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CONTROL DEVICE

Filed May 8, 1961

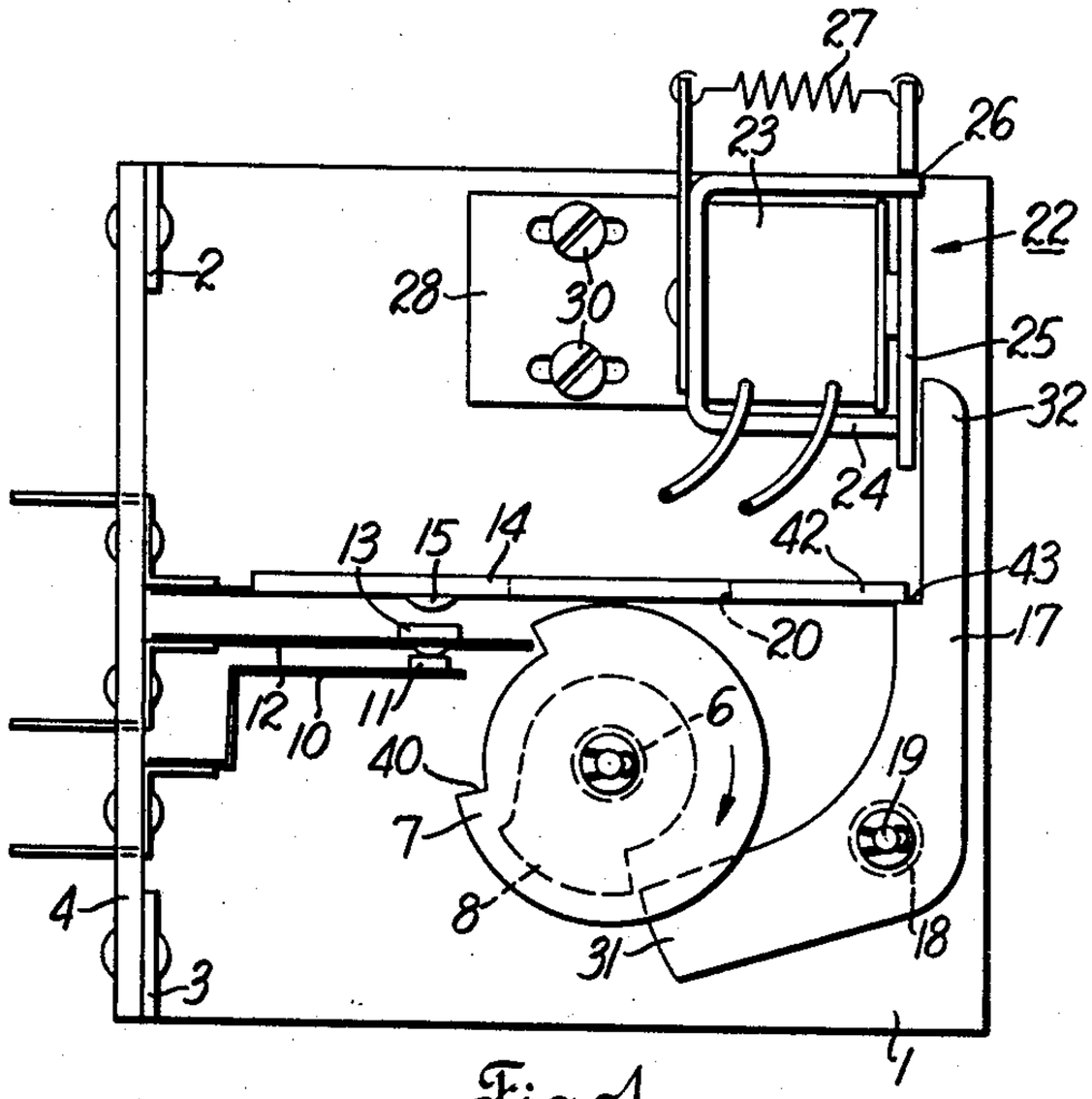

Fig. 1

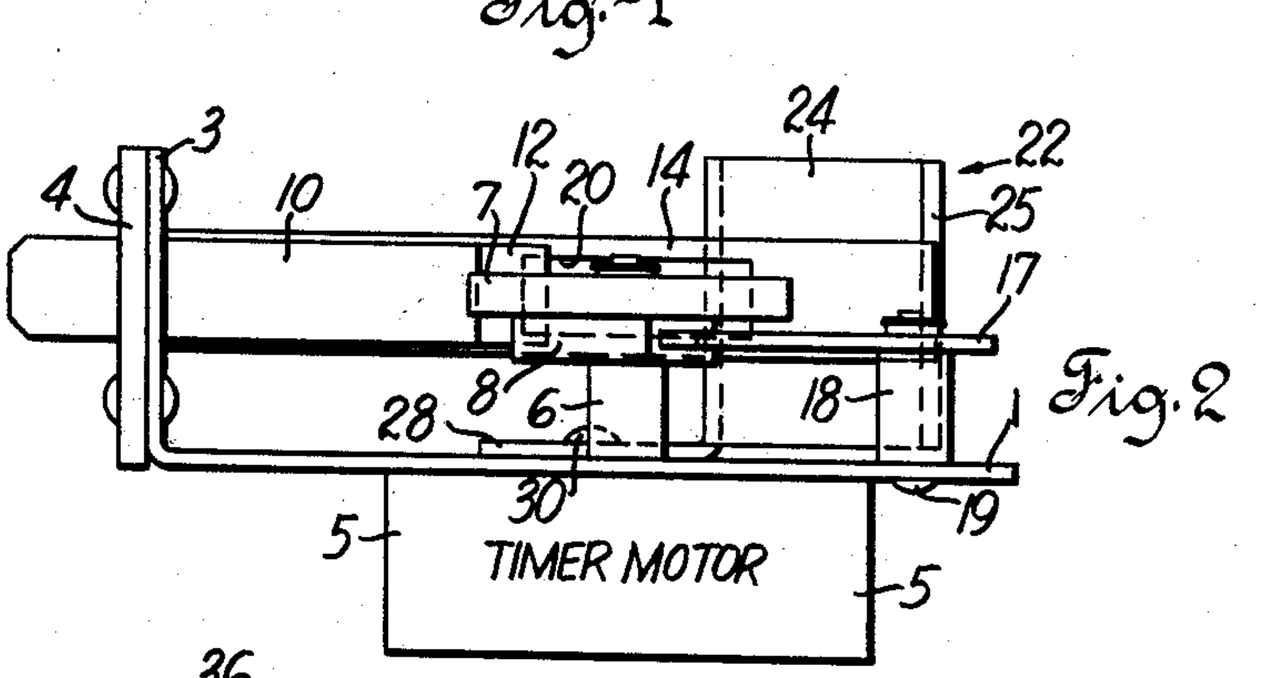

Fig. 2

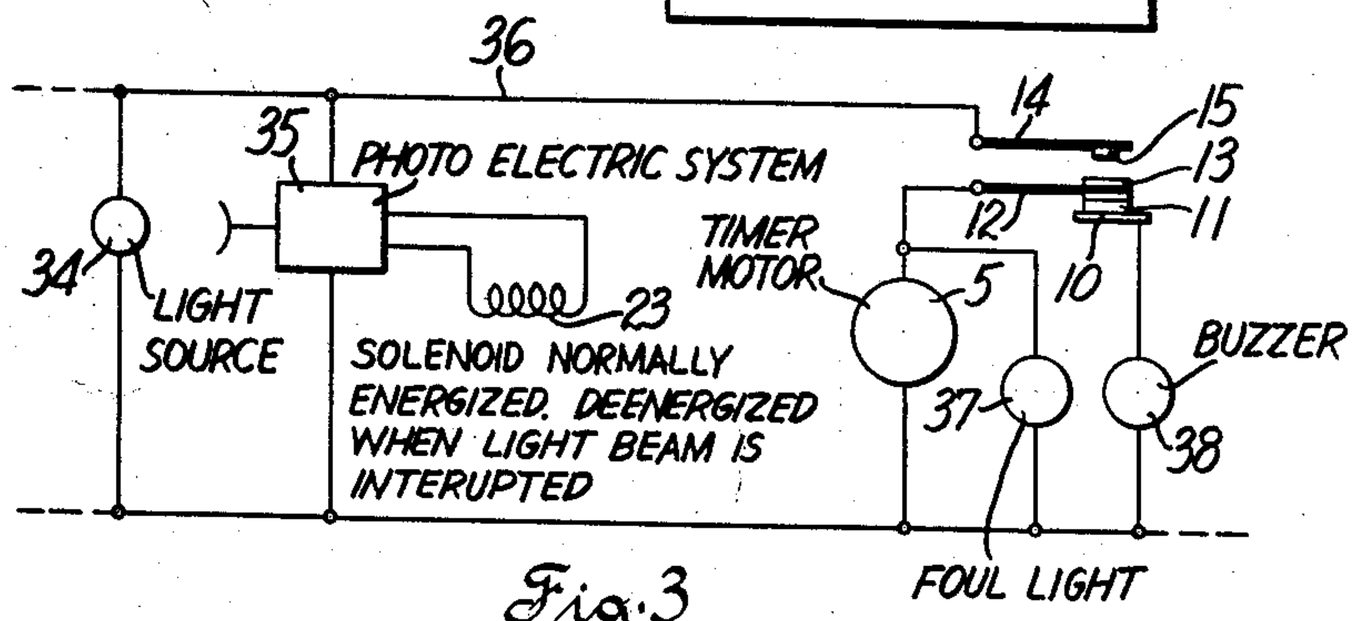

Fig. 3

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CONTROL DEVICE

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This invention relates in general to electro-mechanical controls of the type in which a switch or other control device is mechanically actuated in response to a variation in flow of current in an electric control circuit.

Devices of this type include an electro-magnet or solenoid having a coil wired into the control circuit, and an armature which pulls in or drops out in response to the degree of current flow in the control circuit. One characteristic of such devices is that the current required to pull in the armature is considerably higher than necessary to hold the armature in. This is due to the air gap in the magnetic circuit when the armature is out. This characteristic places a limit on the amount of movement and the force available from an electro-magnet for a given current variation available in the control circuit.

The primary object of this invention is to provide an electromagnetically operated controller in which the required differential in current flow for pulling in and holding in is substantially reduced or even completely eliminated. In the preferred form of the invention, the electromagnet is arranged to provide its controlling function when it drops out, and is provided with a biasing spring so that it drops out at a predetermined current value in the control circuit. This dropping out action operates a switch or other control device to give the desired results in the control system. Instead of requiring the electromagnet to pull itself back in, a motor is provided which returns the electro-magnet either partially or completely to the pulled in position. As a result, the maximum current required in the control circuit is substantially the hold in current. This use of external power for returning the armature makes it possible to reduce the size of the electro-magnet for a given application. Also, it makes it possible to work with smaller values of current in the control circuit, thus eliminating necessity for amplification, etc.

While it is preferred to use the drop out action of the electro-magnet for providing the controlling function, the principles of the invention are also applicable to the reverse arrangement in which the electro-magnet pulls in to exert a controlling function. In such cases the motor would be arranged to move the armature part way back to the pulled-in position, so that a smaller current flow is required for pulling the armature in the rest of the way.

A further object is to provide an electric timer having an electro-magnetic starter which starts the timer through a time cycle in response to a variation of current in a control circuit, and in which the timer motor mechanically operates the electro-magnet during the time cycle.

Other objects will appear from the following description and appended claims.

For a full disclosure of the invention, reference is made to the accompanying drawings in which:

FIG. 1 is a front view of a timer embodying the invention.

FIG. 2 is a bottom view of the timer shown in FIGURE 1.

FIG. 3 is a schematic wiring diagram illustrating the application of the timer to an automatic foul indicator system for bowling alleys.

The timing unit consists of a base plate **1** having ears **2** and **3** which support a switch panel **4**. This base plate also supports a timer motor **5** having an output shaft **6** carrying cams **7** and **8**. This timing motor rotates the cams **7** and **8** in a clockwise direction as seen in FIGURE 1. The switch panel **4** supports a switch consisting of a stationary contact bracket **10** carrying a contact **11**. The

switch also includes a flexible switch blade **12** which rides the cam **7**. This switch blade carries a double contact **13**. The switch also includes an extended switch blade **14** carrying a contact **15**. This switch blade extends over the cam **7** and engages a latch **17**. As shown in FIGURE 2, this latch is supported on a bearing **18** which is carried by a stud **19** secured to the base plate **1**. Also as shown in FIGURE 2 the switch blade **14** is provided with a slot **20** adjacent the cam **7** so that the blade may drop over the upper surface of the cam but not touch the cam.

Also carried by the base plate **1** is an electro-magnet generally indicated as **22**. This electro-magnet includes a coil **23** which is supported in a U-shaped frame **24**. This frame **24** also carries a clapper or armature **25**. This armature is pivoted to the U-shaped bracket **24** at **26** and is provided with a spring **27** which biases the armature in a counter clockwise direction about its pivot **26**. The U-shaped bracket **24** is carried by a bracket **28** which is secured to the base member by screws **30**. Preferably the bracket is slotted as shown so that the position of the electro-magnet may be adjusted on the base **1**.

The latch **17** controls the switch blade **14**. This latch **17** includes a cam follower portion **31** which rides the cam **8**. The latch **17** also includes an extension **32** which extends adjacent the armature **25**.

Referring to FIGURE 3, this figure indicates the application of the timer to an automatic foul indicator system for bowling alleys. In such a system, the light source **34** sends a light beam across the foul line to a photo-electric system **35** which controls the current flow through the coil **23** of the electro-magnet **22**. In the embodiment of the invention illustrated, the photo-electric system is arranged to maintain the coil **23** energized as long as the light beam is not interrupted. When the light beam is interrupted the current flow through the coil **23** is substantially reduced.

The switch blade **14** is connected to the line wire **36**. Switch blade **12** is connected to the timer motor **5** and a foul light **37**. The contact bracket **10** is connected to a buzzer **38**.

Operation

With the parts in the positions shown, the system is in the stand-by condition. The light source in such condition is not interrupted and thus the photo-electric system **35** maintains the coil **23** energized which causes the electro-magnet armature **25** to be in the "pulled-in" position. Also in this stand-by condition the switch blade **12** has been dropped by the cam **7** which causes contacts **11** and **13** to be engaged. At this time the timer motor, foul light, and buzzer are all deenergized due to the circuit being open at contacts **13–15**.

When a bowler commits a foul, his foot will interrupt the light beam across the foul line, and this will result in the electro-magnet coil **23** being substantially de-energized. When this happens, the magnetic holding force on the armature **25** disappears and the spring **27** rotates this armature counter clockwise about its pivot **26**. This movement engages the latch extension **32** and rotates the latch **17** clockwise about its pivot **19**. This motion disengages the switch blade **14** which now drops down causing engagement of contacts **13** and **15**.

This closure of contacts **13–15** completes the circuit to the timer motor **5** and the foul light **37**. It also completes a circuit through contacts **13** and **11** to the buzzer **38**. Thus the commission of a foul energizes the buzzer and also a foul sign which indicates to all concerned that a foul has been committed. This also results in the timer motor **5** being energized which starts rotation of cams **7** and **8** in unison in a clockwise direction.

In approximately two seconds the shoulder **40** of the cam **7** will engage the switch blade **12** and raise this blade

which disengages contacts 11–13 and de-energizes the buzzer. The contacts 13 and 15 remain engaged and the switch blade 14 rises in unison with the switch blade 12. This causes the extension 42 of this switch blade to rise above the latching shoulder 43 of the latch 17.

In the meantime the cam follower portion 31 of the latch 17 has been riding the cam 8. After the end 42 of the switch blade rises beyond the shoulder 43 of the latch, this latch is cammed in a counter clockwise direction back to the latch position shown. At the end of the cycle, the switch blade 12 drops off the cam 8. The switch blade 14 is now held up by the latch 17 so that contacts 13–15 are now open. This action extinguishes the foul light and de-energizes the timer motor.

During the interval that the timer is running, the person who committed the foul will have departed from the foul line, causing the photo-electric system to reenergize the electro-magnetic coil 23. The counter clockwise motion of the latch 17 by the cam 8 during this time cycle has two functions. The first function is to bring the latching surface 43 of the latch back under the extension 42 of the switch blade 14. The other function is to return the armature 25 back to approximately its normally energized position. This movemhent is caused by engagement of the latch extension 32 with the armature 25. This application of power from the timer motor for actuating the electro-magnet, makes it possible to control the electro-magnet by a very minute change in current. In other words the electro-magnet is returned from its drop-out position to its hold-in position by the timer motor, and it is unnecessary for the coil 23 to develop sufficient pull for this movement. Thus it is necessary only to increase the coil current slightly above the drop-out value in order to hold the solenoid in the IN position.

This feature makes it possible to employ an extremely small solenoid for controlling the timer. It also eliminates stages of amplification in the controlling circuit, thus providing an over-all cost reduction in the control system.

While a preferred form of the invention has been illustrated it is obvious that many changes may be made without departing from the spirit and scope of the invention. It is therefore desired to be limited only by the scope of the appended claims.

What is claimed is:

1. In a timing device, a first switch blade, a cam for operating said first switch blade, a timer motor for driving said cam, a second switch blade located adjacent said first switch blade and on the side thereof opposite said cam, cooperating contacts carried by said switch blades, a latch for holding said second switch blade in raised position so that the contacts disengage when the first switch blade is lowered by said cam, an electro-magnet for releasing said latch to close said contacts, and means operated by the timer motor for mechanically affecting said electro-magnet.

2. In a timing device, a first switch blade, a cam for operating said first switch blade, a timer motor for driving said cam, a second switch blade located adjacent said first switch blade and on the side thereof opposite said cam, cooperating contacts carried by said switch blades, a latch for holding said second switch blade in raised position so that the contacts disengage when the first switch blade is lowered by said cam, an electro-magnet for releasing said latch to close said contacts, means operated by the timer motor for mechanically affecting said electro-magnet, and cam means for positively returning said latch to holding position before said first switch blade is lowered by said cam.

3. In a timing device, a first switch blade, a cam for operating said first switch blade, a timer motor for driving said cam, a second switch blade located adjacent said first switch blade and on the side thereof opposite said cam, cooperating contacts carried by said switch blades, a latch for holding said second switch blade in raised position so that the contacts disengage when the first switch blade is lowered by said cam, and cam means for positively returning said latch to engaging position before said first switch blade is lowered by said cam.

4. In a timing device, a first switch blade, a cam for operating said first switch blade, a timer motor for driving said cam, a second switch blade located adjacent said first switch blade and on the side thereof opposite said cam, cooperating contacts carried by said switch blades to form a switch, a latch for holding said second switch blade in raised position so that the contacts disengage when the first switch blade is lowered by said cam, said switch being connected to control said motor, an electro-magnet having a coil and an armature arranged to release the latch, said coil being adapted for connection in a control circuit and to cause movement of the armature to release the latch in response to a change of current flow in such control circuit, said releasing of the latch causing closure of the switch for a predetermined time cycle which is ended by lowering of the first switch blade by the timer cam, and reset means for reducing the current change in the coil required for operating the latch by the armature, said reset means including means powered by the timer motor during the time cycle for affecting the armature.

5. In a control system, a control circuit, an electro-magnet having a coil and an armature movable in two directions, said coil being connected in said control circuit and causing movement of said armature in response to a change in current flow in the control circuit, a motor, means including a control device actuated in response to movement of the armature caused by a current change in the coil for starting said motor, means for stopping said motor after operation through a predetermined cycle, and reset means for reducing the current change in the coil required for actuating said control device by said armature, said reset means including means operated by the motor during said predetermined cycle for moving said armature.

6. In a control system, a control circuit, an electro-magnet having a coil and an armature movable in two directions, said coil being connected in said control circuit and causing movement of said armature in response to a change in current flow in the control circuit, an electric motor, means including a control device actuated by movement of the armature caused by a current change in the coil for energizing said electric motor, means for deenergizing said electric motor after operation through a predetermined cycle, and reset means for reducing the current change in the coil required for actuating said control device by said armature, said reset means including means operated by the motor during said predetermined cycle for moving said armature.

7. In a control system, a control circuit, an electro-magnet having a coil and an armature movable in two directions, said coil being connected in said control circuit and causing movement of said armature in response to a change in current flow in the control circuit, an electric motor, means including a switch actuated by movement of the armature caused by a current change in the coil for energizing the motor, means actuated by the motor after operation through a predetermined cycle for operating said switch to stop the motor, and reset means for reducing the current change in the coil required for actuating said switch by said armature, said reset means including means operated by the motor during said predetermined cycle for moving said armature.

8. In a control system, a control circuit, an electro-magnet having a coil and an armature movable in two directions, said coil being connected in said control circuit and causing movement of said armature in response to a change in current flow in the control circuit, a motor, means including a control device actuated by outward movement of the armature away from the coil in response to a decrease of current flow in the control circuit for starting the motor, means for stopping the motor after operation through a predetermined cycle, and reset means

for reducing the current change in the coil required for actuating said control device by said armature, said reset means including means operated by the motor during the predetermined cycle for moving the armature toward the coil, said reset means being arranged to release the armature before the motor stops.

9. In a timing device, an electric timing motor, an electro-magnet having a coil and an armature, said coil being adapted for connection in a control circuit and to cause movement of the armature in response to a change in current flow in such control circuit, an electric motor means including a switch closed in response to movement of the armature caused by a current change in the coil for starting the motor, means for stopping the motor after operation for a predetermined time cycle, and reset means for reducing the current change in the coil required for actuating the switch by the armature, said reset means including means powered by the motor for moving said armature.

10. In a timing device, an electric timing motor, an electro-magnet having a coil and an armature, said coil being adapted for connection in a control circuit and to cause movement of the armature in response to a change in current flow in such control circuit, a switch for controlling said timing motor, said switch being actuated conjointly by said motor and by said armature, said switch being closed to start the timing motor in response to movement of the armature caused by a current change in the coil, and being opened by the motor to stop the same at the end of a predetermined time cycle, and reset means for reducing the current change in the coil required for actuating the switch by the armature, said reset means including means powered by the timing motor during the timing cycle for moving the armature.

11. In a timing device, an electric timing motor, an electro-magnet having a coil and an armature, said coil being adapted for connection in a control circuit and to cause movement of the armature in response to a change in current flow in such control circuit, an electric motor, means including a switch actuated by movement of the armature caused by a current change in the coil for energizing the motor, means actuated by the motor after operation through a predetermined cycle for operating said switch to stop the motor, and reset means for reducing the current change in the coil required for actuating said switch by said armature, said reset means including means operated by the motor during said predetermined cycle for moving said armature.

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