Aug. 14, 1934. M. W. MUEHTER 1,970,333

INTERMITTENTLY OPERATING ELECTRICAL DEVICE

Original Filed Jan. 2, 1931

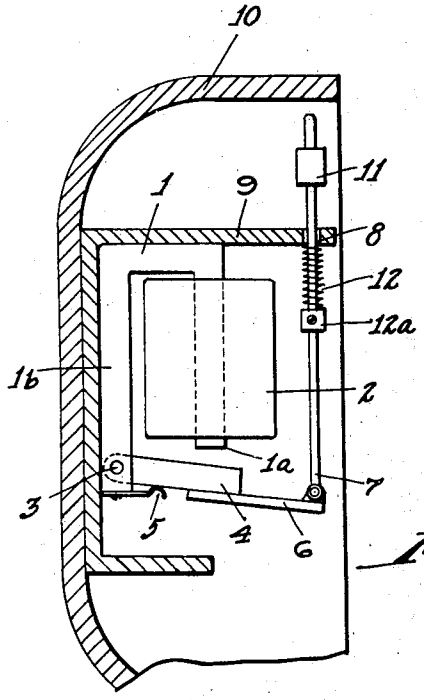


Fig. 1.

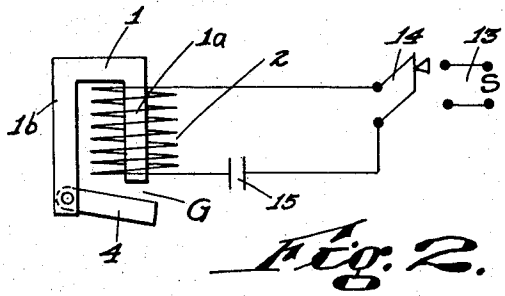


Fig. 2.

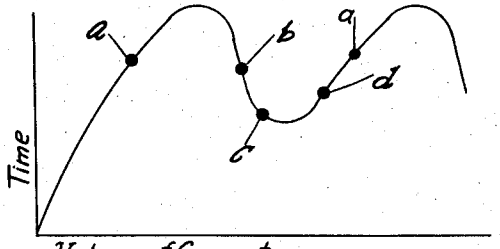


Fig. 3.

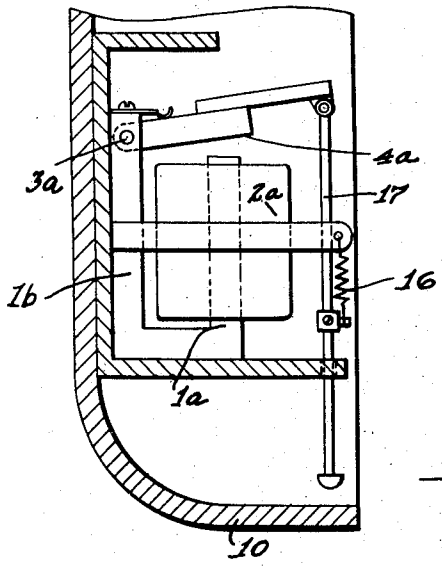


Fig. 4.

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INTERMITTENTLY OPERATING ELECTRICAL DEVICE

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6 Claims. (Cl. 175—335)

The present invention relates to an improved intermittently operating electrical device, or relay, that is particularly characterized by the fact that when supplied from a source of alternating current, the device will operate intermittently, although its actuating coil or winding is continuously energized.

As an illustrative embodiment of the invention, it is shown and described in connection with a bell or gong, so that successive movements of the magnetic armature of the device will cause recurrent sounding of the resonant member, as in a vibrating bell. As will be hereinafter pointed out, recurrent operations of the device are obtained without breaking the circuit of the energizing winding, as in the ordinary vibrating bell, the device continuing to operate intermittently in a uniform manner as long as alternating current is supplied to its winding.

Briefly stated, the principle underlying the present invention resides in causing an ordinary relay device to operate in such a manner that when the magnetic armature of the device is attracted by the core upon energization of the winding, the current consumption of the relay winding is automatically decreased to such an extent that the magnetic attraction of the armature is not strong enough to hold it up, so that it drops back to its initial position without requiring deenergization of the winding itself. However, upon reestablishment of the initial conditions, with the armature separated from its core by the maximum air gap, the armature will be attracted, as before, until it reaches a position in which the air gap is substantially a minimum, whereupon the circuit conditions are again such as to automatically bring about a decrease of the energizing current and release of the armature. Therefore, an intermittent operation of the armature continues, as long as the device is energized, without any breaking of the energizing circuit. The above and other advantageous features of the invention will hereinafter more fully appear from the following description, with reference to the accompanying drawing, in which—

Fig. 1 is a view partially in vertical section and partially in elevation showing the invention embodied in a bell or gong.

Fig. 2 is a diagrammatic view illustrating the electrical circuit of the device shown in Fig. 1.

Fig. 3 is a diagrammatic view illustrating graphically the fluctuations in the current consumption of the device shown in Fig. 1, whereby intermittent operation of the same is automatically obtained.

Fig. 4 is a view similar to Fig. 1 showing another form of the device.

Like reference characters refer to like parts throughout the drawing.

Referring first to Fig. 1, an illustrative embodiment of the device comprises a U-shaped magnetic core 1, having legs of different lengths, with the shorter leg 1*a* surrounded by a winding 2. The longer leg 1*b* of the core carries a pin 3 for pivotally supporting an armature 4 which normally occupies a position in engagement with a stop 5 when the winding 2 is deenergized. The armature 4 provides an extension 6 to which is pivotally connected a plunger 7 extending upwardly through an opening 8 in the frame 9 which supports the core 1. The plunger 7 extends above the frame 9 with its upper extremity spaced from a resonant member or gong 10, it being evident that the plunger will strike the gong 10 when the armature 4 is drawn upwardly toward the core leg 1*a* upon energization of the winding 2. The upper portion of the plunger 7 above the frame 9 carries a weight 11, and a portion of the plunger 7 below the frame is surrounded by a coil spring 12 held by a pin 12*a*, the purpose of which will hereinafter more fully appear.

Referring now to Fig. 2, should the winding 2 be continuously energized from a source 13 of alternating current as by closing a switch 14, the armature 4 would be drawn up into substantial engagement with the leg 1*a* of the core 1 where it would remain as long as the switch 14 is closed, in the absence of any factor disturbing the circuit relation indicated. This is the normal operation of a relay, and it is known that when the armature is drawn up, so that the air gap G is substantially a minimum, the current flowing through the winding is less than the current which initially flows through the winding 2, with the armature in engagement with its stop 5 and with the air gap G at a maximum. The particular reason for this decrease of current consumption by the winding 2, as the armature 4 moves to its closed position, is that the inductance of the circuit increases as the air gap decreases. However, the pull exerted on the armature when closed is not dependent on the value of the current alone, but rather on the magnetic flux through the armature which is greater for the closed armature. Therefore, the armature remains closed in spite of the decreased current.

As previously pointed out, the principle underlying the present invention resides in alter-

ing the energizing circuit of the winding 2 in such a manner that whenever the armature 4 is attracted to the core leg 1*a*, the current passing through the winding 2 is automatically decreased to such an extent, below its normal value, that the armature 4 will drop back, even though the winding 2 remains energized, thereby resulting in intermittent movement of the armature 4. In order to accomplish this result the invention contemplates the utilization of a condenser 15 in series circuit relation with the winding 2, the capacity of the condenser being such that the circuit is in a condition of resonance with the armature 4 in the open position, as shown in Fig. 2. Obviously this condition of resonance is disturbed when the armature 4 starts to move toward the core leg 1*a*, the net result being that the impedance of the circuit shown in Fig. 2 rapidly increases, as the air gap G decreases. Therefore, with the condenser 15 in circuit with the winding 2, as shown in Fig. 2, it follows that the current consumption of the winding 2 will decrease very rapidly as the armature 4 approaches the core leg 1*a*, so that the armature tends to drop back to its open position, irrespective of the fact that the winding 2 remains energized from the alternating current source 13. However, when the armature 4 drops back, the resulting increase of the air gap lowers the inductance of the relay to such an extent that the initial condition of resonance in the circuit is reestablished, whereupon the current increases and the armature 4 is again attracted to the core leg 1*a*. As a result, intermittent movement is imparted to the armature 4 as long as the switch remains closed.

In the embodiment of the invention, shown in Fig. 1, the plunger 7 connected to the armature 6 carries a weight 11 at its upper end and is surrounded by a coil spring 12 below the opening 8 through which the plunger 7 passes in the frame 9. The purpose of the weight 11 is to reduce the frequency of the armature oscillations and increase the inertia of the armature 4 to such an extent that the armature 4 will not start to pull up until the current has reached a relatively high value. This insures that the plunger 7 will finally have a quick upward movement imparted thereto, so that the upper end of the plunger strikes the gong 10 sharply.

As the plunger moves upwardly under the pull of the armature, this movement is opposed by gravity acting against the pull of the armature to which is added the increasing resistance of the spring 12, as it is compressed against the frame 9. Therefore, as the plunger 7 reaches the upper end of its stroke, the combined forces acting on the plunger, in opposite directions, tend to reach a condition of equilibrium. As this point is approached, with the plunger 7 at the upper end of its stroke, the rapid decrease in the current consumption of the winding 2, resulting from closure of the armature and the disturbance of the condition of resonance in the circuit, so reduces the upward pull on the armature that the plunger 7 falls sharply after having made a single quick stroke on the gong 10. When the armature 4 reaches its open position, the current consumption immediately increases again, upon reestablishment of the condition of resonance in the circuit, but the armature does not begin to pull up until sufficient pull on the armature has been developed to overcome the inertia of the armature 4, plunger 7, and weight 11. Therefore, a full stroke of the plunger 7 is always secured.

Referring now to Fig. 3, there is shown graphically the fluctuations of the current in the winding 2 in the form of a curve in which increments of current are plotted against increments of time, as indicated. Following closure of the switch 14, the current increases according to the time constant of the coil 2 up to the point *a* where the armature starts to pull up. At the point *b* the armature is in its fully closed position, the current having reached a maximum value somewhere between the points *a* and *b* and having started to decrease on account of the higher inductance of the relay in its closed position. From the point *b* the current falls rapidly until at the point *c* the pull on the armature has decreased to such a value that the armature starts to fall. As the armature starts to fall, the increase in the air gap immediately lowers the inductance of the relay, so that by the time the armature 4 reaches its open position at *d* the current is on the increase. However, the force of gravity acting through the weight 11 and plunger 7, plus the accelerating force of the spring 12, is such as to insure that the armature will reach its fully open position even though the current be increasing at the point *d* on the curve. In fact, the inertia of the armature and its associated parts is such that upward movement of the armature does not start until the current has reached the point *a* near the top of the curve, whereupon the cycle is repeated.

In the form of the device shown in Fig. 4, the armature 4*a* is pivoted at the upper end of the longer leg of the inverted core and a spring 16 connected to a plunger 17 extending downwardly from the armature 4*a* tends to maintain the armature away from the core, as shown. Upon energization of the winding 2*a*, in circuit with a condenser, as shown in Fig. 2, the pull on the armature 4*a* has added to it the effect of the downwardly moving mass of the armature and plunger 17. As the end of the plunger 17 strikes the resonant member or gong 10, the spring 16 is distended to the point where it overcomes the rapidly decreasing pull on the armature and the armature returns to its open position.

From the foregoing it is apparent that by the present invention there is provided an improved electrical device, or relay, particularly characterized by the fact that continuous energization of its winding from a source of alternating current will automatically result in intermittent movement of the armature, or other member, under the magnetic influence of the winding. Although the invention is shown in connection with the bell or gong, as an illustrative embodiment thereof, it is obvious that the essential principle of the device can be employed in connection with other types of apparatus wherein it is desirable to utilize a recurring or intermittent movement uniform in character.

I claim,

1. In a device of the class described, the combination with a magnetic core carrying a winding and an armature pivotally mounted on said core, of means for energizing said winding from a source of alternating current with the circuit in a condition of resonance while the armature is in an open position.

2. In a device of the class described, the combination with a magnetic core carrying a winding and an armature pivotally mounted on said core, of means for energizing said winding from a

source of alternating current with the circuit in a condition of resonance while the armature is in an open position, whereby closure of said armature automatically causes a decrease in the pull on said armature by said energized winding.

3. In a device of the class described, the combination with a magnetic core carrying a winding and an armature pivotally mounted on said core, of means for energizing said winding from a source of alternating current with the circuit in a condition of resonance while the armature is in an open position, whereby closure of said armature disturbs the condition of resonance in said circuit with a resulting decrease of the pull on the armature.

4. In a device of the class described, the combination with a magnetic core carrying a winding, and an armature movable with respect to said core in response to energization of said winding, of means for energizing said winding from a source of alternating current with the circuit of said winding in a condition of resonance while said armature is in an open position with respect to said core.

5. In a device of the class described, the combination with a magnetic core carrying a winding, and an armature movable with respect to said core in response to energization of said winding, of means for energizing said winding from a source of alternating current with the circuit of said winding in a condition of resonance while said armature is in an open position with respect to said core, closure of said armature automatically causing a decrease in the pull on said armature by said energized winding until said armature is released.

6. In a device of the class described, the combination with a magnetic core carrying a winding, and an armature movable with respect to said core upon energization of said winding, of means for energizing said winding from a source of alternating current with the circuit of said winding in a condition of resonance while said armature is in an open position, closure of said armature automatically decreasing the pull thereon by said energized winding until said armature returns to its open position, whereby to obtain intermittent operation of said armature while said winding remains energized.

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