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## TIMING MECHANISM

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The present invention relates to a timing mechanism and more particularly to a timing mechanism incorporating an electromagnetic device and a thermal device cooperating to control a switching means.

In many installations it is necessary to provide a given timed interval between the closing of a controller, such as a switch connected to an electrical power line, and the connecting of a load to the power line. A timer designed to provide this timed interval must provide this given timed interval upon initial closing of the power line switch and must also sense a momentary power failure to again provide this given timed interval.

It is therefore an object of the present invention to provide a timing mechanism that will energize a load a given timed interval after completion of a control circuit and will also provide the given timed interval after a momentary power failure or a prolonged power failure.

It is a further object of the present invention to provide a timing mechanism that will energize a load a predetermined timed interval after completion of a control circuit and will provide at least the predetermined timed interval even though a power failure of short duration occurs during the timing cycle.

It is a further object of the present invention to provide a timing mechanism making use of an electromagnetic device and a thermal device jointly controlling switching means such that the switching means is moved to circuit closing position upon a heating of the thermal device, the resultant energization of the electromagnetic device, and the subsequent cooling of the thermal device.

It is a further object of the present invention to provide a timing mechanism having an electromagnetic device and a thermal device controlling switching means such that initial energization of the timing mechanism energizes the thermal device to move the switching means to a first position in which the electromagnetic device is energized, the electromagnetic device in the energized position moving the switching means to a second position in which the thermal device is deenergized, and the thermal device, upon cooling, moving the switching means to a third position to complete the timing function of the timing mechanism.

These and other objects of the present invention will be understood upon consideration of the accompanying specification, claims and drawings of which:

Figure 1 is a showing of the first embodiment of the present invention;

Figure 2 is a showing of the second embodiment of the invention;

And, Figure 3 is a showing of the device of Figure 2 along the section 3-3.

Referring to Figure 1, within the broken line 10 is shown the improved timing mechanism. The timing mechanism comprises an electromagnetic device 11 having a winding 12, a movable armature 13, and a core structure 14. A thermal device 15 is shown having a

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heater 16, and a movable bimetal element 17. Switching means 18 is shown having normally open contact pairs 20-21 and 22-23 and normally closed contact pairs 24-25. A supporting structure is shown consisting of rigid metallic members 26 and 27 and insulating blocks 28 supporting contact blades 30, 31, 32, 33 and the bimetal 17. The insulating block structure and contact blades are held firmly together by means of a bolt 34, which bolt is insulated from the above mentioned switch blades and bimetal 17.

A pair of power line conductors 61 and 62 are shown connected to power input terminals 63 and 64 of the timing mechanism 10 through a switch 65. A load 66 is shown connected to power line 61 by means of conductor 67 and by means of conductor 68 to load terminal 69 of the timing mechanism 10. It will be recognized that a timing mechanism has many applications, however, for purpose of explanation the present invention has been shown in conjunction with load 66 and it is the purpose of the timing mechanism to energize the load 66 a predetermined normal time period after the closing of the switch 65.

The apparatus as shown in Figure 1 is in its normally deenergized position. That is, the electromagnetic device 11 is deenergized, and the thermal device 15 is deenergized with the bimetal element 17 in the cold position. When the switch 65 is closed, a circuit can be traced from the power line conductor 62 through switch 65, power input terminal 64, conductor 71, winding 12 of electromagnetic device 11, conductor 72, conductor 73, heater 16 of thermal device 15, conductor 74, conductor 75, and power input terminal 63 to power line conductor 61. From the above traced circuit it can be seen that winding 12 of the electromagnetic device 11 is in series with the heater 16 of the thermal device 15. The relative impedances of winding 12 and heater 16 are such that the winding 12 remains operatively deenergized and the thermal element 15 is operatively energized while the timing apparatus is in this condition of operation. In other words, the level of energization furnished to winding 12 of the electromagnetic device 11 is insufficient for the device 11 to move the armature 13 to its energized position with the armature abutting the core 14.

The thermal timer 15 being operatively energized causes the bimetallic element 17 to move in an upward direction. An insulating member 76 transmits this movement to the switch blade 13 which carries the switch contact 23 and through an insulating member 77 this movement is also transmitted to the switch blade 31 carrying the switch contact 21. It will be noted that this movement is against the force exerted by a spring 78 connecting the switch blade 33 to the rigid support member 27.

A very short time after energization of heater 16, the bimetal 17 will move upwardly to open the contacts 24 and 25. A predetermined length of time thereafter the bimetallic element 17 will have moved in an upward direction sufficiently to close the normally open contacts 22 and 23. It should be noted at this point that the normally opened contacts 20 and 21 are still open although contact 21 has been moved toward its circuit closing position by movement of the bimetal 17.

A circuit can now be traced from the power line conductor 62 through switch 65, power input terminal 64, conductor 71, winding 12 of electromagnetic device 11, conductor 72, conductor 80, switch blade 33, contacts 23 and 22, switch blade 32, conductor 81, conductor 75, and power input terminal 63 to power line conductor 61. It will be noted that the above traced circuit from power line conductor 62 to power line conductor 61 includes only the winding 12 of the electromagnetic device 11.

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Therefore, in this second condition of operation of the switching assembly 18 the level of energization of the winding 12 has been increased so that the electromagnetic device 11 is now operatively energized. Also in this condition of operation the contacts 22 and 23 short circuit the heater 16 to deenergize the thermal device 15. This circuit shorting the heater 16 can be traced from conductor 73 through conductor 80, switch element 33, contacts 23 and 22, switch element 32, conductor 81, and conductor 74 to the heater 16.

With the electromagnetic device 11 operatively energized the armature 13 is moved into engagement with the core 14. The additional movement of the armature 13 in the upward direction is transmitted by means of the insulating member 77 to the contact blade 31 which carries the contact 21. This additional movement is sufficient to close the normally open contacts 20 and 21. The insulating member 76 has a one way connection with the armature 13 so that additional movement of the armature 13 to engage the core member 14 is movement relative to the bimetal element 17. Since the heater 16 is deenergized the bimetal element 17 is free to again return to its cold position independent of the contact blade 33.

The contacts 20 and 21 are in an energizing circuit for load 66, however this circuit is open circuit at contacts 24 and 25. A predetermined time after energization of the electromagnetic device 11 the thermal device 15 returns to the cold position and normally closed contacts 24 and 25 engage. A circuit can now be traced from the power line conductor 62 through switch 65, conductor 85, load terminal 70, conductor 86, contact blade 30, switch contacts 20 and 21, contact blade 31, conductor 87, bimetal element 17, switch contacts 24 and 25, contact blade 88, conductor 89, load terminal 69, conductor 63, load 66, and conductor 67 to power line conductor 61. The load 66 has therefore been energized a given normal timed period after the initial closing of the switch 65. This timed period is a function of both the heating and cooling time of the bimetal element 17 of the thermal device 15.

If, with the load 66 energized as above described, there is a momentary power failure or the switch 65 is opened and subsequently reclosed, the electromagnetic device 11 will sense this momentary interruption of power and the armature 15 biased by the spring tensions of the contact blades 31 and 33 and of the spring 78 will return to its deenergized position as shown in Figure 1. It will now be noted that the energizing circuit for the load 66 is broken at the normally open contacts 20 and 21. Therefore, a complete timing cycle must be completed before the load 66 is again energized.

This timing cycle may be similar to that above described and in that case the normal timed period is again provided before power is reapplied to the load 66. However, it is possible that during this cycle of operation of the timing mechanism 10 a second power failure will occur or that the switch 65 will be opened.

If this interruption of power is of sufficient duration, the bimetal 17 will return to its starting position and the timing mechanism will again cycle when power is again applied to the mechanism.

If this interruption of power is a momentary interruption and if it occurs before contacts 22 and 23 engage, then the mechanism 10 will continue its cycle and the time period between the first power failure and the applying of power to load 66 will be increased by the length of the power interruption plus an amount due to cooling of the bimetal 17 during this interruption.

If this interruption of power is a momentary interruption and if it occurs when the contacts 22 and 23 have just engaged, the thermal device 15 will not cool sufficiently to disengage the contacts 22 and 23 and the restoration of power to the power line conductors 61 and 62 will cause energization of the electromagnetic device 11 as above described. The timing apparatus

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will continue to function as if no power failure had occurred and upon the bimetal element 17 returning to its cool or deenergized position to engage the contacts 24 and 25, the load 66 will be energized a time period after the first power failure equal to the normal timed period plus the duration of the power failure.

It can therefore be seen that if a momentary power failure occurs after the load 66 has been energized the timing apparatus may provide a timing interval which is longer than the normal timing interval before the load is again energized but under no condition will the timing apparatus function to provide a timing interval which is shorter than the normal timing interval. Thus, the device assures that a minimum timed interval will be provided under all conditions before the load can be energized.

Referring to Figure 2, within the broken lines 40 is shown a modified form of the improved timing mechanism having an electromagnetic device 41 including a winding 42, a movable armature 43, and a magnetic core structure 44. A thermal device 45 is shown having a heater 46, and a movable bimetal element 47. A switching means is shown at 48 having a first pair of normally open contacts 50 and 51, a second pair of normally open contacts 52 and 53, and a pair of normally closed contacts 54 and 55. A supporting structure is shown comprising insulating blocks 56 rigidly mounting contact blades 57, 58, 59 and the bimetal element 47 to the core 44 of the electromagnetic device 40 by means of a bolt 60.

The timing apparatus of Figure 2 is connected to power line conductor 61 and 62 through switch 65 and to a load 66. It is the function of the timing apparatus of Figure 2 to provide a predetermined time delay interval after the closing of the switch 65 before power is applied to the load 66.

Assume that the switch 65 is closed. A circuit can now be traced from the power line conductor 62 through switch 65, power input terminal 94, conductor 90, contact blade 59, switch contacts 55 and 54, contact blade 58, conductor 91, heater 46 of thermal device 45, conductor 92, conductor 93, and power input terminal 95 to power line conductor 61. The thermal device 45 is therefore energized and the bimetal element 47 moves in a downward direction. A rigid insulating member 96, rigidly is connected to the bimetal element 47 by means of a bolt 97, transmits this downward movement of the bimetal 47 to the contact blade 57. After a predetermined length of time the bimetal 47 warps downward sufficiently to close the normally open contacts 50 and 51.

A circuit can now be traced from power line conductor 62 through switch 65, power input terminal 94, conductor 90, contact blade 59, contacts 51 and 50, contact blade 57, conductor 98, coil 42 of electromagnetic device 41, conductor 99, conductor 93, and power input terminal 95 to power line conductor 61. This above traced circuit energizes the electromagnetic device 41. Energization of the electromagnetic device 41 causes the movable armature 43 to move into engagement with extension 102 of the core structure 44. This movement of the armature 43 is transmitted by means of an adjustable screw 100 and an insulating block 101 to the contact blade 57.

The movement of the contact blade 57 by the armature 43 is in the downward direction and is effective to open the normally closed contacts 55 and 54 and to maintain the contacts 50 and 51 closed. It will be noted that the member 96 has a one way connection with the blade 57 permitting the contact blade 57 to move in a downward direction relative to the bimetal 47. The bimetal 47 is free to move in an upward direction independent of the contact blade 57. It is also to be noted that the downward movement of the contact blade 59 due to energization of electromagnetic device 41, which movement was transmitted from the contact blade 57 through contacts 50 and 51, moves the contact 52 in engaging direction

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with the contact 53, however, since the bimetal 47 is at this time hot, contact 52 does not engage contact 53.

The breaking of the contacts 54 and 55 as above described breaks the energizing circuit for the heater 46 of the thermal device 45 and the bimetal element 47 now begins to return to its cool position. When the bimetal 47 returns to its cool or deenergized position, the contact 53 engages the contact 52. An energizing circuit can now be traced from the power line conductor 62 through switch 65, power input terminal 94, conductor 90, contact blade 59, contacts 52 and 53, bimetal element 47, conductor 105, load terminal 106, conductor 68, load 66, and conductor 67 to power line conductor 61. The timing apparatus of Figure 2 has therefore provided a normal time delay interval between the closing of the switch 65 and the energization of the load 66, which timed interval is a function of both the heating and the cooling time of the bimetal 47.

If a momentary power failure occurs after the load is energized, or if the switch 65 is momentarily opened, the electromagnetic device 41 immediately senses this interruption of power and the armature 43 returns to its deenergized position with the aid of the tension of the contact blade 57. The switching device 48 immediately assumes its normal position as shown in Figure 2 and therefore the energizing circuit to the load 66 is broken at normally opened contacts 52 and 53. The heater 46 is again reenergized and the timing apparatus is effective to provide a timed interval before power is again applied to the load 66 as above described.

Assume that a second power failure occurs when bimetal elements 47 has just reached its hot or energized position wherein contact 50 engages the contact 51.

The bimetal 47 will not cool to disengage the contacts 50 and 51 and the immediate restoration of power causes the timing apparatus to proceed with its cycle as if no power failure had occurred. It is possible with these assumed conditions to obtain a timing interval between the momentary interruption of power and the energization of the load 66 which is longer than the normal timing interval, however, the timing apparatus of Figure 2 will always provide at least the normal time delay interval for energizing the load 66.

From the foregoing it can be seen that the disclosed improved timing mechanisms under all conditions provide a predetermined minimum or normal timing interval. Many modifications of the above described invention will suggest themselves to those skilled in the art and it is intended that the present invention be limited solely by the scope of the appended claims.

I claim as my invention:

1. Timing apparatus comprising, a thermal timer movable between cold and hot positions when energized and in the opposite sense when deenergized, a switch actuating member biased to a first position and movable by said thermal timer when energized to a second position, an electromagnet, switching means actuated by said switch actuating member in its second position to complete a circuit to energize said electromagnet and to effect deenergization of said thermal timer, said electromagnet when energized acting on said switch actuating member to hold said switching means in a condition to maintain said electromagnet energized and said thermal timer deenergized, and second switching means including contacts positioned by said thermal timer and by said switch actuating member to switch a load circuit when said switch actuating member is held in its second position by said electromagnet and said thermal timer returns to its cold position.

2. Timing apparatus comprising, a thermal timer movable between cold and hot positions when energized and in the opposite sense when deenergized, a switch actuating member biased to a first position and movable by said thermal timer when energized to a second position,

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switching means actuated by said switch actuating member in its second position to effect deenergization of said thermal timer, an electromagnet adapted to hold said switch actuating member in its second position when said thermal timer returns to cold position, second switching means including contacts positioned by said thermal timer and by said switch actuating member to switch a load circuit when said switch actuating member is held in its second position by said electromagnet and said thermal timer is returned to its cold position, and means for deenergizing said electromagnet to return said switch actuating member to its first position.

3. Timing apparatus comprising, a thermal timer including a heating element, said timer being movable between cold and hot positions when energized and in the opposite sense when deenergized, a switch actuating member biased to a first position and movable by said thermal timer when energized to a second position, an electromagnet adapted to hold said member in its second position on deenergization of said thermal timer, means connecting said heater and said electromagnet electrically in series, switching means actuated by said member in its second position to short said heater and thereby effectively energize said electromagnet and deenergize said thermal timer, and second switching means including contacts positioned by said thermal timer and by said member to switch a load circuit when said member is in its second position and said thermal timer is returned to its cold position.

4. Timing apparatus comprising, a thermal timer including a heating element, said timer being movable between cold and hot positions when energized and in the opposite sense when deenergized, a switch actuating member biased to a first position and movable by said thermal timer when energized to a second position, an electromagnet adapted to hold said member in its second position on deenergization of said thermal timer, means connecting said heater and said electromagnet electrically in series, switching means actuated by said member in its second position to short said heater and thereby effectively energize said electromagnet and deenergize said thermal timer, and second switching means including a pair of contacts closed by said member on energization of said electromagnet and another pair of contacts closed by said thermal timer when in cold position, said contact pairs being connected in series in a load energizing circuit.

5. Timing apparatus comprising, a thermal timer movable between cold and hot positions when energized and in the opposite sense when deenergized, a switch actuating member biased to a first position and movable by said thermal timer when energized to a second position, an electromagnet adapted to hold said member in its second position on deenergization of said thermal timer, switching means actuated by said member in its second position including a pair of contacts in an energizing circuit for said electromagnet which are closed by movement of said member to its second position and a pair of contacts in the energizing circuit of said thermal timer which are opened on energization of said electromagnet, and second switching means including a pair of contacts one which is positioned by said thermal timer and the other of which is positioned by said member and adapted to close only when said member is in its second position and said thermal timer is in its cold position.

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