Oct. 6, 1964 E. L. E. PARDEE 3,152,323

PLURAL INTERVAL TIMING DEVICE HAVING A CONDUCTOR MATRIX FOR SELECTION OF THE TIME INTERVALS

Filed Aug. 18, 1959

FIG. 1

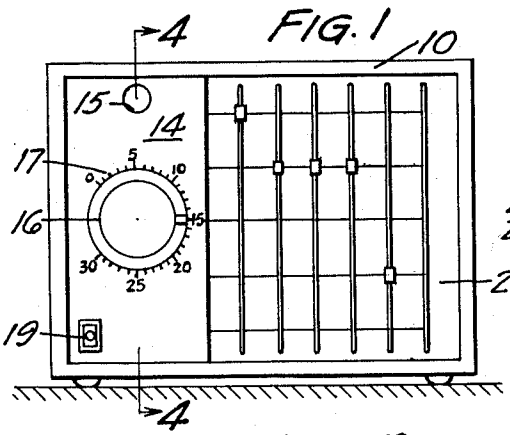


FIG. 2

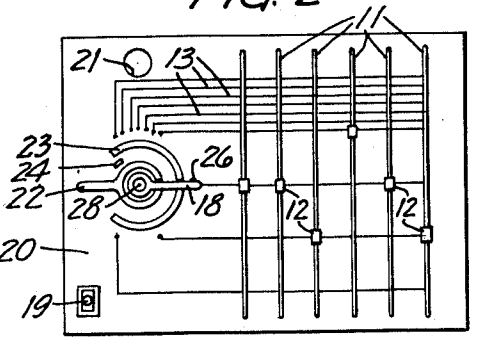


FIG. 3

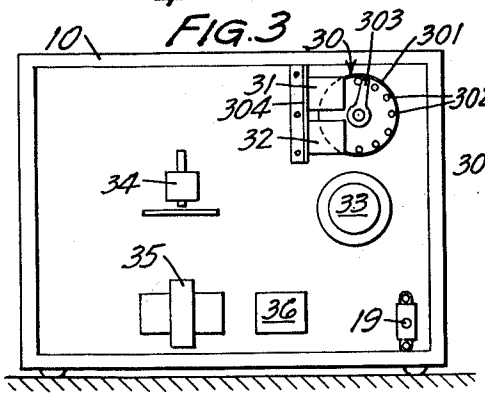


FIG. 4

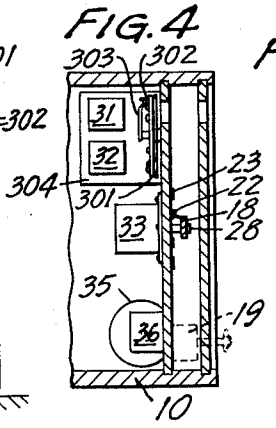


FIG. 5

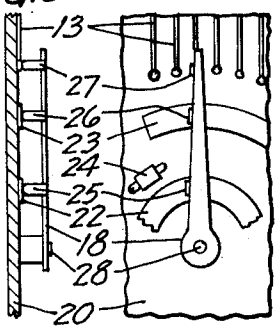
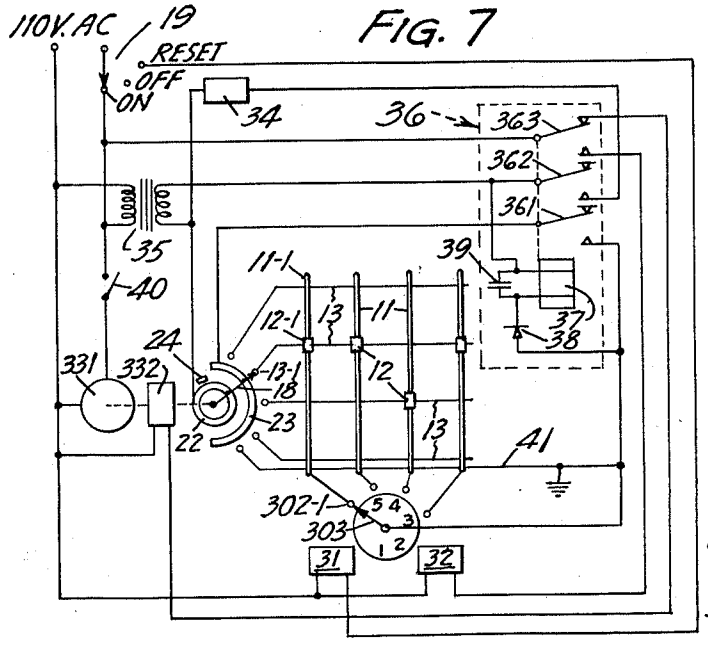


FIG. 6

FIG. 7



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PLURAL INTERVAL TIMING DEVICE HAVING A CONDUCTOR MATRIX FOR SELECTION OF THE TIME INTERVALS

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This invention relates to time-control devices for establishing a sequence of independently changeable time periods.

Accurate timing of series of operations is required in many processes. In the chemical developing of color photographs, for example, each of a large number of consecutive steps in the process must be accurately timed. It is also sometimes necessarily during such processes to vary the time to be devoted to one or more such steps. As an example, a change in the temperature of a developer solution occurring during or prior to its use will require a corresponding inverse change in the length of time for development in such solution. The present invention provides for the accurate timing of each of a number of intervals in continuous sequence, while still permitting alteration of such intervals during the timing operation. The device is accurate, simply and easily adjusted and operated, and positive in action. Other advantages and applications will occur from a study of the following description.

A presently preferred example of an illustrative timing device embodying the features of the invention is hereinafter described in connection with the accompanying drawing, in which:

FIGURE 1 is a front elevation of the device,

FIGURE 2 is a front elevation of the working panel,

FIGURE 3 is a schematic partial rear elevation indicating the preferred location of major components,

FIGURE 4 is a partial section as indicated in FIGURE 1,

FIGURE 5 is a side elevation partly in section, and FIGURE 6 a front elevation, schematically illustrating the main time switch member, and

FIGURE 7 is the schematic circuit diagram.

As seen in FIGURE 1, a frame **10** supports a partial front panel **14** and a working panel **20**. A further partial front panel may be added to enclose the remainder of the working panel if desired, but is here omitted for clarity. Panel **14** is provided with sight-openings or transparent portions **15** and **16**, indicia **17**, and an opening for a three-way switch **19**.

Working panel **20**, shown in more detail in FIGURE 2, carries on its face a series of parallel conductive contact lines **13** terminating in an arcuate path surrounding an arcuate connector member **23** and an inner circular connector member **22**. These several connectors are conveniently produced as printed circuit components, e.g. by chemical etching and removal of adjacent unprotected metal areas of a metal-covered insulating panel. The conductive metal pattern is thin, rugged, and well bonded to the flat underlying panel surface, so that sliding contacts pass over it easily yet give good electrical contact.

A series of parallel slide rods **11** overlie the parallel contact lines at right angles thereto. Each rod carries a slide member **12** which may be set at any desired contact line, thereby forming a contact between the line and the rod. Suitable pointers and indicia, not shown, are provided for ease in setting the slider at the desired line. In a typical example, the device is provided with sixteen slide rods overlying 180 contact lines, although for simplicity of representation the number is greatly reduced in the drawing.

Switch **19** is attached to panel **20** and control arm **18** is attached to shaft **28** passing through the panel. Control

arm **18** makes contact with connector members **22** and **23** and with the ends of connector lines **13** through suitable spring contact members **25**, **26** and **27** respectively, shown in more detail in FIGURES 5 and 6. The position of arm **18** is visible through the sight-opening **16** in front panel **14**, the elapsed time being read from the indicia **17**.

An adjustable stop member **24** is located on panel **20** so as to bring the control arm **18** to rest in proper position for starting the next cycle. The panel is provided with a sight-opening **21** corresponding to sight-opening **15** of panel **14**.

At the rear of panel **20** are located switching mechanism **30**, timer motor unit **33**, chime unit **34**, transformer **35**, and main control relay **36**, together with other components, connectors, switches and the like, omitted from FIGURE 3 but as will be further indicated in connection with the circuit diagram.

Switching mechanism **30** includes an index dial **301**, contact points **302**, lever arm **303**, reset relay **31**, and step relay **32**, together with suitable auxiliary equipment operable by said relays to advance the arm **303** over the contacts **302** by a ratchet mechanism and to return the arm to starting position by a ratchet release mechanism. Such mechanisms are available commercially. Index dial **301** rotates with arm **303** and presents suitable indicia to view through sight-holes **15** and **21** for indicating the position of the lever arm **303**. The assembly **30** is conveniently mounted on a bracket **304** attained to the rear of panel **20**.

The timer assembly **33** includes a synchronous motor clock drive **331** and a magnetic clutch **332**, the latter being connected to shaft **28**. In the circuit here described, a step-down transformer **35** provides a 12-volt supply which is controlled by three-pole double-throw relay **36**.

A chime **34** announces the end of each timed interval; or the device may be connected to some alternative indicator means or to suitable switch or relay means for direct control of process apparatus if desired. Such a relay may conveniently be included in relay **36**.

The operation of the device in the timing of a sequence of operations will now be described, particularly in connection with FIGURE 7.

The circuit is first connected to a source of electric power, here indicated as 110 volts A.C., and switch **19** is first momentarily turned to "re-set" position if necessary. The several sliders **12** are moved to positions determined by the timing schedule desired. At the appropriate instant the switch **19** is moved to "time" position as shown. It will be assumed that "hold" switch **40** is in closed position. Timer motor **331** therefore starts; and, since the circuit to clutch **332** is closed through arm **363** of relay **36**, thereby holding the clutch in closed position, lever arm **18** starts to sweep past the connector lines **13** at constant rate. Assuming that a maximum of 30 minutes is provided for each timing period, with 180 connector lines as previously indicated it will be seen that the switch contact **27** on arm **18** will pass over the connector lines **13** at the rate of six per minute. Each slider may therefore be set at any desired multiple of 10 seconds up to the 30-minute total. Other timer speeds will obviously permit other intervals and other totals, the foregoing being merely illustrative.

As soon as the control arm is advanced to a position at which contact **27** makes contact with the connector line **13–1** with which the slider **12–1** on the rod **11–1** is in contact, the following sequence occurs. Current from the secondary of the transformer **35** flows from connector plate **22** through contact **25**, arm **18**, contact **27**, connector line **13–1**, slider **12–1**, and slider rod **11–1**, to contact **302–1** and lever arm **303**, and from there to a rectifier **38**. The resulting pulsating direct current flows to the transformer **35** through the relay coil **37**,

actuating the relay 36 and also charges the capacitor 39. The relay switches are thereby thrown to the position opposite to that illustrated in FIGURE 7.

The relay is held in the new position by connection made at switch 361 through the rectifier and relay coil 37 and through the switch arm 18, contacts 25 and 26, and connectors 22 and 23, independently of the action occurring at switch 30.

The operation of the relay 36 closes switch 362, causing ringing of the warning chime 34 or actuation of other relay or apparatus connected in place thereof or in addition thereto.

The operation of the relay further opens the circuit through switch 363 leading to the magnetic clutch 332, and closes the circuit through the step relay 32. Opening the clutch permits the arm 18 to snap back against the stop 24 in position for the next sequence. The step relay 32 meanwhile advances the contact arm 303 to the second of contact points 302, and simultaneously rotates the index dial 301 to a position in which the appropriate index number becomes visible through view holes 15 and 21.

As the arm 18 is snapped back to the starting position, out of contact with the connector plate 23 and against stop 24, it may vibrate or "bounce" briefly. A delay of not more than about one-tenth second to provide for termination of such action is therefore provided by the condenser 39, which provides sufficient flow of current through the relay coil 37 to hold the relay 36 momentarily in the actuated position and permit the arm 18 to come to rest.

As soon as the charge in the condenser 39 has been depleted, the relay 36 returns under spring tension to the stable position illustrated. This action again causes the clutch 332 to engage, the arm 18 begins another sweep over the terminals of the connector lines 13, and the process is repeated, in this case through the second of the slider bars 11 and contacts 302.

As soon as the last cycle is completed, the operation of the device is terminated by snapping the switch 19 to the "off" position.

The switch 40 provides means for temporarily interrupting the action of the device at any point in its action, by stopping the clock mechanism 331. When the switch is again closed, the cycle proceeds forward from the previous position.

A particular advantage of the device is the complete separation of each of the individual timing elements, i.e. the slider rods 11 and sliders 12, from the previous timing elements. Each slider may therefore be adjusted to any position, corresponding to any measurable time interval within the limitations of the mechanism, at any time prior to the use of the corresponding circuit. Indeed, a specific slider may be moved while its circuit is in use, to any other one of the contact lines 13 over which the arm 18 has not already passed.

Turning the switch 19 to the "re-set" position actuates the relay 31 which momentarily disengages the ratchet drive of relay 32 and permits the spring-loaded multiple switch and index dial unit 30 to return to initial position, with the digit 1 appearing through the sight-openings 15 and 21.

A terminal line 41, parallel to the several connecting lines 11, may be included to serve as a safety measure in the event of defective contact anywhere within the interval and cycle measuring apparatus. Under such a condition the arm 18 continues into contact with said line 41 and automatically completes the circuit to the relay 36, thus re-setting the mechanism.

It will be appreciated that other specific components may be substituted for the illustrative examples herein described without departing from the invention as defined in the appended claims.

What is claimed is as follows:

1. A timing device to be connected to a source of electric power and suitable for consecutively determining each of a plurality of independently changeable time intervals, comprising, in combination: a series of parallel contact lines defining uniform time intervals, each connected to a corresponding one of a series of stationary contact points; a plurality of spaced conductor bars spaced from and crossing said contact lines, each connected to a corresponding rotary switch contact point; a sliding contact member on each of said bars for making contact between the bar and any one of said contact lines; a contact arm having means for connection to a source of electric power and movable to make contact with each one of said stationary contact points from a first to a last one of said points in sequence; biasing means for normally biasing said contact arm to zero position preceding said first contact; a constant speed motor having means for connection to a source of electric power; releasable clutch means for coupling said motor and said contact arm; a rotary switch contact member for contacting each said rotary switch contact point successively; electrically actuated release means connected to said rotary switch contact member for temporarily uncoupling said clutch for a time sufficient to allow the contact arm to return to the zero position on the completion of a circuit defined by said power source, the contact arm, a stationary contact point, a contact line, a slidable contact member, a conductor bar, a rotary switch contact point, and the rotary switch contact member, and said release means; ratchet impulse means for advancing said rotary switch contact member to the next succeeding rotary switch contact point on activation of said release means; and indicating means for signaling the termination of each of said time intervals concurrently with activation of said release means.

2. A timing device comprising, in combination: a series of timing conductors defining uniform time intervals, each connected to a corresponding one of a series of fixed contact points; a series of indexing conductors, each connected to a corresponding one of a series of contact elements; a movable contact member for each of said indexing conductors for making contact between the indexing conductor and any one of said timing conductors; a first distributing switch means having means for connection to a source of power and having a first movable contact engaging member, means for biasing said contact engaging member to a zero position, a constant speed driving means for advancing said contact engaging member from said zero position into sequential engagement with said series of fixed contact points, said constant speed driving means being releasably coupled to said contact engaging member by releasable clutch means, second switch means having a second movable contact engaging member for sequentially engaging said indexing conductor contact elements, electrically actuated release means connected to said second contact engaging member for temporarily uncoupling said clutch means for a time sufficient to allow said first contact engaging member to return to said zero position on the completion of a circuit defined by said power source, said release means, said second contact engaging member, the contact element with which said second contact engaging member is engaged, the one of said indexing conductors connected to said contact element, the movable contact member of said indexing conductor, the timing conductor contacted by said movable contact member, the fixed contact point connected to said timing conductor, and said first movable contact engaging member, and means for advancing said second contact engaging member to the contact element of the next succeeding one of said indexing conductors on the activation of said release means.

3. A timing device comprising, in combination: a series of parallel conductors defining uniform time intervals, each connected to a corresponding one of a series of fixed contact points, a second plurality of conductor

bars spaced from and crossing said first conductors, each of said second conductor bars connected to a corresponding one of a series of contact elements, a movable contact member associated with each of said second conductor bars for making contact between said conductor bar and any of said first conductors, a first distributing switch means having means for connection to a source of power and having a first movable contact engaging member normally biased to a first zero position and movable from said zero position into contact with each of said fixed contact points in sequence, a second switch means having a second contact engaging member movable into contact with each of said contact elements in sequence, a constant speed driving means for advancing said first contact engaging member into engagement with said contact point, releasable clutch means for coupling said driving means and said first contact engaging member, electrically actuated release means connected to said second contact engaging member for temporarily uncoupling said clutch means for a time sufficient to allow said first contact engaging member to return to said zero position on the completion of a circuit defined by said

power source, said first contact engaging member, one of said series of fixed contact points, the one of said first conductors connected to said contact point, the movable contact member contacting said first conductor, the second conductor bar associated with said movable contact member, the contact element connected to said second conductor bar, the second contact engaging member, and said release means, means for advancing said second contact engaging member into contact with the next succeeding one of said contact elements on activation of said release means, and means for indicating the completion of each circuit.

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