Sept. 20, 1938. R. A. ANDREWS 2,130,405

TIME DELAY APPARATUS

Filed Oct. 10, 1935

Fig. 1.

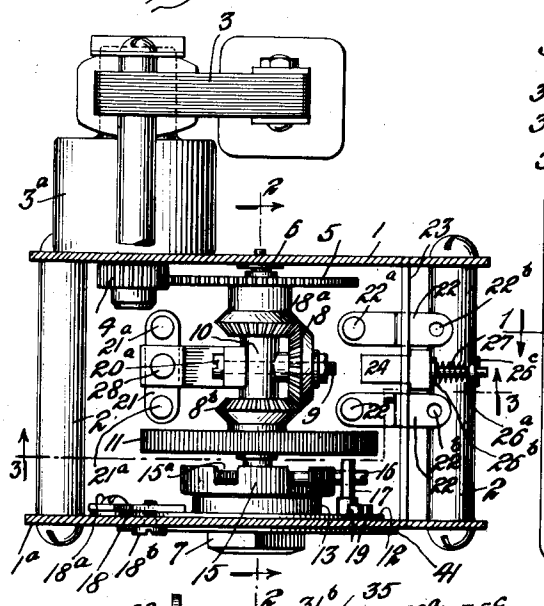


Fig. 3.

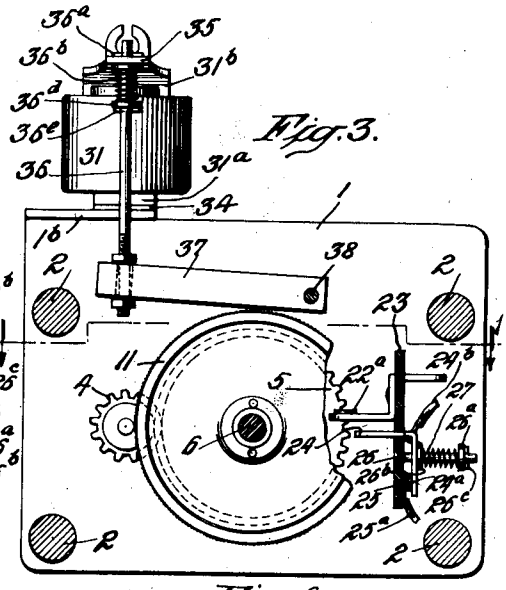


Fig. 2.

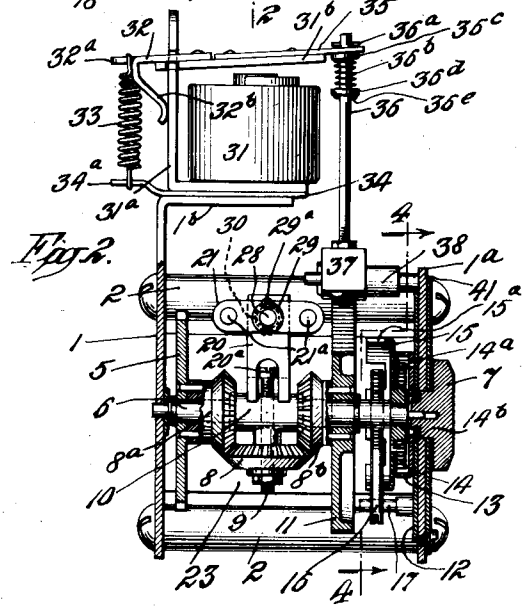


Fig. 4.

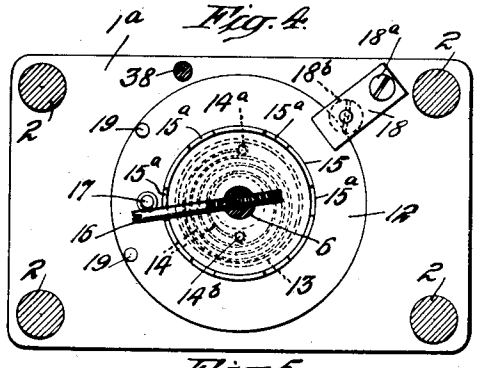


Fig. 5.

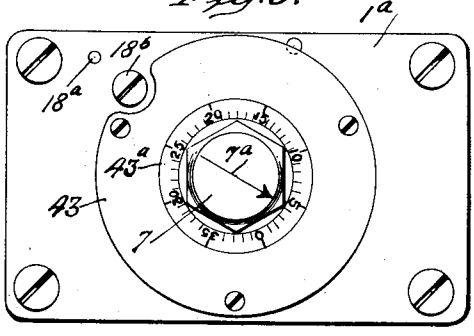
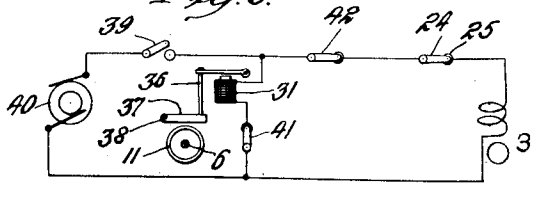


Fig. 6.



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TIME DELAY APPARATUS

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Application October 10, 1935, Serial No. 44,464

5 Claims. (Cl. 161—1)

This invention relates to electrically controlled apparatus applicable to various uses where after one action occurs, such as the initial closing of a circuit, a predetermined time interval is to elapse before some other function is to be performed, such as to close or open another electric circuit or any controlling circuit of another device, or to actuate a movable arm, lever, plunger, or perform any desired operation.

One of the objects of the invention is to obtain an improved form of apparatus which will have a high degree of accuracy in the determination of the time interval and maintain the same time interval under repeated operations in long continued use. Another object is to provide a device which will be independent of changes of temperature. Another object is to obtain a practically instantaneous reset of the device for repeated use as rapidly as desired. Another object is to produce a device which will be dependable with long continued use and of simple and economical construction. Another object is to avoid the uncertainty and inaccuracy of gears thrown into and out of mesh, or the use of clutches and to avoid the excessive wear occasioned by use of such type of apparatus. Other objects and advantages of this invention will be understood from the following description and accompanying drawing illustrating a preferred embodiment thereof.

Fig. 1 is a plan view on the line 1—1 of Fig. 3;

Fig. 2 is a vertical section on the line 2—2 of Fig. 1 with certain parts moved to a different position;

Fig. 3 is a vertical section on the line 3—3 of Fig. 1;

Fig. 4 is a vertical section on the line 4—4 of Fig. 2;

Fig. 5 is a front elevation of the front dial of the device; and

Fig. 6 is a general diagrammatic representation of certain parts and connections.

The apparatus shown comprises two sheet metal plates 1 and 1a spaced apart and supported by cross rods 2. On the rear side of plate 1 is mounted a small electric self-starting motor 3 of the synchronous motor type adapted to be operated from a single phase source. The motor drives a reduction gearing enclosed within a cylinder 3a and, as this motor and gearing is of standard type, it need not be particularly described. The motor drives a shaft which extends through the plate 1 and carries fixed to its inner end a spur gear 4. This gear drives a larger gear 5 which is journaled on a shaft 6 which is supported at its rear end in the plate 1 and at its front end in the middle inner portion of an adjustable knob 7. This knob is shown in the form of a hexagonal nut cooperating with the dial on the front plate. The knob is journaled in the front plate 1a.

Mounted upon the shaft 6 is a differential gear comprising the beveled gears 8, 8a and 8b. The gear 8a is fixed to the gear 5 and rotatable therewith on the shaft 6. The gear 8 is rotatably mounted upon a pin 9 which radially passes through an enlarged portion 10 of the shaft 6. The gear 8b is secured to a wheel 11 which is rotatably mounted upon the shaft 6. This wheel serves as a brake wheel. The outer periphery of this wheel is milled and is adapted to be engaged by a brake lever for holding the same in fixed position when desired.

Fixed to the inner end of the knob 7 is a circular plate 12. On the inside of the plate 12 is fixed a housing 13 for a spiral spring 14 contained within it. The housing is in the form of a disc with an inwardly turned edge which extends over the spring. The outer end of this spring is secured by a pin 14a to the plate 12 or to the flat portion of the housing 13. The other end of the spring 14 is fixed to a barrel 15 by the pin 14b. This barrel has a disc portion which is rotatable on the shaft 6 and an inwardly turned cylindrical portion which has notches 15a formed around its inner edge at regular intervals. A pin 16 has a threaded engagement with, and extends radially through, the shaft 6 and is located within the barrel 15. The outer end of the pin 16 extends beyond the barrel through any desired one of the notches 15a. This pin serves to transmit the tension of the spring 14 to the shaft 6, tending to always turn the shaft 6 in one direction of rotation. The series of notches 15a permits the tension of this spring to be increased or decreased by rotating the barrel 15 while holding the shaft 6 stationary to impose a desired tension upon the spring and then passing the pin 16 through one of the notches in the adjusted position and through the shaft 6. Fixed to the plate 12 and extending from the inner face thereof is a pin 17. This pin extends into the path of the pin 16 where it projects beyond the barrel 15. When the knob 7, and correspondingly the plate 12, is adjusted to a desired position, it similarly adjusts the position of the pin 17, which position limits the extent of movement of the pin 16 and the shaft 6 in one direction of rotation as actuated by the spring 14. Mounted on the rear of the support-

ing plate 1a is a strip or plate of sheet metal 18 secured at one end to the plate 1a by a screw 18a. The other end of this strip extends over the edge of the plate 12. A screw 18b passes through the plate 1a from the front and has a threaded engagement at its inner end with the strip 18 at a point between the plate 12 and the screw 18a. It is evident that when the screw 18b is tightened, it will clamp the plate 12 in any fixed adjusted position. A pair of pins 19 extend from the inner face of the plate 12 and are located so that when the plate 12 is turned, one or the other of the pins 19 will engage the edge of the plate 18 and thus serve as a stop to limit the extreme range of movement of the plate 12.

Fixed to the portion 10 of the shaft 6 is an arm 20 of insulating material, such as "Bakelite", being secured to the shaft by a screw 20a passing through an upturned end of the arm 20. The screw 20a may be extended to form the pin 9 as its opposite end, as shown in the drawing. The present application of the invention is to the control of an electric circuit, and for this purpose the arm 20 carries at its outer end a cross piece 21 of metal having a pair of contacts 21a at its opposite ends on its inner face. These contacts are adapted to engage with a corresponding pair of fixed contacts 22a supported in a fixed position by metal strips 22 mounted on an insulating cross bar or plate 23 supported by and extending between the plates 1 and 1a. The conducting strips 22 are provided with holes 22b at their outer ends for connection to any external circuit to be controlled.

In the path of the end of the arm 20 and between and below the fixed conducting strips 22, is movably mounted a conducting strip 24 which passes through a small opening in the insulating plate 23 and is then bent at right angles and extends downwardly, as shown in Fig. 3. The inner face of the lower end of the strip 24 carries a contact 24a. This contact is adapted to engage a fixed contact 25 mounted on the plate 23 opposite the contact 24a. A pin 26 extends freely through the downwardly extending portion of the strip 24 and extends also through the plate 23. The pin 26 is headed at its inner end to prevent the pin from passing through the plate 23 when the pin is forced outwardly. On the outer end of the pin 26 is a disc 26a having an inwardly turned edge, and a similar disc 26b surrounds the pin 26 and is located at the front of the downwardly extending portion of the conducting strip 24. A spring 27 encircles the pin 26 and extends between the discs 26a and 26b. This spring tends to force the pin 26 outwardly, the disc 26a being prevented from outward movement by a pin 26c passing through the outer end of the pin 26. Normally the spring 27 thus tends to force the downwardly extending portion of the conducting strip 24 inwardly so as to cause contact 24a to be in engagement with fixed contact 25. If, however, the inwardly extending end of the strip 24 be depressed, the downwardly extending portion of the strip 24 will be moved outwardly against the pressure of the spring 27 and the circuit will be opened between the contacts 24a and 25. The strip 24 is electrically connected by a lead 24b which is soldered thereto, to one lead of the electric driving motor 3; and the contact 25 is connected by a lead 25a to one side of the supply circuit of the motor. Thus when the contacts 24a and 25 are in engagement, the motor circuit will be closed provided the motor circuit is otherwise closed; but when the inner end of the strip 24 is depressed, the motor circuit will be open.

The inner end of the strip 24 is in the path of movement of the arm 20; and when this arm is driven to its final position by the motor 3, it engages the inwardly projecting end of the strip 24 and depresses it to open the contacts 24a and 25, thus opening the motor circuit at the completion of its function. The arm 20, in moving to its limiting position, causes the cross strip 21 carried by the arm to engage the fixed contacts 22a before the strip 24 is engaged by the arm 20. In order to permit the arm 20 to continue its movement to engage the inner end of the strip 24, the cross strip 21 is yieldably mounted on the top of the arm 20 by a pin 28 fixed to the arm 20 and passing loosely through the strip 21. Between the strip 21 and a disc 29 retained in place by a pin 29a passing through the outer end of the pin 28, is located a spiral spring 30 which surrounds the pin 28. Thus this spring tends to normally hold the cross piece 21 against the arm 20. When, however, the cross piece 21 is swung over by the arm 20 to engage the contacts 22a, the cross strip 21 is permitted to yield and move upwardly on the pin 28 while still maintaining engagement with the contacts 22a. This permits the arm 20 to continue its movement sufficiently to engage the inner end of the strip 24 and open the circuit of the motor, as already described.

The brake for holding the brake wheel 11 in fixed position when desired is actuated by an electromagnet 31 mounted on an inwardly extending portion 1b of the plate 1. A strip 31a of magnetic material extends from the lower end of the core of the magnet 31 upwardly at the side of the coil of the magnet. Movably mounted on the upwardly extending end of the magnetic strip 31a is an armature 31b which extends over the upper end of the core of the magnet 31. A strip 32 is secured to one end of the armature 31b and has an extension 32a therefrom. A spring 33 is connected at one end to this extension and at the other end to an extension 34a from a strip 34 clamped between the lower portion of the magnetic strip 31a and the extension 1b. Thus the spring 33 tends to force the armature 31b away from the pull of the magnet 31. A pair of tongues 32b extend downwardly from the strip 32 and engage the back of the magnetic strip 31a to limit the outward position of the armature 31b.

On the top of the armature 31b of the magnet is secured a narrow metal strip 35 which extends somewhat beyond the inner end of the armature. A rod 36 passes loosely through the projecting end of the strip 35 and a pin 36a is passed through the upper end of the rod 36 above the strip 35 for supporting the end of the rod by the strip. The lower end of the rod passes loosely through the brake bar 37. This bar extends over the brake wheel 11 and is pivotally mounted at the opposite end from the connection of the rod 36 on a pin 38 projecting from and supported by the plate 1a. The brake bar is supported in relation to the brake wheel so that when the bar is forced downwardly by the rod 36 it will press against the brake wheel 11 and thus hold the wheel in fixed position. At the upper end of the rod 36 is a spiral spring 36b which encircles the rod. The upper end of the spring is seated in a shallow metal cup 36c located on the lower side of the extended portion of strip 35. The lower end of the spring is seated in a similar cup 36d which is retained

from downward movement on the rod by a pin 36e passing through the rod.

When the armature 31b is attracted by the controlling magnet 31, the strip 35 will cause a downward movement of the rod 36 by the strip 35 being forced downwardly against the spring which in turn exerts a downward pressure on the pin 36e and thus causes a downward movement of the rod. Before the armature of the magnet has completed its movement to its final attracted position, the brake bar will engage the circumference of the brake wheel 11; and in the further movement of the armature the spring 36b will be somewhat compressed. This insures the application of a predetermined and sufficient pressure of the brake bar 37 against the brake wheel.

Fig. 6 shows the connections of the parts, there being a main closing switch 39 between the source 40 and the controlling apparatus. The magnet 31 is connected across the supply wires so as to be controlled by the switch 39 and also when desired by switch 41 in the magnet circuit for controlling this circuit independently of the motor circuit. The electric motor is connected across the supply wires through the switch 24 when engaging the contact 25 and this switch is beyond the connections of the magnet 31 so that when the strip or switch 24 is opened, it will not open the circuit of the magnet 31. Another switch 42 is shown in series in the motor circuit which may be used when desired for controlling the motor circuit independently of the magnet circuit.

On the face of the plate 1a is mounted a dial plate 43 having a circular scale 43a concentric with the axis of the knob 7. This scale may be graduated in seconds or any other time intervals desired, depending upon the design and purpose of the apparatus. An arrow 7a is marked on the face of the knob 7 to cooperate with the scale for securing any desired time interval setting.

In operation, the screw 18b will be loosened for permitting adjustment of the plate 12 to attain any predetermined time interval of operation by turning the knob 7 to the proper setting. The screw 18b is then tightened to hold the plate 12 in fixed position. In making this setting, the pin 17 has been adjusted to a certain position which, by its engagement with the pin 16, causes the shaft 6 of the mechanism to assume a certain initial position. The initial position of the shaft will always correspond to the adjusted position of the pin 17 because the spring 14 always tends to actuate the shaft and the pin 16 in a direction to cause the latter to engage the pin 17. In making this adjustment of the initial position of the shaft 6 it necessarily follows that the control arm 20 is moved by the shaft to assume its initial position at some point which is at a predetermined angular position from the fixed contacts 22a. In Fig. 1 the arm 20 is shown at about 180° from a plane passing through the contacts 22a and through the axis of the shaft 6.

Assuming the adjusted position to be that shown in Fig. 1 and with switches 41 and 42 closed, the device is operated by closing the line switch 39. The contact strip 24 is then in engagement with the fixed contact 25 by reason of being closed by the action of spring 27 as already described. The closing of the line switch 39 energizes the magnet 31 which attracts its armature 31b downwardly and moves the brake bar 37 downwardly to engage and hold the brake wheel 11 in fixed position as already explained. The closing of the line switch also starts the motor to drive the gear 8a in one direction of rotation. In view of the brake wheel 11 and its bevel gear 8b being held in fixed position at this time, the rotation of the gear 8a will cause the rotation of the gear 8 on its pin support. On account of the gear 8b being held stationary, it results that the shaft 6 is turned by the gear 8 being forced to travel around the gear 8b. The direction of rotation of the gear 8a is such as to cause the shaft 6 and its arm 20 to be moved in a direction to approach the fixed contacts 22a. The driving movement continues resulting in the cross piece 21 first engaging the contacts 22a and then, as already explained, causing the arm 20 to engage the contact strip 24 and open the circuit of the motor. This stops the motor and prevents any further supply of energy thereto. The arm 20 and the differential gear remain in their final position, however, because the magnet 31 continues to be excited holding the gear 8b in position. The bevel gear 8a also remains in fixed position because friction and the trains of reduction gearing prevent the motor from movement.

After the movement of the controlling arm 20 has accomplished its purpose the line switch 39 may be opened. The controlling arm 20 will then immediately snap back to its initial position because the release of the brake wheel 11 by the magnet permits this wheel to revolve freely and the spring 14 which is always exerting its tension on the shaft is permitted to act to rotate the shaft 6. The rotation of this shaft by the spring causes the differential gear 8 to travel back around stationary gear 8a, permitting the return of the parts to their initial positions. Upon again closing the line switch 39, the operation may be repeated in the manner just described and this repetition may occur as often as desired.

It is evident that by reason of the motor 3, being a synchronous motor and by reason of the frequency of the usual alternating current supply lines being kept substantially constant, the time required for the motor to drive the parts from their initial position to their final position, will always be substantially the same. If it be desired that the time interval between the closing of the line switch 39 and the attainment of the final position of the arm 20 be changed to any other desired time interval, the knob 7 will be adjusted in the manner already described to give the desired time interval by a proper new location of the pin 17. Thus, a wide range of predetermined time intervals may be obtained by a simple and convenient adjustment.

The adjusted tension of the spring 14 does not affect the time interval of the sequence of operations because that is determined by the constant speed of the driving motor. The tension of the spring 14 does affect the time of snapping the parts back to their initial position and this tension may be such as to make the return of the parts substantially instantaneous. The apparatus is not subject to any material wear under long continued use because as regards the brake, there is no appreciable friction wear because the brake bar engages the brake wheel quickly before there is any appreciable torque exerted by this wheel; and as regards the gearing there is no appreciable wear because the gears are always in mesh and there is no shifting of the parts or uncertainty of engagement of shiftable parts.

In some applications of the invention the motor 3 may be started before the circuit of the brake magnet is closed. In such a case the switch 41 will first be opened and the motor started by closing the switch 42, assuming the line circuit to be closed. With the magnet circuit open and the motor running, the control arm 20 remains in its initial position and the bevel gear 8b and brake wheel are loosely driven in a direction reverse to that of gear 8a. Upon closing switch 41 the brake wheel and gear 8b are held in fixed position and the operation of the parts occurs in the manner already described, the time delay interval elapsing after the closing of switch 41. Upon again opening brake magnet switch 41, the control arm 20 will automatically be returned to its initial position, even though the motor resumes its rotation upon the automatic closing of contact strip 24, as the brake wheel is then free to turn idly. Indeed the motor circuit may remain closed continuously and the time delay action initiated by the closing of brake magnet circuit and obtaining reset by opening the brake magnet circuit.

In some cases, instead of using an alternating current synchronous motor, a constant speed direct current motor may be used supplied from a circuit of substantially constant voltage; and it will be understood that various modifications and various applications of this invention may be made without departing from the scope thereof.

I claim:

1. Time delay apparatus comprising a driven element to be moved from an initial position to a final position, a circuit to be controlled, differential gearing for driving said element, an electric motor for driving said gearing in one direction, electromagnetic means for controlling the movement of one of the gears of said gearing, a switch for closing the circuit of said means, a switch for closing the circuit of said motor biased to closed position, means successively engaged by said driven element and controlled thereby for first affecting the connections of said circuit to be controlled and then opening said second named switch upon said element attaining its final position, and a spring for returning said element to its initial position upon the subsequent opening of said first named switch.

2. Time delay apparatus comprising a driven element to be moved from an initial position to a final positon, a circuit to be controlled, differential gearing for driving said element, an electric motor for driving said gearing in one direction, electromagnetic means for holding stationary one of the gears of said gearing, a switch for closing the circuit of said motor and of said means, a switch for closing the circuit of said motor biased to closed position, means successively engaged by said driven element and controlled thereby for first affecting the connections of said circuit to be controlled and then actuating said second named switch for opening the circuit of the motor upon said element attaining its final position, and a spring for returning said element to its initial position upon the subsequent opening of said first named switch.

3. Time delay apparatus comprising a driven element to be moved from an initial position to a final positon, differential gearing for driving said element, an electric motor for driving said gearing, means comprising a magnet for holding stationary one of the gears of said gearing, means for closing the circuit of said motor and of said magnet, circuit controlling means actuated by said element upon its attaining a certain position, a spring for returning said element to its initial position upon opening the circuit of said magnet, a projecting element movable with said driven element, a stop engaged by said projecting element for limiting the initial position of said driven element, and movable means for adjusting the position of said stop, said spring having one end thereof mechanically connected with said movable means.

4. Time delay apparatus comprising a driven element to be moved from an initial position to a final position, differential gearing for driving said element, an electric motor for driving said gearing, means comprising a magnet for holding stationary one of the gears of said gearing, means for closing the circuit of said motor and of said magnet, circuit controlling means actuated by said element upon its attaining a certain position, a spring for returning said element to its initial position upon opening the circuit of said magnet, a projecting element movable with said driven element, a stop engaged by said projecting element for limiting the initial position of said driven element, and means for adjustably connecting one end of said spring to said projecting element.

5. Time delay apparatus comprising a driven element to be moved from an initial position to a final position, differential gearing for driving said element, an electric motor for driving said gearing, means comprising a magnet for holding stationary one of the gears of said gearing, means for closing the circuit of said motor and of said magnet, circuit controlling means actuated by said element upon its attaining a certain position, a spring for returning said element to its initial position upon opening the circuit of said magnet, a projecting element movable with said driven element, a stop engaged by said projecting element for limiting the initial position of said driven element, movable means for adjusting the position of said stop, said spring having one end thereof mechanically connected with said movable means, and means for adjustably connecting the other end of said spring to said projecting element.

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