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A. LOFT

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LONG RANGE TIMING APPARATUS

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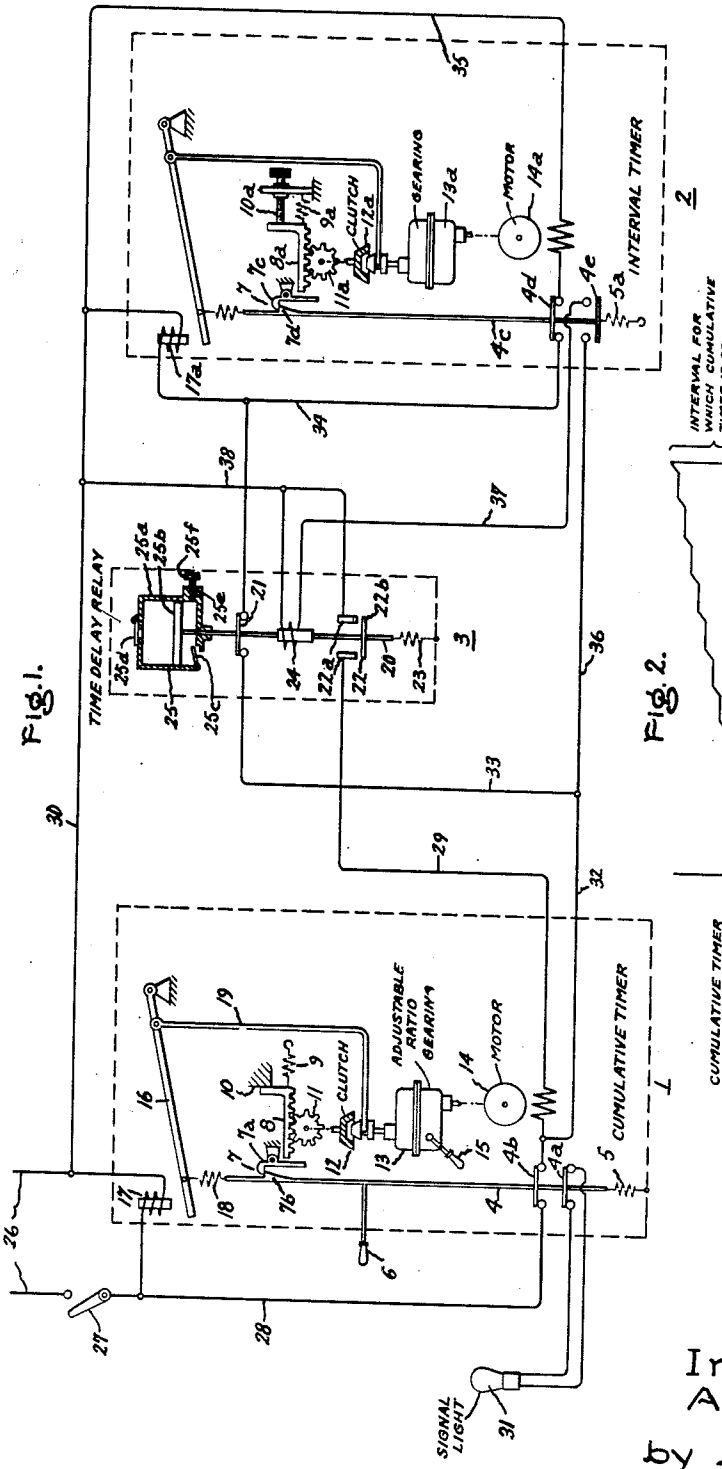


Fig. 1.

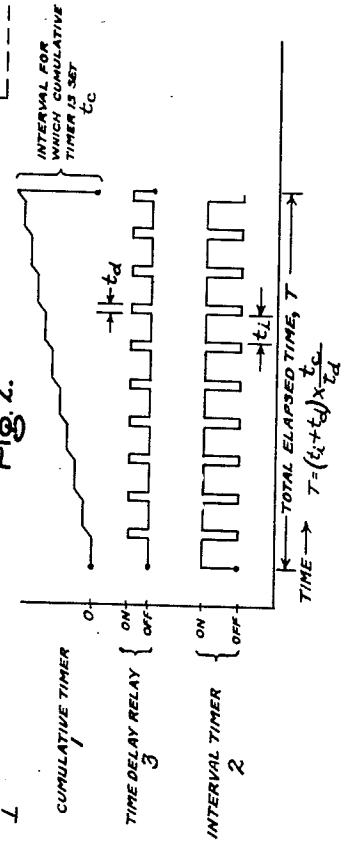


Fig. 2.

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LONG RANGE TIMING APPARATUS

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3 Claims. (Cl. 161—1)

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This invention relates to timing devices, particularly to a combination of timers arranged to provide an extremely wide range of intervals.

In connection with regulators for gas turbine powerplants, it became necessary to provide timing apparatus having a range of adjustment from a few seconds up to many hundred hours, the total range of adjustment being on the order of 5,000,000 to 1.

Accordingly, the purpose of the present invention is to provide improved timing apparatus having an extremely wide range of adjustment, and which can be assembled from standard components of inexpensive and reliable construction.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which

Figure 1 is a schematic representation of timing apparatus incorporating the invention, and

Figure 2 is a diagrammatic representation of the operating cycle of the apparatus.

Generally stated, the invention is practiced by connecting two standard timers and a time delay relay in such a manner that one timer is caused to be repeatedly reset by the time delay relay, while the other timer "counts" the number of cycles through which the time delay relay has caused the first timer to operate.

Referring now more particularly to Figure 1, the invention makes use of two standard timing devices, shown diagrammatically at 1 and 2, and a conventional time delay relay 3.

The timers 1 and 2 are of substantially identical construction, therefore corresponding parts are represented by similar reference numerals, distinguished by appropriate subscripts. The first timing device 1 is adapted to run whenever energized, so as to accumulate a series of identical time intervals, and to perform some indicating or regulating function at the end of a preselected time period. While many equivalent known timing devices for performing this function may be employed, the timer 1 is illustrated diagrammatically as comprising a reciprocable plunger member 4 arranged to actuate a normally closed switch 4a and a second normally closed switch 4b. Connected to the lower end of plunger 4 is an automatic reset spring 5. A manual reset handle 6 may also be provided. Plunger 4 is retained in its lowermost position, with switches 4a and 4b closed, by mechanical latch 7 including a pivoted detent 7a engaging a projecting shoulder 7b on the plunger 4. It will be observed that the lower side of shoulder 7b defines a long

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sloping cam portion adapted to engage the curved upper end of detent 7a so as to push the detent out of the way when plunger 4 descends in the resetting process, as described more particularly hereinafter.

Detent 7a is adapted to be engaged at the end of the preselected time interval by a tripping member in the form of a longitudinally traveling rack 8, which is of course supported in suitable guide members (not shown). Rack 8 is biased by spring 9 to an initial position determined by the stop member 10. Rack 8 is adapted to be driven to the left, so as to trip detent 7a after a preselected time interval, by a pinion 11 driven through a clutch 12 and suitable gearing 13 by an electric motor 14. In order to vary the time required for the rack 8 to engage detent 7a, the gearing may be of any suitable type of variable speed-change gearing, the ratio being selected by the manual lever 15.

The timer 1 is conditioned for operation by means of a pivoted armature 16 actuated by a solenoid 17. As will be apparent from Figure 1, armature 16 is connected to plunger 4 by a tension spring 18, and is also arranged to effect engagement of clutch 12 by means of the shift yoke 19. Energizing solenoid 17 causes armature 16 to rise, thus tensioning spring 18 and engaging clutch 12. When the rack 8 releases detent 7a, the plunger 4 moves upwardly under the tension of spring 18, which is strong enough to overcome the tension of the reset spring 5. When solenoid 17 is de-energized, the weight of armature 16 and the tension of spring 5 cause plunger 4 to descend, whereupon the cam portion of shoulder 7b moves detent 7a clockwise permitting the shoulder 7b to resume the latched position illustrated in the drawing. Switches 4a and 4b are both closed when plunger 4 is in the lowermost position; and both are open when the plunger is in the "tripped" or uppermost position.

The second timer 2 is of the same general type represented at 1, but with a few small differences. Instead of having adjustable ratio gearing as at 13, the gearing 13a is of a fixed ratio type, and adjustment of the time interval is effected by making the stop member 10a adjustable in some suitable manner. In Figure 1, stop 10a is represented as an adjusting screw which can be positioned so as to determine the length of travel of the rack 8a before it engages detent 7c. This is of course a simple mechanical equivalent of the adjustable ratio gearing 13. Furthermore, the switch 4d is normally closed and the switch 4e normally open when plunger 4c is in the

lowermost latched position. When plunger 4c moves upwardly, switch 4e closes and switch 4d opens.

The time delay relay 3 is represented as comprising a plunger member 20 arranged to close a switch 21 when in the lowermost or inactive position as illustrated in Fig. 1, and to maintain a second switch 22 closed throughout the duration of each operating cycle of the time delay relay. To this end, the switch 22 may comprise a pair of elongated contact strips 22a which are ridged by the moving member 22b throughout the stroke of plunger 20, the switch 22 being normally open when the plunger is in the lowermost or "inactive" position shown. Plunger 20 is biased to its inactive position by a tension spring 23 and elevated against the tension of that spring by a solenoid 24. An adjustable time delay is provided by the pneumatic dashpot 25, illustrated as comprising a cylinder 25a containing a piston 25b. Instantaneous upward movement of piston 25b is permitted by a pair of flapper valves 25c, 25d, both of which open when the piston moves upwardly. Conversely, both flapper valves close when the piston starts downwardly, and the rate of downward movement of plunger 20 is regulated by adjusting the air escape vent 25e by means of the thumbscrew 25f. It will be obvious that any equivalent time delay device may be employed.

As will be apparent from the drawings, switch 21 is normally closed, when the relay 3 is inactive, but remains open during the entire operating cycle of the time delay relay, while switch 22 is normally open but remains closed throughout the operating cycle of the relay.

An important advantage of the present invention lies in the fact that it provides an extremely wide range timing apparatus readily assembled from two conventional timers 1, 2 of types well known to the prior art, and a standard time delay relay 3 which may be of any of numerous known types. The timers 1 and 2 may, for instance, be adjustable for time intervals from three seconds to thirty-three minutes, and the time delay relay may be adjustable for intervals from one-quarter second to three seconds. As will be seen hereinafter, the cumulative timer 1 is ordinarily set for a comparatively long interval, the interval timer 2 is set for a shorter interval, and the time delay relay has a still shorter operating cycle. Specifically, the timer 1 may be set for 30 minutes, the interval timer 2 may be set for 10 minutes, and the relay 3 may be set for 3 seconds, giving a total time of 30 mintues times 10 minutes over 3 seconds or 6,000 minutes, or 100 hours.

The interconnections by which these standard components produce the long range timing function are as follows:

The external power supply circuit 26 energizes solenoid 17 when switch 27 is closed. This of course attracts armature 16 and conditions timer 1 by tensioning spring 18 and engaging clutch 12. It will be seen in Figure 1 that the power supply to motor 14 is by way of conductors 28, 29, 33, 30, including the normally closed switch 4b and the normally open switch 22. It will be apparent that motor 14 does not begin to run even though switch 4b is closed, since the switch 22 is open.

The switch 4a associated with plunger 4 performs the ultimate signalling or regulating function, symbolized by the signal light 31. Plunger 4 could of course be provided with other switches or equivalent devices for initiating other signalling or regulating functions.

The power supply circuit for the other timer motor 14a includes the conductor 28, switch 4b, conductors 32, 33, normally closed switch 21, conductor 34, normally closed switch 4d, and conductors 35, 30. It will be apparent that solenoid 17a is connected across conductors 34, 30 so as to be in parallel with motor 14a.

The energizing circuit for solenoid 24 of the time delay relay 3 comprises conductor 28, switch 4b, conductors 32, 36, normally open switch 4e, and conductors 37, 33, 30. It is to be noted that the time delay relay solenoid 24 is energized when plunger 4c of the interval timer 2 is tripped to its uppermost position. The supply of energy to solenoid 24 causes plunger 20 to immediately rise, which opens switch 21 to de-energize solenoid 17a of the interval timer 2. This permits armature 16a to drop, so that plunger 4c is reset by spring 5a to the latched condition shown in Figure 1, in which the supply of energy to solenoid 24 is interrupted. Thus, it will be apparent that each time the interval timer 2 trips plunger 4c at the end of an operating cycle, the switch 4e momentarily energizes solenoid 24 so as to raise plunger 20 and initiate the operating cycle of time delay relay 3, which in turn re-sets the timer 2.

It remains to note that motor 14 of the cumulative timer 1 is energized by switch 22 of the time delay relay throughout the duration of each operating cycle of the relay. Since solenoid 17 of the cumulative timer 1 is continuously energized as long as the timing apparatus is operating, solenoid 6 will remain in its uppermost position, with clutch 12 continuously engaged, so that timer 1 runs intermittently, and without resetting, during each operating cycle of the time delay relay 3.

Timer 1 is reset either by momentarily opening switch 27, or by forcing plunger 4 downwardly by the manual reset handle 6.

The integrated operation of the timing apparatus may be stated briefly as follows (1) the interval timer 2 goes through repeated cycles, being reset at the end of each cycle by the time delay relay 3; (2) in addition to resetting the interval timer 2, the time delay relay 3 serves to energize the cumulative timer 1 throughout each operating cycle of the time delay relay; (3) the cumulative timer 1 adds up the length of successive operating cycles of the time delay relay 3, thus in effect "counting" the number of cycles through which interval timer 2 has operated.

From this description of the operation it will be apparent that the length of each operating cycle is equal to the time interval t_i for which timer 2 is set, plus the length t_d of the operating cycle of the time delay relay 3, while the number of elapsed cycles is represented by the time t_c accumulated on the cumulative timer 1 divided by the length t_d of the opertaing cycle of the time delay relay 3. Therefore, the total elapsed time T, represented by the length of time the signal light 31 is on, may be represented by the expression

$$T=(t_i+t_d)\times\frac{t_c}{t_d}$$

With timers 1 and 2 having a range of from 3 seconds to 33 minutes and time delay relay 3 having a range of from ¼ to 3 seconds, it can be shown that the possible range of values for the elapsed time T is from 6 seconds to 4400

hours, or a range of over 2,500,000 to 1. Thus, the invention provides timing apparatus having tremendous latitude of adjustment.

The functioning of the apparatus described above may be represented diagrammatically as in Figure 2. The abscissa represents the total elapsed time T. The lowermost curve represents the "on" and "off" cycles of the interval timer 2. The middle curve represents the "on" and "off" cycles of the time delay relay 3. And the upper curve represents the cumulative reading of the timer 1. It will be seen that the cumulative timer 1 and the time delay relay are both in the "off" condition while the interval timer 2 runs through its first cycle t_i. When timer 2 trips, the time delay relay 3 goes through its preselected operating cycle, during which period t_d the cumulative timer 1 runs. At the end of the short cycle of time delay relay 3, timer 1 stops and the interval timer 2 starts a second cycle. At the end of the cycle of timer 2, the time delay relay 3 is again energized and the timer 1 runs. This process repeats until cumulative timer 1 reaches the limit of its preselected setting, at which time it trips to extinguish the signal light 31, thus indicating the end of the total preselected interval T.

It is to be understood that the details of the timers 1 and 2 and of the time delay relay 3 do not in themselves form a part of the invention, my invention lying in the manner in which such standard timers and relays may be interconnected to achieve a timing function of enormous latitude not possible with any timing apparatus available previously. The invention has the great advantage of utilizing inexpensive and reliable components which are readily available and easily interconnected to perform the wide range timing function required. Timers and relays of other mechanical, hydraulic, or electrical types could be employed in place of those shown in the drawings, so long as they are capable of performing the functions described for the cumulative or "counting" timer 1, interval timer 2, and re-setting relay 3.

It is of course intended to cover by the appended claims all such modifications as fall within the true spirit and scope of the invention.

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

1. Long range timing apparatus comprising a first motor driven cumulative timer adapted to signal the end of a first preset time interval, a second motor driven interval timer adapted to signal the end of a second preset time interval, a time delay relay having an operating cycle of a shorter third time interval, means for energizing the first timer during each operating cycle of the time delay relay, means for energizing the second timer whenever the time delay relay is in inactive condition, and means for initiating the operating cycle of the time delay relay each time the second timer reaches the end of said second time interval, whereby said first timer accumulates intervals representing the sum of successive operating cycles of the time delay relay.

2. Long range timing apparatus comprising a first motor driven cumulative timer adapted to run without resetting each time it is energized and adapted to signal the end of a first predetermined time interval, a second motor driven interval timer adapted each time it is energized to run through an operating cycle of a second predetermined interval and then stop, a time delay relay having an operating cycle of a third predetermined time interval, means connecting the time delay relay to the second timer to initiate the operating cycle thereof at the end of the operating cycle of the time delay relay, means connecting the time delay relay with said first timer for causing it to run during the operating cycle of the time delay relay, and means associated with the second timer for initiating the operating cycle of the time delay relay each time the second timer reaches the end of its operating cycle, whereby said time delay relay causes the second timer to execute repeated cycles and the first timer accumulates intervals representing the aggregate operating time of the time delay relay.

3. Long range timing apparatus comprising a first cumulative timer having a motor, a plunger member, latch means for holding the plunger in set condition and a trip member driven by the motor and adapted to release said latch after a first preselected time interval, a second interval timer comprising a second motor, a second plunger member, a second latch member adapted to hold said second plunger member in set condition and a second trip member adapted to be driven by said second motor to release the second latch after a preselected second time interval, and a time delay relay comprising a third plunger member with a solenoid adapted to move the third plunger away from its initial position when the solenoid is energized momentarily, the time delay relay having also means for returning the third plunger member to its initial position after a third preselected time interval, means connecting the time delay relay to the cumulative timer for energizing the motor thereof during each time delay interval of the relay, means connecting the time delay relay to the second interval timer for energizing the motor thereof to initiate the operating cycle of said second timer, and means connecting said second timer with the time delay relay for energizing the solenoid thereof each time the second timer reaches the end of its operating cycle, whereby the time delay relay resets the second interval timer each time it reaches the end of its operating cycle, the time delay relay also energizing the motor of the cumulative timer throughout each operating cycle of the time delay relay.

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