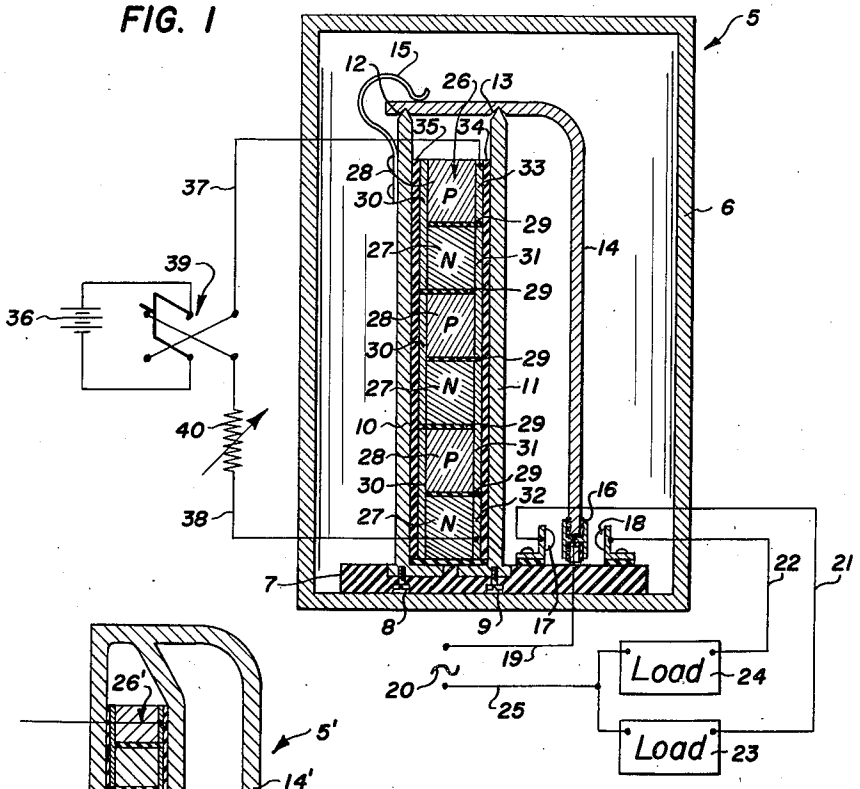
June 5, 1962 R. W. FRITTS 3,038,049

RELAY

Filed Aug. 15, 1957

FIG. 1



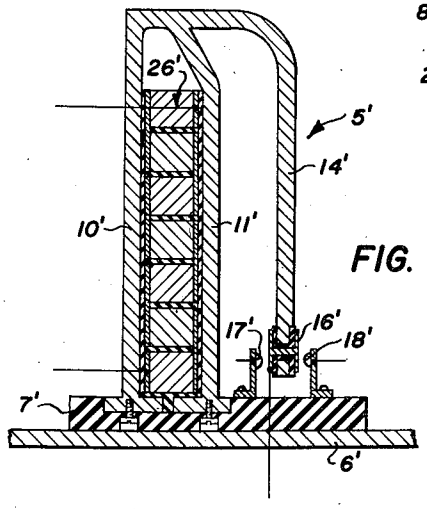




FIG. 2

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# 3,038,049
# RELAY

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This invention relates to improvements in relays, and more particularly to relays of the polarized and time delay type.

A general object of the present invention is to provide an improved relay structure utilizing the operating principles of thermal motors and employing in a novel manner thermoelectric heat pump means.

Another object of the invention is to provide improved relay of the aforementioned character which can be operated either as a single-throw or as a double-throw type of switching means by virtue of the reversibility of the operation of the heat pump means in accordance with the polarity of the energizing current therefor.

Still another object of the invention is to provide an improved relay of the class described having an inherent time delay in the operation thereof, there being means provided for selectively adjusting the extent of said time delay.

Another object of the invention is to provide an improved relay as aforedescribed which is operable on low values of electrical power by virtue of its ability to integrate power supplied thereto over an extended period of time.

Another object of the invention is to provide an improved relay of the aforementioned character, the operation of which is substantially unaffected by changes in the ambient temperature.

Another object of the invention is to provide an improved relay of the class described which is substantially non-responsive to the impression of alternating current on the heat pump means thereof, but is responsive to the impression of direct current on said heat pump means, so that said relay is well adapted for use, for example, in monitoring alternating current circuits for response to the presence of any stray direct current components therein.

A more specific object of the invention is to provide an improved relay of the aforementioned character having temperature responsive means provided with thin boundary layers of relatively high electrical resistance in slidable surface contact with portions of the heat pump means, said layers preventing substantial electrical current flow between the heat pump means and said portions, while permitting substantial heat transfer therebetween.

Another specific object of the invention is to provide an improved relay of the aforementioned character wherein each of the temperature responsive means has a portion movable in a first direction in response to an increase in temperature and in the opposite direction in response to a drop in the temperature, energization of the heat pump means affording heating of one of said temperature responsive means and cooling of the other temperature responsive means to afford differential movement of the movable portions of said temperature responsive means, there being a movable contact member having connection with said movable portions and movable in one direction in response to differential movement of said movable members in one sense, and in the opposite direction in response to differential movement of said movable portions in the opposite sense.

Another object of the invention is to provide an improved relay of the class described which is characterized by highly efficient operation, simplicity of construction and economy of manufacture.



Other and further objects of the invention will become apparent as the description proceeds. The invention is capable of receiving a variety of mechanical expressions, two of which are shown on the accompanying drawings, but it is expressly understood that the drawings are for the purposes of disclosure only, and are not to be construed as a definition of the limits or scope of the invention, reference being had to the appended claims for that purpose. In the drawing:

FIGURE 1 is a vertical sectional view of one form of relay constructed in accordance with the principles of the present invention, the electrical circuitry therefor being shown semi-diagrammatically; and

FIGURE 2 is a fragmentary vertical sectional view similar to FIGURE 1 and showing another form of relay constructed in accordance with the present invention.

Referring more particularly to FIGURE 1 of the drawing, the form of the improved relay illustrated therein is indicated by the reference numeral 5 and preferably comprises an hermetically sealed enclosure 6 having therewithin a base member 7 which is preferably made of material having low thermal and electrical conductivity. Mounted on the base 7, as by screws 8 and 9, are a pair of condition, i.e., temperature, responsive means 10 and 11 which, in the illustrated embodiment, take the form of upstanding metallic legs which are preferably parallel and are substantially identical. The members 10 and 11 are preferably of metal having a high coefficient of thermal expansion, for example aluminum. The upper ends of the members 10 and 11 are bevelled to afford knife edges which are received in complementary grooves 12 and 13 formed in an L-shaped contact arm 14. A resilient spring member 15 has one end anchored to the member 10, and its other end engages the contact arm 14 to hold the latter end in engagement with the members 10 and 11 as shown.

The contact arm 14 carries an insulated contact 16 and has an intermediate position as shown, wherein the contact 16 is spaced between a pair of fixed contacts 17 and 18 cooperable therewith. The movable contact 16 may be connected to a conductor 19 which is also in circuit with a source, for example an alternating current source 20. The fixed contacts 17 and 18 may be respectively connected to conductors 21 and 22 of circuits to be controlled, which circuits may include loads 23 and 24 which are also connected in circuit with the source 20 by means of a conductor 25. It will be observed that when the movable contact 16 is in the position shown, neither of the load circuits 23 and 24 is energized, whereas engagement of the contact 16 with the contact 17 effects energization of the load circuit 23 by current from the source 20, and engagement of the movable contact 16 with the fixed contact 18 effects energization of the load circuit 24 by current from the source 20.

Means is provided for effecting differential movement of the upper ends of the members 10 and 11 to thereby effect controlling movement of the contact arm 14 toward one or the other of the contacts 17 and 18. This means comprises thermoelectric heat pump means 26 interposed between the members 10 and 11 as shown, and it includes a plurality of N-type thermoelements 27 having a plurality of P-type thermoelements 28 alternated therewith, the adjacent thermoelements being separated by insulators 29 of low thermal and electrical conductivity. The thermoelements 27 and 28 are connected in series circuit by means of metallic thermojunction members 30 of good thermal and electrical conductivity at the side thereof adjacent the member 10 and similar thermojunction members 31 at the side thereof adjacent the number 11. Terminal connections for the heat pump means 26 are provided by thermojunction members 32 and 33 which, in the illustrated embodiment, are at the side thereof adjacent the member 11.

The heat pump means 26, and more particularly thermojunction members 30 to 33 thereof, are electrically insulated from the members 10 and 11, but are in good heat transfer relation therewith. The numerals 34 and 35 indicate with exaggerated thickness relatively thin layers of material having relatively high electrical resistivity. The layers 34 and 35 may take the form of boundary layers formed by anodizing the aluminum members 10 and 11, such layers being of aluminum oxide which inherently has relatively high electrical resistivity. The thin character of said layers permits substantial heat transfer therethrough.

The heat pump means 26 may be connected in circuit with a source of direct current 36, illustrated schematically as a battery, by connection of the thermojunction member 33 with the conductor 37 and thermojunction member 32 with the conductor 38. The conductors 37 and 38 may have a doublethrow reversing switch 39 interposed therein as shown, and a variable resistance 40 may be interposed in the conductor 38 for a purpose to be hereinafter described.

The function of the heat pump means 26 is to pump heat from one of the members 10 and 11 to the other, and for this purpose it is desirable that the thermoelements 27 and 28 be of any suitable material which exhibits a high Peltier coefficient, low thermal conductivity and low electrical resistivity. More specifically, the thermoelements 27 and 28 may be of the materials described in the copending application of Robert W. Fritts and Sebastian Karrer, Serial Number 512,436, filed June 1, 1956, now Patent No. 2,896,005 and assigned to the assignee of the present application. Such materials are semi-metallic alloys or compositions which may be characterized as binary metallic compounds of slightly imperfect composition, i.e., containing beneficial impurities constituting departures from perfect stoichiometry by reason of an excess of one of the metals over the other and/or containing added beneficial impurity substances denominated hereinafter "promoters." Such semi-metallic compositions have semiconductor-like conductivity (both electrical and thermal as aforementioned). Semi-metallic alloys or compositions also include mixtures of such binary metallic compounds, which may be denominated ternary metallic alloys or compositions. Certain of these alloys or compositions exhibit negative and certain exhibit positive electrical characteristics.

It is preferred that one of the thermoelements, for example the thermoelements 28, exhibit positive electrical characteristics and the other thermoelements, for example thermoelements 27, exhibit negative electrical characteristics. The reason for this is that current flow through an element which exhibits positive electrical characteristics causes heat to be pumped in the direction of current flow therethrough, whereas current flow through a thermoelement which exhibits negative electrical characteristics causes heat to be pumped in the direction opposite to the direction of current flow therethrough. Thus, if current flows through the heat pump means 26 from the terminal 32 to the terminal 33, heat will be pumped from the member 10 to the member 11 in each of the thermoelements 27 and 28, thereby effecting elongation of the member 11 and simultaneous contraction of the member 10 by virtue of heating of the member 11 and cooling of the member 10. This causes retractile movement of the upper end portion of the member 10 and projectile movement of the upper end portion of the member 11, with the result that the contact arm 14 is effectively pivoted in a counter-clockwise direction to cause the movable contact 16 to engage the fixed contact 18. As aforementioned, this effects energization of the load 24 by current flowing through the engaged contacts from the source 20. Conversely, if the polarity of the energizing current is reversed, for example by manipulation of the reversing switch 39, current flow through the heat pump means 26 from the terminal 33 to the terminal 32 causes heat to be pumped from the member 11 to the member 10 in each of the thermoelements 27 and 28, producing simultaneous elongation of the member 10 and contraction of the member 11 with resultant projectile movement of the upper end portion of the member 10 and retractile movement of the upper end portion of the member 11 and clockwise swinging movement of the contact arm 14 bringing the contact member 16 into engagement with the contact member 17. As aforementioned, this results in energization of the load 23 by current from the source 20. If the switch 39 is left open, the temperatures of the members 10 and 11 will gradually equalize and return the arm 14 to its intermediate position shown. As the upper end portions of the members move longitudinally there is sliding contact between the boundary layers 34 and 35 and the engaged thermojunction members.

There is an inherent time delay between energization of the heat pump means 26 and movement of the contact arm 14. This is because of the thermal mass of the thermoelements 27 and 28, thermojunction members 30 to 33 and members 10 and 11. The speed of response of the relay 5 is dependent upon the magnitude of current supplied to the heat pump means 26, and the amount of the aforementioned time delay can be varied by simply adjusting the amount of resistance interposed in the conductor 38 by the variable resistance 40 to thereby vary the amount of current flowing through the heat pump means 26.

The negative thermoelements 27 may, for example, be formed of an alloy comprising lead and at least one member of the group of tellurium, selenium and sulphur. For example, a negative thermoelement of lead-selenium-tellurium composition could include a tellurium-selenium constituent in which the selenium is but a trace. In this case, such constituent should constitute from 35% to 38.05% by weight of the composition, the balance (61.95% to 65% by weight) being lead. At the other extreme where the tellurium-selenium constituent consists almost entirely of selenium with but a trace of tellurium, such constitutent should comprise from 25% to 27.55% by weight of the final composition, the remainder (from 72.45% to 75% by weight) being lead. Between these two extremes, the selenium-tellurium constituent varies linearly with the ratio of selenium to tellurium (expressed in atomic percent) in the selenium-tellurium constitutent.

The negative thermoelements 27 may also be formed of an alloy of lead, selenium and sulphur. For example, a thermoelement of lead-selenium-sulphur composition could consist of a selenium sulphur constituent in which the sulphur is but a trace. In this case, such constituent should constitute from 25% to 27.55% by weight of the composition, the balance (75% to 72.45% by weight) being lead. At the other extreme, where the selenium-sulphur constituent consists almost entirely of sulphur with but a trace of selenium, such constituent should comprise from 12.8% to 13.37% by weight of the final composition, the remainder (from 87.2% to 86.63% by weight) being lead. Between these two extremes, the selenium-sulphur constituent varies linearly with the ratio of selenium to sulphur (expressed in atomic percent) in the selenium-sulphur constituent. With regard to the aforementioned compositions, it will be observed that in each case there is an excess of lead over and above the amount thereof necessary for satisfying the stoichiometric proportions of the compound formed in the second constituent or constituents, i.e., the tellurium, selenium or sulphur. For example, a composition consisting substanially of lead and selenium can contain up to 10.4% lead by weight of the total composition over and above the 72.41% lead stoichiometrically necessary for combination with selenium.

The electrical characteristics of the aforementioned semi-metallic alloys, desirable, for example, in thermoelements for heat pump application, can be markedly and advantageously altered in a reproducible manner by the addition thereto of controlled amounts of matter other than the constituents of the base composition. Such compositions may also be denominated "beneficial impurities"

as distinguished from undesirable impurities. For convenience, these additions are hereinafter designated "promoters," since they tend to enhance the electrical characteristics desired for the particular application of the base compositions.

As has previously been observed, all of the aforementioned base compositions exhibit negative Peltier E.M.F. and negative conductivity. By the addition of certain "promoters," such negative properties may be enhanced, while the polarity of the electrical properties of the base compositions may be reversed by the addition of certain other "promoters" to provide a semi-metallic composition having positive electrical characteristics, i.e., positive conductivity and Peltier E.M.F. Such materials are desirable for use as the positive thermoelements **28**.

The aforementioned copending application of Robert W. Fritts and Sebastian Karrer gives a complete description of the beneficial impurities, including both departures from perfect stoichiometry and promoters, which have been found to be effective for improvement of the electrical properties of semi-metallic thermoelements for heat pump application when added to the aforementioned base compositions in minor amounts. For example, up to a maximum of 6.9% by weight of beneficial impurity including 3.9% excess lead and 3.0% promoter for promoted compounds and a maximum of 10.4% by weight of beneficial impurity for unpromoted compositions.

The proportions and ranges of the various constituents aforementioned and particularly the minimum limits of lead constituent in the compositions, must be regarded as critical if the composition is to have the electrical properties desired in thermoelectric heat pump elements. If the lead content is significantly less than the minimum amount indicated for any particular selenium-tellurium or selenium-sulphur proportion, the desirable values of Peltier E.M.F. and resistivity will not be afforded, and the significant electrical and mechanical properties will not be reproducible. On the other hand, if the lead content for any composition appreciably exceeds the aforementioned maximum limit, the resulting composition is too metallic in nature to afford satisfactory electrical characteristics for the purposes of the present invention.

The positive thermoelements **28** may also be formed of an alloy of lead and tellurium in which there is an excess of tellurium over and above the amount thereof necessary for satisfying the stoichiometric proportions of the compound lead-telluride. Such alloy or composition should consist essentially of lead and tellurium in which the lead is present in the range of 58.0% to 61.8% by weight and the balance in the range of 42.0% to 38.2% by weight tellurium. It will be observed that in this case there is an excess of tellurium over and above the amount thereof necessary for satisfying the stoichiometric proportions.

As has been previously observed, the tellurium rich base lead-tellurium compositions exhibit positive Peltier E.M.F. and positive conductivity. The electrical characteristics of this compound, desirable, for example in thermoelements for heat pump applications, can be markedly and advantageously altered in a reproducible manner by addition thereto of controlled amounts of matter other than the constituents of such base composition. Such matter may also be denominated "beneficial impurities" as distinguished from undesirable impurities, and for convenience, such additions are also designated "promoters," since they tend to enhance the electrical characteristics desired for the particular application of the base composition.

The aforementioned copending application of Robert W. Fritts and Sebastian Karrer gives a complete description of the beneficial impurities, including both departures from perfect stoichiometry and promoters, which have been found to be effective for improvement of electrical properties of semi-metallic thermoelements for heat pump applications when added to the aforementioned tellurium rich base lead-tellurium compositions. For example, up to a maximum of 5.5% by weight of beneficial impurity including 4.9% excess tellurium and 0.60% promoter for promoted compounds and a maximum of 6.7% by weight of beneficial impurity for unpromoted compositions.

The proportions and ranges of the constituents of the tellurium rich compositions aforementioned and particularly the minimum limits of tellurium in the compositions, must be regarded as critical if the composition is to have the electrical properties desired in thermoelectric heat pump elements. If the tellurium content is significantly less than the minimum amount indicated, the desired values of Peltier E.M.F. and resistivity will not be afforded and the significant electrical and mechanical properties will not be reproducible. On the other hand, if the tellurium content appreciably exceeds the aforementioned maximum limits, the resulting compositions will not afford satisfactory electrical characteristics for the purposes of the present invention.

Not only are the proportions and ranges of the compositions aforedescribed considered to be critical, but so also is the purity. More specifically, the limit of tolerable metallic impurity in the final composition has been found to be on the order of 0.01%, and the composition must be substantially oxygen free, if the mechanical and electrical properties desired are to be maintained and are to be reproducible. In the case of promoted compositions, however, the limit of tolerable impurity is 0.001%.

It will be observed that in the operation of the improved relay **5**, controlling movement of the contact arm **14** is effected by differential movement of the upper end portions of the members **10** and **11**. This being true, it is apparent that the improved relay is substantially unaffected by changes in ambient temperature, since such changes affect the members **10** and **11** similarly and therefore produce no differential movement of the upper end portions of members **10** and **11**.

The concept of the present invention includes the use of the relay **5** in applications other than that shown. The heat pump means **26** is substantially unaffected by the flow of an alternating current therethrough, but is highly responsive to the flow therethrough of a direct current. This fact makes the relay **5** highly suited for use in monitoring of alternating current circuits, connections thereto being by the conductors **37** and **38** in place of to the source **36**. In such an application, the contact arm **14** of the relay **5** would normally be in its intermediate position shown as long as no direct current component is present in the alternating current system being monitored. Upon occurrence in said circuit of a stray direct current component, however, the heat pump means **26** would immediately respond by pumping heat from one of the members **10** and **11** to the other to thereby effect controlling movement of the contact arm **14** and engagement of the contact **16** with one of the contacts **17** and **18**.

Another variant, within the concept of the present invention, is to have the reversing switch **39** take the form of a thermostat, to afford control of the energization of load circuits **23** and **24** in accordance with the ambient temperature at such thermostat.

The improved relay **5** is highly efficient, not only by reason of the efficiency of the heat pump means **26** in pumping large amounts of heat per unit of electrical energy expended, but also because of the novel structural arrangement whereby the effectiveness of the heat pump means **26** is substantially doubled by taking advantage of both the heat absorbing function and the heat emitting function thereof to extract heat from one of the members **10** and **11** and add said heat to the other member. The reversibility of the operation of the heat pump means **26** in accordance with the polarity of the energizing current makes possible double-throw or polarized operation of the relay **5**.

FIGURE 2 illustrates fragmentarily another form of

relay 5' constructed in accordance with the present invention. In FIGURE 2 the parts indicated by primed reference characters correspond to parts in FIGURE 1 indicated by the same reference characters unprimed. The relay 5' is in all respects substantially identical with the relay 5, except that in the relay 5' the members 10' and 11', and the contact arm 14' are integral, the upper end of the arm 11' above the heat pump means 26' being angled toward the member 10' joined to the contact arm 14' adjacent the upper end of the member 10'. This type of construction omits the knife edge-V groove connections between the members 10, 11 and 14 of the relay 5 shown in FIGURE 1. The operation, however, is substantially identical, the relative displacement of the arm 14' being provided by the elastic properties of the metal used to form the unitary member comprising members 10', 11' and 14'.

Various other modifications, adaptations and alterations may be applied to the specific forms of the relay shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention, and all of such modifications, adaptations and alterations are contemplated as may come within the scope of the appended claims.

What is claimed as the invention is:

1. A polarized control device comprising, Peltier type heat pump means operable when energized by current of one polarity to create a first temperature differential between portions thereof and when energized by current of a second polarity to create a second temperature differential between said portions, current source means connected in circuit with said heat pump means for energization thereof, temperature responsive first switch means operatively associated with said heat pump means and including a double-throw contact member having an intermediate position and movable therefrom in one direction to a first position in response to creation of said first temperature differential and in another direction to a second position in response to creation of said second differential in said heat pump means, and second switch means in circuit with said source and said heat pump and operable to selectively reverse the polarity of current supplied to said heat pump.

2. A variable time delay switch comprising, Peltier type heat pump means operable when energized by current of one polarity to create a first temperature differential between portions thereof and when energized by current of a second polarity to create a second temperature differential between said portions, current source means connected in circuit with said heat pump means for energization thereof, temperature responsive first switch means operatively associated with said heat pump means and having a contact member movable to a first position in response to creation of said first temperature differential and to a second position in response to creation of said second differential in said heat pump means, second switch means in circuit with said source and said heat pump and operable to selectively reverse the polarity of the current supplied to said heat pump, and means operatively associated with said heat pump means for adjustably varying the rate of response of said first switch means to energization of said heat pump means by current from said source means.

3. A variable time delay polarized switch comprising, Peltier type heat pump means operable when energized by current of one polarity to create a first temperature differential between portions thereof and when energized by current of a second polarity to create a second temperature differential between said portions, current source means connected in circuit with said heat pump means for energization thereof, temperature responsive first switch means operatively associated with said heat pump means and including a double-throw contact member having an intermediate position and movable therefrom in one direction to a first position in response to creation of said first temperature differential and in another direction to a second position in response to creation of said second differential in said heat pump means, second switch means in circuit with said source and said heat pump and operable to selectively reverse the polarity of current supplied to said heat pump, and means operatively associated with said heat pump means for adjustably varying the rate of response of said first switch means to energization of said heat pump means by current from said source means.

4. An actuator comprising first and second metallic temperature responsive means each having a portion movable in one direction in response to a temperature change in a given sense and in the opposite direction in response to a temperature change in the opposite sense, said movable portions each having integral relatively thin high electrical resistance boundary layers, and electroresponsive Peltier heat pump means having thermojunction portions directly engaging the boundary layers of said said first and second temperature responsive means in heat transfer relation for varying the temperature to which said means are responsive, means to be actuated, and actuating connection means between said means to be actuated and said movable portions to effect actuation of said means to be actuated by simultaneous movement of said movable portions, the relatively high resistance of said boundary layers effectively preventing substantial current flow therethrough, whereas the relatively thin character of said layers permits substantial heat flow therethrough.

5. In an operator, first and second temperature responsive actuating means respectively comprising first and second elongated members of thermally expansible and contractible material disposed in spaced generally parallel relation, a thermoelectric heat pump comprising thermoelement means having oppositely facing opposite end surfaces, and thermojunction members joined to said end surfaces to form heat absorbing and heat emitting thermojunctions respectively at the opposite ends of said thermoelement means, said thermoelement means affording substantially straight line current flow path means between the heat absorbing and heat emitting thermojunction members joined thereto, said heat pump being interposed physically between elongated side wall portions of said first and second elongated members with said heat absorbing thermojunctions in juxtaposition and heat transfer relation with said side wall portion of said first member and said heat emitting thermojunctions in juxtaposition and heat transfer relation with said side wall portion of said second member, said heat pump tending when energized to transfer heat energy from said first member to said second member to effect simultaneous thermoelectric cooling of said first and thermoelectric heating of said second member and to thereby effect simultaneous shortening of said first and lengthening of said second member, and an actuating member operatively connected to said elongated members, said connection effecting movement of said actuating member upon said simultaneous shortening of said first and lengthening of said second elongated member.

6. An operator according to claim 5 wherein said first and second elongated members are fixedly anchored at one end to a support and have movable opposite end portions to which said actuating member is operatively connected.

7. In a relay having a contact member movable between first and second operating positions, an operator for said contact member comprising first and second temperature responsive actuating means each having a portion tending to move in response to changes in temperature, a thermoelectric heat pump comprising thermoelement means having oppositely facing opposite end surfaces, and thermojunction members joined to said end surfaces to form heat absorbing and heat emitting thermojunctions respectively at the opposite ends of said

thermoelement means, said thermoelement means affording substantially straight line current flow path means between the heat absorbing and heat emitting thermojunction member joined thereto, said heat pump being interposed physically between said first and second actuating means with said heat absorbing thermojunctions in juxtaposition and heat transfer relation with said first actuating means and said heat emitting thermojunctions in juxtaposition and heat transfer relation with said second actuating means, said heat pump tending when energized by current of one polarity to transfer heat energy from said first actuating means to said second actuating means to effect simultaneous thermoelectric cooling of said first and thermoelectric heating of said second actuating means and to thereby effect simultaneous movement of said movable portions of both of said actuating means in one sense, said heat pump also tending when energized by current of the opposite polarity to transfer heat energy in the opposite direction to effect simultaneous movement of said movable portions in an opposite sense, and means affording an actuating connection between said movable portions and said contact member to effect movement of said contact member toward said first operating position with movement of said movable portions in said one sense and movement of said contact member toward said second operating position with movement of said movable portions in said opposite sense.

8. A relay according to claim 7 wherein said first and second temperature responsive actuating means each comprises an elongated member of thermally expansible and contractible material, said members being fixedly connected to each other at one end and each having a movable opposite end portion cooperable with said actuating connection.

9. In a relay having a contact member movable between first and second operating positions, an operator for said contact member comprising first and second temperature responsive actuating means respectively comprising first and second elongated members of thermally expansible and contractible material, said elongated members being disposed in spaced generally parallel relation, means fixedly connecting said elongated members to each other, a thermoelectric heat pump comprising a plurality of generally parallel thermoelements having oppositely facing opposite end surfaces, and thermojunction members joined to said end surfaces to form heat absorbing and heat emitting thermojunctions respectively at corresponding opposite ends of said thermoelements, said thermoelements each affording a substantially straight line current flow path therethrough between the heat absorbing and heat emitting thermojunction members joined thereto, said heat pump being interposed physically between elongated side wall portions of said first and second elongated members with said heat absorbing thermojunctions in juxtaposition and heat transfer relation with said side wall portion of said first elongated member and said heat emitting thermojunctions in juxtaposition and heat transfer relation with said side wall portion of said second elongated member, said heat pump tending when energized by current of one polarity to transfer heat energy from said first elongated member to said second elongated member to effect simultaneous thermoelectric cooling of said first elongated member to below the ambient temperature and thermoelectric heating of said second elongated member to above the ambient temperature and to thereby effect simultaneous shortening of said first and lengthening of said second elongated member, said heat pump also tending when energized by current of the opposite polarity to transfer heat energy in the opposite direction to effect simultaneous lengthening of said first and shortening of said second elongated member and means affording an actuating connection between said elongated members and said contact member to effect movement of the latter toward one of said operating positions in response to simultaneous shortening of said first and lengthening of said second elongated member and toward said second operating position in response to simultaneous lengthening of said first and shortening of said second elongated member.



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