 granted September 10, 1946.

An object of the invention is to provide a counting relay chain capable of counting forwardly and backwardly.

Another object of the invention is to provide a two-way counting relay chain capable of reversing the direction of counting at any point in a counting cycle and proceeding with the counting operation in the reverse direction.

The invention features a set of counting relays for counting upwardly or downwardly between 0 and 9. Specifically, the set consists of eight relays so interrelated that at all times a minimum of two relays are energized and under some circumstances three relays are energized. This interrelation of the relays provides for the preparation of a sequential circuit path on either side of a path which is at the time effective, so that the direction of counting may reverse at any time and proceed in such reverse direction.

In accordance with the preferred embodiment of the invention a controller for the counting relay chain in the nature of a potential divider has six fixed potential points which are connected to the first six contacts of a ten-contact switch bank and has four of the six points connected to the remaining four contacts of the contact bank. A pair of voltage supply conductors extends from the ends of the potential divider to a source of direct current electrical potential. The switch arm of the ten-contact point switch is connected to the control electrodes of five electron discharge devices.

A potential divider having fixed potential points is connected across the source of potential, and the cathodes of the electron discharge tubes are connected to the several fixed potential points so that the tubes have progressively greater negative bias. Since the control electrodes of all of the tubes receive like potentials over the switch arm conductor from any contact of the switch, none, one or more of the tubes will be rendered conductive depending upon the instantaneous value of the control electrode potential of the tubes relative to their progressively different cathode potentials. From no tubes to five tubes may be rendered conductive thus providing six selective conditions for the first six contacts of the switch. The remaining four contacts of the

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switch provide potentials which duplicate four of those afforded by the first six contacts and thus provide four repeated selective conditions of the electron discharge tubes.

A set of five relays is controlled by the five electron discharge tubes and in turn controls a set of eight counting relays. The counting relays prepare circuits for performing any desired useful operation such as, for example, the lighting of indicator lamps. Since ten selective conditions are afforded by the counting relays, there may be ten lamps each of which has one terminal connected in common to one terminal of a source of electrical potential and has the other terminal connected to an individual lamp conductor.

Referring to the set of discharge tube controlled relays, counting relays, and individual lamp conductors, one lamp conductor is electrified directly under the control of the discharge tube controlled relays when none of those relays is energized, one lamp conductor is electrified directly under the control of those relays when all five of the relays of the set are energized and the remaining eight lamp conductors become electrified selectively through paths prepared by the eight counting relays. Only one lamp conductor may be electrified at any instant and thus only one lamp will be lighted at any instant.

Referring again to the set of counting relays, the relays thereof are so interrelated that at all times a minimum of two relays are energized and under some circumstances three relays are energized. Specifically, when none of the electron discharge tube controlled relays is energized the first and last counting relays of the set are energized. When all of the discharge tube controlled relays are energized, the fourth and fifth counting relays are energized. Under certain other conditions of the discharge tube controlled relays, which conditions are with one or four relays energized, two of the counting relays are simultaneously energized. With the remaining possible conditions, namely, two or three of the discharge tube controlled relays energized, three of the counting relays are energized. The counting relays prepare conductive paths for electrification of the individual lamp conductors as previously stated, and since the counting relays, by virtue of the multiple energization, will count in either direction, they will choose individual lamp conductors successively in ascending or descending order and will reverse at any time that the direction of operation of the contactor of the controlling switch is reversed. As previously mentioned, the selective conditions of the electron

discharge tubes for the last four contacts of the switch duplicate four of the first six contacts of the switch. These conditions are represented by acitivation of one, two, three or four of the electron discharge tubes and energization of the corresponding relays which they control. For these four conditions, only one of which may exist at any instant, either the first four counting relays or the last four counting relays control electrification of their associated individual lamp conductors, the two subsets of four counting relays being operably effective alternately as the counting operation progresses in either direction. With the foregoing arrangement, during one traversal of the controlling switch contacts by the contact arm, the counting relays will go through a complete cycle and will sequentially electrify the ten individual lamp conductors.

For a complete understanding of the invention reference may be had to the following detailed description to be interpreted in the light of the accompanying drawing consisting of a single figure which is a circuit diagram showing the preferred embodiment of the counting relay chain and a system for controlling it.

Referring now to the drawing, the reference numeral **23** designates a double-ended switch arm which wipes across a bank of contacts **24**, of which there are ten arranged in slightly less than a semicircle. Thus, for each half revolution of switch arm **23**, it will traverse the ten contacts of contact bank **24**. The two ends of the switch arm **23** cannot engage the end contacts of contact bank **24** simultaneously, there being an offset equal to the mounting centers of the contacts.

Associated with the contact bank **24** is a potential divider **41** which may comprise a single resistor winding having a plurality of taps or may comprise a plurality of individual resistors serially connected. From the terminals of potential divider **41** conductors **42** and **43** extend to a battery, as will be described later. The individual contacts of the bank **24** have been designated **0** to **9**, inclusive, and it will be noted that the end terminals of potential divider **41** are connected to the terminals **0** and **5** of bank **24**. The four tap terminals of potential divider **41** are connected to contacts **1**, **2**, **3** and **4** and also to contacts **6**, **7**, **8** and **9** of switch bank **24**.

A conductor **44** extends from switch arm **23** to the control electrodes or grids of five electron discharge tubes **51**, **52**, **53**, **54** and **55**. A potential divider comprising serially-connected resistors **66**, **67**, **68**, **69**, **70** and **71** is connected between conductors **42** and **43**. A battery **72** or other source of direct current potential has its negative terminal connected through a resistor **73** to conductor **42** and has its positive terminal connected through resistors **74**, **76**, **77** and **78** to conductor **43**. Assuming that the conductors **42** and **43** have negligible resistance substantially the same potential will be impressed across potential divider **41** as is impressed across the potential divider comprising resistors **66** to **71**, inclusive. The cathode of tube **51** is connected to the junction of resistors **66** and **67** so that the cathode is more positive than conductor **42** and the upper terminal of potential divider **41** by the potential difference across resistor **66**. The cathode of tube **52** is connected to the junction of resistors **67** and **68** so that the cathode of the tube will be more positive than that of tube **51** by the potential difference across resistor **67** and will be more positive than the potential of conductor **42** by the total potential difference across resistors **66** and **67**.

Similarly, the cathode of tube **53** is connected to the junction of resistors **68** and **69**, the cathode of tube **54** is connected to the junction of resistors **69** and **70** and the cathode of tube **55** is connected to the junction of resistors **70** and **71** so that the cathode of each tube is progressively more positive than the tube preceding it. Conductor **43** is more positive than the cathode of tube **55** by the potential difference across resistor **71**.

The anode of tube **51** is connected through the upper winding of an electrically biased relay **81** to the junction of resistors **70** and **71**. Thus the anode of tube **51** is more positive than the cathode by the total potential difference across resistors **67**, **68**, **69** and **70**, diminished by the potential difference, if any, across the winding of relay **81**. The operating winding of relay **81** stands as a load device in relation to tube **51**. Resistors **67**, **68**, **69** and **70** taken together represent the anode voltage source for the tube **51**, since they are part of a potential divider connected across the power supply. When the tube **51**, or any other of the tubes is passing current of insignificant magnitude under the control of its grid, the potential difference across the winding of relay **81**, and other relays in relation to other tubes, will be similarly insignificant in magnitude and in the case of tube **51** the potential of its anode relative to its cathode may be considered as substantially equal to the potential difference across resistors **67**, **68**, **69**, and **70**. The anode of tube **52** is connected through the upper winding of electrically biased relay **82** to the junction of resistors **71** and **78** which affords a higher positive potential for the anode of tube **52** than the cathode of that tube has. Similarly, the anodes of tubes **53**, **54** and **55** are connected through the upper windings of relays **83**, **84** and **85**, respectively, to the junctions of resistors **78** and **77**, **77** and **76**, and **76** and **74**, respectively. The biasing windings of relays **81** to **85** are connected in series with resistors **73** and **74** across battery **72**.

The several resistive sections of potential divider **41** are so proportioned and the potential differences across resistors **66**, **67**, **68**, **69** and **70** are such that when switch arm **23** engages the zero contact of bank **24** none of the tubes **51** to **55** will pass sufficient anode current to operate any of the relays **81** to **85**. When switch arm **23** engages the contact **1** of bank **24** the grids of tubes **51** to **55** will be made less negative with respect to their cathodes and tube **51** will be rendered sufficiently conductive to operate relay **81**. When switch arm **23** engages contact **2** of bank **24** tube **52** will be rendered sufficiently conductive to operate relay **82**, tube **51** remaining conductive because its grid is made still less negative with respect to its cathode. As switch arm **23** engages contacts **3**, **4** and **5** of bank **24** in succession, tubes **53**, **54** and **55** will be rendered conductive in succession to operate relays **83**, **84** and **85**, respectively, so that when the switch arm engages contact **5** all of the tubes **51** to **55** will be conductive and all of the relays **81** to **85** will be operated. When switch arm **23** moves into engagement with contact **6** of bank **24** the grids of tubes **51** to **55** will be reduced to the same potential that they had when the switch arm engaged contact **1** and tubes **52** to **55** will be cut off, leaving only tube **51** conductive and only relay **81** operated. As switch arm **23** successively engages contacts **7**, **8** and **9** of bank **24**, tubes **52**, **53** and **54** will be rendered conductive in succes-

sion and relays 82, 83 and 84 will again be operated. As switch arm 23 moves out of engagement with contact 9 of bank 24 and into engagement with the zero contact all of the tubes 51 to 55 are cut off or are rendered insufficiently conductive to operate the relays 81 to 85, inclusive, so that the armatures of these relays are restored to their left-hand contacts. From the foregoing it will be apparent that tubes 51 to 55, inclusive, are all cut off only when switch arm 23 engages the zero contact and are all conductive only when the switch arm engages contact 5. Tubes 51 to 54 are rendered conductive in succession as switch arm 23 traverses contacts 1 to 4, inclusive, and again as the switch arm traverses contacts 6 to 9, inclusive.

It should be noted with reference to the electron discharge tubes that the particular contact engaged by the switch arm determines the number of tubes that are rendered conductive and that none of the tubes is dependent for its operation upon the operation of another of the tubes so that the switch arm 23 may be operated in either direction and tubes will be successively rendered conductive or successively cut off in the reverse direction depending solely upon the direction of rotation of the switch.

The armature of relay 85 is connected to the positive terminal of battery 86, the negative terminal of which is connected to ground. The left-hand contact of relay 85 is connected to the armature of relay 84, the left-hand contact of relay 84 is connected to the armature of relay 83, the left-hand contact of relay 83 is connected to the armature of relay 82, and the left-hand contact of relay 82 is connected to the armature of relay 81. The left-hand contact of relay 81 is connected over individual lamp conductor 87 to one terminal of a left-hand lamp of a group of ten lamps 88. The other terminal of the left-hand one of the lamps 88 and one terminal of each of the other lamps is connected to the negative terminal of battery 90, the positive terminal of which is grounded. Thus, with none of the tubes 51 to 55 conductive and none of the relays 81 to 85 operated, a path will be established from the positive terminal of battery 86 over conductor 87 and through the left-hand one of the lamps 88 to the negative terminal of battery 90 and the lamp will be lighted.

The right-hand contact of relay 85 is connected by individual lamp conductor 89 to one terminal of the sixth lamp 88, counting from the left. With switch arm 23 engaging contact 5 of bank 24 all of the tubes 51 to 55 will be conductive, all of the relays 81 to 85 will be operated, and a circuit will be completed from battery 86 over the right-hand contact of relay 85, conductor 89, the sixth lamp in the bank counting from the left to battery 90 on the other terminal and the lamp will be lighted. It will be noted that the two conditions for the lighting of the two lamps identified in this paragraph and the preceding paragraph effect the control of the lamps directly through the relays 81 to 85.

The right-hand contacts of the four relays 81, 82, 83 and 84 are connected by conductors 111, 112, 113 and 114, respectively, to the armatures of four counting relays 116, 117, 118 and 119. These contacts are also connected through branching conductors 121, 122, 123 and 124, respectively, to the armatures of four additional counting relays 126, 127, 128 and 129. Each of the relays 116 to 119, inclusive, and 126 to 129, inclusive, is a biased polar relay having three operating windings and a biasing winding. Current through the series connected biasing windings of each of these relays is produced by batteries 91 and 92 and is in a direction to drive the single armature of the relay away from the single front or off-normal contact. The three operating windings of each of these relays are so connected that when current flows in any one of the windings, there being no provision for reversal of current in these windings, the magnetic field thereby produced will exceed and oppose the effect of the biasing winding and will cause the single armature to engage the single front contact.

Assuming that the system is in operation and that switch arm 23 is engaging the zero contact of bank 24, as shown, none of the relays 81 to 85 will be energized and a circuit may be traced from the positive terminal of battery 86, through the armatures and left-hand contacts of the relays 81 to 85, serially, conductor 87, branching conductor 131, the second operating winding of counting relay 129, conductor 132, the third operating winding of counting relay 116, resistor 133 and conductor 134 to the negative terminal of battery 136, the positive terminal of which is connected to ground. Relays 116 and 129 will thus be energized, overcoming the effect of the biasing windings and operating their armatures to the single front contacts. Battery 136 and battery 90 having like polar connections, the lamps 88 cannot become operated over unintentional or sneak conductive paths, such as the one from battery 90, the extreme left-hand lamp 88, conductors 87 and 131, second winding of relay 129, conductor 132, third winding of relay 116, and resistor 133 to battery 136. Individual lamp conductors 141, 142, 143 and 144 extend from the front contacts of relays 116 to 119, inclusive, to one terminal of each of the second, third, fourth and fifth of the lamps 88 counting from the left. Similarly, individual lamp conductors 146, 147, 148 and 149 extend from the front contacts of relays 126 to 129, inclusive, to one terminal of each of the seventh, eighth, ninth and tenth of the lamps 88. Although relays 116 and 129 may be assumed to be energized at this time, as previously stated, conductive paths are not extended through their armatures to the second and tenth lamps, respectively, because the armatures of relays 81 and 84 are out of engagement with their right-hand contacts from which conductive paths extend to the armatures of relays 116 and 129, respectively. None of the relays 117, 118, 119, 126, 127 and 128 will be energized at this time.

One operating winding of each of the counting relays 116 to 119 and 126 to 129 is shunted by a condenser 150 for the purpose of imparting a slow release characteristic to each relay. The condensers have been shown connected in shunt with the third operating winding of each relay. It makes no difference which operating winding is shunted by a condenser, as the magnetic field produced by the cessation of current through any one of the operating windings of these relays will induce, in the winding which is shunted by the condenser, current which flows to charge the condenser, and the armature will be held while this charging current exceeds the biasing current.

Upon movement of the switch arm 23 from the zero contact to the contact 1 of bank 24, tube 51 becomes conductive and relay 81 operates its armature to the right-hand contact. In leaving the left-hand contact the armature of relay 81 interrupts the previously traced circuit to the

extreme left-hand lamp 88 and also interrupts the previously traced circuit through the second winding of relay 129 and through the third winding of relay 116. These relays hold for a short interval, due to their shunting condensers 150, and maintain conductive paths through their armatures and front contacts. At its right-hand contact relay 81 completes a circuit over conductor 111, the armature and front contact of relay 116 and over conductor 141 to the second lamp 88 which lights. The relay also completes a circuit over conductor 111 and through the armature and front contact of relay 116, first winding of that relay, third winding of relay 117, resistor 151 and conductor 134 to the negative terminal of battery 136, over which circuit relay 116 remains operated and relay 117 becomes operated. Since no circuit is completed through an operating winding of relay 129, that relay releases after its characteristic delay interval.

When the switch arm 23 is advanced to the contact 2 of switch bank 24, tube 52 becomes conductive, tube 51 remaining conductive, and relay 82 operates, relay 81 remaining operated. At its left-hand contact relay 82 interrupts the circuit through the armature of relay 81 and conductor 111 so that the second lamp 88 is extinguished and the circuit through the first winding of relay 116 and the third winding of relay 117 is interrupted. At its right-hand contact the relay 82 completes a circuit over conductor 112, armature and front contact of relay 117 and conductor 142 to the third lamp, which lights, and also through the first winding of relay 117, second winding of relay 116, third winding of relay 118, resistor 152 and conductor 134 to the negative terminal of battery 136 whereby relay 118 becomes energized and relay 116 is held energized along with relay 117.

When the switch arm 23 is moved to contact 3 of bank 24, tube 53 will be rendered conductive and relay 83 will be operated. At its left-hand contact relay 83 interrupts a circuit over conductor 112 and the armature and front contact of relay 117 to the third lamp from the left and also interrupts the circuit through the first winding of relay 117, the second winding of relay 116 and the third winding of relay 118. At its right-hand contact the relay 83 completes a circuit over conductor 113 and the armature and front contact of relay 118 and over conductor 143 to the fourth lamp from the left, which lights. A circuit is also completed from the front contact of relay 118 through the first winding of that relay, second winding of relay 117, third winding of relay 119, resistor 153 and conductor 134 to the negative terminal of battery 136 so that relays 117 and 118 remain energized, relay 119 becomes energized and relay 116 is released.

When the switch arm 23 is advanced to the next contact of bank 24 which is contact 4, tube 54 will be activated and relay 84 will be energized to release the circuit over which relays 117, 118 and 119 have been held operated and also to open the circuit of the fourth lamp, and to complete the circuit for the fifth lamp over conductor 114, armature and front contact of relay 119 and conductor 144, and also to complete a circuit through the armature and front contact of relay 119, first winding of that relay, second winding of relay 118, resistor 154 and conductor 134 to the negative terminal of battery 136. It will be noted that in this condition of the apparatus only two of the counting relays, namely, the relays 118 and 119, are energized, whereas when only the relays

81 and 82 were energized, relays 116, 117 and 118 were energized and when only the relays 81, 82 and 83 were energized the relays 117, 118 and 119 were energized. The reason for this is that in the next step of the switch arm 23 and the energization of the final relay in the series 81 to 85, the circuit of the sixth lamp will be completed directly over conductor 89 from the right-hand contact of relay 85 as previously described and not through the armature and front contact of one of the counting relays, and it is not necessary for the relay 119, when completing its holding circuit through its armature and front contact, to prepare a path for the operation of the next lamp by energizing the next counting relay.

Suppose now that the direction of rotation of switch arm 23 had been reversed and instead of advancing to the contact 4 it had gone from contact 3 back to contact 2 of bank 24. Under this circumstance tube 54 would not have been activated and tube 53 would have been cut off, releasing relay 83 and leaving only tubes 51 and 52 conductive. The armature of relay 83 upon moving out of engagement with its right-hand contact interrupts the circuit of the fourth lamp 88 and also interrupts the circuit through the first winding of relay 118, the second winding of relay 117 and the third winding of relay 119. The armature of relay 83 in returning to the left-hand contact completes a circuit from the positive terminal of battery 86 through the armature and right-hand contact of relay 82, conductor 112, armature and front contact of relay 117, and conductor 142 for the third lamp and also through the armature and front contact of relay 117, first winding of that relay, second winding of relay 116, third winding of relay 118, resistor 152 and conductor 134 to the negative terminal of battery 136. The result of this reversal of switch 23 is that relay 119 has been released and relay 116 has been reenergized in anticipation of continued rotation of switch arm 23 in the reverse direction to the contact 1 of bank 24. It will be apparent from this that the counting relay circuit is arranged to count in either direction by the preparatory energization of counting relays on either side of a counting relay through which a lamp is being operated, in anticipation of the necessity for completing the circuit of a lamp through either one of the prepared relays. In the case of the operation of a lamp through the armature and front contact of relay 119 there is no occasion for preparatorily energizing a relay beyond it because the conductor 89 stands in lieu of a counting relay and is always prepared to operate the sixth lamp counting from the left, the circuit being completed solely by operation of the relay 85.

Assuming again clockwise movement of arm 23, from contact 4 to contact 5, relay 85 is operated, and in addition to connecting positive battery to the sixth lamp, it also completes a circuit through the second winding of relay 119, third winding of relay 126, resistor 156 and conductor 134 to battery 136 to hold relay 119 and to operate relay 126 in preparation for movement of switch arm 23 either to contact 4 or to contact 6 of bank 24. Under this condition only two of the counting relays are energized, which satisfies the requirement for preparation of a lamp operating circuit on either side of the circuit over which a lamp is operated.

When the movement of switch arm 23 is from contact 5 to contact 6 the condition which existed when switch arm 23 engaged contact 1 of bank 24 is duplicated as far as tubes 51 to 55 and relays

81 to 85 are concerned, the duplication involving cutting off of tubes 52 to 55 and releasing relays 82 to 85. Relay 116 is at this time unoperated so that no circuit is completed through its armature and front contact, and a lamp operating circuit is traced through conductor 111 from the right-hand contact of relay 81, branching conductor 121, armature and front contact of relay 126 and conductor 146 to the seventh lamp. Also a circuit is completed through the armature and front contact of relay 126, first winding of that relay, third winding of relay 127, resistor 157, conductor 134 and battery 136 so that relay 127 becomes preparatorily energized and relay 126 remains energized. Only two of the counting relays are required to be energized at this time because in the event that the switch arm 23 is moved back to contact 5, the sixth lamp will be operated over conductor 89 without any preparational operation.

As the switch arm 23 is advanced to contact 7 the next lamp, namely, the eighth lamp is operated, relays 126 and 127 are held energized through their second and first windings respectively and relay 128 is preparatorily energized through its third winding and resistor 158. When the switch arm steps to contact 8, the next or ninth lamp is energized, relay 126 is released and relay 129 is preparatorily energized through its third winding and resistor 159.

When the switch arm is moved to contact 9, the last contact in the bank, which movement is evidenced by activation of all of the tubes except tube 55, the circuit of the tenth or extreme right-hand lamp is completed over conductor 149, relays 128 and 129 are held energized through their second and first windings, respectively, and resistor 160, and relay 127 is released. This is again a condition under which only two of the counting relays are energized. The reason for this is that when switch arm 123 advances another step in the same direction it will leave contact 9 and engage the zero contact, thus cutting off all of the tubes 51 to 55 and completing a conductive path from battery 86 to the first or extreme left-hand lamp over conductor 87 which stands in lieu of a counting relay and requires no counting relay preparation.

Assuming that the switch arm 23 advances through this additional step, thus returning to the point of beginning, all of the relays 81 to 85 are released so that the circuit through the armature and front contact and first winding of relay 129 and second winding of relay 128 is interrupted. However, a circuit is completed which was traced as part of the initial condition including conductors 87 and 131, second winding of relay 129, conductor 132, third winding of relay 116, resistor 133 and conductor 134 to battery 136 so that relay 129 will be held energized and relay 116 will be preparatorily energized. Under this condition only two of the counting relays are energized and these occupy sequential positions on either side of conductor 87 so that the preparational conditions for operation of the extreme right-hand lamp or the second lamp from the left are satisfied.

Although a specific embodiment of the invention has been shown in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiment but is capable of modification and rearrangement, and substitution of parts and elements without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a counting relay system, a relay having an armature and front contact and a holding winding energizable through said armature and front contact, and second and third relays having preceding and succeeding sequential counting relation to said first-mentioned relay and each having a winding energizable through the armature and front contact of said first-mentioned relay whereby said second and third relays are prepared by said first-mentioned relay to count backwardly and forwardly from said first-mentioned relay.

2. In a counting relay system, a relay having an armature and front contact and a holding winding energizable through said armature and front contact, and second and third relays having preceding and succeeding sequential counting relation to said first-mentioned relay and each having a winding energizable in series with the holding winding of said first-mentioned relay, whereby said second and third relays are prepared by said first-mentioned relay to count backwardly or forwardly from said first-mentioned relay.

3. In an electrical distributor system, a plurality of distribution paths including some permanently established and others requiring preparatory establishment, means controlled from each of said permanently established paths for preparatorily establishing two of said other paths having preceding and succeeding sequential relation to said permanently established paths, means controlled over either of said sequentially preceding and succeeding paths for preparatorily establishing an adjacent path in sequential direction away from the permanently established path, and means controlled from each such adjacent paths for preparatorily establishing two paths having preceding and succeeding sequential relation thereto, whereby said distributor system always has three consecutive distribution paths in prepared state and is capable of distributing in either direction from the middle one of said three paths.

4. In an electrical distributor system, first and second permanently established distribution paths, a plurality of distribution paths having sequential dispositions intermediate said first and second permanently established paths, a plurality of distribution paths having sequential disposition intermediate said second and first permanently established paths, each of said intermediate paths including means operable to preparatorily establish said paths, means controlled from each of said permanently established paths for operating the path establishing means in the two intermediate paths immediately adjacent to said permanently established paths, means controlled from each of said immediately adjacent paths for operating the path establishing means in the next intermediate path in sequential direction away from its adjacent permanently established path, and means controlled from each other intermediate path including said next intermediate path for operating the path establishing means in the two paths immediately adjacent thereto, whereby said distributor system always has three consecutive distribution paths in established condition and is capable of distributing in either direction from the middle one of said three paths.

5. In an electrical distributor system, a plu-

rality of sequentially related and functionally coordinate distribution paths of which a small percentage are permanently prepared and the remainder are preliminarily preparable, means for completing said paths individually in succession in either sequential direction, and means controlled from any path upon completion thereof for preparing a minimum of one and a maximum of two of said preliminarily preparable paths whereby two distribution paths in sequential juxtaposition to any completed path are at all times prepared.

6. In an electrical distributor system, a plurality of sequentially related and functionally coordinate distribution paths of which a small percentage are permanently prepared and the remainder are preliminarily preparable, said permanently prepared paths being uniformly interspersed among said preliminarily preparable paths, means for completing said paths individually in succession in either sequential direction, and means controlled from any path upon completion thereof for preparing a minimum of one and a maximum of two of said preliminarily preparable paths whereby two distribution paths in sequential juxtaposition to any completed path are at all times prepared.

7. In an electrical distributor system, a plurality of distribution paths of which a small percentage are permanently prepared and the remainder are preliminarily preparable, and means controllable over said distribution paths and interassociated with each other and with said permanently prepared paths in a closed ring pattern for preparing a minimum of one and a maximum of two of said preliminarily preparable paths whereby a minimum of two distribution paths in sequential juxtaposition to any completed path are at all times prepared.

8. In an electrical distributor system, a plurality of distribution paths of which a small percentage are permanently prepared and the remainder are preliminarily preparable, said permanently prepared paths being uniformly interspersed among said preliminary preparable paths, and means controllable over said distribution paths and interassociated with each other and with said permanently prepared paths in a closed ring pattern for preparing a minimum of one and a maximum of two of said preliminarily preparable paths whereby a minimum of two distribution paths in sequential juxtaposition to any completed path are at all times prepared.

9. In an electrical distributor system, a series of relays each having an armature and front contact, a plurality of distribution control paths having sequential distributing relation each connected to the armature of one of said relays, a local holding winding and an operating winding for a minimum of one and a maximum of two adjacent relays connected to the front contact of each relay, at least one additional distribution control path, an operating winding of each of two of said relays connected to said additional distribution control path, said additional distribution control path having intermediate relation to the distribution control paths associated with the armatures of the relays having operating windings connected to said additional distribution control path whereby said additional distribution control path has distributive bridging relation to the immediately preceding and following distribution control paths and affords progressive distribution in either direction between them.

10. A system according to claim 9 in which the relays having operating windings connected to said additional distribution control path are at opposite ends of said series of relays and the bridging relation of said additional distribution control path affords continuous distribution in repetitious cycles in either sequential direction among said distribution control paths.

11. In an electrical distributor system, at least two series of relays each having an armature and front contact, a plurality of distribution control paths having sequential distributing relation, each path being connected to the armature of a relay in each series, a local holding winding and an operating winding of a minimum of one and a maximum of two relays in the same series connected to the front contact of each relay, at least one additional distribution control path, and a connection from an operating winding of an end relay of one series and from an operating winding of the non-corresponding end relay of the other series to said additional distribution control path, whereby said additional distribution control path has distributive bridging relation to the distribution control paths connected to the armatures of the specified end relays of the two series and affords progressive distribution in either direction between said distributively bridged distribution control paths.

12. A system according to claim 11 in which the distribution control paths having connections to the armatures of the relays in the two series are adapted to control the relays of the two series in succession.

13. In an electrical distributor system, at least two series of relays each having an armature and front contact, a plurality of distribution control paths having sequential distributing relation, each path being connected to the armature of a relay in each series, a local holding winding and an operating winding of a minimum of one and a maximum of two relays in the same series connected to the front contact of each relay, additional control paths equal in number to the number of sets of relays, and connections from an operating winding of an end relay of one series and from an operating winding of a non-corresponding end relay of another series to each of said additional distribution control paths whereby said additional distribution control paths have distributive bridging relation to the distribution control paths connected to the armatures of the end relays having operating windings connected to said additional distribution control paths and afford progressive distribution in repetitious cycles in either sequential direction among said distribution control paths.

14. In an electrical distributor system, a plurality of distribution paths having sequential distributive relation and adapted to be completed individually, a plurality of relays adapted to prepare said distribution paths, said relays each having operating windings connected to two of said paths and each such connection including operating windings of two of said relays for operating the relays to prepare their distribution paths, and means for completing said paths successively in either sequential direction.

15. In an electrical distributor system, a plurality of distribution paths having sequential distributive relation and adapted to be completed individually, a plurality of relays adapted to prepare said distribution paths, said relays each having operating windings connected to the two of said paths sequentially juxtaposed to the path controlled by the particular relay and each such

connection including operating windings of the two relays controlling the paths sequentially juxtaposed to the particular path for operating the relays to prepare their respective distribution paths, and means for completing said paths in either sequential direction.

16. In a counting relay system, a relay having an armature and front contact and a holding winding energizable through said armature and front contact, second and third relays having like armatures and front contacts and holding windings and having operating windings preparatorily energizable through the armature and front contact of said first-mentioned relay, a work circuit connected to each of said front contacts, and means for completing the holding winding circuit and work circuit of said first-mentioned relay and the energizing winding circuit of said second and third relays and adapted to complete the holding winding circuit and work circuit of either of said preparatorily energized second and third relays, whereby to count in either direction

from said first-mentioned relay and the work circuit associated therewith.

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