

Jan. 4, 1944.

E. VROOM

2,338,218

TIME MEASURING DEVICE

Filed Dec. 11, 1942

FIG. 1

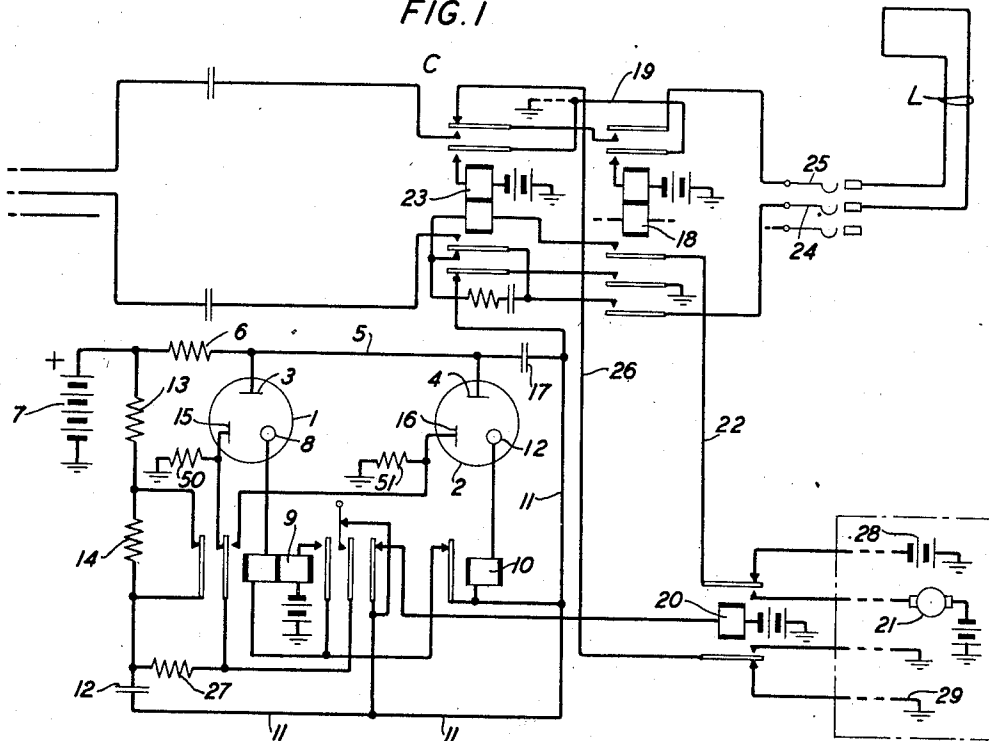
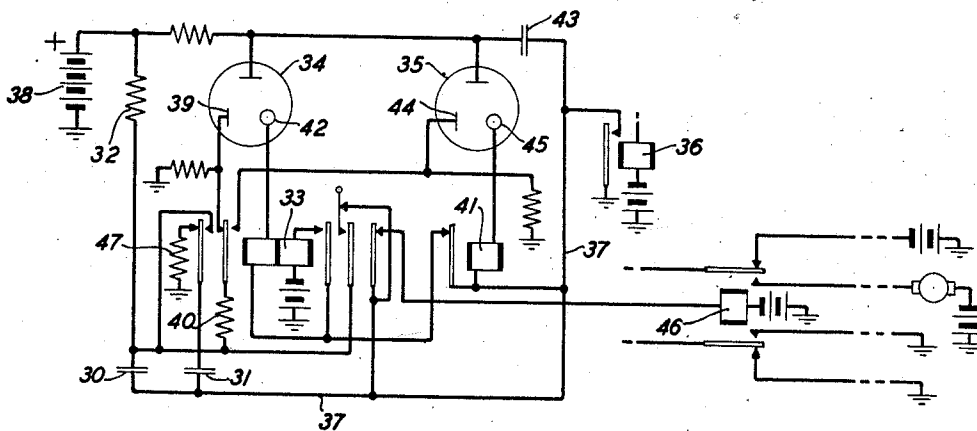


FIG. 2



INVENTOR
E. VROOM
BY *W. R. McFarney*
ATTORNEY

UNITED STATES PATENT OFFICE

2,338,218

TIME-MEASURING DEVICE

Edward Vroom, Ossining, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 11, 1942, Serial No. 468,657

5 Claims. (Cl. 179—84)

This invention relates to time-measuring and interrupting devices and particularly to these devices when used for controlling the closing and opening of circuits in signaling and other electrical systems.

The objects of the invention are to obtain a greater degree of accuracy in the measurement of time intervals, such as those used for signaling in telephone systems; to realize simplification and economy in the devices used for measuring these time intervals; to substitute electronic devices for the power-driven interrupters commonly used for measuring signaling intervals in telephone systems; and to effect other improvements in time-measuring and signaling systems.

The foregoing objects, as well as other advantages of the present invention, are realized by means of a time-measuring arrangement in which a pair of space discharge tubes are operated alternately and repeatedly under the control of a single time-measuring condenser which is charged in a first measured interval through one value of resistance to the operating voltage of one tube and is recharged in a second measured interval through another value of resistance to the operating voltage of the second tube, the operation of each tube serving to mark the termination of the associated measured interval. More specifically, the time-measured condenser is charged through a resistor in a desired interval of time until it reaches the ionizing voltage of the first tube, whereupon the tube discharges and operates a relay which serves to discharge the condenser, shift the connection of the condenser from the first tube to the second tube, and to include an additional resistor in the charging circuit. Thereupon the condenser recharges at a different rate until it reaches the ionizing voltage of the second tube and in so doing measures the second desired interval of time. The discharge of the second tube at the end of the second measured interval results in the release of the relay and the quenching of the first tube, whereupon the timing cycle is repeated. The operation of the relay when the first tube discharges marks the termination of the first measured interval, and the release of the relay at the time the second tube discharges marks the termination of the second measured interval.

The intervals thus measured may be equal or proportioned in any desired manner depending upon the values of the resistance included in the charging circuit of the condenser. The intervals measured by the relay may be utilized

in any well-known manner for controlling the opening and closing of electrical circuits, such as those used in signaling telephone subscribers' lines.

These and other features and advantages will be discussed more fully in the following detailed specification.

In the drawing accompanying the specification:

Fig. 1 discloses one embodiment of a time-measuring system incorporating the features of this invention; and Fig. 2 discloses an alternative form thereof.

Systems and devices designed for the measurement of one or more predetermined time intervals and for repeating the measured intervals cyclically have many uses in the electrical arts and particularly in telephone, telegraph and other communication systems where numerous circuit closures and openings must be formed in definite sequences. In automatic telephone systems, for example, there are many instances in which it is necessary to measure one or more definite intervals of time following the occurrence of some event, such as the operation or the release of a specific relay. Also in these systems the automatic signaling of a called subscriber requires a timing mechanism or interrupter designed to measure alternate ringing and silent intervals, the length of these intervals having definite and predetermined values. It has been common practice in the past to obtain these measured intervals by means of mechanical interrupters which generally involve rotating or other power-driven devices. In the system of the present invention it is proposed to dispense with these mechanical time-measuring devices and substitute therefor a simplified arrangement including a pair of cold-cathode gas-filled discharge tubes. This new tube interrupter system not only has the advantages of simplicity and economy compared with other forms of time-measuring devices, but it is also capable of a high degree of accuracy and precision in the measurement of the desired intervals. To illustrate one of the many uses of the present invention, the tube interrupter has been shown herein when incorporated in an automatic telephone system for the purpose of controlling the application of ringing current to subscribers' lines.

Referring to Fig. 1 of the drawing, the time-measuring interrupter is illustrated therein in conjunction with a connector switch C for controlling the application of ringing current to

subscribers' lines, such as the line L. The interrupter includes a pair of gas-filled discharge tubes 1 and 2 which may be of any suitable and well-known type. These tubes have a main anode and a main cathode forming the main discharge gap and also an auxiliary anode which forms a starting gap with the main anode. The main anodes 3 and 4 are connected over the common conductor 5 and through the common resistor 6 to the positive pole of battery 7. The cathode 8 of tube 1 is connected through the operating winding of relay 9 and the normal contact of relay 10 to the ground conductor 11, and the main cathode 12 of tube 2 is connected through the winding of relay 10 to said conductor 11. The resistors 50 and 51, which are high enough in value to prevent interference with the normal operation of the tubes serve to drain off extraneous potentials that might otherwise accumulate on the starting anodes 15 and 16.

The system also includes a single time-measuring condenser 12 which is capable of measuring two separate time intervals, the operation of tube 1 serving to mark the completion of one of these intervals and the operation of tube 2 serving to mark the completion of the other interval. Since it is frequently desirable to have these two intervals of unequal duration, the first one is measured by charging the condenser 12 through resistor 13, and the second one is measured by charging the condenser through resistors 13 and 14 in series. When relay 9 is in its normal position, the condenser 12 is connected across the starting gap formed by the cathode 8 and starting anode 15 of the tube 1, and the resistor 14 is excluded by a short circuit, leaving only resistor 13 in the charging circuit of the condenser. After the tube 1 has discharged and relay 9 has operated, the condenser 12 is disconnected from tube 1 and is connected across the starting gap formed by the cathode 12 and starting anode 16 of tube 2 and resistor 14 is included in the charging circuit of the condenser. When the tube 2 operates at the end of the second measured interval and relay 10 becomes energized, relay 9 releases and restores the circuits to their original condition in order that the measuring cycle may be repeated.

A condenser 17 is connected between the main anodes of the tubes and the ground conductor 11 and serves to accumulate sufficient energy during each of the measured intervals to operate the associated tube in response to the ionization of its starting gap.

The operation of the system will now be described, assuming that a telephone call has been extended over connector C to the called subscriber's line L and that the cut-through relay 18 has been operated in the usual manner to start the ringing operation. The relay 18 operates over its lower winding and locks over its upper winding and contact to the holding conductor 19. As soon as relay 18 operates a circuit is closed from battery through the winding of relay 20, normal contacts of relay 9, conductor 11, normal contacts of relay 23, to ground at the front contacts of relay 18. Relay 20 operates and applies ringing current to the line L over a circuit traceable from battery, through the common ringing generator 21, front contact of relay 20, conductor 22, front contact of relay 18, lower winding and normal contact of ringing trip relay 23, front contact of relay 18, brush 24, thence over the subscriber's line, through the bell there-

at and returning through brush 25, front contact of relay 18, normal contact of relay 23, conductor 25, front contact of relay 20 to ground over the common ringing circuit.

While ringing current is thus being applied to the called line, the first or ringing interval is undergoing measurement by the interrupter circuit. To this end the operation of relay 18 results in the closure of a charging circuit for condenser 12 from the positive pole of battery 7, resistor 13, normal contacts of relay 9, condenser 12, to the grounded conductor 11. At the end of this measured interval the condenser 12 has acquired a charge which is just sufficient to ionize the starting gap 8-15 of the tube 1. During this interval the condenser 17 also acquires a charge in a circuit from the positive pole of battery 7, resistor 6, conductor 5, condenser 17, to the grounded conductor 11. Although the resistor 6 is fairly high, the condenser 17 is also relatively large and acquires a substantial charge during the measured interval. At the end of the first measured interval the charge on condenser 12 ionizes the starting gap 8-15, the circuit therefor being traceable from the cathode 8, through the left winding of relay 9, normal contacts of relay 10, conductor 11, condenser 12, resistor 27, normal contacts of relay 9, to the starting anode 15. Upon the ionization of the starting gap of tube 1, the charge on condenser 17 causes the flow of current for the main discharge gap of the tube over a circuit traceable from the left-hand terminal of the condenser, conductor 5, anode 3, cathode 8, left-hand winding of relay 9, normal contacts of relay 10, conductor 11, to the right-hand terminal of condenser 17. The current flow in this circuit is sufficient to operate the relay 9, whereupon the relay locks in a circuit from battery, through its right-hand winding and closed contacts, normal contacts of relay 10, to ground on conductor 11. As soon as the charge on condenser 17 has declined below the sustaining voltage of the tube 1, the tube quenches, but the relay 9 remains locked in the circuit above traced.

While the relay 9 is operating, its middle right-hand armature engages its continuity contacts thus establishing for a brief moment a discharge circuit for the condenser 12. This circuit may be traced from the upper terminal of said condenser, resistor 27, continuity contacts of relay 9, conductor 11, to the lower terminal of condenser 12. Thus the condenser 12 is fully discharged and is made ready for the measurement of the next interval of time. Relay 9, in operating, also releases relay 20, which disconnects the ringing generator 21 to terminate the ringing interval and to commence the silent interval. During this silent interval the battery 28 and ground lead 29 are connected over the back contacts of relay 20 to the subscriber's line L to furnish energy for operating the tripping relay 23 in the event a subscriber responds during the silent interval.

During the second measured interval, the silent interval, the condenser 12 is recharged in a circuit from battery 7, through both resistors 13 and 14 in series, condenser 12, to the grounded conductor 11. At the end of this interval the condenser 12 causes the ionization of the control gap 12-16 of the tube 2 over a circuit traceable from the upper terminal of the condenser, resistor 27, front contacts of relay 9, starting anode 16, cathode 12, winding of relay 10, conductor 11, to the other terminal of the con-

denser. During this second measured interval the condenser 17 again assumes a charge from the battery 7, and, when the control gap of the tube 2 ionizes, the condenser is discharged in a circuit traceable from its left-hand terminal, anode 4, cathode 12, winding of relay 10, conductor 11, to the other terminal of said condenser. The current flowing in this main discharge circuit is sufficient to energize the relay 10 momentarily. As soon, however, as the charge on condenser 17 is reduced below the sustaining voltage of the tube 2, the tube is quenched and relay 10 releases. When relay 10 operated, it opened the circuit of relay 9. Relay 9 releases and recloses momentarily at its continuity contacts the discharge circuit of condenser 12. Relay 9 also causes the reoperation of relay 20 to terminate the silent interval and to commence the next ringing interval. Furthermore, relay 9 disconnects the condenser 12 from tube 2 and reconnects it to tube 1 and closes the shunt circuit around the resistor 14. In this manner the cycle of ringing and silent intervals is measured repeatedly until the called subscriber responds or until the connection is released.

When the called subscriber answers, the ringing trip relay 23 operates and locks and in so doing opens the ringing circuit and removes ground potential from conductor 11. The removal of ground potential from conductor 11 releases either relay 9 or relay 20 depending on which one is operated at the time and discontinues the time-measuring operation.

The release of the connector switch is effected in the well-known manner by removing ground potential from the hold conductor 19, permitting relays 18 and 23 and other energized relays to restore to their normal positions.

In the alternative time-measuring system shown in Fig. 2, the two separate intervals per cycle are measured respectively by condensers 30 and 31 of different capacities. First the condenser 30 is charged in series with resistor 32 to measure the first interval of time, and then the condenser 31 is charged through the same resistor to measure the second interval of time. As in the system of Fig. 1 the relay 33 serves to connect the condenser 30 to the tube 34 and the condenser 31 to the tube 35 alternately and repeatedly.

When relay 36 operates and applies ground potential to conductor 37, condenser 30 charges from the battery 38 in series with resistor 32 to measure the first interval. At the end of this interval the charge on condenser 30 ionizes the control gap of tube 34 over a circuit traceable from the anode 39, normal contacts of relay 33, resistor 40, condenser 30, conductor 37, normal contacts of relay 41, left winding of relay 33, to the cathode 42. The tube 34 discharges, and relay 33 operates from the energy stored in condenser 43. Relay 33 locks to the grounded conductor 37, discharges condenser 30 at its continuity contacts, disconnects condenser 30 from the starting anode 39 of tube 34 and connects condenser 31 in the charging circuit and also across the discharge gap 44-45 of tube 35. Furthermore, relay 33 releases relay 46 to terminate the ringing interval.

The condenser 31 is now charged to measure the second interval in a circuit from battery 38, resistor 32, front contacts of relay 33, condenser 31 to the grounded conductor 37. Condenser 30 is also charged during this interval but performs no useful function. At the end of the second

measured interval the charge on condenser 31 ionizes the control gap of the tube 35 over a circuit traceable from the starting anode 44, front contacts of relay 33, resistor 40, front contacts of relay 33, condenser 31, conductor 37, winding of relay 41, to the cathode 45. The tube 35 discharges and relay 41 operates momentarily from the energy stored in the condenser 43. Relay 41 releases relay 33 which, in turn, reoperates relay 46. Relay 33 on releasing closes its continuity contacts and discharges condenser 30. Condenser 31 discharges in a circuit closed through the back contacts of relay 33 and resistor 41. Relay 33 also disconnects condenser 31 from the tube 35 and reconnects condenser 30 to the tube 34 in order that the intervals of the next cycle may be measured.

What is claimed is:

1. The combination in a time-measuring mechanism for measuring consecutive intervals of time and for repeating the intervals cyclically of two space discharge devices, a condenser, a resistor, a charging circuit, a source of voltage in said circuit for charging said condenser to the operating voltage of the first one of said discharge devices in a desired interval of time, said charging circuit including a portion of said resistor for measuring said interval, circuit means for connecting said condenser to said first discharge device to operate the same at the end of said interval, means responsive to the operation of said first discharge device for causing said source to charge said condenser to the operating voltage of the second one of said discharge devices in a second desired interval of time, said charging circuit including another portion of said resistor for measuring said second interval, circuit means for connecting said condenser to said second discharge device to operate the same at the end of said second interval, and means responsive to the operation of said second discharge device for releasing said first discharge device to repeat the measuring cycle.

2. The combination in a time-measuring mechanism for measuring consecutive intervals of time and for repeating the intervals cyclically of two space discharge devices, a condenser, a resistor, a charging circuit, a source of voltage in said circuit for charging said condenser to the operating voltage of the first one of said discharge devices in a desired interval of time, said charging circuit including a portion of said resistor for measuring said interval, circuit means for connecting said condenser to said first discharge device to operate the same at the end of said interval, means responsive to the operation of said first discharge device for including another portion of said resistor in said charging circuit and to charge said condenser to the operating voltage of the second one of said discharge devices in a second interval of time the length of which is measured by said resistor, circuit means for connecting said condenser to said second discharge device to operate it at the end of said second measured interval, and means responsive to the operation of said second discharge device for releasing said first discharge device to repeat the measuring cycle.

3. The combination in a time-measuring mechanism for measuring consecutive intervals of time and for repeating the intervals cyclically of two space discharge devices, a condenser, a resistor, a charging circuit, a source of voltage in said circuit for charging said condenser to the operating voltage of the first one of said dis-

charge devices in a desired interval of time, said charging circuit including a portion of said resistor for measuring said interval, circuit means for connecting said condenser to said first discharge device to operate the same at the end of said interval, a relay responsive to the operation of said first discharge device for discharging said condenser and for including another portion of said resistor in said charging circuit to recharge said condenser to the operating voltage of the second one of said discharge devices in a second desired interval of time the duration of which is measured by said resistor, said relay serving to disconnect said condenser from the said first discharge device and to connect it to said second discharge device to operate the same at the end of said second measured interval, and means responsive to the operation of said second discharge device for releasing said first discharge device and said relay to repeat the measuring cycle.

4. The combination in a time-measuring mechanism for signaling systems of two space discharge tubes, a time-measuring condenser, a resistor, a charging circuit, a source of voltage in said circuit for charging said condenser to the operating voltage of the first one of said tubes in a desired interval of time, said charging circuit including a portion of said resistor for measuring said interval, circuit means for connecting said condenser to said first tube to operate the same at the end of said measured interval, a relay responsive to the operation of said first tube for including a second portion of said resistor in said charging circuit to charge said condenser to the operating voltage of the second one of said tubes

in a second desired interval of time, said relay serving to disconnect said condenser from the first tube and to connect it to said second tube to operate the same at the end of said second interval, means responsive to the operation of said second tube for releasing said first tube and said relay, a signaling circuit and a source of signaling current, and means controlled by said relay for connecting said source of signaling current to said signaling circuit during said first measured interval of time and for disconnecting said signaling source from said signaling circuit during said second measured interval of time.

5. The combination in a time-measuring mechanism for measuring consecutive intervals of time and for repeating the intervals cyclically of two space discharge tubes, storing means, a charging circuit, a resistor in said charging circuit, a source of voltage for charging said storing means through said resistor to the operating voltage of the first one of said tubes in a desired interval of time, circuit means for connecting said storing means to said first tube to operate the same at the end of said interval, means responsive to the operation of said first tube for causing said source to charge said storing means through said resistor to the operating voltage of the second one of said discharge tubes in a second desired interval of time, circuit means for connecting said storing means to said second discharge tube to operate the same at the end of said second interval, and means responsive to the operation of said second tube for releasing said first tube to repeat the measuring cycle.

EDWARD VROOM.