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2,895,088

RELAY CHAIN CIRCUIT

Filed Aug. 19, 1955

2 Sheets-Sheet 1

FIG. 1

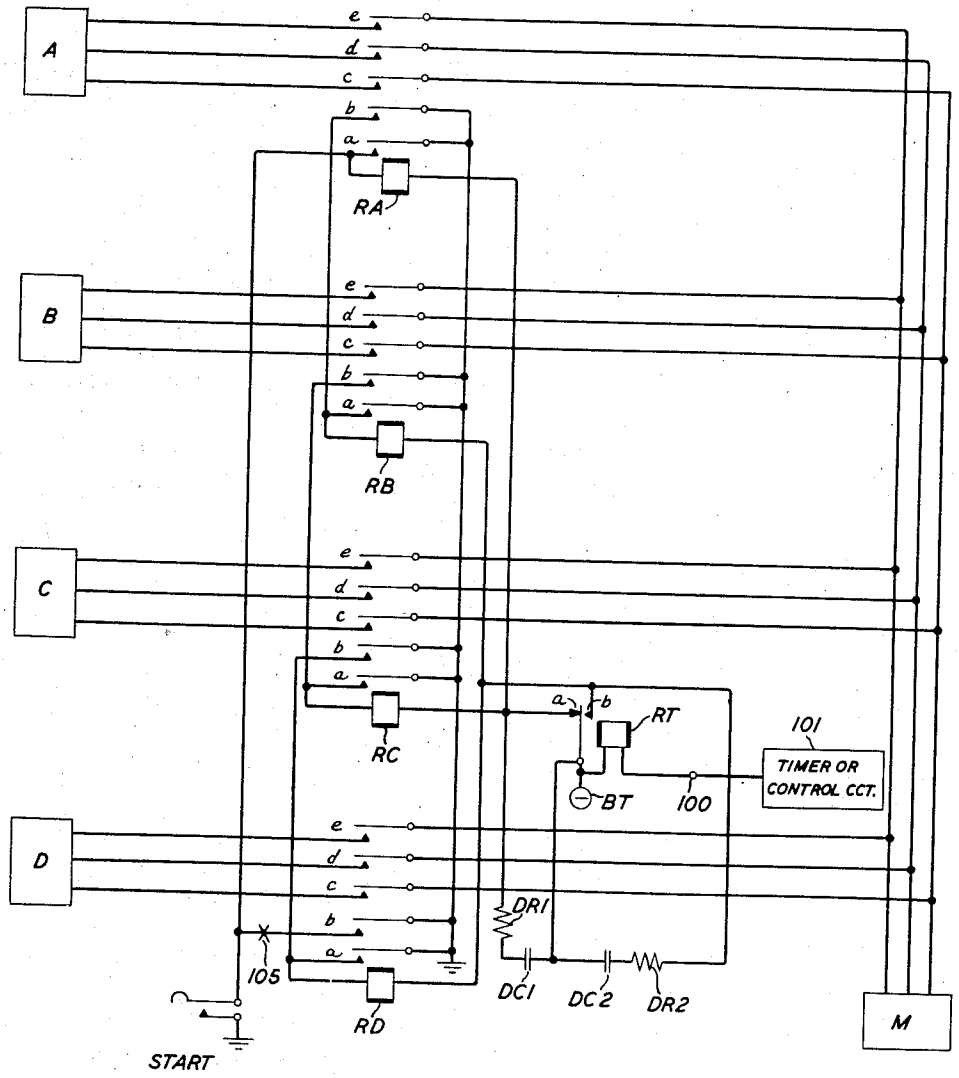

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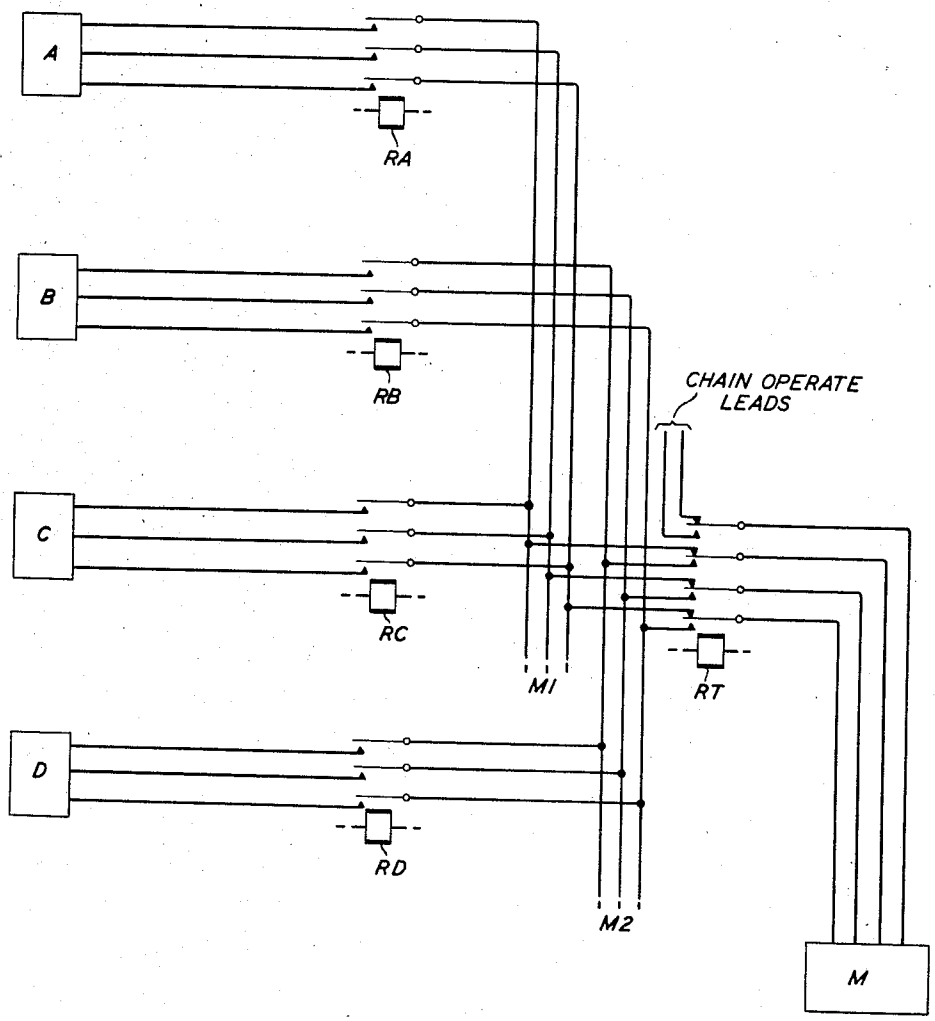
FIG. 2



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RELAY CHAIN CIRCUIT

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6 Claims. (Cl. 317—139)

This invention relates to switching systems, and more particularly to an improved type of switching circuit known as a chain circuit or a ring circuit.

An object of the invention is the improvement of chain circuits or ring circuits.

A more particular object of the invention is the simplification of chain or ring circuits.

The chain or ring circuit of the present invention is improved and simplified over those presently known in the art in that it requires fewer contacts than any presently known chain or ring circuit to control the stepping of the chain or ring from each stage to the next and the locking of a stage in the operated condition.

As is generally well understood in the switching art, a chain circuit is a circuit which contains a number of sequentially operated switches. It has many applications. For instance, it may be used in connecting a number of individual circuits in sequence to a common circuit. Each stage of the chain will connect an individual circuit to the common circuit and the individual stages of the chain will be operated in sequence to connect each of the individual circuits in its turn to the common circuit. The operation of the successive stages may be periodic or aperiodic, depending upon the requirements. Such a circuit may be arranged so that after operating through each of the stages in turn, the circuit is automatically actuated so that it repeats the cycle. A circuit so arranged is a special kind of chain circuit termed a ring circuit because of this so-called reentrant characteristic.

Because of their widespread use it is desirable that the number of elements required in each stage of a chain or ring circuit be kept to a minimum. This is important obviously, for reasons of economy, but it is more important with respect to the reduction of trouble sources and minimizing maintenance to increase reliability.

A feature of the present invention is a chain circuit having a reduced number of elements in each stage to perform the chain functions.

Another feature of the invention is a chain or ring circuit employing make contacts only and requiring no break or transfer contacts. This makes it possible to employ a presently available relay having very desirable qualities of high speed and freedom from contact troubles, which relay, because of its construction, cannot be equipped with contacts other than make contacts.

The invention may be understood from the following description when read with reference to the associated drawings which show preferred embodiments in which the invention is presently incorporated. It is to be understood, however, that the invention is not limited to the described embodiments but may be practiced in other forms which may be suggested to those skilled in the art by a consideration of the following.

In the drawings, Fig. 1 shows a chain or ring circuit of the present invention;

Fig. 2 shows a modification of the circuit of Fig. 1.

On the drawings the symbol ⊖ represents grounded negative battery.

Refer now to Fig. 1. In this figure an arrangement is shown for interconnecting four individual circuits, indicated by rectangles A, B, C and D, in sequence to a common circuit, represented by the rectangle designated M. It is to be understood that the four individual circuits A, B, C and D and the common circuit M may take any of a large number of forms depending upon the particular system in which the circuit of Fig. 1 is applied.

Relays RA, RB, RC and RD are individual to circuits A, B, C and D, respectively. Relay RT controls the timing of the connections of circuits A, B, C and D to the common circuit M. The right-hand terminal **100** of the winding of relay RT may be connected obviously to any form of timer or control circuit **101**. The intervals of operation of relay RT may be uniform or non-uniform according to the requirements in the particular case. The circuit is provided with a Start key, shown in the lower left-hand corner, the function of which is to start the operation of the circuit.

When the Start key is actuated, a circuit is established from ground through the contacts of the Start key, winding of relay RA, contact *a* of timing relay RT and battery BT to ground operating relay RA. When relay RA is operated, a circuit is established from grounded battery BT through contact *a* of relay RT, winding of relay RA and contact *a* of relay RA to ground locking relay RA. When relay RA is operated, the individual circuit A is connected by means of three conductors through contacts *c*, *d* and *e* of relay RA to the common circuit M. At the termination of an allotted interval, a condition is applied from the timer or control circuit **101** through terminal **100** and the winding of relay RT to grounded battery BT. This actuates the armature of relay RT to engage its contact *b*. This in turn establishes a circuit which may be traced from ground through battery BT, contact *b* of relay RT, winding of relay RB and contact *b* of relay RA to ground operating relay RB.

Attention is particularly called to capacitor-resistor pairs DC1, DR1 and DC2, DR2, shunting contacts *a* and *b*, respectively, of relay RT. The function of these is to delay the release of relays RA, RB, RC and RD, in turn, until the relay of the succeeding stage operates in each instance. With respect to relay RA, when contact *a* of relay RT is opened, relay RA starts to release; however, its release is delayed to permit the operation of relay RB through contact *b* of relay RA by the effect of the charging current through capacitor DC1 and resistor DR1 which flows through the winding of relay RA and its contact *a* to ground until capacitor DC1 is charged. This delay in release of relay RA permits the armature of relay RT to make its transit from its contact *a* to its contact *b* and to furnish current through the winding of relay RB and contact *b* of relay RA until relay RB operates. Relay RB, when operated, locks over a circuit from ground through battery BT and contact *b* of relay RT, winding of relay RB and contact *a* of relay RB to ground. Relay RB operated connects individual circuit B through contacts *c*, *d* and *e* to common circuit M. When relay RT is next actuated to engage its contact *a*, relay RC will be operated and relay RB will be released. Individual circuit C will be connected to common circuit M. Thereafter, individual circuit D will be connected to common circuit M when the armature of relay RT engages its contact *b*.

Attention is specifically directed to connection **105** which provides the means whereby the circuit in accord-

ance with Fig. 1 can be operated either as a chain circuit or as a ring circuit. When connection **105** is open, the circuit of Fig. 1 operates as a chain circuit. When connection **105** is closed relay RD will be operated in its turn when the armature of relay RT engages contact *b* of relay RT. When the armature of relay RT reengages with its contact *a* after the operation of relay RD, a circuit is established from ground through battery BT, contact *a* of relay RT, winding of relay RA, connection **105** and contact *b* of relay RD to ground, operating relay RA to start a new cycle of operation of each relay in the chain.

It should be apparent from the foregoing that the number of stages in the chain or ring circuit has no limitation. Attention is also called to the fact that when the circuit of Fig. 1 operates as a chain, without the reentrant feature, the Start key must be operated once to actuate the chain each time. When the circuit functions as a ring circuit, only one operation of the Start key is necessary for continuous operation of the ring. When operating as a ring, if desired, the circuit may be released by disconnecting battery BT in any convenient manner.

In the arrangement of Fig. 1 attention is called to the fact that, during the interval while any relay, such as relay RA, is delayed in releasing, after a succeeding relay in the chain, such as relay RB, is operated, it is possible that two of the individual circuits, such as circuits A and B, may be connected simultaneously to the common circuit M. In certain cases this may be undesirable, When it is undesirable the arrangement according to Fig. 2 may be employed.

In Fig. 2 elements corresponding to those in Fig. 1 have corresponding designations. The circuit of Fig. 2 is distinguished from that of Fig. 1 in that relay RT is provided with multiple transfer contacts instead of a single transfer contact as shown in Fig. 1 and the individual circuits are grouped in a pair of multiples as indicated in Fig. 2, the three conductors from circuit A being multipled to the three conductors from circuit C after being extended through the contacts of their individual relays RA and RC as shown. The conductors of individual circuits B and D are similarly arranged. Any other individual circuit, not shown, may be connected to its respective multiple. When the contacts of relay RT are in one position, the common circuit M will be connected to one of the two multiples so formed and when the contacts of relay RT are in their alternate position, the common circuit M will be connected to the other multiple. As thus arranged even though two relays, such as relays RA and relay RB, in consecutive positions in the chain or ring may be simultaneously operated for a short interval, it is not possible to connect more than one individual circuit such as circuit A or circuit B to the common circuit M simultaneously, because only consecutive relays, such as relays RA and RB, or RB and RC can ever be operated simultaneously and their associated individual circuits, such as A and B, B and C, connect to different multiples, only one of which can be connected through contacts in alternate positions of relay RT to circuit M at any one time.

What is claimed is:

1. A relay chain circuit having a single magnetic relay for each stage in the chain, each said relay having a total of one winding thereon and each said relay having a total of two pairs of make contacts thereon for performing the chain functions, one of said pairs and said one winding having means for actuating said stages sequentially and the other of said pairs and said one winding having means for locking each stage sequentially, a total of one switch common to said chain circuit and means including a direct current circuit responsive to the actuation of said switch to alternate positions for actuating each of said relays in said chain circuit in sequence.

2. A relay chain circuit comprising a plurality of relays, one of said relays for each stage in the chain, each of said relays having a total of one winding thereon and a total of two pairs of contacts thereon for successively operating and holding each relay in the chain, a total of one magnetic relay common to all of said plurality of relays, timing means for actuating said common relay to alternate positions, means responsive to said operation to alternate positions for controlling the connection and disconnection of a direct current circuit through each of said plurality of relays in sequence, to operate said plurality of relays in sequence.

3. A relay chain circuit comprising a plurality of relays, one of said relays for each stage in the chain, each of said relays having a total of one winding and a total of two contacts for controlling said stages sequentially, said contacts being make contacts only, a single common relay having contacts thereon controlling all of said plurality of relays, a delay circuit individual to said common relay connected directly to said common relay, means responsive to the operation of any relay in said chain circuit for locking said operated relay in a circuit interconnecting said one winding on said operated relay and said contacts on said common relay, means responsive to the operation of any relay in said chain circuit for preparing a circuit for the operation of the next succeeding relay in said chain, and means responsive to the operation of said common relay for effectively connecting said delay circuit to said winding on said operated relay to delay its release until after said next succeeding relay in said chain has operated.

4. A relay chain circuit having a plurality of relays, one of said relays for each stage in the chain, each of said relays having a total of one winding and a total of two contacts for controlling said stages sequentially, each of said contacts being make contacts only, a single timing relay common to all of said relays, said relay including means for controlling the operation of all of said stages in sequence, said means comprising a first direct current circuit connected in parallel to said winding on each of a first group of relays in alternate stages in said chain responsive to a first condition of said timing relay and a second direct current circuit connected in parallel to said winding on each of a second group of relays in alternate stages in said chain responsive to a second condition of said timing relay.

5. A relay chain circuit having a plurality of stages, each of said stages having a single relay only, each of said relays having a single winding only thereon a stepping circuit for stepping said stages in said chain circuit either periodically or aperiodically, said stepping circuit having a single switch control only actuable to two conditions, a first direct current circuit, responsive to a first condition of said switch, connectable, in parallel, to said single winding in each of a first group of alternate stages in said chain, and a second direct current circut, responsive to a second condition of said switch, connectable, in parallel, to said single winding in each of a second group of alternate stages in said chain and means responsive to the alternate connection of said first direct current circuit and said second direct current circuit to said first stages and said second stages for actuating all of said stages in sequence.

6. A relay chain circuit having a plurality of stages, each of said stages having a single relay only, each of said relays having a single winding, only, thereon, each of said relays having contacts thereon, a timing circuit for stepping said stages, said timing circuit having a single switch control actuable to two conditions, a first circuit, connectable, in parallel, to said single winding in each of a first group of alternate stages in said chain, establishable in response to a first condition of said control, a second circuit connectable in parallel to said single winding in each of a second group of alterate stages in said chain, establishable in response to a second condition of said control, an individual circuit connectable

through said contacts on said relay in each stage to a single common circuit, said individual circuits from alternate stages connected in multiple, each of said multiple connections connected through individual paths in said timing control to said single common circuit, and means responsive to the actuation of said control to alternate conditions for establishing said alternate paths, to prevent the connection of more than one of said individual circuits to said common circuit simultaneously.

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