

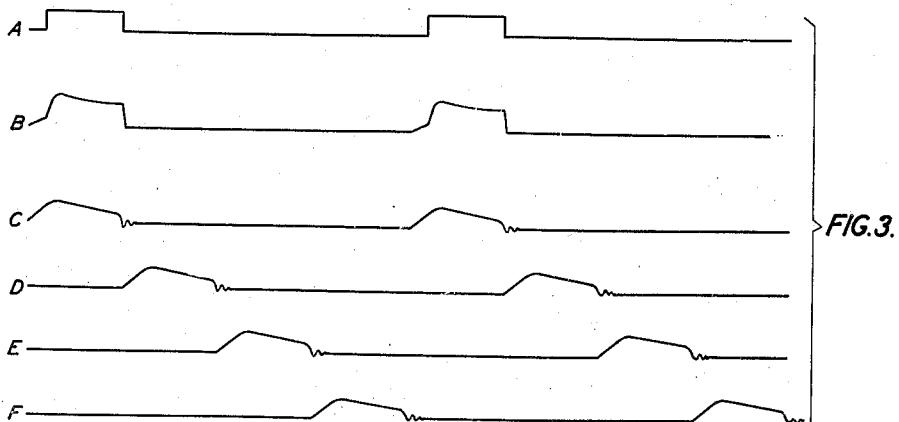
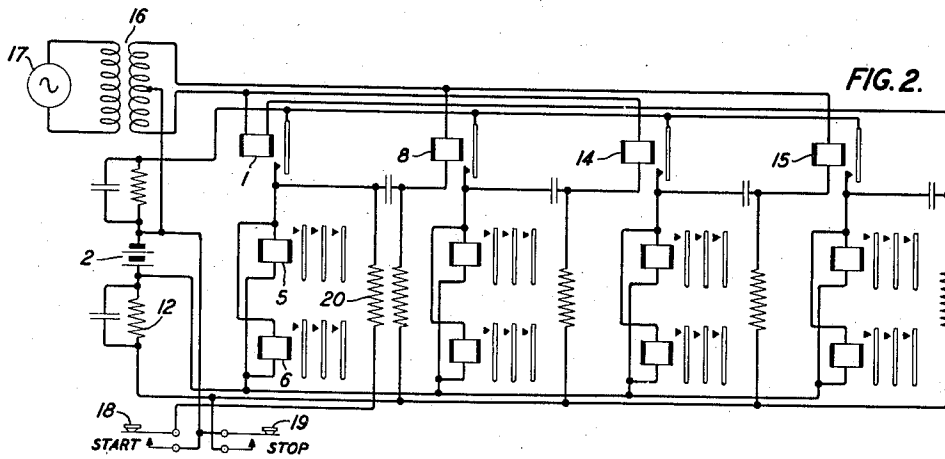
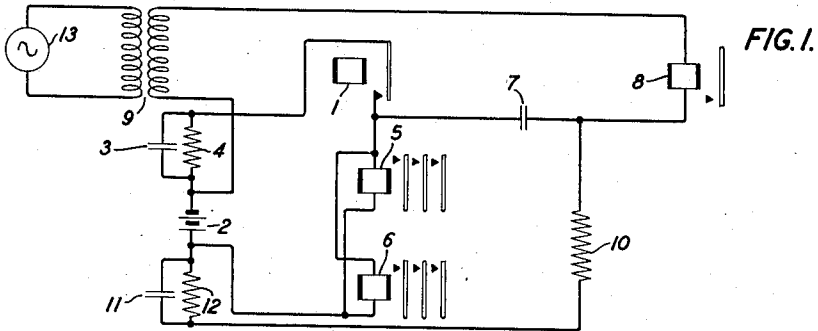
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RELAY OPERATION

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## RELAY OPERATION

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This invention relates to chain relay circuits and particularly to means for continuously and successively operating a plurality of sets of contacts.

The object of the invention is to provide simple means comprising a plurality of units each containing a load relay and a drive relay which will operate continuously and automatically. The principle of operation is to provide a contact operated by the drive relay of a preceding unit to operate the load relay so that the load relay will be operated as long as the drive relay of such preceding unit is operated. Upon the deenergization of such preceding drive relay there is a certain amount of energy stored in the winding of the load relay and this is now dissipated through the winding of the drive relay of the unit. This drive relay thereupon operates and causes the energization of the load relay of the succeeding unit. However, the energy stored in the load relay of the unit is soon dissipated and the drive relay is released. It will be seen that by placing a plurality of these units in a series arrangement and particularly in a closed ring that the load relays will operate successively and continuously.

A feature of the invention is the use of single make contacts only such as are provided by the Ellwood sealed reed relay contact disclosed in Patent No. 2,289,830 granted to W. B. Ellwood July 14, 1942. Heretofore a number of chain or counting relay circuits have been devised but in general each one depended on some complicated circuit arrangement making use of both back and front contacts, continuity contact arrangements and a plurality of contact sets. Applicant achieves great simplicity and economy by his use of simple make contacts.

In accordance with another feature of the invention the speed of operation of the units of the chain circuit may be increased and rendered regular and uniform by introducing a source of alternating current, of a frequency somewhat greater than the normal periodicity of operation, into the circuit of the drive relay. In accordance with this feature the drive relay is biased with alternating current and direct current so that rise and fall of its energization is slight and varies above and below the release value of the relay. This addition of a small influence of regular periodicity is enough to cause more regular operation than that which depends on the circuit constants alone.

In accordance with another feature of the invention the introduction of this source of alternating current is reversed in each succeeding cir-

cuit unit whereby the successive operation of the load contacts is at a rate the double of the cyclic rate of the said alternating current.

Other features will appear hereinafter.

The drawing consists of a single sheet having three figures, as follows:

Fig. 1 is a circuit diagram showing the power source and a single unit circuit;

Fig. 2 is a more complete circuit diagram showing the interconnection of four unit circuits in an arrangement wherein the four unit circuits will operate continuously in rotation; and

Fig. 3 is a time current diagram such as would be produced by an oscillograph used herein to explain the mode of operation of a unit circuit.

The operation of the unit circuit may be explained by a consideration of Fig. 1. Drive relay 1 is energized in a manner which will appear hereinafter by a preceding unit circuit. Its energization is momentary so that its contact is only closed for a brief interval of time. Upon the energization of relay 1, current will flow from battery 2, through the network consisting of condenser 3 and resistance 4, the armature and contact of relay 1, thence in parallel through the two load relays 5 and 6 back to the battery 2. The load relays will operate and close their contacts for any useful purpose. Shortly thereafter relay 1 will become deenergized. Thereupon the energy stored in the inductive windings of the load relays 5 and 6 will produce a surge in the form of an impulse which will flow through the condenser 7 and thence in one branch circuit through the drive relay 8, secondary of transformer 9, battery 2 to the other terminal of the load relays and in another branch circuit through the resistance 10 and the network consisting of the condenser 11 and resistance 12 to the other terminal of the load relays. This surge is sufficient to operate the drive relay 8 to operate the next unit circuit as the corresponding relay 1 has operated this circuit. The period of time over which relay 8 will remain operated depends on the value of the circuit elements 10, 11 and 12 and may be adjusted to any desired value by the proper selection of these elements.

The transformer 9 may lead from a source of alternating current 13 whereby the operation of relay 8 may be further controlled and made more uniform particularly as between a plurality of unit circuits. If the operation of relay 8 depended only on the values of the circuit elements including the capacity 7 and the inductance of the load relay windings, it would require great nicety of selection and adjustment to provide a

plurality of unit circuits to operate exactly alike. The introduction of this source of alternating current lends great regularity to the operation of the unit circuits without the nicety of selection of circuit elements otherwise required.

The connection of the secondary of transformer 9 in series with the drive relay 8 of the succeeding unit acts as a periodical regulator of the current which will flow through the condenser 7 and the relay 8, upon the opening of the contacts of relay 1. The instantaneous value of the alternating current thus supplied will aid or will oppose the flow of current from the windings of relays 5 and 6 upon the opening of the contacts of relay 1 so that the operation of relay 8 will be delayed if the alternating current is opposing and will be hastened if the alternating current is aiding. This, of course, tends to time the operation of relay 8 so that it will always operate on an increasing and aiding value of the alternating current wave, thereby making the operation of the various drive relays occur with the same regularity as the alternations of current from the source 13.

Fig. 3 is a graphical illustration of the operation of certain of the parts of the arrangement shown in Figs. 1 and 2. It consists of six traces drawn from oscillographic records. Trace A represents the intervals during which the contacts of the load relays 5 and 6 are closed. During the long intervals while these contacts are open the contacts of the succeeding load relays will be closed, the trace A therefore representing the action of only one pair of load relays in an arrangement of four unit circuits.

Trace B represents the current in the windings of the load relays 5 and 6 and requires no special comment.

Trace C represents the current in the winding of the drive relay 1. Similar traces D, E and F represent the currents in the succeeding drive relays, being shown in this manner to bring out the time relationship between them. Thus as the current in the winding of drive relay 1 falls off to zero and due to the opening of the contact of this relay, the current in the winding of drive relay 8 begins to rise. A similar relationship will be seen between each drive relay and its successor.

In Fig. 2 the drive relays are numbered 1, 8, 14 and 15 and they will become operated repeatedly in that order. It will be noted that each other drive relay is connected to a different terminal of the transformer 16. This arrangement is made so that the negative as well as the positive half cycles of current from the source 17 may be used so that if the source 17 is a 60-cycle source the operation of the drive relays will be at the rate of 120 per second or the cyclic operation of the complete circuit will be at the rate of 30 per second.

In Fig. 2 a start key 18 is provided by which the load relays 5 and 6 may be energized through the resistance 20. Upon the release of the key 18 the drive relay 8 will be energized in the same manner as when drive relay 1 opens its contacts and the cyclic operation of the whole circuit will proceed as described.

A complete cycle of operations of the circuit of Fig. 2 will be as follows. In the course of operation of the circuit, relay 1 will operate and close the circuit for the corresponding drive relays 5 and 6. The operation of relay 1 is only momentary since it occurs through the discharge of the energy from the load relays of the preceding stage, associated with drive relay 15, and the

associated condenser and aided by the alternating current from the lower half of the secondary winding of transformer 16, and is thus of short duration. Upon the release of relay 1, the energy stored in the windings of relays 5 and 6 will be spilled into the next drive relay 8 which will close its contacts and cause the energization of its associated load relays shown directly below relay 8. Upon the release of relay 8 the energy stored in the windings of its associated load relays will cause the operation of the next drive relay 14 which will thereupon result in the operation of the load relays shown directly below relay 14. Upon the subsequent release of relay 14, the energy stored in the windings of its associated load relays will cause the operation of the next drive relay 15 which will thereupon result in the operation of the load relays shown directly below relay 15. Upon the subsequent release of relay 15 the energy stored in the associated load relays will be spilled into the first drive relay 1 and the cycle of operations thus shortly described will be repeated continuously and automatically until stopped as by the operation of key 19.

The operation of the circuit may be stopped by operating the stop key 19. This will bridge the resistance 12 across the battery 2 and stop any further energization of the load relays. Thereupon the action of the drive relays will cease and the operation of the circuit as a whole will come to an end.

What is claimed is:

1. A circuit for operating contacts in succession comprising a plurality of unit circuits arranged in a chain, each said unit comprising a circuit closing contact operated by a drive relay of a preceding unit, a load relay operated by said circuit closing contact, contacts operated by said load relay and a drive relay for operating a circuit closing contact of a succeeding unit, and circuit connections between the winding of said drive relay and the winding of the load relay whereby the drive relay is operated responsive to energy stored in the winding of said load relay when said energy is released by the opening of said first circuit closing contact.

2. A circuit for operating contacts in succession comprising a plurality of unit circuits arranged in a chain, each said unit comprising a circuit closing contact operated by a drive relay of a preceding unit, a load relay operated by said circuit closing contact, contacts operated by said load relay and a drive relay for operating a circuit closing contact of a succeeding unit, and circuit connections between the winding of said drive relay and the winding of the load relay whereby the drive relay is operated responsive to a transient current resulting from the release of energy stored in the winding of said load relay upon the opening of said first circuit closing contact.

3. A circuit for operating contacts in succession comprising a plurality of unit circuits arranged in a chain, each said unit comprising a circuit closing contact operated by a drive relay of a preceding unit, a load relay operated by said circuit closing contact, contacts operated by said load relay, a drive relay for operating a circuit closing contact of a succeeding unit, and a source of alternating current in series with said drive relay, and circuit connections between the winding of said drive relay and the winding of the load relay whereby the drive relay is operated responsive to energy stored in the winding of said load relay when said energy is released by

the opening of said first circuit closing contact and to current from said source of alternating current.

4. A circuit for operating contacts in succession comprising a plurality of unit circuits arranged in a chain, each said unit comprising a circuit closing contact operated by a drive relay of a preceding unit, a load relay operated by said circuit closing contact, contacts operated by said load relay, a drive relay for operating a circuit closing contact of a succeeding unit, and a source of alternating current in series with said drive relay, and circuit connections between the wind-

ing of said drive relay and the winding of the load relay whereby the drive relay is operated responsive to energy stored in the winding of said load relay when said energy is released by the opening of said first circuit closing contact and to current from said source of alternating current, the polarity of said alternating current source being reversed between adjoining units whereby the periodicity of the successive operation of said load relay contacts is equal to twice the frequency of said alternating current.

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