Feb. 5, 1935. H. I. TURNER 1,989,723

ELECTRIC CIRCUIT CONTROLLING MECHANISM

Filed Dec. 6, 1932

Fig. 1

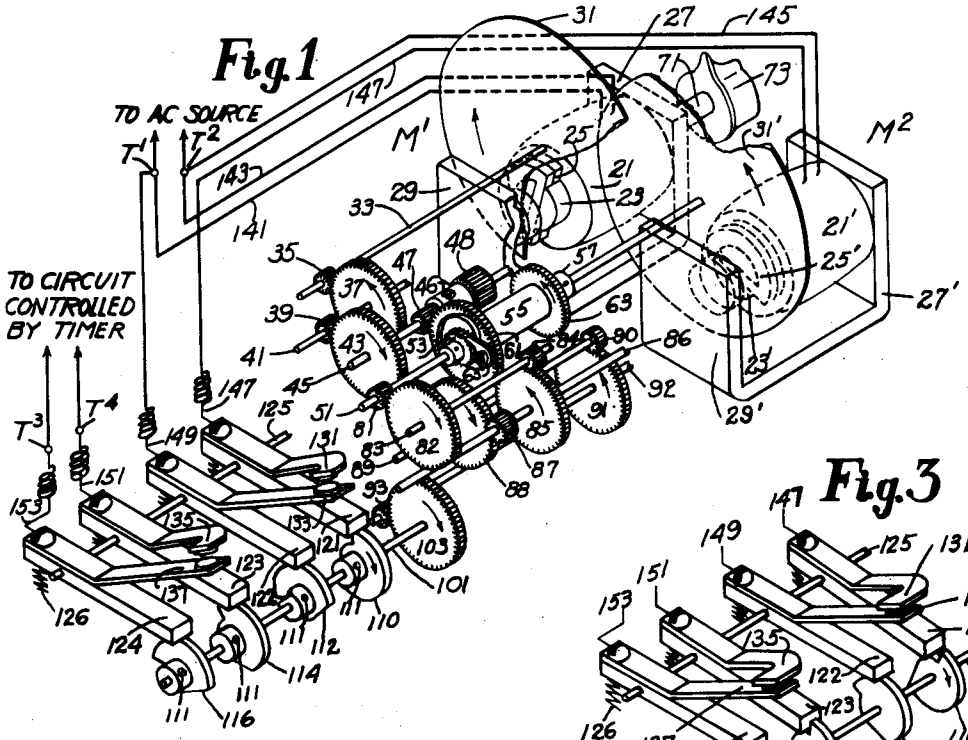


Fig. 3

Fig. 2

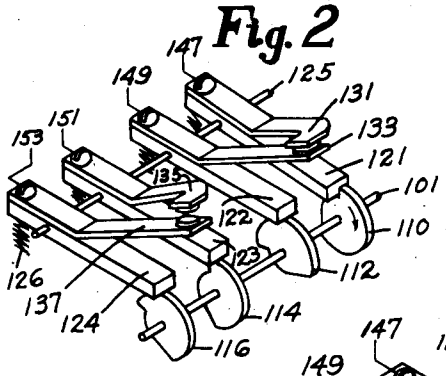


Fig. 4

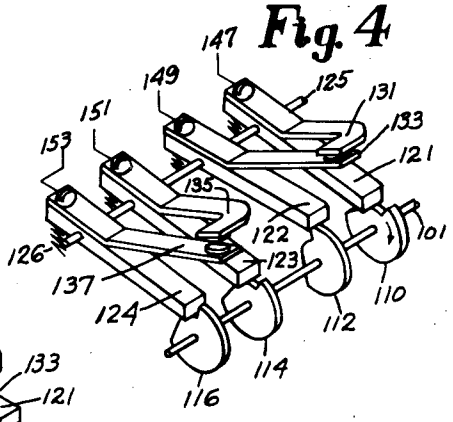
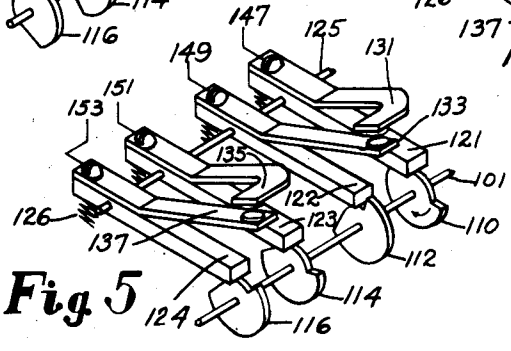


Fig. 5



INVENTOR
HARRISON I. TURNER
BY C. E. Beach
ATTORNEY

Patented Feb. 5, 1935 1,989,723

UNITED STATES PATENT OFFICE

1,989,723

ELECTRIC CIRCUIT CONTROLLING MECHANISM

Harrison I. Turner, Moline, Ill., assignor to The Gamewell Company, Newton Upper Falls, Mass., a corporation of Massachusetts

Application December 6, 1932, Serial No. 645,983

10 Claims. (Cl. 200—33)

This invention relates generally to electric circuit controlling mechanism arranged for periodic actuation of electric circuit controllers or switches; and more particularly relates to controllers for circuits the normal condition of which should, at comparatively infrequent occasions, be altered for an interval of comparatively short and reasonably uniform duration.

Time controlled switches have heretofore been employed for service of this general character, but where such switches have been arranged to act at intervals on the order of 6, 8, 10, 12 or more hours, it has been found to be difficult to limit the duration of abnormal circuit conditioning to less than a substantial fraction of an hour; such, for example, as fifteen minutes.

This difficulty apparently has been due to the slow movement of the member which ultimately effects actuation of the switch mechanism. Such slow movement of switch actuating members of prior-art time switches has further involved problems as to back-lash of gearing, and the like, because of which it has been found to be difficult to avoid extensive variations between durations of one and another of the intervals of a succession of abnormal positionings of the switches.

The construction of prior switches for similar service has further been such that it has been difficult to dependably provide for ready adjustability of the duration of abnormal switch positionings in comparatively small steps, say on the order of one minute or less.

The inherent characteristics of such prior controlling switches have further been such that, although given mechanisms have provided facilities for varying the duration of abnormal conditionings, or for varying the interval between the commencement of such abnormal conditions,—facilities have been lacking in each of the various types of switches for readily accomplishing both of such adjustments in any given switch; and, insofar as provision has been available for varying the duration of one interval or the other, such variations have usually necessitated a revision of all settings, as a change in the speed of operation affecting one interval has also affected the duration of the other.

It is therefore an object of this invention to provide a mechanism arranged to act periodically, upon comparatively infrequent occasions, separated by intervals say on the order of 6, 8, 10, 12, or more hours, to effect abnormal conditionings of circuit controlling mechanism for comparatively short intervals, say on the order of one or more minutes.

It is a further object to provide such a mechanism in which, with any given setting or adjustment thereof, the duration of successive abnormal conditionings of the circuit controlling mechanism will be substantially identical, and whereby the maximum variation between the durations of a series of abnormal conditions may be minimized, say to a minor fraction of a minute.

It is a further object to provide, in such a mechanism, means whereby the durations of intervals between the commencement of succeeding abnormal conditionings of the circuit controlling mechanism may be adjusted, at will, throughout comparatively wide variations, without thereby affecting the duration of such abnormal conditionings.

It is a further object to provide, in such a mechanism, means whereby the duration of abnormal conditionings of the circuit controlling mechanism may be adjusted, at will, throughout a comparatively wide range, without thereby altering the time which elapses between commencements of succeeding abnormal conditionings.

It is a still further object to provide, in a single mechanism of the general type indicated, facilities whereby both the duration of abnormal conditionings of the circuit controlling mechanisms or the duration of intervals between the commencements of such succeeding abnormal conditionings may be adjusted, at will, throughout comparatively wide variations, without, in any event, affecting the duration of either of such intervals through revision of setting for the other of such intervals.

Other objects of this invention, and the features of construction by which they are attained, will be pointed out hereinafter in connection with the description of the illustrated embodiment of the invention.

In order to facilitate understanding thereof, an embodiment of this invention is shown in the accompanying drawing and will be hereinafter described in detail, which embodiment is particularly suited for controlling the motor of air filtering equipment to infrequently effect (say once in twelve hours) a brief so-called "washing" of the screen, for a time say on the order of one or two minutes; facilities being provided whereby the interval between washings may be adjusted, and whereby the duration of washings may be independently adjusted.

Like reference characters denote the same parts throughout the various views of the accompanying drawing, in which

Figure 1 is a distorted perspective view of operating mechanism of a circuit controller embodying this invention, with supporting frame plates removed, mainly diagrammatic for the sake of clarity, and showing the various gear elements displaced axially much further than would be necessary in a physical embodiment;

Figs. 2, 3, 4 and 5 show the circuit controlling mechanism of Fig. 1 at various stages of the operative cycle thereof.

Referring to Fig. 1, the disc motor M^1 comprises an electromagnet coil 21 having, at one end thereof, a pole piece 23 equipped with a shading coil 25 and having secured to the other end thereof a U-shaped strap 27, an end 29 of which is disposed adjacent to and parallel with the face of the pole 23.

A disc 31 extends between the pole piece 23 and end 29, for rotation responsive to alternating current excitation of the coil 21. Said disc 31 is fixed upon a shaft 33 for rotation therewith, and the pinion 35 is also fixed upon said shaft and drives the shaft 45, through the gear 37 and pinion 39 which move together and are carried by the shaft 41, and which, in turn, drive the gear 43 which is fixed upon the shaft 45.

The disc motor M^2 comprises an electromagnet coil 21', a pole piece 23', a shading coil 25', a strap 27' having an end 29', and a disc 31', similar in arrangement and operation to the corresponding parts of the motor M^1.

The disc 31' is fixed upon the shaft 51, to which the ratchet wheel 53 is also fixed. A sleeve 55 is loosely mounted on the shaft 51 between the ratchet wheel 53 and the fixed collar 57, for rotation independently of said shaft. The gear wheels 61 and 63 are fixed upon the respective ends of the sleeve 55, and a ratchet dog 65 carried by the gear 61 engages the ratchet wheel 53, so that the shaft 51 may be turned in one direction responsive to rotation of the gear 61, without excitation of the coil 21', or else said shaft 51 may be turned in such direction, without thereby causing rotation of the gear 61 and parts moving therewith, by driving the disc 31' responsive to alternating current excitation of the coil 21'.

A boss 46 is carried by the shaft 45, for rotation therewith, and carries the pinions 47 and 48 at the respective ends thereof. Said boss 46 is axially adjustable on the shaft 45 so that the pinion 47 may be brought into driving engagement with the gear 61, as shown; or, when the boss 46 is in another position the pinion 47 will be withdrawn from the gear 61 and the pinion 48 will be brought into driving engagement with the gear 63. The ratio between the pinion 47 and the gear 61 differs from that between the pinion 48 and the gear 63, so that, with a given speed of the disc 31, the rate of rotation of the gear 61 may be varied by moving the boss 46 axially along the shaft 45.

A shaft 71, operable by the handle 73 provides means for manually adjusting the position of the shading coil 25 of the motor M^1, so that the torque and hence the speed of this motor can be adjusted in a well-known manner.

A cam shaft 101 is driven by a gear 103, which gear is connected with the shaft 51 through reduction gearing comprising the pinion 81, gear 82, shaft 83, pinion 84, gear 85, shaft 86, pinion 87, gear 88, shaft 89, pinion 90, gear 91, shaft 92 and pinion 93.

The cams 110, 112, 114 and 116 are carried by the shaft 101; these cams being detachably secured to said shaft, as by means of the set screws 111 indicated in Fig. 1, where these screws are shown as being applied through bosses carried by the respective cams. Such bosses and set screws are omitted, in the interest of clearness, from Figs. 2, 3, 4 and 5.

The tracers 121, 122, 123 and 124 are associated with the cams 110, 112, 114 and 116, respectively. Said tracers are independently fulcrumed on a shaft 125, and each has a spring 126 so applied thereto as to urge the free end of the tracer toward the periphery of its associated cam. The contacts 131 and 133 are associated with the tracers 121 and 122, respectively, and said contacts are so formed and arranged that the free ends thereof will be adjacent and parallel to one another, but spaced somewhat apart, when the free ends of their associated tracers are supported by their associated cams substantially equidistant from the shaft 101, but so that when the support of the raised portion of cam 110 is withdrawn from the tracer 121 at a time when tracer 122 is being supported by the raised part of cam 112, the resultant movement of tracer 121 will carry contact 131 into engagement with contact 133; and, correspondingly, when the support of the raised portion of cam 112 is withdrawn from tracer 122 the resultant movement of said tracer will carry the contact 133 away from the contact 131.

The contacts 135 and 137 are associated with the tracers 123 and 124, respectively, for similar functional actuation responsive to rotation of the cams 114 and 116.

The terminals T^1 and T^2 are provided for connection with a source of alternating current of voltage and frequency suitable for intended excitation of the electromagnet coils 21 and 21'.

The respective ends of the winding of the coil 21 are connected through the conductors 141 and 143 with the terminals T^1 and T^2.

One end of the winding of the coil 21' is connected to the terminal T^2 through conductor 145, and the other end of said winding is connected to the contact 131 through conductor 147. Contact 133 is connected to terminal T^1 through conductor 149.

Contacts 135 and 137 are connected through conductors 151 and 153 to terminals T^4 and T^3, respectively, and the circuit, the condition of which should be periodically altered by this mechanism, is suitably connected to terminals T^3 and T^4.

The cams 114 and 116 are so positioned upon the shaft 101 that, when said shaft is driven by the motor M^2, the time which elapses from the withdrawal of the rise of cam 114 from tracer 123 to the time of the withdrawal of the rise of the cam 116 from the tracer 124, will be that for which it is desired to abnormally condition the circuit associated with the terminals T^3 and T^4. As shown, such abnormal conditioning consists in closure of the contacts 135 and 137. It will, however, be obvious to those skilled in this art that, should it be desired that the connection between terminals T^3 and T^4 should be normally closed and should be opened for abnormal conditioning thereof, such result may be readily obtained by reversal of relationship between the contacts 135 and 137 and/or alteration of the shape and/or setting of the cams 114 and 116.

The cam 110 should be so positioned that its raised portion will be withdrawn from the path of tracer 121 as soon as and preferably in advance

of the withdrawal of the raised portion of cam 114 from the path of the tracer 123, at any intended or anticipated setting of said cam 114. Correspondingly, the cam 112 should be so set that its raised portion will be withdrawn from the path of tracer 122 at a point in the rotation of the shaft 101 no earlier than and preferably subsequent to any intended or anticipated setting of the cam 116; to the end that, in any event, the raised portion of the cam 112 will not be withdrawn from its associated tracer 122 until the raised portion of cam 116 has been withdrawn from the path of the tracer 124. Although, as just indicated, the mechanism will operate successfully if contacts 131 and 133 close and break simultaneously with contacts 135 and 137, it is preferable that the contacts 131 and 133 close prior to and break later than the contacts 135 and 137, in the cycle of movement of the shaft 101; for the reason that, otherwise, slight wear or shifting of parts might at some time result in the closing and/or opening of contacts 135 and 137 in advance of like action of the contacts 131 and 133. Should either or both occasionally occur, the duration of the interval of closure of the contacts 135 and 137 might be objectionably varied, due to the slower movement of the shaft 101 while the separation of the contacts 131 and 133 cause deenergization of the motor M^2.

It is, of course, obvious that the respective forms of the cams 110, 112, 114 and 116 may be varied, to suit differing conditions; and that, if desired, multiple rise cams may be provided in place of each of these cams, so that the cycle of the movement of the shaft 101 for each functional actuation of the contacts controlled by the associated tracers would be less than one revolution of said shaft.

The duration of intervals between closures of the contacts 135 and 137 may be varied by moving the boss 46 axially along the shaft 45 so as to either bring pinion 47 into mesh with gear 61 or pinion 48 into mesh with gear 63. The duration of such interval may be further varied by rotation of the shading coil 25 by means of the handle 73.

As already indicated, the duration of abnormal relative positioning of contacts 135 and 137 may be varied by relatively rotating the cams 114 and 116.

The operation of the mechanism is as follows:

Assuming a source of electrical energy of suitable voltage and frequency to be connected to terminals T^1 and T^2, and a circuit which should be periodically controlled to be suitably associated with the terminals T^3 and T^4; it is evident that the coil 21 will be continuously excited; current being conducted to the ends of the windings of said coil through conductors 141 and 143 from terminals T^1 and T^2, respectively, and the mechanism will operate through the various phases of its cycle.

If at the time of the completion of a connection of the terminals T^1 and T^2 with a source of suitable alternating current, the cams, tracers and contacts are relatively positioned substantially as indicated in Fig. 1, the rotation imparted to the disc 31, because of the excitation of the coil 21, will be transmitted through the shaft 33, pinion 35, gear 37, shaft 41, pinion 39, gear 43, shaft 45, pinion 47, gear 61 (or through pinion 48, gear 63 and sleeve 55 to gear 61, depending upon the positioning of bushing 46), thence through dog 65, ratchet wheel 53, shaft 51, pinion 81, gear 82, shaft 83, pinion 84, gear 85, shaft 86, pinion 87, gear 88, shaft 89, pinion 90, gear 91, shaft 92, pinion 93 and gear 103 to the shaft 101; and the speed at which said shaft 101 will be driven will be determined by the positionings of the bushing 46 and of the shading coil 25.

When, in the course of the ensuing rotation of the shaft 101, the raised portion of the cam 110 is withdrawn from the path of the tracer 121,—the contact 131 will move into engagement with the contact 133; whereupon, the cams, tracers and contacts will be relatively positioned substantially as indicated by Fig. 2.

Upon such closure of the contacts 131 and 133, the coil 21' of the motor M^2 will be energized through a current path extending from terminal T^1, through conductor 149, contacts 133 and 131, and conductor 147 to one end of the winding of coil 21'; and from the other end of said winding, through conductor 145 to terminal T^2.

Throughout such energization of the coil 21' the motor M^2 will drive the shaft 51, and through it, the shaft 101, at speeds substantially in excess of that at which said shafts are driven by the motor M^1; such increased speed of said shafts being permitted by the ratchet mechanism 53, 65 without requiring change in the speed of said motor M^1. Shortly after the commencement of such increased speed, the raised portion of cam 114 will be withdrawn from the path of the tracer 123, and said tracer will thereupon be moved by its spring 126 to carry contact 135 into engagement with contact 137, and thus connect terminals T^3 and T^4; thereby abnormally conditioning the circuit associated therewith. The cams, tracers and contacts will thereupon be relatively positioned substantially as indicated by Fig. 3.

Following such closure of the controlled circuit between contacts 135 and 137, at the end of the desired interval for which the cams 114 and 116 have been set to effect closure of the controlled circuit, the raised portion of the cam 116 will be withdrawn from the path of the tracer 124, which tracer will then be moved by its spring 126 to carry the contact 137 away from the contact 135, and thus effect restoration to normal conditioning of the circuit associated with terminals T^3 and T^4. The cams, tracers and contacts will thereupon be relatively positioned substantially as indicated by Fig. 4.

After the contacts 135 and 137 have been restored to normal relationship, as just described, further rotation of the shaft 101 will effect withdrawal of the raised portion of cam 112 from the path of tracer 122, whereupon said tracer will be moved by its spring 126 so as to carry contact 133 away from contact 131 and thereby effect deenergization of the motor M^2. The cams, tracers and contacts will thereupon be relatively positioned substantially as indicated by Fig. 5.

Following separation of the contacts 131 and 133, as just described, the shaft 101 will be rotated by the motor M^1 (and more slowly than said shaft had been rotated by the motor M^2) until the raised portion of cam 110 is again withdrawn from the path of its associated tracer 121, whereupon the cycle of operation just described will be repeated.

Inasmuch as the time required for rotation of the shaft 101, from the time that the raised portion of cam 112 is withdrawn from the path of tracer 122 until the raised portion of cam 110

is withdrawn from the path of tracer 121 is dependent upon the rate of rotation imparted to the shaft 101 by the motor M^1, it is evident that the length of such time may be varied by changing the position of the bushing 46 so as to bring either pinion 47 or pinion 48 into mesh with its associated gear, or by rotating the shading coil 25 through actuation of the handle 73; so that the duration of intervals between the commencement of succeeding abnormal positionings of the contacts 135 and 137 may be varied, throughout a comparatively wide range, without in any wise affecting the duration of the abnormal conditioning of said contacts.

It will be correspondingly apparent that the duration of the abnormal relative positioning of the contacts 135 and 137 may be extensively varied by altering the relative positions of the cams 114 and 116, without thereby affecting the duration of the intervals between the commencements of succeeding abnormal conditionings of said contacts.

It will be further evident that the gearing may be so proportioned that, when the shaft 101 is driven by the motor M^2, a speed of rotation will be attained such that the duration of abnormal conditionings of contacts 135 and 137 may be readily pre-established with any needful or desirable degree of nicety, through relative adjustments of the cams 114 and 116.

It has been found that, when periodically actuated circuit controlling mechanism constructed in accordance with this invention is employed for governing the activity of the screen washing motor of air filtering equipment, variations in the intervals between such washings, and in durations thereof, which do not exceed say 5%, are not objectionable; and that ordinary induction disc motors will assure accuracy within such limits. If, however, a greater degree of accuracy is desired,—it is obvious that either or both of the motors M^1 and M^2 may be of various types of well-known synchronous motors.

The embodiment of this invention shown by the accompanying drawing and hereinbefore described provides for continuous energization of the motor M^1. If, however, it is desired to deenergize such motor during excitation of the motor M^2, it is obvious that such deenergization may be attained through the use of additional cams and contacts, or through the connection of the controlling coil of a relay in the current path which supplies the motor M^2, which relay would govern the current path which supplies the motor M^1, or otherwise.

It will also be evident that if the circuit to be controlled by such a mechanism is supplied from the same alternating current source which supplies the motors M^1 and M^2, the contacts 135 and 137, together with their associated parts, may be omitted; and the loop to be controlled may be connected in parallel with the coil 21′ of motor M^2.

It will furthermore be evident that the adjustability of the speed at which the shaft 101 is driven by the motor M^1 may be obtained through change gearing to the exclusion of a movable shading coil, or vice versa. Also that a movable shading coil and/or change gear mechanism may be provided for varying the speed at which shaft 101 is driven by motor M^2.

It will be understood by those skilled in this art that still other changes in number, form and arrangement of parts might be made without departing from the spirit of this invention; it should therefore be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

I claim:

1. In periodically actuated circuit controlling mechanism,—a revoluble shaft, a series of cams driven by said shaft and adjustable as to their relationships one with another, two sets of circuit controllers responsive to said cams, a motor associated in driving relationship with said shaft, connections whereby energization of said motor is governed by one of said sets of circuit controllers, the adjustment of said cams being such that the other set of circuit controllers will be abnormally positioned only during energization of said motor, a second motor, and gearing whereby said second motor may drive said shaft at a speed slower than that imparted to said shaft by said first motor.

2. In periodically actuated circuit controlling mechanism,—a revoluble shaft, cams adjustably secured to said shaft to be driven thereby, a circuit controller responsive to said cams, a motor associated in driving relationship with said shaft, connections whereby energization of said motor is governed by said circuit controller, a second motor, and gearing whereby said second motor may drive said shaft at a speed slower than that imparted to said shaft by said first motor.

3. In periodically actuated circuit controlling mechanism,—a revoluble shaft, means responsive to rotation of said shaft for changing the condition of a circuit alternately between normal and abnormal, said means adjustable to vary relative proportions of said normal to said abnormal conditionings incident to a given cycle of the movement of said shaft, a motor geared to said shaft, means operable responsive to rotation of said shaft for conditioning said motor for operation at and from a point in the cycle of the rotation of said shaft, preceding the occurrence of a predetermined one of said circuit condition changes to a point in said cycle subsequent to the opposite circuit condition change, a second motor driving means including adjustable change gears and ratchet mechanism whereby operation of said second motor may rotate said shaft at a speed slower than that imparted to said shaft by said first motor while permitting such faster rotation of said shaft.

4. In a periodically actuated circuit controlling mechanism,—a revoluble shaft, means responsive to continuous rotation of said shaft for changing the condition of a circuit alternately between normal and abnormal, said means adjustable to vary relative proportions of such normal to said abnormal conditionings incident to given movement of said shaft, a motor associated with said shaft for driving it at a substantially uniform speed, means driven by said shaft for effecting operative energization of said motor during one of the conditions of said responsive means, a second motor, means for causing operation of said second motor throughout deenergization of said first named motor, means comprising a ratchet and driven by said second motor for driving said shaft at a speed slower than that imparted to said shaft by said first motor, and means for varying the rate of rotation imparted to said shaft by said second named motor.

5. In periodically actuated circuit controlling

mechanism,—a revoluble shaft, means responsive to continuous rotation of said shaft for changing the condition of a circuit alternately between normal and abnormal, said means adjustable to vary relative proportions of such normal to said abnormal conditionings incident to given movement of said shaft, a motor associated with said shaft for driving it at a substantially uniform speed, means operable responsive to said shaft for effecting operative energization of said motor throughout one of the conditions of said responsive means, a second motor associated with a source of energy for continuous actuation thereby at a substantially uniform speed, means comprising a ratchet driven by said second motor for driving said shaft at a speed slower than that imparted to said shaft by said first motor, and means for varying the rate of rotation imparted to said shaft by one of said motors.

6. In periodically actuated circuit controlling mechanism,—the combination of a revoluble shaft, means cyclically actuated incidental to rotation of said shaft for periodically effecting alternate abnormal and normal conditionings of an electric circuit, means for driving said shaft at one speed throughout abnormal positionings of said conditioning means, means for driving said shaft at a substantially slower speed during normal positioning of said conditioning means, means for effecting changes in the timing of complete actuation cycles of said controlling means by altering the speed at which said shaft is driven by said first named driving means without thereby altering duration of abnormal positionings of said conditioning means, and means for altering the duration of abnormal positionings of said controlling means without thereby altering the timing for complete actuation cycles of said conditioning means.

7. In periodically actuated circuit controlling mechanism,—the combination of a revoluble shaft, means cyclically actuated incidental to rotation of said shaft for periodically effecting alternate abnormal and normal conditionings of an electric circuit, means for driving said shaft at one speed during abnormal positionings of said conditioning means, means for driving said shaft at a substantially slower speed during normal positioning of said conditioning means, means for effecting changes in the timing of complete actuation cycles of said controlling means by altering the speed at which said shaft is driven by said first named driving means without thereby altering duration of abnormal positionings of said conditioning means, and means for altering the duration of abnormal positionings of said controlling means without thereby altering the timing for complete actuation cycles of said conditioning means.

8. In periodically actuated circuit controlling mechanism,—the combination of a revoluble shaft, means cyclically actuated incidental to rotation of said shaft for periodically effecting alternate abnormal and normal conditionings of an electric circuit, means for driving said shaft at one speed during abnormal positionings of said conditioning means and for driving said shaft at a substantially slower speed during normal positioning of said conditioning means, means for effecting changes in the timing of complete actuation cycles of said controlling means by altering the speed at which said shaft is driven during normal positioning of said conditioning means without thereby altering duration of abnormal positionings of said conditioning means, and means for altering the duration of abnormal positionings of said controlling means without thereby altering the timing for complete actuation cycles of said conditioning means.

9. In periodically actuated circuit controlling mechanism,—the combination of a revoluble shaft, means cyclically actuated incidental to rotation of said shaft for periodically effecting alternate abnormal and normal conditionings of an electric circuit, means for driving said shaft at one speed during abnormal positionings of said conditioning means and for driving said shaft at a substantially slower speed during normal positioning of said conditioning means, and means for altering the duration of abnormal positionings of said controlling means without thereby altering the timing for complete actuation cycles of said conditioning means.

10. In periodically actuated circuit controlling mechanism,—the combination of a revoluble shaft, means cyclically actuated incidental to rotation of said shaft for periodically effecting alternate abnormal and normal conditionings of an electric circuit, and means responsive to said circuit conditioning means for driving said shaft at one speed during abnormal positionings of said conditioning means and for driving said shaft at a substantially slower speed during normal positioning of said conditioning means.

HARRISON I. TURNER.