Dec. 23, 1930. G. O. WILMS ET AL 1,785,852

THERMOSTATICALLY ACTUATED DEVICE

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Fig. 1.

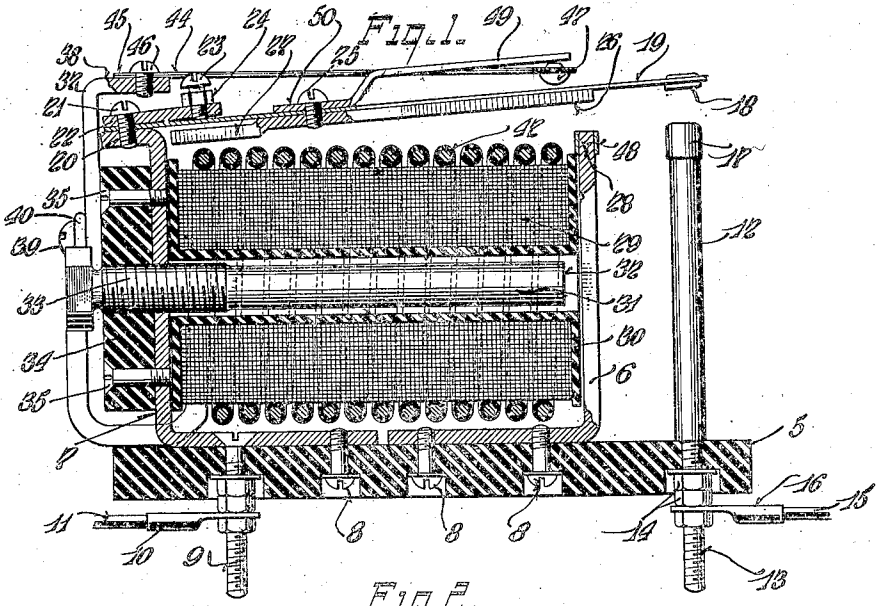


Fig. 2.

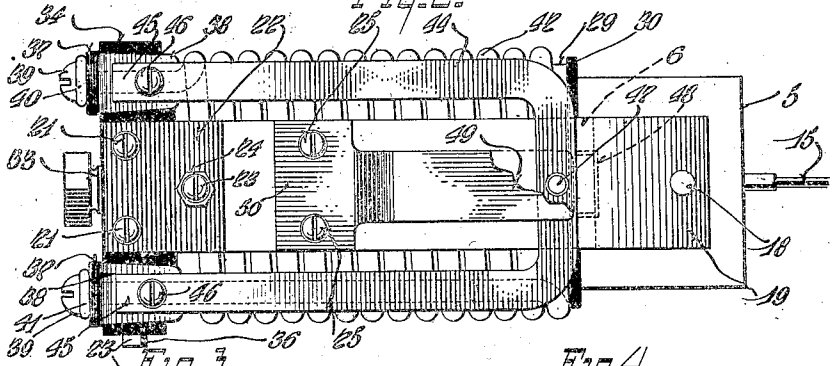


Fig. 3.

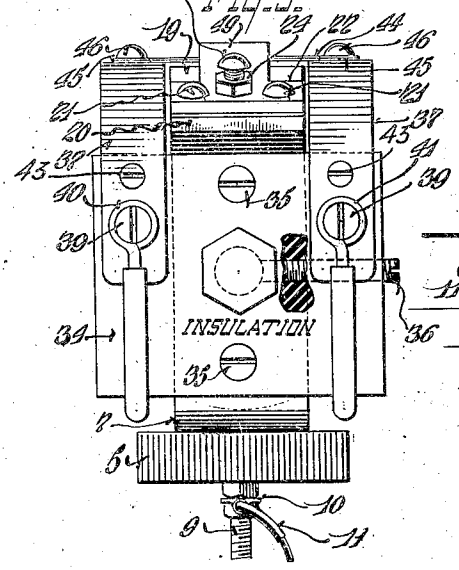
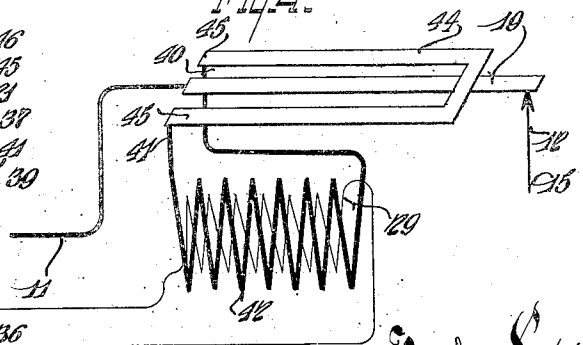


Fig. 4.



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Fig. 5.

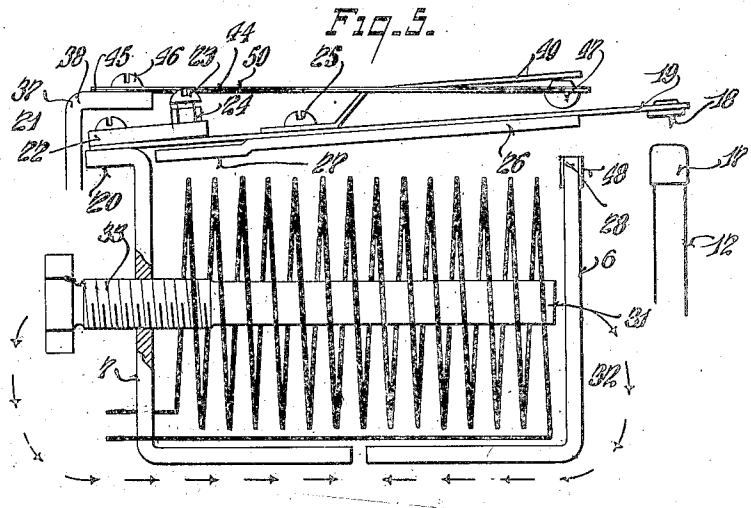
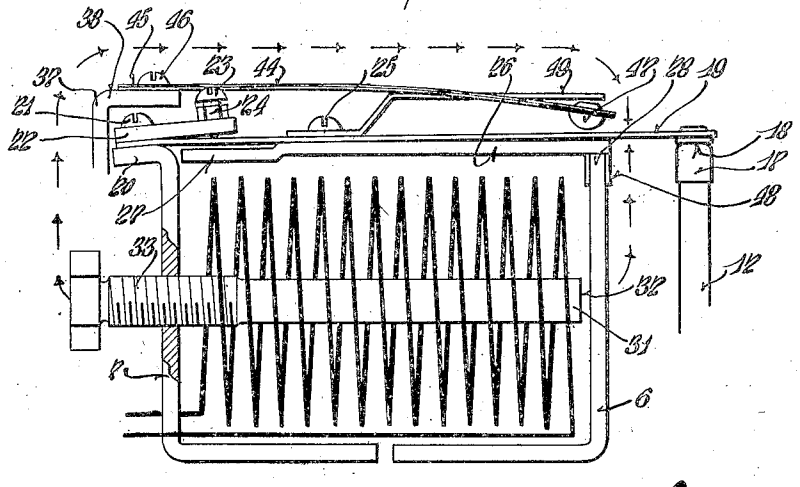


Fig. 6.



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UNITED STATES PATENT OFFICE

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THERMOSTATICALLY-ACTUATED DEVICE

Application filed August 8, 1928. Serial No. 298,302.

This invention relates particularly to a thermomagnetic device for producing a mechanical movement by thermoelectric means assisted by magnetic flux transfer and in the present instance is exemplified in an alternating current voltage timing relay.

It is an object of this invention to provide a device of the character described which incorporates a bi-metallic member as a prime-mover.

Another object of this invention resides in the provision of a device of the character described in which the prime-mover is actuated by heat generated within itself.

And a further object of this invention resides in the provision of a device of the character described adapted for use with alternating current and having an armature adapted to be moved to perform any desired work and a prime-mover, the prime-mover producing a shading effect to prevent chattering of the armature.

With the above and other objects in view which will appear as the description proceeds, our invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

In the accompanying drawings, we have illustrated one complete example of the physical embodiment of our invention constructed according to the best mode we have so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a transverse sectional view taken through a relay device embodying our invention;

Figure 2 is a top plan thereof;

Figure 3 is an end view;

Figure 4 is a diagrammatic view illustrating the circuits included in our improved device;

Figure 5 is a diagrammatic view illustrating the position of the parts when the structure is in its normal or inactive position, and

Figure 6 is a view similar to Figure 5 illustrating the parts in their operative positions.

Referring now more particularly to the accompanying drawings, in which like numerals designate like parts throughout the several views, the numeral 5 represents a base of suitable insulating material having a pair of substantially right angle members 6 and 7 mounted thereon to form a U shaped frame. The member 6 is secured to the base by screws 8 extended through the base and threaded in the horizontal portion thereof and the member 7 is secured to the base by one screw 8 threaded in its horizontal portion and by a contact terminal screw 9 having its head positioned in a counterbored aperture in the member and extending through the base to have a terminal 10, connected with one end of a conductor 11, secured thereon.

An upwardly extended contact stud 12 is mounted on the opposite end of the base 5 by having a reduced threaded portion 13 passed through an aperture therein to receive binding nuts 14 and is electrically connected with a conductor 15 through a terminal 16 secured on its threaded end. The upper end of the contact stud 12 is provided with a stationary contact 17 preferably formed of arc resisting material with which a movable contact 18 cooperates, the movable contact 18 being carried by a switch blade 19 formed of spring metal and secured at its opposite end to a laterally directed portion 20 of the right angle frame member 7. Thus it will be seen that when the contacts 17 and 18 are engaged, the conductors 11 and 15 are electrically bridged.

The blade 19 is secured to the lateral portion 20 of the frame member 7, which is directed at a slight downward angle, by screws 21 which pass through aligned apertures in the blade 19 and a plate member 22 to be threaded in the portion 20. The plate member 22 is positioned above the blade and extends inwardly to mount an adjusting screw 23 having a lock nut 24 to provide means for adjusting the tension of the blade 19 and provide a gap between the contacts 17 and 18. Secured to the blade 19 by means of screws 25, is an armature 26 formed of a strip of magnetic metal, the inner end of which is offset, as

at 27, to facilitate the adjustment of the blade by means of the screw 23.

The armature 26 is arranged to be attracted to a pole piece 28 after it has been moved a predetermined distance by means, to be later described, to close the contacts 17 and 18. The pole piece 28 is the upper end of the frame 6 and derives its magnetic motive force or attraction from a solenoid coil 29 wound upon a spool 30 and constituting the primary of a transformer. The spool 30 on which the solenoid coil 29 is wound is positioned between the vertical arms of the U shaped frame formed by the members 6 and 7 and has a core 31 extending throughout the length of the coil with its end 32 spaced from the adjacent portion of the frame member 6. The core 31 is also formed of magnetic metal and is adjustable longitudinally to vary the gap between its end 32 and the frame 6 by means of a threaded portion 33 threaded in aligned apertures in the frame member 7 and a block of insulating material 34 secured to the vertical arm of the member 7 by screws 35, a hexagonal head being formed on the outermost portion of the core to facilitate its adjustment and a set screw 36 threaded in the block 34 maintains the core in adjusted position.

Secured to the insulating block 34 are two upwardly extending brackets 37 having their upper ends directed laterally, as at 38. The brackets 37 are secured to the insulating block by screws 39, which likewise electrically connect the ends 40 and 41 of a coil 42 with the brackets 37, and by screws 43 passed through the brackets and threaded in apertures in the block 34.

The coil 42 constitutes the secondary of the transformer of which the solenoid coil 29 is the primary and is formed of comparatively few turns of relatively heavy wire wound directly around the solenoid 29.

A U shaped member 44 formed of bi-metallic material has its ends 45 secured to the lateral portions 38 of the brackets 37 by screws 46 and thereby closes the circuit of the secondary coil 42, the material of greatest expansion being on top to deflect the member 44 downwardly when subjected to heat. A rivet 47 is secured to the U shaped member at a medial point of its closed end to engage the blade 19 and move the same downwardly when the bi-metallic member is deflected by heat produced in a manner to be later described.

Thus it will be seen that the device includes a transformer having a primary of many turns which is the solenoid 29 and a secondary of comparatively few turns, the secondary having the U shaped bi-metallic member in series with it thereby closing its circuit as clearly illustrated in the diagrammatic showing in Figure 4; the primary or solenoid coil being connectible with an outside source of alternating current, not shown.

With alternating current flowing through the primary coil a magnetic flux is set up in the magnetic circuit of the transformer, the major portion of which is substantially as shown by arrows in Figure 5, and an electromotive force is induced in the closed secondary circuit. As the bi-metallic member has an electrical resistance, the current flow generates heat therein causing the bi-metallic member to bend downwardly carrying with it the switch blade 19 and the armature 26.

As the armature gradually nears the pole 28 the magnetic reluctance of that section of the magnetic circuit in which the armature is included gradually decreases to a point at which the gap between the armature and the pole 28 is equal to the gap between the adjacent ends of the frame members 6 and 7. At this point the magnetic lines of force passing through the stationary portion of the magnetic circuit and through the armature are equal but as soon as the gap between the armature and the pole 28 becomes less than the stationary gap between the members 6 and 7, the magnetic lines of force transfer from the stationary magnetic circuit to the armature. The transfer of the magnetic lines of force produces a strong magnetic attraction of the armature to the pole and quickly moves the armature to engagement therewith to close the contacts 17 and 18. This is the position of the parts as illustrated in Figure 6 and remains as long as current passes through the primary winding of the transformer or the solenoid coil 29.

When in this position, a shading coil 48 positioned at the pole 28 prevents chattering of the armature and when the parts are in their position illustrated in Figure 5, the bi-metallic member produces substantially a shading effect on the armature.

When the current supplied the primary or solenoid coil 29 is cut off, the flow of current in the secondary circuit and through the bi-metallic member ceases, permitting the bi-metalic member to cool and again assume its normal position. Normally, rupturing the primary circuit deenergizes the pole 28 to permit the armature and the switch blade to move to their inactive position, but in the event of a tendency to remain closed, the upward movement of the bi-metallic member is imparted to the switch blade and the armature by means of an arm 49 having an offset portion 50 by which it is secured to the blade by the screws 25. When the circuit of the primary is first closed, the normal initial surge of flux tends to instantly close the contacts, which action is resisted by the bi-metallic member against which the arm 49, carried by the armature, abuts.

As the gap between the end 32 of the core and the adjacent frame member 6 is adjustable it is possible to adjust the time required to actuate the mechanism to its fully closed

position to close whatever circuit it may be used with.

From the foregoing description taken in connection with the accompanying drawing it will be readily apparent to those skilled in the art to which an invention of this character appertains that we provide a novel device adapted for use with alternating current which utilizes a combination of a pulsating or alternating flux to induce an electric current through a bi-metallic member and causes motion which is assisted by a magnetic flux transfer.

We claim:

1. In a device of the character described, a primary winding adapted to be connected with a source of current, a secondary winding in inductive relation to the primary winding whereby an electromotive force is induced in the secondary winding upon passage of current through the primary winding, and a member having its ends permanently connected with the ends of the secondary winding to close its circuit whereby the electromotive force induced in the secondary winding produces a flow of current through the closed secondary circuit to move the said member.

2. In a device of the class described, a transformer including a primary winding and a secondary winding, a bi-metallic member connected across the secondary winding to close its circuit whereby energization of the primary winding induces an electric current in the closed secondary circuit to cause the bi-metallic member to deflect, an armature, the deflection of the bi-metallic member moving the armature a predetermined degree, and means whereby the armature is moved from the position to which it is moved by the deflection of the bi-metallic member to its fully closed position.

3. In a device of the character described, a relay, supporting members for the relay, said relay having a normal magnetic circuit through its supporting members, one of its supporting members constituting a pole piece a movably mounted armature adapted to be normally positioned beyond the active field of the pole piece, and means for moving the armature to a position at which the magnetic lines of force flowing through the armature and to the pole piece are greater than those of the normal magnetic circuit of the relay, whereupon the armature is quickly attracted to its pole piece.

4. In a device of the character described having a magnetic circuit, a supporting frame included in the magnetic circuit and having a gap at one portion, one end of the frame forming a pole piece, a movably mounted armature included in the magnetic circuit, means normally urging the armature to a position spaced from the pole piece a distance greater than the gap in the supporting frame, and means for moving the armature toward the pole piece to a position at which the distance between it and the pole piece is less than the gap in the frame, whereupon the reluctance of the magnetic circuit including the armature is lowered with respect to that of the frame member.

5. In a device of the character described having a magnetic circuit interrupted by a gap, a pole piece, a movably mounted armature included in the magnetic circuit and spaced from the pole piece a distance greater than said gap, and means for moving the armature toward the pole piece to decrease the distance between it and the pole piece to lower the reluctance of the armature section of the magnetic circuit which quickly moves the armature to engage its pole piece.

6. In a device of the character described, a transformer having a primary winding and a secondary winding, a thermally responsive member having its ends connected directly across the secondary winding to form a closed circuit therewith, a pole piece, a movably mounted armature, and means normally maintaining the armature in a position spaced from the pole piece and beyond the active field thereof whereby energization of the primary winding induces a current in the secondary circuit which flows through the thermally responsive member to deflect the same and move the armature within the field of the pole piece.

7. In a device of the character described, a transformer having a primary winding and a secondary winding, a substantially U shaped bi-metallic member having its ends connected directly across the secondary winding to form a closed circuit therewith, a pole piece, a movably mounted armature, and means normally maintaining the armature in a position spaced from the pole piece and beyond the active field thereof whereby energization of the primary winding induces a current in the secondary circuit which flows through the thermally responsive member to deflect the same and move the armature within the field of the pole piece.

8. In a device of the character described having a magnetic circuit interrupted at a plurality of points, a pole piece, a movable armature included in the magnetic circuit and having a gap between the armature and pole piece constituting one interruption in the magnetic circuit, means for moving the armature toward the pole piece to decrease the gap therebetween to a degree less than the second interruption in the magnetic circuit whereby the reluctance of the magnetic circuit including the armature becomes less than that portion of the circuit including the second gap to permit the armature to engage its pole piece, and means for adjusting a third interruption in the magnetic circuit.

9. In a device of the character described, a relay, a frame for the relay providing a

pole piece, a core, means adjustably spacing one end of the core from the frame, an armature, a magnetic circuit including the frame and the armature, and means whereby the reluctance of a magnetic circuit including the armature may be lowered with respect to that portion of the circuit including the frame, the position of the adjustable core determining the time required for said means to function.

10. In a device of the character described, a transformer including a primary winding and a secondary winding, a thermally responsive member having its ends permanently connected across the secondary winding to form therewith a closed secondary circuit, said thermally responsive member heating and moving upon the passage of current through the closed secondary circuit, and a member arranged to be moved by the thermal member.

11. In a device of the character described, a relay having a magnetic circuit interrupted by a plurality of air gaps, a pole piece, an armature movable to and from the pole piece, the pole piece and the armature being incorporated in the magnetic circuit and the armature normally being spaced from the pole piece to form one of the gaps, said gap being greater than the other gap whereby the reluctance of the magnetic circuit at the first mentioned gap exceeds that at the other gap so that the armature retains its normal position, and means for moving the armature to a position at which the reluctance at the gap between it and the pole piece is less than that at said other gap whereupon the armature is quickly attracted to its pole piece.

In testimony whereof we have hereunto affixed our signatures.

GUSTAV O. WILMS.
ALBERT J. DAWE.