June 13, 1933. D. R. PRICE 1,914,215

DIRECT CURRENT TIMING DEVICE

Filed May 6, 1931

Fig. 1.

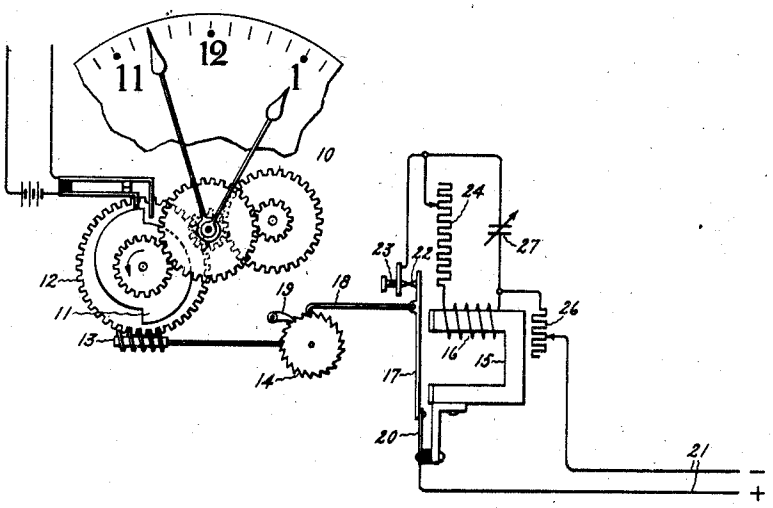
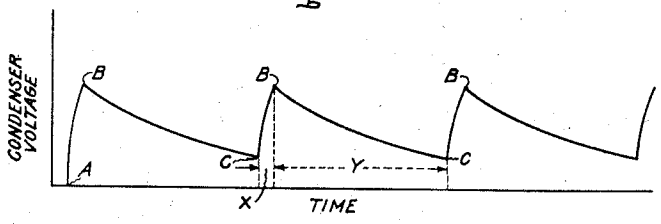


Fig. 2.



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UNITED STATES PATENT OFFICE

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DIRECT CURRENT TIMING DEVICE

Application filed May 6, 1931. Serial No. 535,550.

My invention relates to an electric timing device suitable for operation from a direct current source of supply.

The now well known synchronous motor driven timing device operated from an alternating current circuit of regulated frequency has certain advantages over spring driven timing device and a timing device having corresponding advantages is needed where direct current only is available. The primary object of my invention is to supply this need.

In carrying my invention into effect, I employ a condenser or other equivalent electric energy storage means together with a circuit and control arrangement for alternately charging and discharging the condenser to predetermined maximum and minimum voltages respectively. The duration of the cycle of operation thus produced constitutes the timing cycle of my invention. The constants of the condenser discharge circuits are maintained fixed so that the time necessary for the condenser to discharge from the maximum voltage to the minimum voltage is fixed and constant. The charging period of the condenser may vary slightly if the voltage of the source of supply varies. However, I make the charging period very much shorter than the discharge period so that the possibility of error on account of variations in the supply voltage is minimized. The control of the condenser charging circuit is preferably accomplished by an electromagnet and the energizing coil of this electromagnet is included in the condenser discharge circuit so that the operation of the electromagnet is responsive to the maximum and minimum voltages of the condenser. The armature of this electromagnet which is employed to open and close the condenser charging circuit is also employed to actuate either directly or indirectly any form of timing device.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention, reference is made in the following description to the accompanying drawing which represents in Fig. 1 a preferred embodiment of my invention as employed to operate a contact making clock, and Fig. 2 shows a voltage time curve of a condenser which will be referred to in explaining the operation of the invention.

Referring to Fig. 1 in the drawing, I have represented my invention as directly applied to the operation of a contact making clock. It might be used for any other timing purpose, such as to drive a chart of a recording instrument or for operating the timing element of a demand meter either directly as represented or through relay devices. As represented the clock indicated at 10 and the contact cam 11 are driven through worm gears 12 and 13 from ratchet wheel 14.

The ratchet wheel is operated by an electromagnet or ratcheting relay comprising the magnetic core 15, energizing winding 16, armature 17 and pawl 18. A stop pawl 19 may be added to prevent any appreciable backward movement of the ratchet wheel 14. The armature 17 is represented in its detracted position to which it is biased by its resilient spring pivot 20. The mechanical features thus far mentioned are old and may be varied to suit different operating requirements.

The arrangement for energizing coil 16 from a direct current source of supply so that the armature will be actuated at a uniform rate is believed to be novel. The direct current source is indicated at 21. One side of this source is connected to coil 16 through armature spring 20, the magnetic armature 17, a pair of contacts 22 and 23 and a resistance 24. The other side of the source is connected to the other side of the coil through resistance 26 which has a somewhat lower value than resistance 24. A condenser 27 is connected across the coil 16 in series with resistance 24 and in the operation of my device the condenser is alternately charged from source 21 when contacts 22 and 23 are closed and discharged through resistance 24 and coil 16 when the above-mentioned contacts are open. The contact 23, the resistances and the condenser are shown adjustable. They may be adjusted to obtain the desired relay actuating interval, but when properly adjusted for this purpose they ordi-

narily do not need further adjustment unless the time interval is to be changed. To give a practical example but not to limit the invention, it may be assumed that coil 16 contains 20,000 or more turns of fine wire, such as .003 inch enameled wire. Resistor 24 may have approximately 20,000 ohm resistance and 26 about 5,000 ohm resistance. The condenser 27 may have from one to five microfarads capacity. Such a combination may be used to reciprocate the armature 17 from about two complete operations a second to about one in five seconds depending upon the adjustment.

The operation of the device is as follows: In the position shown the armature 17 is in its detracted position and closes the charging circuit of the condenser to the source of supply. During this period a charging current flows to the condenser and the voltage across it gradually increases. Resistance 26 prevents an instantaneous charging of the condenser but allows the charge to build up gradually. The voltage of the condenser is also applied across resistance 24 and coil 16 so that when this voltage reaches the proper predetermined maximum value the electromagnet is energized sufficiently to attract armature 17 thereby opening the condenser charging circuit at contact 22. The condenser now discharges through coil 16. The current through coil 16 decreases as the condenser charge leaks off until a condition is reached where the magnetism of core 15 can no longer hold the armature 17 in the attracted position and the latter moves away under the action of spring 20 and closes the condenser charging circuit again. Owing to the materially different resistance relations in the charging and discharging circuits of the condenser the charging period is relatively short as compared to the discharge period.

Fig. 2 represents the relations mentioned above and shows the condenser voltage variation with respect to time. Curve AB represents the variation of condenser voltage with respect to time during an initial charging period, A representing zero voltage and B the maximum condenser voltage which is that value sufficient to actuate the electromagnet and open the charging circuit. Curve BC represents the condenser voltage with respect to time during a discharge period, C being the voltage where the current through coil 16 has decreased to a value where armature 17 is released. The values B and C are also proportional to the current which flows through coil 16. At point C some charge remains on the condenser so that the subsequent charging periods are represented by only portion CB of the initial charging curve. The charging time is therefore represented by the distance X and the discharge time by the distance Y and a complete timing cycle by the distance X plus Y.

It will be evident that the values B and C are independent of variations in the supply of voltage at 21. The time Y is also independent of such variations. The only time value that can change is the charging period X which is such a small portion of the total time involved in a complete cycle that it may be neglected in most cases where the supply of voltage is fairly constant. The time error incident to high and low voltage conditions will tend to cancel out in any event if the apparatus is calibrated for an average voltage condition.

In many cases timing devices are used for operating time switches, the resetting apparatus of demand meters and for other purposes where master clock accuracy is not required and my invention is suitable for such purposes even where the direct current source of supply varies somewhat.

It will not do to eliminate resistance 26 entirely except where a constant source of supply is available. Some means such as resistance 26 or its equivalent is desirable to prevent instantaneous charging of the condenser when the charging circuit is closed. The condenser should be charged at a sufficiently slow rate to enable the electromagnet to correctly select the predetermined voltage B at which charging is stopped. If the condenser were allowed to charge instantaneously the value B would rise and fall in proportion to variation in the supply voltage and the discharge time Y would no longer be constant.

The resistance characteristics of the circuits will preferably be made independent of temperature variations and resistance elements having the proper temperature coefficient of resistance to eliminate temperature errors should be used. Where the armature 17 is used in combination with a pawl 18 as represented to directly actuate a ratchet wheel, it will be desirable to arrange matters so that the armature will be attracted at the same value of flux in core 15 for all conditions of loading. The armature pawl 18 should preferably have the load removed therefrom at the instant of attraction. This may be accomplished by making its reciprocating movement slightly greater than the distance between the teeth in the ratchet wheel 14 so that no load is applied until the armature has moved towards the magnet 15 slightly and is thus subject to a stronger pull than its initial pull. The faces of the magnet 15 against which the armature rests when in the attracted position are preferably of non-magnetic material so that there will be no tendency for the armature to stick and will be released at the same value of flux at all times.

While only one embodiment has been illustrated and described, it will be evident to those skilled in the art that various changes

may be made in the arrangement of the different elements contained in the charging and discharging circuits, in the construction of the control relay, and in the values hereinbefore mentioned by way of example. Such modifications of the invention as fall fairly within the true spirit and scope of the invention are intended to be included in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. A timing device comprising electric energy storage means, means for alternately charging said energy storage means to a predetermined maximum voltage in a relatively short interval of time and discharging said energy storage means to a predetermined minimum voltage in a predetermined longer interval of time and time means operated in response to said predetermined maximum and minimum voltages, said timing device as a whole having a timing function dependent upon the length of the charging and discharging time intervals.

2. A timing device comprising a condenser, a direct current circuit for charging said condenser, an electromagnet having an energizing circuit connected across the condenser and comprising a discharge circuit therefor, and an armature for the electromagnet movable to attracted and detracted positions respectively in response to predetermined relatively high and low voltages across the condenser, said armature serving to open and close the condenser charging circuit in its attracted and detracted positions respectively, the charging and discharging circuits of the condenser having constants such that the charging and discharging periods of the condenser are of appreciable duration and the discharging period is appreciably longer than the charging period, said periods determining the timing function of the device.

3. A timing device comprising a condenser, a direct current circuit for charging said condenser, an electromagnet having an energizing circuit connected across said condenser and a movable armature for opening the charging circuit in response to a predetermined voltage across the condenser and closing the charging circuit in response to a predetermined lower voltage across the condenser, the charging circuit of the condenser including resistance means for preventing the condenser from being charged instantaneously when the circuit is closed, and the electromagnet energizing circuit containing resistance means for making the condenser discharge period appreciably longer than the charging period.

4. A timing device comprising a condenser, a charging circuit therefor, a direct current source of supply for said circuit, an electromagnet having an energizing circuit connected across the condenser, a movable armature for said electromagnet for alternately opening and closing the charging circuit in response to predetermined maximum and minimum voltages across the condenser respectively, and means for limiting the charging rate of said condenser so that it is charged sufficiently slowly that its maximum charge is determined by the opening of the charging circuit by the electromagnet and is independent of the supply voltage.

5. A timing device comprising a condenser, a charging circuit therefor, a direct current source of supply for said circuit, an electromagnet for alternately opening and closing said charging circuit in response to predetermined maximum and minimum degrees of energization of the electromagnet, a discharge circuit for said condenser including the energizing winding of said electromagnet whereby the charging circuit is opened in response to a predetermined voltage across the condenser and closed at a predetermined lower voltage across the condenser, the constants of the charging circuit being such that the maximum charge on the condenser is determined by the operation of the electromagnet and is independent of the voltage of the source of supply so long as such voltage is sufficient for the purpose described, and the constants of the discharge circuit being such as to make the discharge period materially longer than the charging period.

6. A timing device comprising a condenser, a direct current charging circuit and a discharge circuit therefor, an electromagnet having an armature movable to attracted and detracted positions for respectively opening and closing the condenser charging circuit and having an energizing coil included in the discharge circuit for the condenser, the arrangement being such that the condenser is alternately charged through the circuit closed by the armature and discharged through the energizing coil when the charging circuit is opened, the charging and discharging circuits having constants such that the charging period is of sufficient duration that the maximum condenser charge is determined by the opening of the charging circuit and the discharge period is of appreciably longer duration, and a timing device operated by the movement of said armature.

In witness whereof, I have hereunto set my hand.

DAVID R. PRICE.