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N. H. CLOUGH

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CONTROL APPARATUS FOR RADIOBEACON SYSTEMS

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Fig. 1

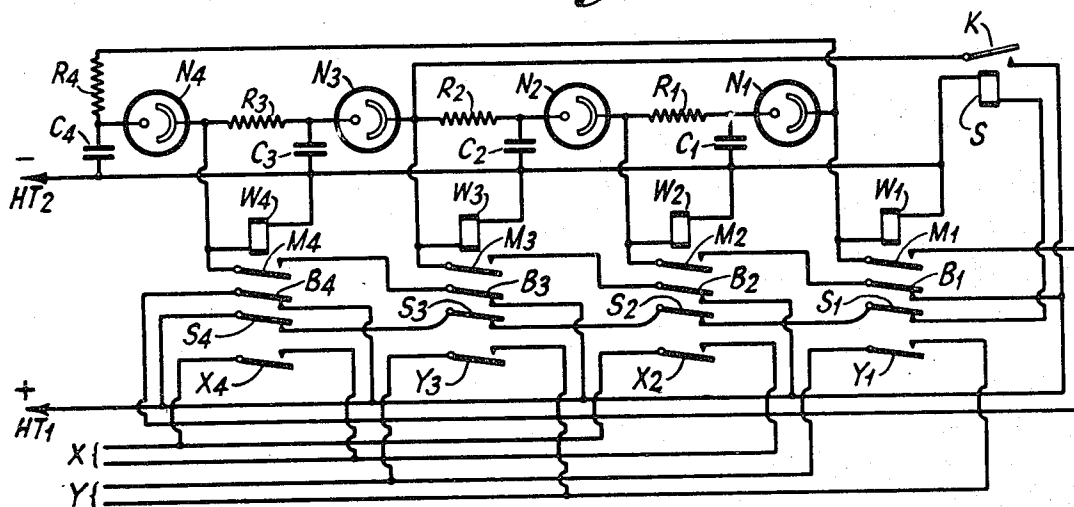


Fig. 2

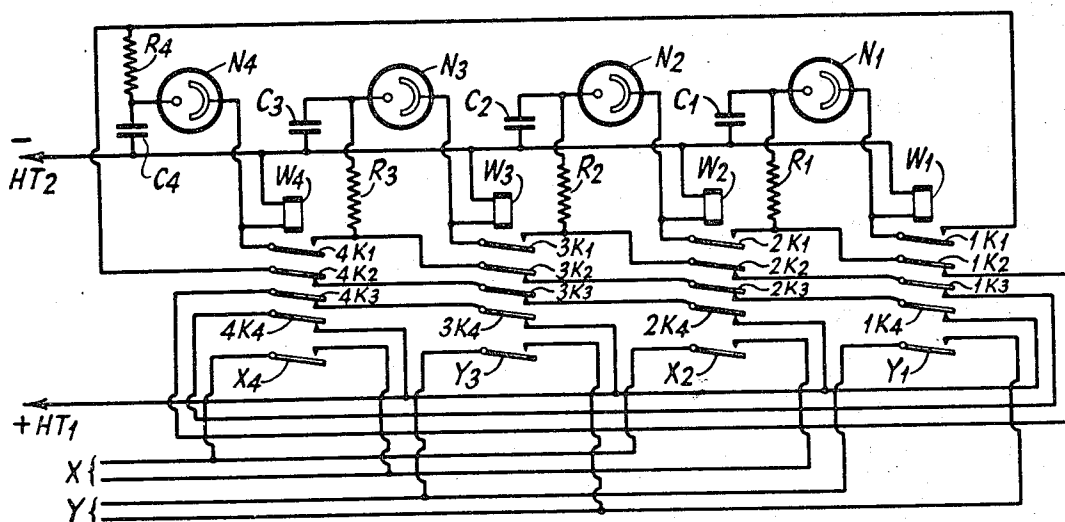
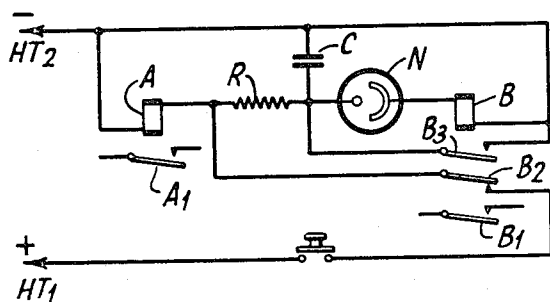


Fig. 3



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CONTROL APPARATUS FOR RADIOBEACON SYSTEMS

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4 Claims. (Cl. 175—320)

This invention relates to electrical control apparatus and has for its object to provide electrical control apparatus adapted to control radio transmitting or other apparatus in such manner as to produce repeatedly desired signals or combinations of signals.

The invention is of wide application but an important application of the said invention is to navigation aiding radio transmitters of the equi-signal and similar types wherein predetermined combinations of signals are required to be repeatedly and periodically transmitted. For example, in one well known type of equi-signal transmitter two directional overlapping radiations are transmitted to produce an equi-signal zone in the overlap area, one of said radiations being keyed or modulated with one and the other with another of two complementary or interlocking signals, for example, the Morse letters A and N or the Morse letters E and T. In known apparatus of this kind it has been usual to generate the complementary signals by means of cam-operated switches or commutators driven by clockwork for other rotary driving means. The present invention, as will be seen later, provides apparatus whereby desired signals may be repeatedly and periodically obtained without the use of clockwork or other rotary machinery and by apparatus involving the minimum of mechanically moving parts.

According to the main feature of this invention, electrical control apparatus suitable for use for the purpose specified comprises a plurality of condensers each having its own charging circuit designed to permit the appropriate condenser to charge to a predetermined voltage in a predetermined time, and a glow discharge tube in series with a relay winding in shunt with each condenser, each relay winding controlling the operation of a plurality of contacts which include contacts for exercising the desired control functions and at least two pairs of additional contacts, said additional contacts being included in circuit with the relay windings and the additional contacts on the respective relays being interconnected so that the condensers charge one at a time in predetermined sequence the completion of the charge in any one condenser to a voltage sufficient to break down the associated glow discharge lamp causing (through the energization of the associated relay) a breaking of the energizing circuit for the relay which was last energized.

The control by each relay winding of the associated plurality of contacts may be direct, i. e.,

each winding may actually operate the said contacts or, in order to reduce the load upon the winding, each winding may operate directly only a single pair of contacts which are in the circuit of the winding of a subsidiary relay which operates the said plurality of contacts, there being thus one subsidiary relay associated with each of the first mentioned relay windings.

The invention is illustrated in the accompanying drawing in which:

Figure 1 shows diagrammatically a typical circuit arrangement adapted to control a pair of radio transmitters for use in an equi-signal beacon of the complementary signal type;

Fig. 2 show a modification of the circuit arrangement, and

Fig. 3 shows an alternative feature which may be used under certain conditions.

Referring to Fig. 1, there are four relay windings W1, W2, W3 and W4. Each relay winding is shunted by a series circuit consisting of a condenser and a neon or other glow discharge tube in series, the condensers being marked C1, C2, C3 and C4, and the tubes being marked N1, N2, N3 and N4. Charging resistances R1, R2, R3 and R4 are provided, one for each condenser, the charging potential being obtained from a source (not shown) which is connected at HT1, HT2. In the arrangement illustrated each relay is arranged to operate four pairs of contacts directly without the interposition of a subsidiary relay, but as hereinbefore stated, indirect operation may be resorted to. The contacts marked M1, M2, M3 and M4 are "holding" circuit contacts for the various relays; the contacts marked B1, B2, B3 and B4 are "releasing" contacts for the various relays; the contacts marked S1, S2, S3 and S4 are "starting" contacts; and the contacts marked Y1, X2, Y3, and X4 are "operating" contacts.

It is thought that the operation of the arrangement will to a large extent be understood from the figure itself. Ignore for the moment the contacts S1, S2, S3 and S4 and suppose that one of the relays, for example, the relay having winding W1, is moved by hand into its energized or operated position. The contacts M1 are thus closed and the relay winding W1 will maintain itself in energized condition through the said contacts M1. Simultaneously the condenser C4 will commence to charge through a circuit including the resistance R4 the contacts M1 and the contacts B4. When the potential across condenser C4 reaches a sufficient value to "break down" the tube N4, the said condenser will discharge through the tube N4 and winding W4 in series, operating the relay

in question and accordingly closing the contacts M4 and opening the contacts B4. The opening of contacts B4 opens the circuit for the winding W1 and the closing of the contacts M4 closes a holding circuit for the winding W4. Upon examination of the figure it will be seen that a similar interlocking action applies between all the relays, which will close, one at a time, in succession. The next relay to close will be the relay having winding W3; the next relay to close will be that with winding W2 and so on with cyclic repetition.

In practice it is obviously inconvenient to start the action by closing a relay by hand, and accordingly a starting relay having a winding S is provided. This relay S operates to close contacts K thus completing a circuit across the D. C. terminals HT1 and HT2, through the winding of relay W3. The operating circuit for relay S may be traced across the terminals HT1 and HT2, and is completed only when all of the series-connected contacts S1, S2, S3 and S4 are simultaneously closed, that is, when the operation of the system is to be started. During sequence operations of the device the holding circuit for each relay is caused to lock its own relay and to de-ionize the associated glow tube by applying positive potential to the cathode thereof. Since each pair of holding circuit contacts for one relay is in series with a pair of contacts which are opened by a subsequently operable relay, it will be clear that the locking circuits are arranged to be closed and opened in succession, thereby producing a sequential action of the relays and associated glow tubes.

The contacts X4, X2, Y3 and Y1 are operating contacts, X4 and X2 being in parallel across the leads X (which are the control leads for one transmitter—not shown) and the contacts Y1 and Y3 being in parallel across the leads Y (which are the control leads for the other transmitter—not shown). The supply voltage, the various charging circuits and the glow discharge tube ignition voltages are so chosen that the various charging times are of the desired values appropriate to the signals desired. The operating speed of the whole arrangement can obviously be varied by varying the potential applied at the terminals HT1, HT2.

In Fig. 1 the various relay contacts are shown in their normal positions; that is to say, in the positions they occupy when the operating windings associated therewith are not energized.

Fig. 2 of the accompanying drawing shows a modification of the arrangement shown in Fig. 1. In this modification each relay operates either directly as shown, or through a subsidiary relay, five pairs of contacts instead of, as in Fig. 1, four pairs of contacts. Of these contacts X4, Y3, X2, Y1 correspond to and serve the same purpose as the correspondingly referenced contacts of Fig. 1. The other contacts are marked 1K1, 1K2, 1K3, 1K4 for relay winding W1; 2K1, 2K2, 2K3, 2K4 for winding W2; 3K1, 3K2, 3K3, 3K4 for winding W3; and 4K1, 4K2, 4K3 and 4K4 for winding W4, those with the suffix "1" e. g., 1K1, 2K1, etc., being holding circuit contacts (corresponding to the contacts M of Fig. 1), all other "K" contacts being releasing contacts, (corresponding to contacts B of Fig. 1). As will be seen, assuming that all the relays are in de-energized position (that shown) all the condensers C1, C2, C3, C4 will commence to charge as soon as positive potential is applied at HT1. The charging circuit for C1 includes 1K2, 4K3

and 3K4; that for C2 includes 2K2, 1K3 and 4K4; that for C3 includes 3K2, 3K3, and 1K4; and that for C4 includes 4K2, 3K3 and 2K4. One discharge device N1, N2, N3 or N4 will breakdown first and the associated relay winding will accordingly be energized. Suppose the first to breakdown is N3. Then relay W3 will be energized and will maintain its own circuit by closing 3K1 breaking all the charging circuits except one by opening contacts 3K2, 3K3, and 3K4. The one charging circuit left complete will be that for condenser C2. When condenser C2 is charged sufficiently to breakdown device N2 the relay winding W2 is energized, the main circuit for W3 is broken at 2K2, the circuit of winding W2 is maintained at 2K1 and the charging circuit for C2 is broken at 2K2, the charging circuit for C1 being completed at 3K4. The only condenser now to charge is C1. When, in due course, N1 breaks down, W2 is de-energized, W1 is energized and self-maintained, C1 ceases to charge and C4 charges. The next relay winding to be energized will be W4 and then W3 and so on, the cycle repeating itself. If desired, each relay or subsidiary relay as the case may be, may be fitted with an extra pair of contacts connected to short circuit (when the relay winding is energized) the condenser whose discharge has occasioned energization of said relay, thus completing the discharging partly effected through the appropriate discharge lamp.

In some cases one or more of the characters in a signal to be transmitted may be of such short duration as to render it unnecessary to arrange for the corresponding relay winding to be self-maintaining. In such a case the maintaining contacts (the "K1" contacts of the accompanying Fig. 2) of the appropriate relay together with charging and breaking contacts (of other relays) connected therewith may be omitted and the maintaining contacts of the next relay in the sequence may be permanently short circuited. A case of this type is illustrated in the accompanying Fig. 3 which shows a two relay combination capable of switching a transmitter to transmit either E or T or interlocked E and T as may be required, for example, in an equi-signal "blind approach" navigation aiding radio system.

In Fig. 3 the two relay windings are indicated at A and B, a discharge lamp at N, a condenser at C, and a charging resistance at R. On closing the main switch condenser C begins to charge and does so until lamp N breaks down and, in so doing, energizes winding B. This breaks the circuit of A at B2 but such interruption is only momentary for, as soon as condenser C has sufficiently discharged, winding B is de-energized and contacts B2 reclose. The contacts B3 shown are optional; they serve to complete discharging of condenser C. The contacts A1 associated with winding A may be used for the T signal and the contacts B1 for the E signal.

In some cases it may be desired so to arrange matters that one and the same relay acts as a change-over relay to switch one signal on and the other off, instead of using (as in Fig. 1) one relay for switching off and another for switching on. For example, the embodiment illustrated in Fig. 1 might be modified by transferring contact X4 so as to be operated by relay winding W3 (the transferred contact X4 being normally closed so that it opens when contact Y3 closes) and transferring contact X2 to be operated by relay winding W1 (the transferred

contact X2 similarly opening when contact Y1 closes). Again the transmitters or other signal source may be electrically interlocked in a manner similar to that which is described in my co-pending United States application, Serial No. 82,515 which was filed May 29, 1936. However, I now propose to omit the timing and charging circuits and to make or break a single contact on each of two alternately operable relays. Thus in Fig. 1 relays W1 and W3 may be utilized to "trigger" the interlocking circuit. The arrangement shown in the accompanying Fig. 3 is also suitable for use in combination with the electrically interlocked valve circuits of the above mentioned co-pending application.

I claim:

1. An electrical control apparatus suitable for use for the purpose specified comprising a plurality of condensers each having its own charging circuit, means including a glow discharge tube in series with a relay winding and in shunt with each condenser for enabling an appropriate condenser to charge to a predetermined voltage in a predetermined time, and means comprising contacts under control of each relay winding for exercising predetermined control functions, each said relay having at least two pairs of additional contacts, said additional contacts constituting holding and releasing circuit controlling means associated with the relay windings and with the glow tubes and so arranged that the respective relays and associated glow tubes are caused to be energized and de-energized in a predetermined sequence, one pair of said additional contacts being adapted to serve as holding contacts for its own relay and to de-ionize the glow tube associated therewith, and another pair of said additional contacts being adapted to release a previously energized one of said relays.

2. An electrical control apparatus suitable for use for the purpose specified comprising a plurality of condensers each having its own charging circuit, means including a glow discharge tube in series with a relay winding in shunt with each condenser for enabling an appropriate condenser to charge to a predetermined voltage in a predetermined time, a plurality of contacts under control of each relay winding, said contacts comprising means for exercising predetermined control functions and at least three pairs of additional contacts, one of said three pairs being a normally open pair of contacts in a charging circuit for the condenser associated with the next relay and also in a holding circuit for the relay winding with which it is itself associated, said holding and charging circuits including a normally closed second pair of contacts associated with the said next relay, the third pairs of contacts of all the relays being normally

closed contacts connected all in series with a starting relay, the whole arrangement being characterized in that, after operation of the starting relay the condensers are enabled to charge one at a time in predetermined sequence, the completion of the charge in any one condenser to a voltage sufficient to break down the associated glow discharge lamp causing (through the energization of the associated relay) a breaking of the energizing circuit for the relay which was last energized.

3. An electrical control apparatus suitable for use for the purpose specified comprising a plurality of condensers each having its own charging circuit, means including a glow discharge tube in series with a relay winding in shunt with each condenser for enabling an appropriate condenser to charge to a predetermined voltage in a predetermined time, a plurality of contacts under control of each relay winding, said contacts comprising means for exercising predetermined control functions and at least as many pairs of additional contacts as there are relays, one of said pairs being a normally open pair of contacts in a holding circuit for the relay winding with which it is itself associated, said holding circuit including in series a normally closed second pair of contacts associated with the next relay, a normally third closed pair of contacts associated with the next relay but one . . . and so on, all the contacts in said series circuit being also the only contacts in a charging circuit for the condenser associated with said next relay, the whole arrangement being characterized in that, upon switching on, all the condensers are enabled to begin charging but, when one has charged sufficiently to operate its associated relay through the appropriate discharge tube, said relay operates to maintain its own circuit and break all charging circuits for all except the next condenser, the condensers and relays thereafter charging and operating in cyclic succession.

4. Apparatus for exercising predetermined control functions in timed sequence comprising a circuit arrangement including a plurality of gaseous discharge tubes each in series with the winding of a relay, means including a condenser in shunt with each said tube and relay winding for storing an energy charge sufficient to produce a gaseous discharge in said tube, means including holding contacts operated by each said relay for locking itself, for de-ionizing its associated tube and for applying energy to one of said condensers subsequently chargeable, and means including circuit breaking contacts operated by each said relay for successively opening the circuits of the holding contact means.

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