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Gruenwald

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[45] **June 12, 1973**

[54] **REVERSIBLE PROGRAMMER FOR ELECTRIC CIRCUITS**

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[73] Assignee: **Alpha Press Electronics, Inc.,** Alpha, N.J.

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[52] **U.S. Cl.** ..... **200/38 R,** 200/47, 307/141.4

[51] **Int. Cl.** **H01h 43/10,** H01h 21/28

[58] **Field of Search** 200/38, 47; 318/65, 318/280; 219/486; 307/141, 141.4, 141.8

[56] **References Cited**

UNITED STATES PATENTS

3,306,997	2/1967	Jacobs	200/47
2,566,824	9/1951	Carlson	200/47
3,247,732	4/1966	Barnhart	200/47 X
3,175,418	3/1965	Schaefer	200/47 X
2,951,920	9/1960	Miller	200/47
3,579,264	5/1971	Mork et al.	200/38 B X
3,221,117	11/1965	Simmons	200/38 BA
3,267,767	8/1966	Neal	200/38 BA X
3,260,129	7/1966	Drain	200/38 BA X
3,449,699	6/1969	Davin	200/38 B X
3,110,776	11/1963	Hogan et al.	200/38 BA

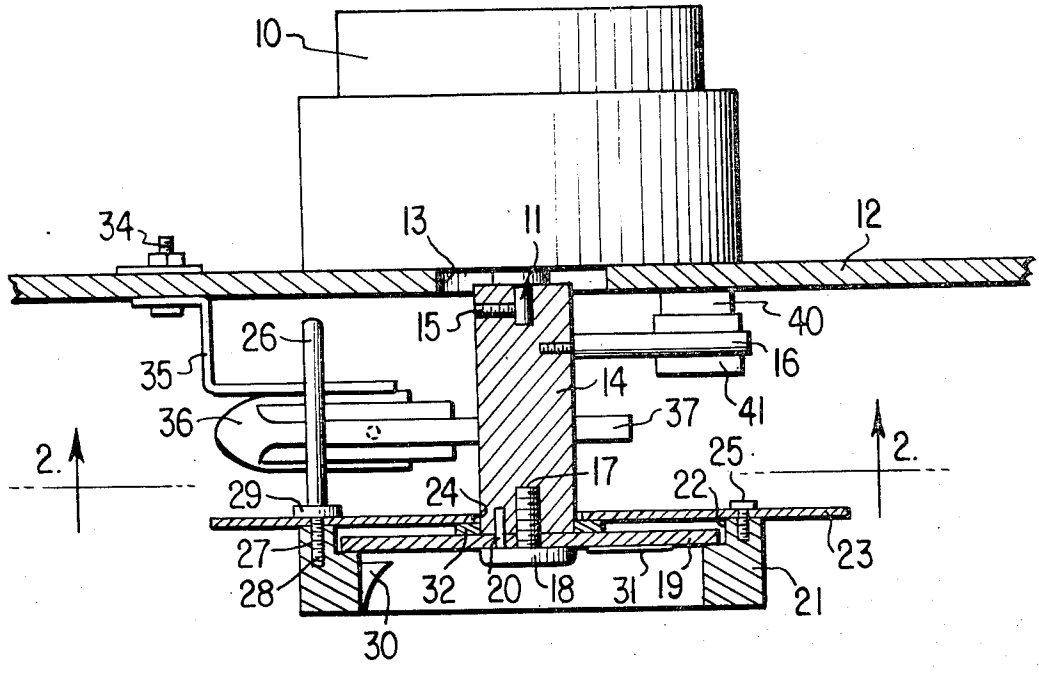
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[57] **ABSTRACT**

A device for providing repetitive pulses having adjustable width and spacing including a drive motor, a cam pin rotatable with the output shaft of the drive motor and a second cam pin carried with the first pin but angularly manually adjustable relative thereto. A switch mounted adjacent the paths of travel of the pins causes the motor to periodically reverse as the pins sequentially operate the switch back and forth. One or more other switches are operated by one or both of the cam pins to control external load means. The angular relationship of the pins is adjustable by moving one pin, through a friction clutch, relative to the other. Increasing the angle between pins increases the pulse spacing, and adjustment of an output switch position alters the pulse duration.

2 Claims, 23 Drawing Figures



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SHEET 1 OF 4

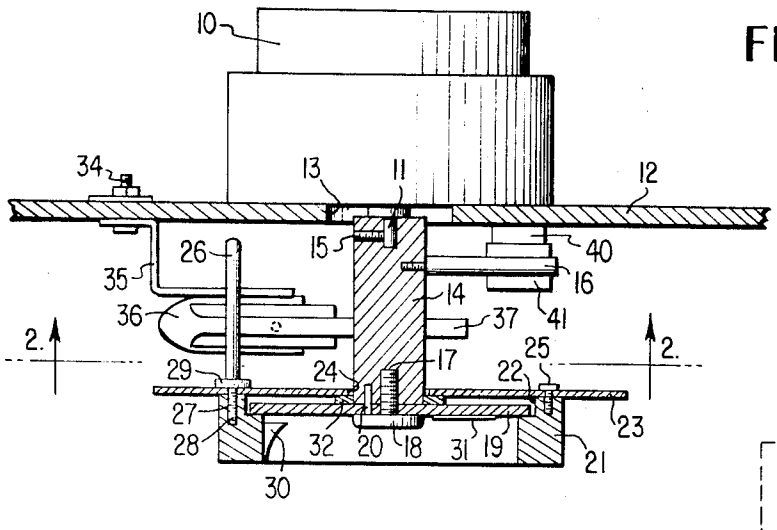


FIG. 1

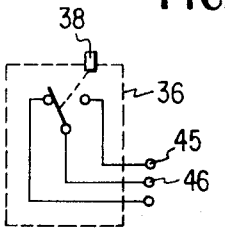


FIG. 4

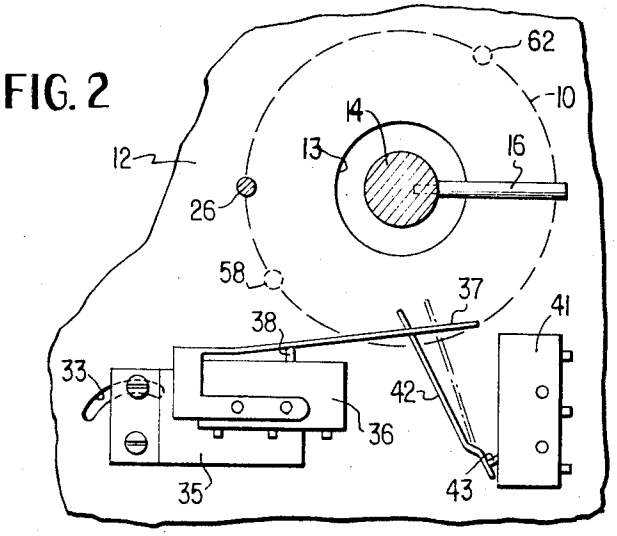


FIG. 2

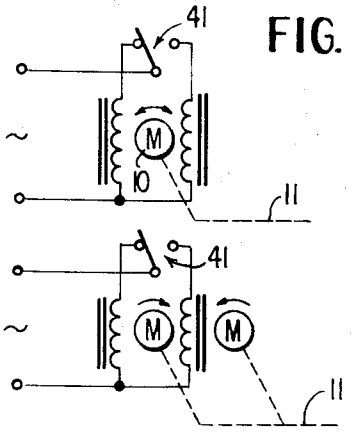


FIG. 5

FIG. 6

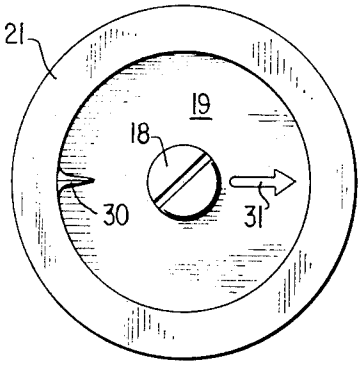


FIG. 3

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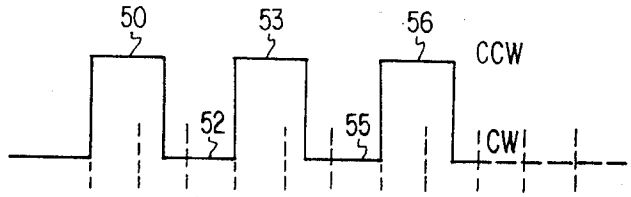


FIG. 7A

FIG. 7B

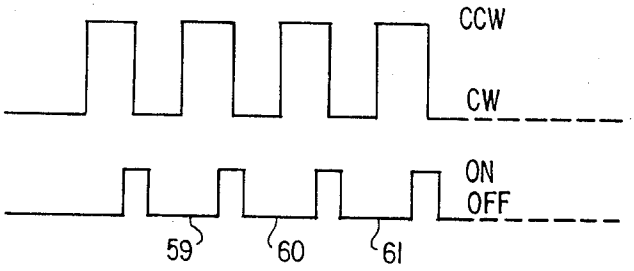


FIG. 7C

FIG. 7D

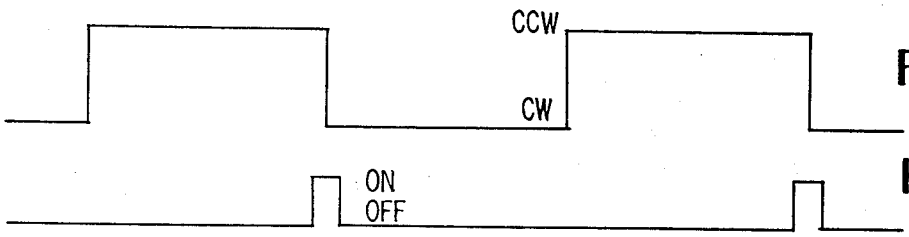


FIG. 7E

FIG. 7F

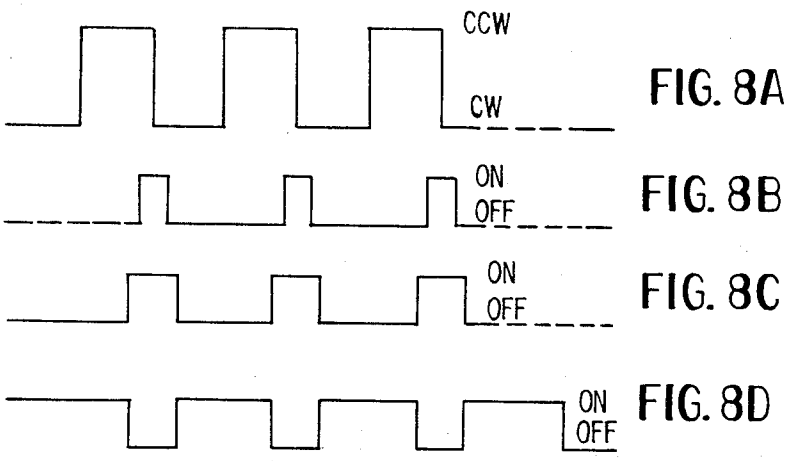


FIG. 8A

FIG. 8B

FIG. 8C

FIG. 8D

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FIG. 9

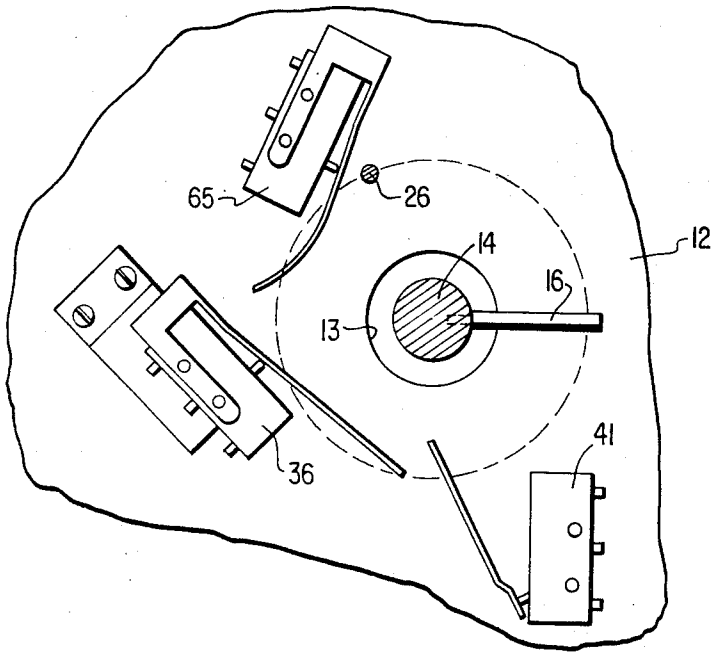


FIG. 10A

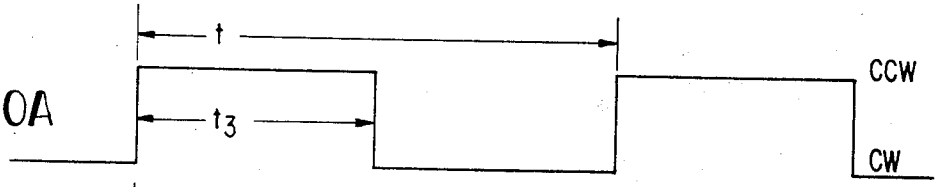


FIG. 10B

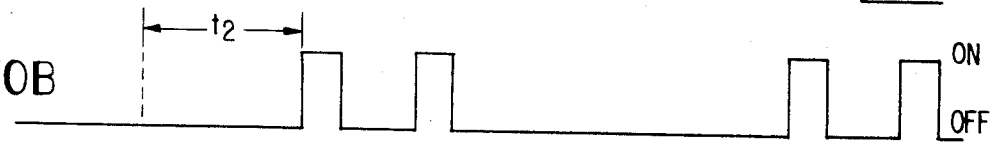


FIG. 10C



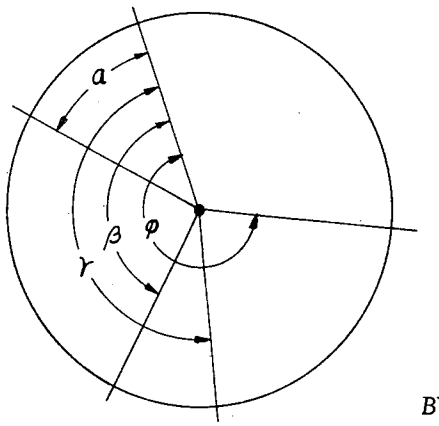


FIG. 11

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FIG. 12

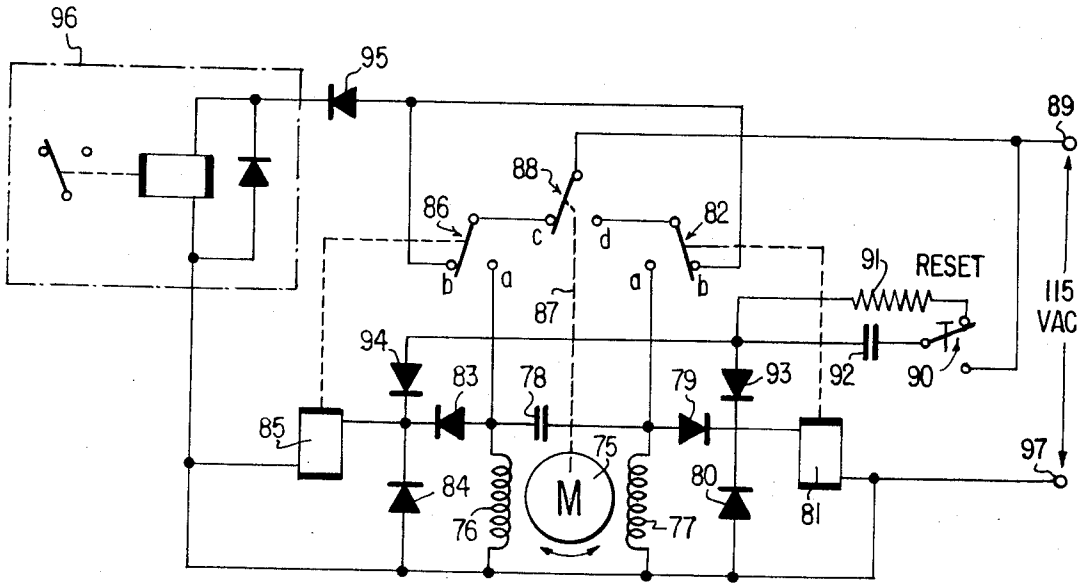
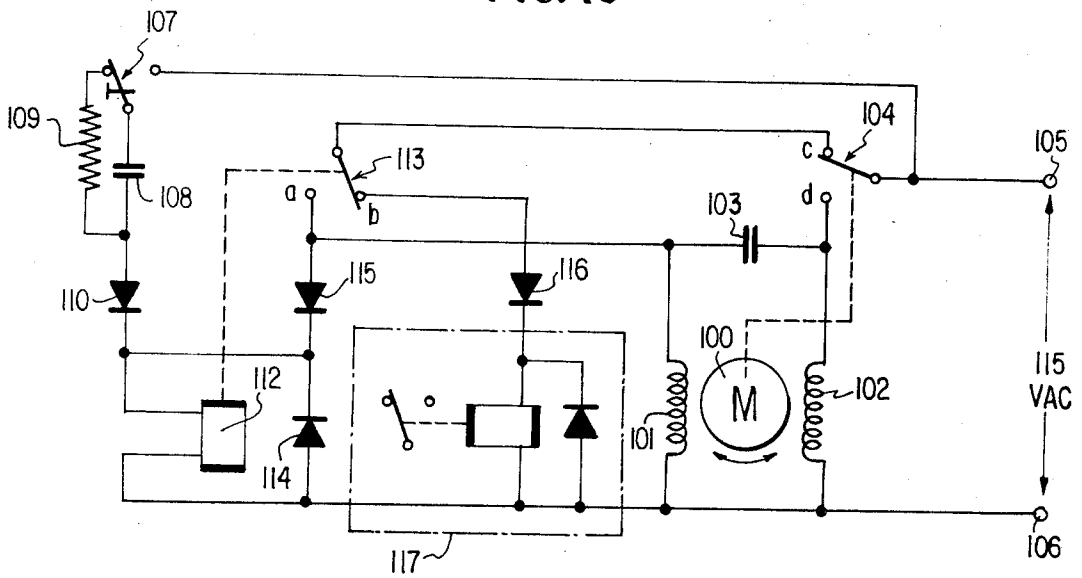


FIG. 13



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REVERSIBLE PROGRAMMER FOR ELECTRIC CIRCUITS

This invention relates to timing apparatus, and, more specifically, to an electromechanical apparatus for providing a repetitive cyclic output having adjustable predetermined characteristics.

The prior art includes many examples of efforts to construct timing devices of an electromechanical type which are capable of producing cyclic outputs having predetermined patterns. Most of these involve motors, cams and switches, the cams being designed to actuate these switches in accordance with some prearranged program.

However, it has been generally necessary to construct each timer in accordance with the desired program, the timers so constructed being somewhat special purpose devices and incapable of significant adjustment. Although most such timers have the capacity for replaceable cams and the like there does not appear to be any simple device in the prior art for producing a cyclic output having adjustable on and off times so that the timer can function as a general purpose device.

Accordingly, it is an object of the present invention to provide an electromechanical timer having means for producing a repetitive cyclic output in which the ratio of on time to off time is adjustable and in which the absolute value of off time is similarly adjustable.

A further object is to produce a timing device in which repetitive output pulses are produced, the spacing between the pulses being adjustable and the duration of the pulses being constant throughout the range of pulse spacing adjustment.

Briefly described, the apparatus of the invention includes a rotary drive means, a structure capable of rotary or arcuate motion between preselected angularly spaced limits, the structure being driven by the drive means. The drive means is reversible and cam means carried by the structure and rotatable therewith activates the reversing means and also provides a cyclic output. The means carried by the structure constitutes two cam devices which are angularly spaced from each other, the angular spacing being adjustable to alter the spacing between output pulses.

In order that the manner in which the foregoing and other objects are attained in accordance with the invention can be understood in detail, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is a plan view, in partial section, of an apparatus in accordance with the invention;

FIG. 2 is a section along lines 2—2 of FIG. 1;

FIG. 3 is a front elevation of a portion of the apparatus of FIG. 1;

FIG. 4 is a schematic diagram of a typical switch usable in the apparatus of FIG. 1;

FIGS. 5 and 6 are schematic diagrams of alternative arrangements for the electrical connection of the drive means;

FIGS. 7A–F and 8A–D are timing diagrams illustrating the modes of operation of the apparatus of FIGS. 1–6;

FIG. 9 is an elevation, in section, of a further embodiment of an apparatus in accordance with the invention;

FIGS. 10A–C are timing diagrams illustrating the operation of the apparatus of FIG. 9; and

FIG. 11 is a diagram showing the angular relationship in the apparatus of FIGS. 1–6 and 9.

As shown in FIG. 1, a preferred embodiment of the apparatus includes a housing 10 which contains a drive device such as a conventional reversible electrical motor, operable in either direction. The motor 10 has an output shaft 11 which is rotatable with the motor in either direction. For convenience, the motor is shown mounted to a panel or mounting bracket 12, the bracket having an opening 13 through which shaft 11 protrudes.

A cylindrical body 14 is coaxially mounted on shaft 11 and is firmly attached thereto by a pin or set screw 15 so that the body rotates with shaft 11. A pin 16 protrudes radially outwardly from body 14, pin 16 being attached to the body by a threaded connection or, for example, by an adhesive.

The distal end of body 14 is provided with an internally threaded axially inwardly extending hole 17 which is threaded and dimensioned to receive a machine screw 18, screw 18 having a large head. A disc 19 is provided with a central opening through which the shaft of bolt 18 extends, the disc being held thereby against the flat end of body 14. A pin 20 can be driven through the disc and the end of body 14 to prevent rotation of the disc relative to the body.

It will be recognized that the structure thus far described, including the motor, shaft 11, pin 16, body 14, disc 19 and bolt 18 all rotate together in either direction in accordance with the manner of energization of motor 10.

An additional structure is carried by body 14 and disc 19 and includes an annular ring 21. Ring 21 is generally rectangular in cross section but has an inwardly extending annular recess 22 forming a shoulder which bears against the peripheral margin of the outer surface of disc 19. A second disc 23, which is of larger diameter than disc 19,has a central opening 24 which loosely surrounds body 14. Disc 23 is held against the back surface of annular ring 21 between the ring and bracket 12 by any suitable fastening means such as a standard machine screw 25. An axial pin extends axially from the back face of ring 21 toward bracket 12, passing through disc 23. Pin 26 has an externally threaded end 27 which threadedly engages an axially inwardly extending hole 28 through the back surface of ring 21. An annular shoulder 29 is provided on pin 26 at a suitable position to assist in retaining ring 23 firmly engaged with the back surface of ring 21. A pointer 30 is formed on, or attached to, the inner cylindrical surface of ring 21.

A mounting bracket 35 is attached to bracket 12 and supports a sensitive switch 36. Switch 36 can be any conventional switch of the type generally referred to as "micro" action switches or sensitive switches which require relatively little force for actuation. Switch 36 is provided with an actuating arm 37, depression of which operates a button 38 which extends through the housing of the switch and mechanically moves the operating switch mechanisms therein. The contents of the switch are, in general terms, well known and will not be described in mechanical detail. However, it should be noted that the switch can be a single-pole, single-throw, normally open or normally closed, or a single-pole, double-throw usable in either mode.

An additional bracket 40 is mounted on bracket 12 and supports a sensitive switch 41 which is also a switch

requiring little force for its actuation, but is of a different variety in that it should include at least one single-pole, double-throw contact set. Switch **41** is provided with an actuating arm **42** which, when moved, operates a toggle **43** to operate the switch mechanism within the switching housing.

As will be recognized from the above description, the apparatus includes a drive means for rotating an assembly wherein the assembly constitutes two parts which normally move together but which can be adjusted relative to each other. Further, the assembly includes two cam members or pins, one on each of the two subportions of the assembly so that the pins can be adjusted relative to each other. In particular, body **14**, bolt **18** and disc **19** are fixed to and always move with shaft **11** and the motor. However, the subassembly including ring **21**, disc **23** and pin **26** can be slipped relative to disc **19**, adjusting the position of pin **26** relative to pin **16**. It will be observed that a friction washer **32** is provided between discs **19** and **23** to normally maintain these two in fixed relationship. However, by simply grasping ring **21** and rotating it, an adjustment can be accomplished.

As shown in FIG. **3**, the nature of the adjustment can be observed by observing the relative positions of pointer **30**, which is mounted on and moves with ring **21**, and an arrow **31** which is provided on the outer face of disc **19**. Arrow **31** is always aligned with pin **16** whereas pointer **30** is always aligned with pin **26**.

It will also be observed from FIG. **1** that actuating arm **37** is axially spaced from pin **16** and never comes in contact with that pin. However, pin **26** is capable of moving arm **37** and operating switch **36**.

Conversely, switch **41** can be operated by either pin. Pin **16** is axially spaced from bracket **12** the same distance as actuating arm **42** of switch **41** so that pin **16** engages the arm and moves it whenever it is rotated to the appropriate angular position. Furthermore, pin **26** axially extends sufficiently close to plate **12** to permit the switch to be operated as that pin approaches the angular position of the operating arm, again operating the switch.

The manner of operation can be best seen by referring to FIG. **2**. In this figure switch **41** should be regarded as the "reversing" switch, the function of that switch being to reverse the direction of the drive means whenever it is moved from one position to the other. Also, since switch **41** is a bistable, or toggle switch, it remains in whichever position it is moved to by whichever pin causes its movement.

To discuss the operation of the apparatus consider energization of the drive means in a counterclockwise direction as viewed in FIG. **2**. Pins **26** and **16** will then be driven in the counterclockwise direction, the path of pin **26** being approximately defined by the circular outline of motor housing **10**. As pin **26** rotates approximately 95° from the position it occupies in FIG. **2**, arm **42** of switch **41** will be moved from the position shown to its alternative stable position, shown in dotted lines in FIG. **2**. At that point, the motor will be reversed and pins **26** and **16** are driven in the clockwise direction until pin **16** engages arm **42** at which time switch **41** is moved to its other stable state, causing the drive means to be reversed to its originally assumed direction of motion. This institutes a new cycle of operation, which cycle continues as long as the motor is energized.

Now consider the operation of switch **36**. Each time switch **26** approaches the reversing location, arm **36** of switch **36** is moved, causing the switch, which is monostable in nature, to be either opened or closed. Switch **36**, being the output switch, then produces a pulse the duration of which is determined by the time required for pin **26** to move through the angle defined by the first actuation of switch **36** and the actuation of switch **41** and then back again until switch **36** is returned to its original state.

A typical switch usable as switch **36** is shown in FIG. **4**, wherein the actuating button **38** is schematically shown mechanically coupled to the movable contact of a single-pole, double-throw switch. Clearly, connections can be made to the center terminal and either or both of the terminals connected to the fixed contact so that single-pole, double-throw or single-pole, single-throw with either normally open or normally closed operation can be accomplished. Thus, the output constitutes several possible combinations.

However, it will be assumed in discussions hereafter that the switch is connected so that terminals **37** and **46** are connected to a load device and a source of voltage. The switch is then operated as a normally open, single-pole, single-throw switch and will provide outputs as shown in the subsequent figures.

FIGS. **5** and **6** are simple schematic diagrams showing possible connections of the drive means. In FIG. **5**, the reversing switch indicated generally at **41** is connected to either of two windings of the motor **10**, the motor being reversible depending upon which winding is energized.

In FIG. **6**, a two-motor approach is used, one motor being connected to drive the output shaft **11** in one direction and the other motor being connected to drive the shaft in the opposite direction. It will also be recognized that motors designed for use with either alternating or direct current sources can be employed.

The operation of the apparatus can be further understood by observing the wave form and timing diagrams in FIG. **7** A–D. FIG. **7A** constitutes a timing diagram with equal time intervals being displayed by the graduations along the abscissa. When the wave form is in its lowest position the time interval of clockwise motion is indicated, while counterclockwise motion is indicated when the wave form is in its upper position.

Along with FIG. **7A**, consider the output diagram illustrated in FIG. **7B** which shows the positions of switch **36** as detected at terminals **45** and **46**, FIG. **4**. When the diagram is in the upper position the switch is "closed" (i.e., conductive) between those two terminals, the lower position being the off or open position.

It will be observed that actuation of the output switch occurs when pin **26** approaches the end of one interval of counterclockwise movement such as interval **50**, initiating the beginning of an output pulse **51**. Then, after the motor has reversed and commenced moving in the clockwise direction, switch **36** is released, terminating pulse **51**. The motor and apparatus carried thereby then moves in the clockwise direction for interval **52** until pin **16** causes reversal again, initiating interval **53**, near the end of which an output pulse **54** is produced. The cycle is then repeated for intervals **55** and **56** and pulse **57**, and so forth for so long as the apparatus is energized.

Now, assume that ring **21** is rotated relative to disc **19** causing a decrease in the angle between indicators

30 and 31 and pins 26 and 16. This location is illustrated in FIG. 2 by the dotted line 58, indicating the new position of pin 26. The operation of the apparatus with this adjusted position is shown in FIGS. 7C and 7D, FIG. 7C being a timing diagram similar to FIG. 7A and FIG. 7D showing the output produced between terminals 45 and 46 as in FIG. 7B. It will be observed that each output pulse is of the same duration as pulses 51, 54 and 57, the duration of each such pulse being determined solely by the relative positions of switches 36 and 41 and their actuating arms. However, the intervals 59, 60 and 61 are shorter than the "off" intervals between pulses in FIG. 7B because the total cycle time has been reduced as seen in FIG. 7C.

Adjustment of ring 21 in the opposite direction to move pin 26 to a position represented approximately by the dotted line 62 in FIG. 2 results in diagrams such as those shown in FIGS. 7E and 7F. It will be seen in FIG. 7E that the absolute time intervals of clockwise and counterclockwise motion are greatly increased, thus increasing the off time between output pulses. However, the duration of the output pulses remains the same for the reasons discussed above.

FIGS. 8A–E illustrate alternative modes of operation of the apparatus. FIG. 8A is a diagram showing the cycle time of counterclockwise and clockwise movement of the drive means and the apparatus carried thereby. FIG. 8B is a diagram similar to FIGS. 7B and 7D, showing the output produced by switch 36.

FIG. 8C illustrates a further feature of adjustability which can be incorporated in the apparatus whereby the duration of the "on" pulse or output pulse can be adjusted. This adjustability can be incorporated simply by arranging for adjustment of the relationship of actuating arms 37 and 42. One manner is which this can be accomplished is by providing an arcuate slot 33 for one of the fastening devices associated with bracket 35. By loosening a nut 34 (FIG. 1) bracket 35 can be loosened enough to rotate the bracket about the fixed fastener, permitting the arm 37 to be moved relative to arm 42, thereby causing switch 36 to be closed earlier and opened later than in FIG. 8D. It will be observed, however, that so long as switch 36 is closed during the reversal time the output pulse will necessarily straddle the reversal as shown in all of FIGS. 7 and 8.

FIG. 8D illustrates the phase inversion which can be accomplished simply by using the normally closed contacts of the output switch shown in FIG. 4.

Still other arrangements of the apparatus can be provided simply by altering the mounting arrangement of the switches. For example, as shown in FIG. 9, switch 36 can be mounted farther away from switch 41 so that the actuating arm of switch 36 is operated to turn the switch on and off again before the cam which operates that switch contacts the reversing arm of switch 41. Then, on its return trip, switch 36 is again operated. This is illustrated in FIGS. 10A and 10B wherein FIG. 10A again shows the reversing cycle of the drive means and FIG. 10B illustrates the output of switch 36 when connected to terminals 45 and 46 as previously discussed.

Still further, additional switches such as switch 65 can be positioned in other locations in the path of travel of either pin 16 or pin 26 to be actuated as the pin passes the actuator thereof. The result of such an addition is the production of output pulses at other locations with respect to the rotation wave form of FIG. 10A, the pulses such as might be produced by switch 65 being shown in FIG. 10C.

In FIGS. 10B and 10C it will be recognized that the time spacing for the pulses is a function of the angular relationship between the two pins and the angular relationship between the adjustable limits of motion of the pins and the switch actuators. As shown in the angle diagram of FIG. 11, if the total angle between pins is the angle ϕ, then the total cycle time is equal to that angle divided by the angular rate of travel of each pin r. This time t, is shown in FIG. 10A. The interval between the beginning of such a cycle and the output pulse produced by switch 65 would then be equal to the angle α divided by r, illustrated in FIG. 10C as the interval t_1. In similar fashion, the interval to production of an output pulse by switch 36 is the angle β divided by r, or interval t_2 as shown in FIG. 10B. Likewise, interval t_3 to the reversal point is equal to the angle γ divided by r. The time relationships of the other output pulses can be similarly calculated.

Although the motor circuits shown in FIGS. 5 and 6 are suitable for continuous operation, it is possible to operate the apparatus in single cycles or half cycles with appropriate switching circuits, and it can be convenient to do so. The foregoing apparatus can be combined with manually or externally operable switch or pulsing means and stop switches which will cause the motor to terminate its rotation at the end of each cycle, or half cycle, and await a signal from the external source. Circuits for accomplishing this will now be described with reference to FIGS. 12 and 13.

In FIG. 12 a circuit is shown for operating the apparatus in the "half cycle" mode wherein the motor, when energized, rotates in one direction until it reaches the limit of motion in that direction as determined by the switch actuator at which time it stops and awaits an external signal. In the circuit of FIG. 12 a motor 75 is provided with windings 76 and 77, each of the windings being designed to drive the motor in one direction. A capacitor 78 is provided to supply the necessary phase shift in a well known manner. A series-parallel circuit is connected in parallel circuit relationship with winding 77, this circuit including a conventional semiconductor diode 79 in series with the parallel circuit including a conventional diode 80 and the winding of an electromagnetic relay 81. Winding 81 controls a single-pole, double-throw contact set indicated generally at 82, this contact set having a movable contact which is movable between fixed contacts identified as a and b. The movable contact is in the b position, as shown, when winding 81 is de-energized.

Diode 80 is included to absorb the de-energization current when winding 81 is de-energized.

A similar circuit is in parallel with winding 76 of motor 75, this circuit including a conventional semiconductor diode 83 in series circuit relationship with a parallel circuit including a diode 84 and a relay winding 85 which controls the operation of a single-pole, double-throw contact set indicated generally at 86. The movable contact of contact set 86 is also movable between fixed contacts identified as a and b, b again being the de-energized position.

The shaft of motor 75 is connected to mechanical means 87 for actuating a single-pole, double-throw bistable switch indicated generally at 88. Switch 88 has a movable contact which is movable between fixed contacts c and d, depending upon the operation of the

motor shaft and actuating means **87**. It will be recognized that the actuating means can be the combination of pins and levers shown, for example, in FIG. **2**, switch **88** then being analogous to bistable switch **41**.

The movable contact of switch **88** is connected at terminal **89** to a source of AC line voltage such as **115** volts AC. Terminal **89** is also connected to a starting circuit which includes a momentary contact reset switch indicated generally at **90**. Terminal **89** is connected to the normally open fixed contact of that switch set, the other fixed contact being connected to one terminal of a fixed resistor **91**. The movable contact of switch **90** is connected to one terminal of a capacitor **92**, the other terminal of which is connected to the other terminal of resistor **91** and to the anode electrodes of two conventional semiconductor diodes **93** and **94**. The cathode of diode **93** is connected to winding **81** and the cathode of diode **94** is connected to winding **85**.

Fixed contacts *b* of switches **82** and **86** are connected through a diode **95** to a relay circuit **96** which is operated by the timing circuit and controls a load device. The relay circuit shown is, of course, merely an example. The other side of relay circuit **96** is connected to the other AC line terminal **97** as are the other terminals of the relay windings and motor windings discussed heretofore.

The operation of the circuit of FIG. **12** can be described by commencing with the switches in the positions shown. As such, the relays and motor are de-energized and the motor is in one extreme position of its rotary movement, that position at which switch **88** was moved to its *c* position. To commence operation, switch **90** is momentarily closed, permitting capacitor **92** to be charged through two parallel circuits including diodes **93** and **94** and relay windings **81** and **85**. Because of the relatively large current which flows at the initial stages of charging a capacitor, and with suitable circuit values chosen, the relays are both energized, causing contact sets **82** and **86** to switch to their *a* positions. It will be seen that energization of the relays immediately establishes a circuit for one of motor windings **76** and **77**, depending upon the position of switch **88**. As shown, the circuit is completed from terminal **89** through switch **88** to the *c* contact, through switch **86** and its *a* contact and through motor winding **76**. The motor is accordingly caused to rotate in the direction which, at its limit, will cause switch **88** to move to its *d* position. However, before that position is reached, it will be seen that capacitor **92** will shortly become charge, or else switch **90** is released or both. Release of switch **90** causes capacitor **92** to discharge again through resistor **91**, but regardless of which event occurs first, the means for initially energizing relays **81** and **85** is removed. At that time *a* circuit has already been established through switches **88** and **86** to winding **76**, and a holding circuit is thus provided through diode **83** and winding **85**, maintaining that relay energized. Insufficient voltage appears on the side of the circuit including diode **79** and winding **81** to maintain that set in its energized condition and contact set **82** returns to its *d* position. The circuit remains with the motor running and relay winding **85** energized until the motor reaches its limit of motion at which switch **88** is moved to its *d* position. This breaks the circuit through switch **86** to windings **76** and **85**, thereby stopping the motor and de-energizing winding **85**. Contact set **86** returns to its *d* position and the circuit is again dormant until an external signal, in the form of the momentary closing of switch **90**, again initiates the operation of the circuit which is essentially the same as described above except that winding **77** and relay winding **81** are energized, causing the motor to rotate in the opposite direction.

The circuit of FIG. **13** is somewhat similar in principle but involves a slightly different sequence of operation. In FIG. **13** a motor **100** is provided with windings **101** and **102** and a capacitor **103**, the windings being energizible individually to drive the motor in opposite directions. Winding **102** is connected to the *d* fixed contact of a single-pole, double-throw contact set indicated generally at **104**, the movable contact of which is operated by the motor shaft at the limits of its motion. It will be observed that a movable contact is in connection with fixed contact *c* when the apparatus is in its dormant or rest condition. The movable contact of contact set **104** is connected to one terminal **105** of an AC source and also to one fixed contact of a momentary contact push button switch **107** which is analogous to push button switch **90**. A capacitor **108** is connected in series circuit relationship with switch **107**, the switch and capacitor being paralleled by a discharge resistor **109**. A conventional semiconductor diode is connected in series circuit relationship with the switch and capacitor and with the energizing winding **112** of an electromagnetic relay. Energizing winding **112** actuates a single-pole, double-throw contact set indicated generally at **113**, the movable contact of the set being movable between fixed contacts *a* and *b*, contact *b* representing the de-energized condition. A diode **114** is connected in parallel relationship with winding **112**, and a diode **115** is connected in series with the winding. It will be noted that diode **115** completes a circuit between contact *a* of contact set **113** and winding **112** so that a latching circuit can be completed. The movable contact of contact set **113** is connected to fixed contact *c* of contact set **104**.

Contact *b* of the contact set **113** is connected through a diode **116** to a load relay **117** or other suitable utilization device. It will be noted that winding **101** of the motor is also connected to contact *a* of set **113** and is therefore energized simultaneously with relay winding **112**.

In operation, push button **107** is operated to complete a circuit between **105**, through the push button and capacitor **108** and diode **110** to winding **112**, the charging current of the capacitor causing energization of winding **112** and actuation of contact set **113**. As soon as the relay has been actuated a circuit is available from terminal **105** through contact set **104** in the position shown in FIG. **13**, through contact set **113** in its energized position to contact *a* so that the relay is maintained in its energized condition after the push button is released or the capacitor has charged, and winding **101** of the motor is also energized. Thus, the motor runs until it causes operation of contact set **104** to the position in which the movable contact is against contact *d*. At that point the relay holding circuit is lost and the relay returns to its de-energized position. Winding **102** is then energized through the circuit from terminal **105**, switch **104**, winding **102** to terminal **106**, causing the motor to run in the opposite direction. The motor runs until it reaches its limit of motion at which time contact set **104** is returned to its *c* contact and the sys-

tem again becomes dormant, awaiting a new initiation by closing contact set **107.**

It will be seen that in the operation of the circuits of FIGS. **12** and **13** a precisely timed interval is initiated by operation of a push button switch, the interval in the circuit of FIG. **12** constituting rotation of the motor in one direction from one of its limits to the other, and the interval in FIG. **13** being defined by the movement of the motor from one limit to the other and back again. Thus, the FIG. **12** circuit can be referred to as a "half cycle" circuit while FIG. **13** constitutes a "full cycle" circuit.

While certain advantageous embodiments have been chosen to illustrate the invention it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A timer comprising first means mounted for reciprocating arcuate motion between preselected angularly spaced limits;

means for repetitively driving said first means alternately in both directions between said limits;

means for reversing the direction of said means for driving upon arrival of said first means at each of said limits; and

means carried by said first means for actuating said means for reversing and for providing a cyclic output,

wherein said means carried by said first means includes a first cam mounted in fixed relationship to said first means; and

a second cam mounted for movement with respect to said fist cam, said second cam being angularly adjustable with respect to said first cam to adjust the angular spacing between said angularly spaced limits;

and wherein said second cam comprises

a disc fixedly attached to said output shaft;

an adjustable disc frictionally engaging said fixed disc; and

a cam surface carried by said adjustable disc.

2. A timer comprising first means mounted for reciprocating arcuate motion between preselected angularly spaced limits,

means having an output shaft for repetitively driving said first means alternately in both directions between said limits;

said first means including

a disc attached to said output shaft for movement therewith; and

a second disc carried by said output shaft, said second disc being angularly adjustable relative to said first disc;

means for reversing the direction of said means for driving upon arrival of said first means at each of said limits; and means carried by said first means for actuating said means for reversing and for providing a cyclic output, said means carried by said first means including

a first actuating pin attached to said output shaft;

a second actuating pin carried by said second disc; and

means for adjusting the angular spacing between said preselected angularly spaced limits.

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