Dec. 14, 1943. F. H. WINTER 2,336,908

TIME DELAY DEVICE

Filed Oct. 31, 1942

Fig. 1.

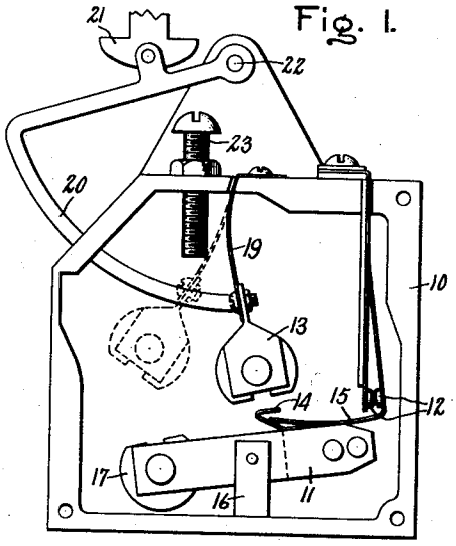


Fig. 2.

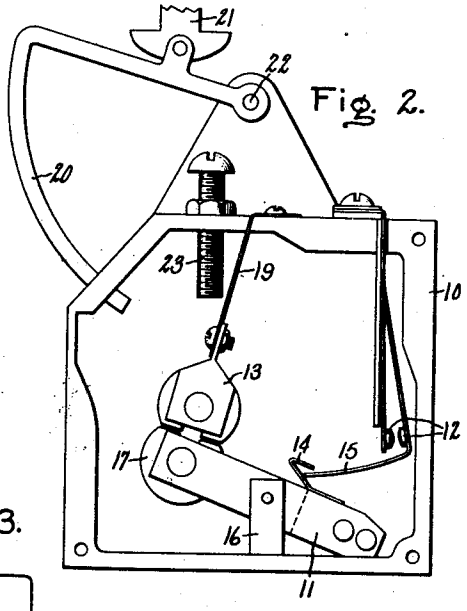
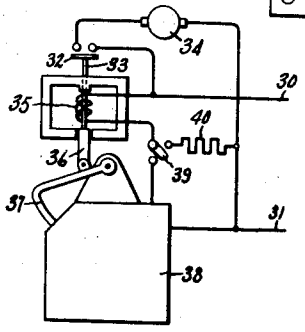


Fig. 3.



Inventor:
Fred H. Winter,
by Harry E. Dunham
His Attorney.

Patented Dec. 14, 1943

2,336,908

UNITED STATES PATENT OFFICE

2,336,908

TIME DELAY DEVICE

Fred H. Winter, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application October 31, 1942, Serial No. 464,099

10 Claims. (Cl. 200—97)

My invention relates to time delay devices and more particularly to time delay circuit controllers or switches.

Time element devices of the pendulous magnet type have been known heretofore. Such a device is shown applied to a time delay electric switch in Patent 1,316,984—Thompson. The device of the Thompson patent comprises a swinging magnet and a cooperating iron armature so arranged that the magnetic attraction between the magnet and its armature increases gradually and continuously to a maximum as the magnet approaches its mid-position from either side. Because of the initially rapid speed of the swinging magnet, the armature is not attracted until the amplitude of swing and the speed of the magnet are so reduced that the magnet remains within the immediate region of its mid-position sufficiently long to pick up the armature.

It is a general object of the present invention to provide a new and improved time delay device of the pendulous magnet type.

More specifically, my invention has for its object the improvement of such a device by means for more accurately predetermining the duration of selected time interval and means for selectably adjusting the time interval to a desired value.

The invention itself comprises a pendulous magnet of substantially U shape, or one so magnetized that it has a pair of poles of opposite polarity the faces of which lie substantially in a single plane tangent to the arcuate path of movement of the magnet, in combination with a movable member carrying a similar magnet movable surbstantially radially of the arcuate path at the mid-position of the pendulum. The provision of a pair of U-shaped or plural pole magnets with one arranged to swing across the face of the other results in a central zone of strong magnetic attraction when the pendulum is very near to its mid-position, and a pair of bounding zones of repulsion when the magnet is only slightly removed from its mid-position on either side. As a result of this arrangement, the amplitude range of swing of the swinging magnet within which the other magnet will be attracted is strictly limited and accurately predeterminable. The duration of the time delay may be controlled by damping the pendulum by varying the effective length of the pendulum, or by varying the amount of energy initially imparted to the pendulum.

The invention itself will be more fuilly understood and its objects and advantages more adequately appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawing in which Fig. 1 is an elevational view of an electric switch embodying my invention and showing the movable switch member in its unattracted position: Fig. 2 is another elevational view of the device of Fig. 1 showing the position of the parts after the completion of a time delay operation; and Fig. 3 is a simplified schematic circuit diagram showing one useful application of the device to the control of an electric circuit.

Referring now to the drawing and particularly to Figs. 1 and 2, I have illustrated my invention in its application to a time delay switch comprising a base 10 formed as a hollow rectangular casing and having mounted therein a movable switch member 11, a pair of relatively movable circuit controlling contacts 12, and a swinging magnet 13. The switch member 11 is movable from the unattracted position shown in Fig. 1 to the attracted position shown at Fig. 2, and is provided with a hooked projection 14 arranged to engage one end of an L-shaped spring 15 to separate the contacts 12. The member 11 is pivotally mounted upon a fixed supporting bracket 16 and is biased to the unattracted position of Fig. 1 by the weight of a U-shaped magnet 17 mounted upon one end of the switch member. The switch member is positioned so that the magnet 17 lies in spaced attractive relation to the swinging magnet 13 when the swinging magnet is in its mid-position. The swinging magnet 13 is shown at its mid-position at Fig. 2, and it will be understood that if the swinging magnet remains substantially in this position, or oscillates thereabout with a predetermined limited amplitude, it will be sufficiently close to the unattracted position of the magnet 17 to attract the magnet 17 to the position shown at Fig. 2. In order to ensure a slight air gap between the magnets 13 and 17 when the magnet 17 is in its attracted position and thereby prevent sticking of the magets, the opposite end 18 of the movable switch member 11 is arranged to strike a fixed stop for limiting the movement of the switch member 11 and determining its attracted position. In the form of the invention shown, the lower surface of the casing 10 acts as a stop.

The swinging magnet 13 is pendulously mounted upon the free end of a cantilever leaf spring 19 attached to the upper surface of the casing 10. As shown at Fig. 1, the swinging or pendulous magnet 13 is normally biased to a position spaced from its mid-position and out of attractive relation with the magnet 17. For holding the

magnet 13 in its biased position and for releasing the magnet to initiate a time delay operation, I have shown by way of illustration an arcuate actuating arm 20 connected to the armature 21 of a suitable actuating solenoid and arranged by its own weight to hold the magnet 13 in the position shown at Fig. 1. The arm 20 is mounted upon a fixed pivot 22 and is movable from the normal position shown in Fig. 1 to the actuated position shown at Fig. 2 when the armature 21 is pulled upward by a suitable actuating solenoid.

From the foregoing it will be understood that the duration of the time delay after the release of the swinging magnet 13 and before the attraction of the movable magnet 17 is determined both by the natural period of oscillation of the magnet 13 and by the amount of energy stored in the spring 19 when held in its biased position of Fig. 1. Thus the duration of the time delay may be controlled either by changing the natural period of oscillation of the pendulous magnet, by damping the oscillations, or by changing the amount of energy stored in the spring 19 in its initial position. In the form of the invention shown, the initial position of the magnet 13 and spring 19 is fixed and thus the initial energy stored in the spring 19 is always the same. Accordingly, I provide means for changing the natural period of oscillation of the spring 19 and magnet 13 and for damping the oscillation in order to control the duration of the time delay. This means takes the form of a bolt 23 projecting through the upper surface of the casing 10 and arranged to engage the spring 19 as a stop at any one of a plurality of selectable points along its length depending upon how far the bolt 23 is screwed down into the casing. In the form of the invention shown the bolt 23 is arranged at a slight angle to the normal unbiased position of the spring 19, as shown in Fig. 2. As the angularly disposed bolt 23 is screwed down into the casing 10, it engages the spring 19 nearer to its free end and also nearer to its mid-position thereby to shorten the time delay between release of the pendulous magnet 13 and attraction of the movable magnet 17. The approach of the stop bolt 23 to the mid-position of the spring 19 serves primarily to vary its damping effect, while its approach to the free end of the spring serves to vary both the damping effect and the effective length of the pendulum. It will be understood that my invention is not intended to be limited to a stop means which is simultaneously adjustable in both directions, but that the duration of time delay may also be adjusted by a stop movable solely longitudinally of the spring 19 or solely perpendicular thereto. It will, of course, also be understood by those skilled in the art that, if desired, the control of time delay may be effected by providing any suitable means in connection with the actuating arm 20 to change the initial position of the swinging magnet 13 and thus the initial energy stored in the spring 19.

At Fig. 3, I have shown a schematic circuit diagram of a system of control embodying one application of my time delay switch. The control system comprises a pair of line conductors 30 and 31 connected to a suitable source of alternating current supply and through the contact 32 of a suitable contactor 33 to an electric translating device, such as a motor 34. The contactor 33 comprises an actuating coil 35 and an armature 36. The armature 36 is connected to the actuating arm 37 of a time delay switch 38 of the type shown at Figs. 1 and 2. The contacts of the switch 38 are normally closed, as shown at Fig. 1, and are connected in series circuit relation with the actuating coil 35 of the contactor 34. A selector switch 39 is arranged to complete an energizing circuit for the coil 35 across the alternating current supply lines 30 and 31 either through the contacts of the switch 38 or through a resistor 40. The resistor 40 is preferably one characterized by a marked positive temperature coefficient of resistance; that is, the resistance of the resistor 40 increases sharply as its temperature increases. Many such resistors are well known, such as the ordinary tungsten filament incandescent lamp.

In the circuit shown at Fig. 3 the contactor 33 is one having a sufficient magnetic retentivity so that after it has been actuated by an initial application of alternating current, its residual magnetism will be sufficient to hold it in its attracted position until later it is demagnetized.

In the operation of the circuit of Fig. 3 the contactor 33 is actuated by completing an energizing circuit for the coil 35 through the switches 38 and 39. When the contactor 33 picks up, it completes an energizing circuit for the motor 34 through its contact 32 and simultaneously releases the time delay switch 38 by movement of the actuating arm 37. From the previous description of Figs. 1 and 2, it will be clear that the contacts of the time delay switch 38 will be separated a predetermined time after actuation of the contactor armature 36. Separation of the contacts of the switch 38 disables the energizing circuit of the coil 35, and the contactor 33 is then held in by its own residual magnetism. When it is desired to deenergize the motor 32, the contactor 33 may be dropped out by moving the switch 39 to energize the actuating coil 35 through the resistor 40. Due to the initially low resistance of the resistor 40, a large alternating current initially passes through the coil 35, but as the resistance of the resistor 40 increases, the amplitude of the alternating current is gradually diminished to a very small value, and the contactor 33 is thus demagnetized in a well known manner.

No claim is made herein to the control system shown at Fig. 3, since this system forms the subject matter of a copending application of Pieter Juchter, Serial No. 376,810, filed January 31, 1941, and assigned to the same assignee as the instant application.

While I have described only one preferred embodiment of my invention by way of illustration, many further modifications will occur to those skilled in the art. I therefore wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a first magnetic member penduluously mounted for swinging movement in an arcuate path on each side of a normal mid-position, a second magnetic member mounted for movement normal to said arcuate path at said mid-position, each of said magnetic members having a plurality of poles so arranged that as said first magnetic member moves to each side of said mid-position it experiences first a zone of attraction for said second magnetic member and then a bounding zone of repulsion, and means

for initiating swinging movement of said first magnetic member about said mid-position and periodically through said zones with a gradually decreasing amplitude of swing, whereby attraction of said second magnetic member by said first magnetic member is delayed until the swing of said first magnetic member lies substantially wholly within said zone of attraction.

2. In combination, a first magnetic member mounted for swinging movement upon each side of a predetermined normal mid-position, said magnetic member having a pair of poles of opposite polarity the faces of which lie adjacent each other in substantially the same plane, a second magnetic member having a pair of poles of opposite polarity for cooperation with said first pair of poles, said second magnetic member being movable toward said first magnetic member to an attracted position when said first magnetic member is in said mid-position, means for biasing said second magnetic member to a position spaced from said attracted position, and means for causing said first magnetic member to swing about said mid-position with a gradually decreasing amplitude thereby to preclude attraction of said second magnetic member until the amplitude of swing becomes sufficiently small so that opposite poles of said pairs of poles remain substantially in attractive relation.

3. In combination, a permanent magnet pendulously mounted for swinging movement along a predetermined arcuate path on each side of a normal mid-position, said magnet having a pair of poles of opposite polarity the faces of which lie adjacent each other in a plane substantially tangent to said arcuate path, a second permanent magnet having a cooperating pair of poles and positioned so that its pole faces lie in a plane substantially parallel to the tangent to said arcuate path at said mid-position, said second magnet being movable substantially normal to said tangent toward said permanent magnet to an attracted position when said permanent magnet is in said mid-position, means for biasing said second magnet to a position spaced from said attracted position, and means for causing said permanent magnet to swing about said mid-position with a gradually decreasing amplitude thereby to preclude attraction of said second magnet until the amplitude of swing becomes sufficiently small so that opposite poles of said pairs of poles remain substantially in attractive relation throughout the swing.

4. A time element electric switch comprising a permanent magnet pendulously mounted for swinging movement along an arcuate path on each side of a normal mid-position, said magnet having a pair of poles of opposite polarity the faces of which lie adjacent each other in a plane substantially tangent to said arcuate path, a movable switch member comprising a second permanent magnet movable substantially normal to the tangent to said arcuate path at said mid-position to an attracted position adjacent said first magnet when said first magnet is at said mid-position, said second magnet having a pair of poles cooperating with the poles of said first magnet so that as said first magnet moves to each side of said mid-position said magnet experiences first a limited zone of attraction and then a bounding zone of repulsion, means for biasing said movable switch member to a position such that said second magnet is spaced from said attracted position, restraining means normally holding said first magnet spaced from said mid-position, and means for releasing said first magnet for swinging movement about said mid-position with a gradually decreasing amplitude thereby to delay movement of said switch member to said attracted position under the influence of said magnets until the swing of said first magnet lies substantially wholly within said zone of attraction.

5. In combination, a swinging pendulum including a first magnetic member mounted for movement in an arcuate path on each side of a normal mid-position, a second magnetic member mounted for movement normal to said arcuate path at said mid-position, each of said magnetic members having a plurality of poles so arranged that as said first magnetic member moves to each side of said mid-position it experiences first a zone of attraction for said second magnetic member and then a bounding zone of repulsion, means for initiating swinging movement of said first magnetic member about said mid-position and periodically through said zones with a gradually decreasing amplitude of swing thereby to delay attraction of said second magnetic member by said first magnetic member until the swing of said first magnetic member lies substantially wholly within said zone of attraction, and manually adjustable means operable in conjunction with said pendulum to control the time delay between initiation of said swinging movement and attraction of said second magnetic member.

6. In combination, a swinging pendulum comprising a first magnetic member mounted for movement in an arcuate path on each side of a normal mid-position, a second magnetic member mounted for movement normal to said arcuate path at said mid-position to an attracted position adjacent said first magnetic member, means for normally biasing said second magnetic member to a position spaced from said attracted position and for biasing said first magnetic member to a position spaced from said mid-position, means for initiating swinging movement of said first magnetic member about said mid-position with gradually decreasing amplitude of swing thereby to delay attraction of said second magnetic member by said first magnetic member until said amplitude of swing becomes sufficiently small so that said first magnetic member remains substantially wholly within a predetermined zone of strong attraction for said second magnetic member, and manually adjustable means operable in conjunction with said pendulum to vary the time interval between initiation of said swinging movement and attraction of said second magnetic member.

7. In combination, a swinging pendulum comprising a magnet mounted for movement in an arcuate path on each side of a normal mid-position, a second magnet mounted for movement substantially normal to said arcuate path at said mid-position, said second magnet being movable toward said first magnet to an attracted position when said first magnet remains in the region of said mid-position for a predetermined time, means for biasing said second magnet to a position spaced from said attracted position, means for initiating swinging movement of said pendulum about said mid-position with a gradually decreasing amplitude thereby to delay attraction of said second magnet until said amplitude of swing is reduced to a predetermined value, and damping means arranged adjustably to engage said pendulum for controlling the time interval between initiation of said swinging movement

and attraction of said second magnetic member.

8. In combination, a swinging pendulum comprising a magnet mounted for movement in an arcuate path on each side of a normal mid-position, a second magnet mounted for movement substantially normal to said arcuate path at said mid-position, said second magnet being movable toward said first magnet to an attracted position when said first magnet remains in the region of said mid-position for a predetermined time, means for biasing said second magnet to a position spaced from said attracted position, means for initiating swinging movement of said pendulum about said mid-position with a gradually decreasing amplitude thereby to delay attraction of said second magnet until said amplitude of swing is reduced to a predetermined value, and adjustable means for controlling the natural period of oscillation of said pendulum thereby to control the time interval between initiation of said swinging movement and attraction of said second magnetic member.

9. A time element electric switch comprising a magnet mounted upon the free end of a cantilever spring for oscillatory arcuate movement upon each side of a normal mid-position, a movable switch member including a magnetic member movable substantially normal to said arcuate path at said mid-position to an attracted position adjacent said magnet, means for biasing said switch member to a position spaced from said attracted position, means for initiating oscillatory movement of said magnet thereby to delay attraction of said magnetic member until the amplitude of oscillation of said magnet is reduced to a predetermined value, and stop means arranged to be adjustably positioned in the path of movement of said cantilever spring at selectable points along its length thereby to control the time interval between initiation of said oscillatory movement and attraction of said magnetic member.

10. A time element electric switch comprising a magnet mounted upon the free end of a cantilever spring for oscillatory arcuate movement upon each side of a normal mid-position, a movable switch member including a magnetic member movable substantially normal to said arcuate path at said mid-position to an attracted position adjacent said magnet, means for biasing said switch member to a position spaced from said attracted position, means for initiating oscillatory movement of said magnet thereby to delay attraction of said magnetic member until the amplitude of oscillation of said magnet is reduced to a predetermined value, and stop means arranged to be adjustably spaced from the mid-position of said spring to engage said spring and damp the oscillations thereof thereby to control the time interval between initiation of said oscillatory movement and attraction of said magnetic member.

FRED H. WINTER.