W. A. RHODES.

ELECTROTHERMAL RELAY.

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1,399,226.

Patented Dec. 6, 1921.

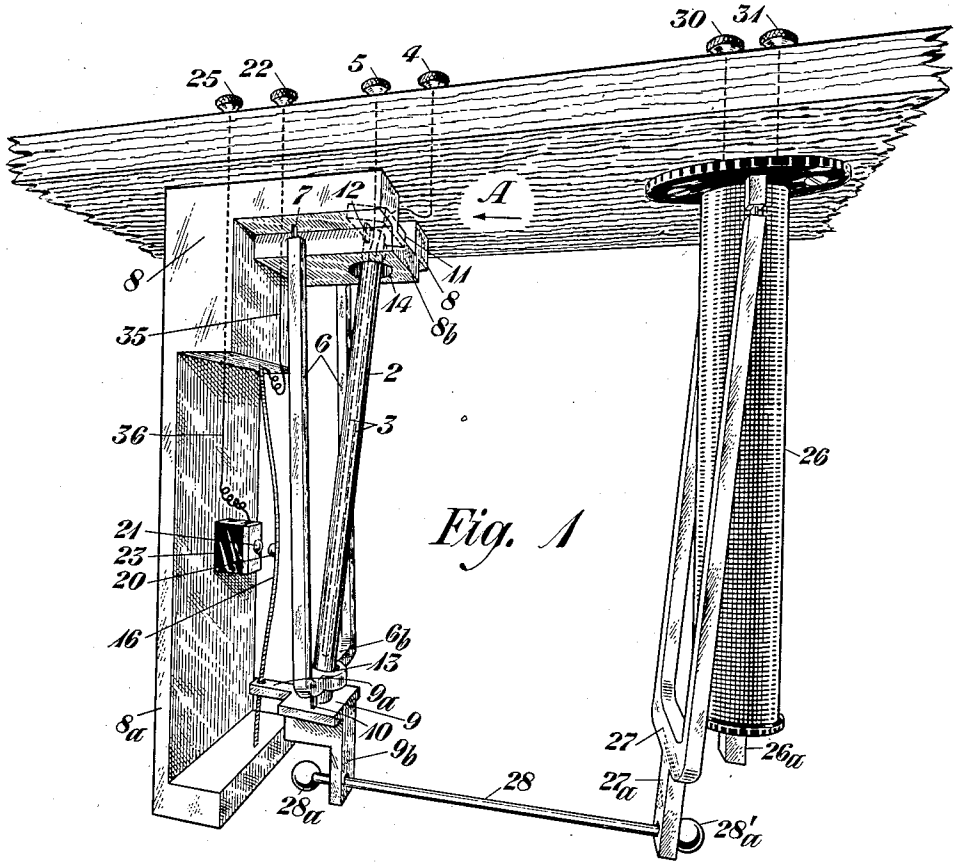


Fig. 1

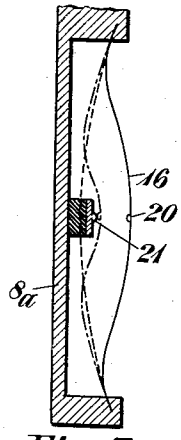


Fig. 3

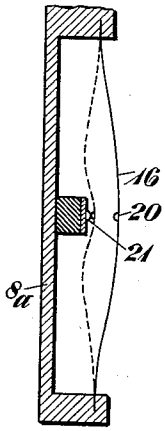


Fig. 4

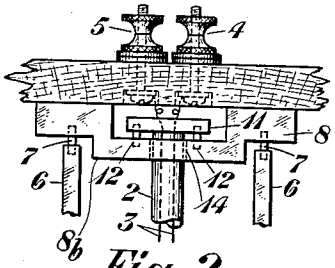


Fig. 2

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ELECTROTHERMAL RELAY.

1,399,226. Specification of Letters Patent. Patented Dec. 6, 1921.

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To all whom it may concern:

Be it known that I, WILLIAM A. RHODES, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Electrothermal Relays, of which the following is a specification.

This invention relates to time-element translating devices and particularly concerns devices of this character in which an expansion member responsive to electric current operates a snap contact.

The expansion member of this invention may consist of a tube in which is inclosed a filament for heating the tube and thus causing a slight elongation thereof. This tube is combined with a device whereby its expansion movement is amplified and caused to operate a contacting device comprising a spring bowed in one direction and arranged to snap into a position of reverse flexure to operate the contact. The spring may be returned to its first position by means of a restoring magnet or it may be so adjusted that the tube causes it to snap back when its temperature is reduced.

These and other features of the invention will be readily understood from the following description thereof, reference being had to the accompanying drawing, in which Figure 1 is a perspective view of one form of relay embodying the invention; Fig. 2 is a view showing an elevation of the left upper part of Fig. 1, looking in the direction of the arrow A; Fig. 3 is a view showing a longitudinal section of the member 8^a, in which view the spring 16 is shown in its various positions, the curvatures of the spring being somewhat exaggerated to permit of a ready understanding of the action thereof; and Fig. 4 is a view similar to Fig. 3, showing the curvatures of spring 16 in a modified form of embodiment of the invention.

In the drawing, reference character 2 designates a metallic tube through which passes a filament 3, connected to terminals 4 and 5, which may be associated with a source of electromotive force for sending heating current through the filament and causing a slight elongation of the tube. For the purpose of amplifying this elongation, the tube is associated with a U shaped member 6 which is hinged by means of thin flexible strips 7 to a support 8. The lower end of tube 2 is secured to a block 9 which is hinged by strips 10 to the cross-bar 6_b of member 6 and the upper end of tube 2 is similarly secured to a block 11 hinged by strips 12 to the cross-beam 8_b of support 8. The lower end of tube 2 extends through a hole 13 in the cross-bar 6_b and is free to move therein. The upper end of tube 2 extends through a hole 14 in the cross-beam 8_b of support 8. The lower end of tube 2 is thus secured to member 6 by strips 10 in the plane of this member, but the upper end of the tube is secured to support 8 a small distance from this plane, and this distance although shown comparatively large in the drawing for the sake of clearness, may be made so small that a slight elongation of tube 2 will cause member 6 to swing to the left and thus move block 9 through a much larger distance. Member 6 is preferably made of the same metal as tube 2 so that changes of temperature of the surrounding medium cause equal expansions of both, and no resultant lateral movements of block 9.

A finger 9_a extending from block 9 is provided with a hole through which passes a thin flat spring 16 which has its ends anchored in an extension 8_a of support 8. A contact point 20 is secured to the spring at a point intermediate its ends, in such manner that it coöperates with a contact point 21 affixed to the member 8_a by a block 23 of insulating material. These contact points are preferably of platinum or like arc-resisting metal and connected by wires 35 and 36 to terminals 22 and 25. When block 9 is moved to the left by the expansion of tube 2 the spring snaps into contacting position, as described more fully hereinafter.

An electromagnet 26 having a pole 26_a and an armature 27 is provided to operate spring 16 from contacting to non-contacting position, the armature for this purpose being provided with an extension 27_a which is connected by means of a link 28 with the extension 9_b of block 9. Link 28 is free to slide in holes through extensions 9_b and 27_a and knobs 28_a and $28'_a$ are provided at the ends of the link to force block 9 to follow the movement of armature 27 when the electromagnet is energized by means of a source of current connected to its terminals 30 and 31. When block 9 is thus moved to the right by the action of electromagnet, it causes the

spring to snap into non-contacting position as described below.

Fig. 3 shows to an exaggerated degree the flexures of the spring in its contacting and non-contacting positions. The spring is biased to the position indicated by the dash line. It is prevented by contact point 21 from assuming this position and therefore bears against this point with sufficient pressure to hold the contact firmly closed, the curvature of the spring being as shown by the dot and dash line. When block 9 is moved to the right by magnet 26 it distorts the curvature of the spring until the same suddenly yields and snaps out of contact with point 21 into the position shown in full lines. The forces acting on the spring due to its bias and resiliency are in equilibrium in this position, and the contact consequently remains open when the magnet is de-energized. A very slight movement of block 9 to the left, due to an expansion of tube 2, is sufficient to cause the spring to lose its equilibrium and snap back into contacting position. The energy expended by the electromagnet in moving the spring against its bias into non-contacting position is thus utilized for returning the spring to contacting position. Very little energy is consequently required to cause a closure of the contact; merely enough, to heat the tube sufficiently to cause its expansion to upset the equilibrium of the spring.

In the use of this translating device, terminals 4 and 5 are associated with a circuit for causing the device to close its contact, terminals 30 and 31, with a circuit for causing it to open the contact and terminals 22 and 25, with a circuit to be controlled by the contact. When current is caused to flow in the circuit associated with the terminals 4 and 5, the filament heats the tube which expands and causes block 9 to upset the equilibrium of the spring, which thereupon snaps into contacting position under the action of its bias as explained above. This operation of the contact does not occur, however, the moment current is applied to the filament, but only after such time has elapsed as to permit the tube to become sufficiently heated to expand the required amount. This time interval depends as well on the construction and adjustment of the various parts of the relay, as on the current supplied to the filament and may, therefore, be predetermined and adjusted to suit convenience. Once the contact spring has been operated to its closed position, current may be taken off the filament without causing the contact to open, the reason for this being that the biasing force of the spring is greater than the pull of block 9 resulting from the contraction of the tube. The thin flexible hinge strips 7, 10 and 12, as a result of this, bend sufficiently to accommodate the slight shrinkage of the tube. The circuit connected to terminals 22 and 25 is thus held closed and it is opened only when the circuit associated with terminals 30 and 31 causes an energization of the electromagnet 26. When this occurs, the pull of armature 27 overcomes the biasing force of the spring and restores the same to its non-contacting position, in which position it remains, as explained hereinbefore, when the current is taken off the electromagnet.

The mechanical connection between the restoring magnet and the spring may be eliminated if the magnet is so placed adjacent to the spring that its flux traverses the same. The spring in this case fulfils the functions of the armature of the magnet and is attracted thereby into non-contacting position when the magnet is energized.

The restoring magnet is dispensed with in a modified form of embodiment of the invention. The spring in this case is so anchored in support 18 that it is bowed as shown in full lines in Fig. 4 when in non-contacting position, and, as shown in dotted lines, when in contacting position. The expansion element operates the spring from each position to the other and therefore requires more energy to operate, and the contact opens when the tube contracts.

The relay of this invention is applicable to many fields of the electrical arts and may be designed to operate on large currents although it is particularly adapted to respond to small currents. Spring 16, in such case, may be as light as the hair spring of a watch and the distance between the planes of the pivotal strips 7 and 12 may be made as small as several thousandths of an inch. The spring is preferably bowed and shaped as herein described, but it may be given any other suitable size, shape and stress as occasion demands. Various other modifications and changes may be made in the embodiments of this invention, within the scope of the following claims without departing from the spirit and scope of this invention.

What is claimed is:

1. A time element translating device comprising a resilient member fixed at its extremities and flexed in one direction, and a heat responsive device for causing flexure of said member in the reverse direction, said device comprising a hollow member and a heating device therein.

2. A translating device comprising a resilient member flexed in one direction, a heat responsive device for causing flexure of said member in a reverse direction, and an electromagnetic device for restoring said resilient member to flexure in the first mentioned direction.

3. In combination, a pair of heat responsive members, each pivotally supported at one end and associated with the other at the

other end, a conductor associated with one of said members for heating the same and causing lateral movement of said members, a contact device operated by said members, and means for causing said device to snap into and out of contacting position.

4. In combination, a contact point, a resilient member for coöperating therewith and arranged to snap into and out of contacting position, and a time element device for operating said resilient member, said device comprising a pair of members having substantially equal coefficients of expansion, each member being pivotally supported adjacent one end and associated with the other at the other end, and means for heating one of the said members.

5. In combination, a contact point, a resilient member coöperating therewith and having contacting and non-contacting positions, means responsive to current for operating said member from one position to the other, and means for rendering said current responsive means effective to operate said member in only one direction.

6. In combination, a contact member, a resilient member coöperating therewith and having contacting and non-contacting positions, means biasing said resilient member to one of its positions, an electromagnetic device to operate it to its other position, and a heat responsive device to cause said member to return to its biased position.

7. In combination, a contact member having contacting and non-contacting positions, a support for said member for bowing the same and causing it to assume one of its positions, an electromagnetic device for operating said member into its other position, and a heat responsive device for causing it to return to its normal position, said contact member being of resilient material and arranged to snap into and out of each of its positions.

8. A translating device comprising a contacting device having open and closed positions, means responsive to current of predetermined duration to operate said contacting device into one of said positions and separate means comprising an electromagnet adapted to be energized for restoring said contacting device to its other position.

9. A translating device comprising a contacting device arranged to remain in contacting or non-contacting position, a device responsive to a predetermined variation in temperature to operate said contact into one of its positions, means responsive to current to cause said variation in temperature, and means also responsive to current to operate said contacting device into its other position.

10. A translating device comprising a contacting device arranged to have in one of its positions greater potential energy than in its other position, a circuit, a device associated with said circuit and responsive to current of pre-determined duration for causing said contacting device to move from its position of higher potential energy to its position of lower potential energy, and a device responsive to current for restoring said contacting device to its position of higher potential energy.

11. In a time-element translating device, a snap-action contact, a heat responsive operating member therefor, and means operative when said contact is in operated position to render the same unresponsive to said operating member.

In testimony whereof, I have signed my name to this specification this 12th day of May, 1919.

WILLIAM A. RHODES.