

June 15, 1948.

J. J. NEFF

2,443,398

ELECTRONIC SEQUENCE TIMER

Filed Nov. 6, 1944

Fig. 1.

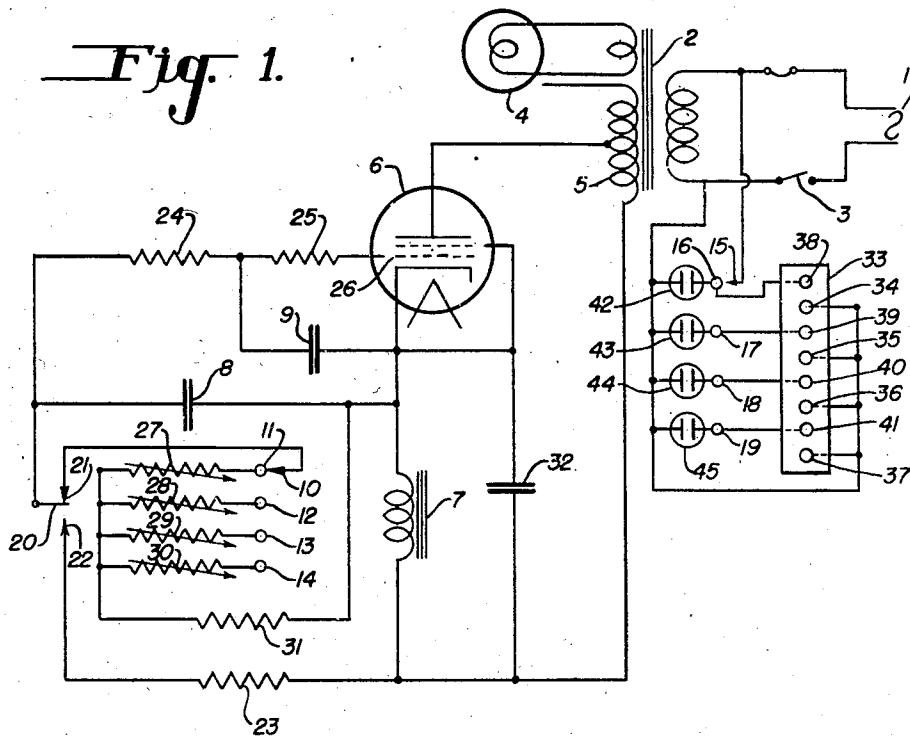
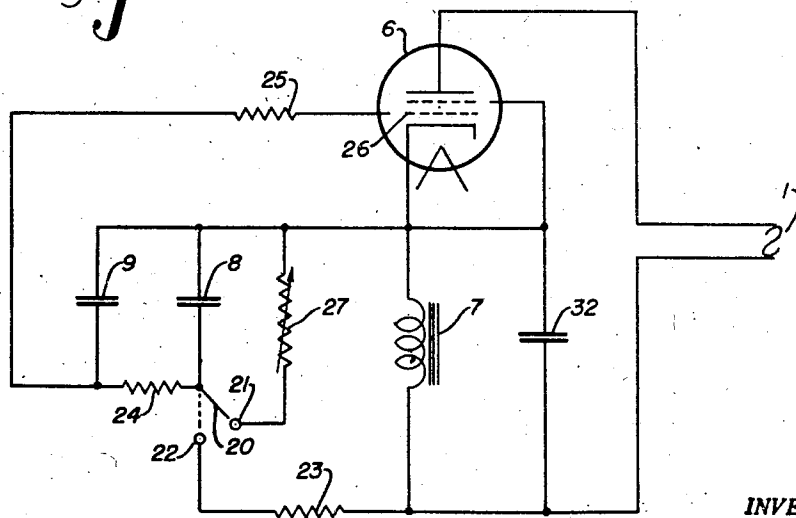


Fig. 2.



INVENTOR.

JOSEPH J. NEFF

BY

*Frank A. Harmon*  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,443,398

## ELECTRONIC SEQUENCE TIMER

Joseph J. Neff, South Euclid, Ohio, assignor, by  
 mesne assignments, to Jack & Heintz Precision  
 Industries, Inc., Cleveland, Ohio, a corporation  
 of Delaware

Application November 6, 1944, Serial No. 562,207

3 Claims. (Cl. 171-97)

1

This invention relates to an electronic system for measuring a succession of timed intervals for performing a sequence of operations and the like.

The object of the invention, in general, is to provide an electronic timing system of greater simplicity and of greater ruggedness and reliability than conventional systems for this purpose.

A further object is to provide a timing system based upon condenser charging and discharging cycles wherein a single timing circuit may be utilized for timing a succession of intervals of either uniform or non-uniform duration, without duplication of the system for each interval to be measured.

A further object is to provide an electronic timing system embodying charge accumulating means, a plurality of discharge circuits for discharging the accumulating means at different rates, and switching means operable in step-by-step action in response to charging and discharging cycles to effect a repetition of said cycles with said different discharge circuits successively, and to successively energize a corresponding plurality of external circuits successively.

The invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a wiring diagram of a preferred embodiment of such a system designed for controlling a sequence of four successive timed intervals or operations and;

Figure 2 is a simplified wiring diagram showing the basic elements of the timing circuit as applied to a single timing interval.

Corresponding circuit elements in Figures 1 and 2 are designated by the same reference numerals, the description of a single timing cycle being readable upon both Figures 1 and 2.

In Figure 1 the numeral 1 designates an A. C. power supply for a transformer 2 having a line switch 3, a pilot light 4 indicating when the system is energized. The secondary 5 provides a plate voltage for a thyatron type tube 6 connected in circuit with the motivating electromagnet 7 of a stepping switch, and timing condensers 8 and 9. The stepping switch is provided with a first movable contactor 10 adapted to progressively engage stationary contacts 11 to 14 upon successive energizations of the electromagnet 7, and a second contactor 15 movable successively over stationary contacts 16 to 19. The stepping switch also includes a switch arm 20 having a rest position in engagement with stationary contact 21 and being movable into engagement with stationary contact 22 while the electromagnet 7 is energized.

When the switch 3 is closed with the condensers 8 and 9 initially discharged, the potential of secondary 5 will ignite the thyatron 6

2

to energize the electromagnet 7, moving contactors 10 and 15 ahead one step and drawing the switch arm 20 into engagement with contact 22 to establish a charging circuit for the condensers 8 and 9, substantially the entire voltage drop of the secondary 5 occurring across the coil of electromagnet 7 when the thyatron is conductive. This voltage drop charges the condenser 8 through the resistor 23 and charges the condenser 9 through the resistors 23 and 24 in series so that as these condensers charge the voltage rise across condenser 9 will lag the voltage rise in condenser 8, the voltage across condenser 9 at any given instant being less than that across condenser 8. The resistor 25, connected to grid 26, is a current limiting resistor required by the tube 6.

The condensers 8 and 9 will continue to charge until the grid 26 attains a sufficient negative potential to extinguish the tube 6, which potential is relatively low in conventional thyratrons. Extinguishing of the tube 6 opens the circuit from the secondary 5 and de-energizes the electromagnet 7. De-energization of the electromagnet 7 causes the switch arm 20 to leave stationary contact 22 and move into engagement with contact 21 to establish a discharge circuit through one of the variable resistors 27 to 30. In Figure 1 the contactor 10 is shown resting upon the contact 11 connecting the resistor 27 in series with a fixed resistor 31 to discharge the timing condensers. At the moment of completing the discharge circuit the potential of condenser 8 is higher than the potential of condenser 9 so that the latter will continue to charge from the former, resistor 24 constituting a discharge path from condenser 8 in parallel with discharge resistors 27 and 31. The potential of condenser 9 will then rise as the potential of condenser 8 falls, until the two potentials are substantially the same, and thereafter both condensers will discharge in parallel through resistors 27 and 31. During this latter stage of the discharge it will be seen that the condenser 8 must discharge through the additional resistor 24 with the result that the fall of potential across condenser 9 will lag behind the fall of potential across condenser 8.

If the secondary 5 produces, for example, a potential of 250 volts, the voltage across condenser 8 may reach a peak value of 100 volts and the potential across condenser 9 at the time the tube is extinguished will be relatively small, inasmuch as a small negative potential on the grid 26 is effective to extinguish the tube. After the tube is extinguished, and the potential of condenser 8 begins to fall, the potential of condenser 9 will rise far above the value required to extinguish the tube. The condensers 8 and 9 will then ultimately discharge to potentials low enough to im-

pose an igniting potential on the grid 26. The condenser 32 serves as a filtering condenser around the electromagnet 7 to prevent vibration or chattering in the latter.

The re-ignition of the tube 6 will again energize the electromagnet 7 to repeat the previously described cycle, moving the switch arm 20 from the contact 21 to the contact 22 and moving the contactors 10 and 15 ahead one step. The two series of stationary contacts 11 to 14 and 16 to 19 are preferably disposed in circular arrangements so that contactors 10 and 15 may rotate always in one direction, moving from the last position to the first so as to repeat the sequence indefinitely as long as the switch 3 is closed. The possible number of timing intervals is thus limited only by the number of contacts which may be arranged in a circle for engagement by the revolving contactors.

A primary advantage of the present system is that the condensers 8 and 9 may be used for timing a plurality of successive intervals of different durations by merely adjusting the resistance values of the respective discharge resistors 27 to 30. In this way a rather wide range of time values may be obtained for successive intervals without duplication of the timing condensers or control tube.

A terminal strip 33 carries a plurality of terminals 34 to 37 connected to one side of the line and terminals 38 to 41 connected to the respective contacts 16 to 19 for a sequential energization by the contactor 15 to connect the line potential to successive circuits. Neon lamps 42 to 45 are connected with the contacts 16 to 19 in the manner shown to indicate which circuit is energized, and these lamps are preferably associated on a control panel with the respective manual controls for the variable resistors 27 to 30.

The present system is of especial utility in timing intervals for life tests of various mechanisms which may be inter-related in their operations, or which may be entirely unrelated, certain mechanisms operating for short intervals and others operating for longer intervals. Thus, while one mechanism is being operated the remainder are at rest, the sequence repeating automatically as long as the switch 3 is closed.

The values of voltage or other circuit constants mentioned in the foregoing description are cited merely by way of example and do not constitute a limitation on the structure or mode of operation, it being understood that any values of voltage, resistance or capacitance may be used in combination which will produce the described cycle of operation.

Whereas with a single timing condenser a charge of only approximately three volts could be accumulated before a conventional thyatron tube would be extinguished, resulting in a very short charging and discharging cycle, the action of the second condenser 9 is such as to enable the charge on the first condenser to reach a relatively high potential for timing purposes, thereby making available a relatively long discharging cycle. Moreover, the second condenser, by its delayed cycles of charging and discharging, still further extends the timing interval obtainable with a given capacitance and supply voltage. It is preferred to accomplish the charging cycle at a relatively fast rate, obtaining most of the measured time interval from the discharging cycle. In operation, the action of this system is found to be very reliable and steady so that once the variable discharge resistor is set to produce a

desired time interval, this interval will be faithfully reproduced for an indefinite number of succeeding cycles. This enables the variable resistors 27 to 30 to be accurately calibrated so that the desired time intervals may be adjusted by dial indexing means on the control panel.

Figure 2 shows the elements of the system of Figure 1 necessary to produce a single timing interval, and is pertinent to the foregoing description of the timing cycle. In Figure 2 the only functions of the electromagnet 7 would be to operate the switch arm 20 and a contactor to make and break a single circuit to the device to be timed. Also, in Figure 2 the transformer 2 has been omitted, the system being connected directly on the line 1.

#### I claim:

1. An electronic timing system comprising a stepping switch arranged in a thyatron circuit to advance one step each time the circuit is energized, a first condenser arranged for charging by a potential in said circuit, a second condenser in series with a resistance in a circuit parallel with said first condenser, a switch operable by said stepping switch to complete said charging circuit, a control grid responsive to the potential of said second condenser to ignite and extinguish said thyatron, said switch being operable by de-energization of said stepping switch to connect said condensers into a discharge circuit comprising a plurality of variable resistors, a contactor actuated by said stepping switch to connect said resistors into said discharge circuit sequentially in successive cycles of operation, and a contactor operable by said stepping switch to energize a plurality of circuits in succession and rotation wherein the interval of energization of each circuit is controlled by said variable resistors respectively.

2. An electronic timing system comprising a stepping switch arranged to energize a plurality of circuits successively, repeatedly and in rotation, a thyatron intermittently energizing said stepping switch, a first condenser arranged for charging by said thyatron circuit, a second condenser under the control of said first condenser for controlling the ignition and extinguishing of said thyatron in accordance with condenser potential, and a plurality of variable discharge circuits arranged for selection successively and in rotation by said stepping switch for the individual timing of the energization of the respective first named circuits.

3. An electronic timing system for controlling a plurality of external circuits in succession comprising means to accumulate an electrical charge, a charging circuit, a plurality of discharge circuits for discharging said charge accumulating means at different rates, and switching means operable in step-by-step action in response to charging and discharging cycles to effect a repetition of said cycles with said different discharge circuits successively and to energize said external circuits successively.

JOSEPH J. NEFF.

#### REFERENCES CITED

The following references are of record in the file of this patent:

#### UNITED STATES PATENTS

| Number    | Name   | Date         |
|-----------|--------|--------------|
| 2,320,916 | Dawson | June 1, 1945 |