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[54] **REED SWITCH MECHANISM MAKING USE OF HEAT-SENSITIVE FERRITE**

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[52] **U.S. Cl.** **335/208**

[51] **Int. Cl.** **H01h 37/68**

[58] **Field of Search** 335/146, 208, 207, 153

[56] **References Cited**

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Attorney, Agent, or Firm—Fidelman, Wolffe, Leitner & Hiney

[57] **ABSTRACT**

A temperature responsive switching device having at least one heat sensitive ferrite to determine the magnetic flux through a reed switch's contilevered contacts and to produce switching when the temperature passes through said ferrite's curie point.

8 Claims, 9 Drawing Figures

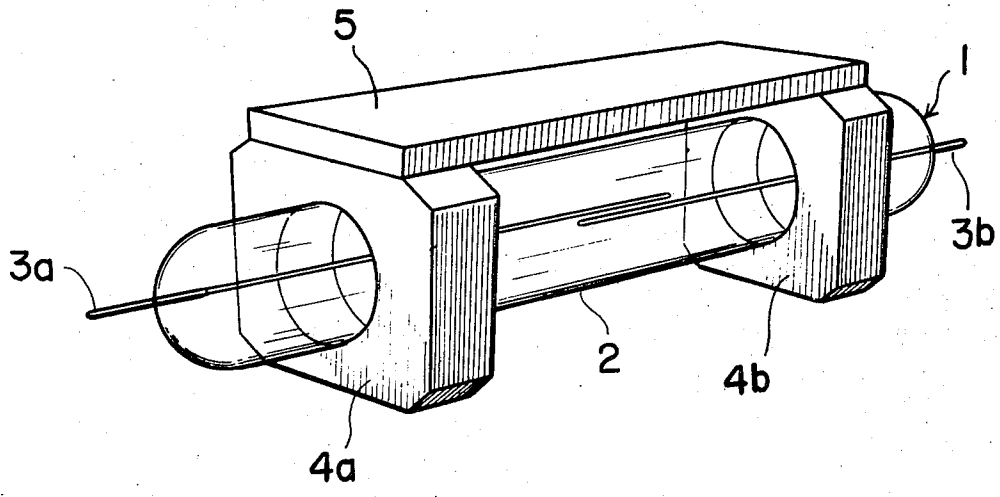


Fig. 1

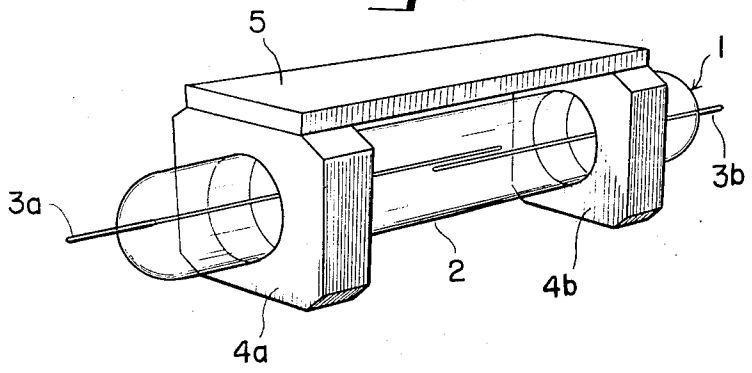


Fig. 2

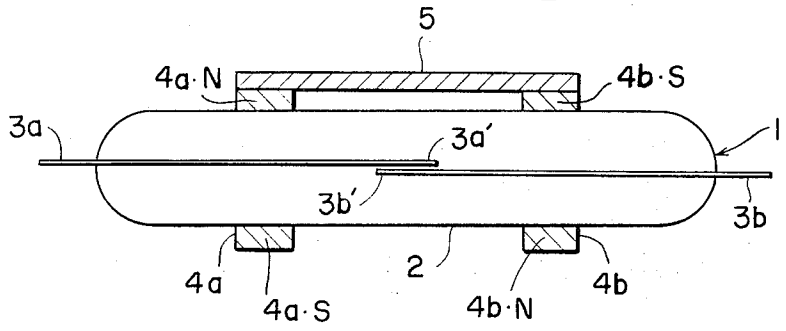


Fig. 3

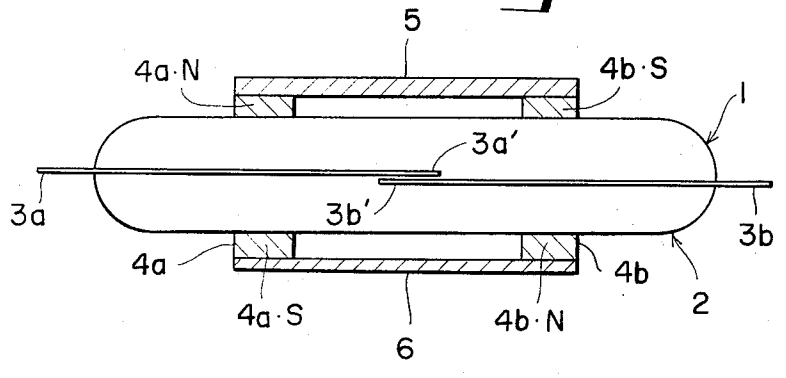


Fig. 4

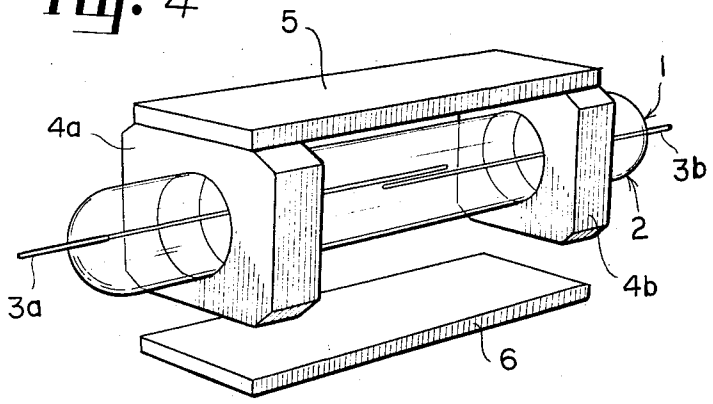


Fig. 5

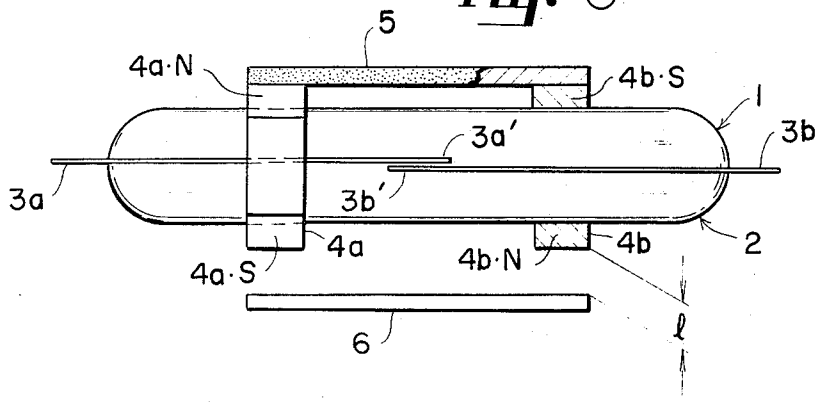


Fig. 6

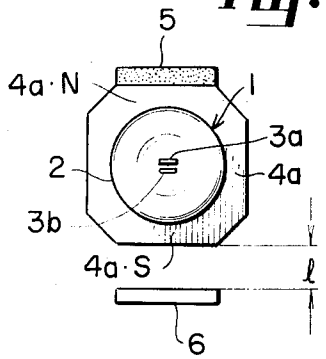


Fig. 7

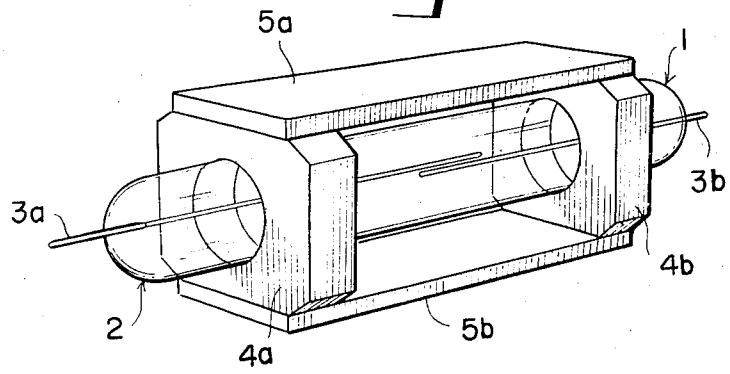


Fig. 8

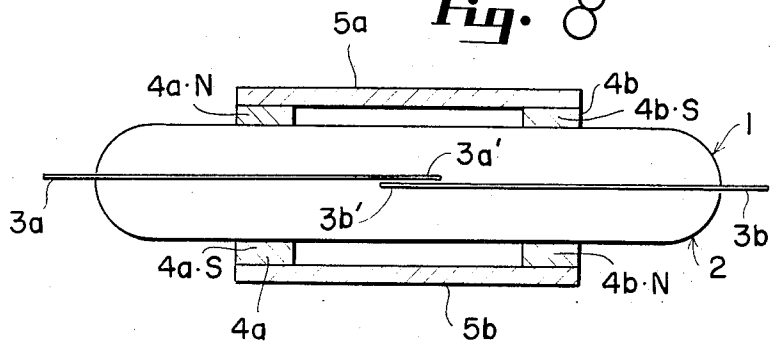
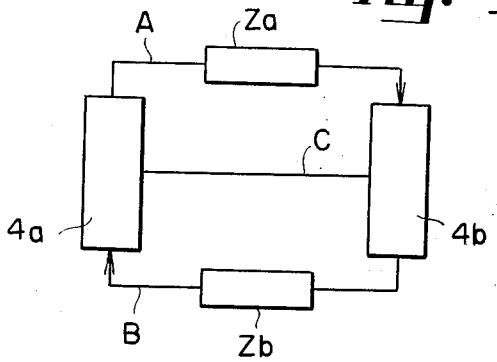


Fig. 9



REED SWITCH MECHANISM MAKING USE OF HEAT-SENSITIVE FERRITE

BACKGROUND OF THE INVENTION

This invention relates in general to a switch mechanism which is responsive to variation of atmospheric temperature, and more particularly to a non bimetallic reed switch mechanism which is responsive variation of atmospheric temperature. These switching devices are used for temperature control of, electric furnace, drying furnace, heater, water heater, air conditioner, electric jar and the like. Also, they are extremely widely used for temperature monitoring, for example, prevention of freezer from freezing, distribution board, vehicle, transformer, motor, prevention of power transistor from over heat, fire alarm, fire-proof shutter, temperature monitoring for heating appliances such as stoves, toaster and bath-buzzer, and temperature monitoring for internal combustion engine, cooling water, hydraulic machineries etc.

Previous electrical circuit elements which are responsive to variation of temperature are bimetal, thermistor and thermocouple. However, the thermistor and the thermocouple, other than bimetal, continuously varies its resistance or electromotive force in accordance with variation of temperature and will not effect by themselves switching operation according to a selected value of temperature. On the other hand, a bimetal switch has a mechanical construction such that a space between both contacts of a switch mechanism is varied, in accordance with variation of temperature, making use of the difference of coefficient of thermal expansion of solid body, and the contacts are closed when the temperature reaches the predetermined temperature. That is, the bimetal converts variation of temperature into variation of mechanical position, by which switching operation is effected. When the atmospheric temperature of bimetal comes in the vicinity of said predetermined temperature, the space between both contacts becomes an extremely small value, and arching will occur before the contacts finally close. Thereby, the form of electric power subjected to switch-control by means of a bimetal is to be extremely limited to low power to prevent arching.

SUMMARY OF THE INVENTION

In the present invention, a combination comprising a reed switch body, which performs switching operation by means of an action of magnetic force, two permanent magnets and, a heat-sensitive ferrite having a curie point within normal or room temperature interrelated so as to form a magnetic bridge circuit with both contact pieces of said reed switch body forming one of the magnetic paths. The magnetic bridge circuit is changed from equilibrium to non-equilibrium condition or reversely thereof by a rapid change of permeability at a temperature determined by the curie point of heat-sensitive ferrite and thus the change of equibrium condition of the magnetic bridge circuit causes switching operation of reed switch body. When the atmospheric temperature in the switch mechanism reaches the determined temperature, there is a rapid change in permeability of heat-sensitive ferrite which changes the bridge condition and thereby causes the reed switch body to actuate switching operation.

Therefore, both contact pieces of reed switch body which performs a switching operation are not particularly displaced even when the atmospheric temperature of switch mechanism is varied within the range of temperature not containing a predetermined temperature, so that there is no fear at all of occurrence of discharging phenomenon or the like between the overlapping ends of the cantilevered contact pieces at an atmospheric temperature other than the predetermined temperature moreover, the permeability, of the heat-sensitive ferrite does not vary proportionally to variation of the atmospheric temperature, but instantaneously changes when the atmospheric temperature reaches the curie point of heat-sensitive ferrite, which is the aforementioned predetermined point. Thus the space between the overlapping ends of both contact pieces is either a constant space when there is no flux or non-existent when the contacts close in the presence of flux. This means that a switching operation by the present switch mechanism may be extremely accurately and securely effected at a predetermined temperature.

It is a prime object of this invention to provide a switch mechanism which accurately and securely performs a switching operation when the atmospheric temperature reached a predetermined temperature.

It is another object of the invention to provide a switching mechanism whereby the predetermined temperature for a switching operation may be varied by means other than changing a curie point of heat-sensitive ferrite.

It is still another object of the invention to provide a switch mechanism, in which the mechanism is in one switching condition for a reselected range of temperatures and in the other switching condition for temperatures outside that range.

A further object of the invention is to provide an inexpensively and easily manufactured switch mechanism having the foregoing objects.

Still further object of the invention to provide a switch mechanism of easily changeable design so as to be applicable to the mode of use in accordance with its purpose of use.

Other objects and a complete understanding of the invention will be apparent from the following detailed description and explanation which refers to the accompanying drawings illstrating the present preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view as a whole showing one embodiment of this invention;

FIG. **2** is a front sectional view of the embodiment shown in FIG. **1**;

FIG. **3** is a front view sectional showing an embodiment of the reed switch shown in FIG. **1** which operates in reverse;

FIG. **4** is a perspective view as a whole showing another embodiment;

FIG. **5** is a fragmentary front view of the embodiment shown in FIG. **4**;

FIG. **6** is a side view of the embodiment shown in FIG. **4**;

FIG. **7** is a perspective view as a whole showing another embodiment of the invention;

FIG. **8** is a front sectional view of the embodiment shown in FIG. **7**; and

FIG. **9** is a circuit diagram of a magnetic bridge of the reed switch mechanism of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention relates to a temperature responsive reed switch mechanism having each a construction that two permanent magnets such having the same magnetic force, dimension and configuration are secured on opposite ends of a reed switch body in such a manner that a straight line connecting both magnetic poles of said permanent magnets is perpendicular to the longitudinal axis of the reed switch body and a straight line connecting poles having a different polarity is to the longitudinal axis of the reed switch body. Heat-sensitive ferrites or conventional ferrites, having a curie point in the range of high temperature in some cases, are mounted between opposite poles of the two permanent magnets so that a magnetic bridge circuit with both contact pieces of the reed switch body as a one magnetic path may be formed between both permanent magnets. Before construction of reed switch mechanism of the invention and mode of operation thereof is described in detail, the heat-sensitive ferrite will briefly be described.

Heat-sensitive ferrite is one kind of magnetic materials so-called "Soft Ferrite," which has an extremely high permeability and an extremely low coercive force. They are manufactured by properly setting a mixing ratio, a manufacturing temperature and a forming pressure for ferrite materials such as manganese (Mn), copper (Cu), zinc (Zn), iron (Fe) and the like so as to have a curie point with the range of temperature (hereinafter called the range of normal or room temperature in a wide sense) between −40° C and +150° C. This heat-sensitive ferrite has a curie point not affected with the age and has a significant characteristic of temperature dependability to a great extent.

This invention, as described previously, relates to a switch mechanism employing the heat-sensitive ferrite, having the foregoing characteristic, as a magnetic resistor element incorporated in a magnetic bridge circuit formed by a combination of a reed switch body and two permanent magnets. The ferrite controls the switching operation of the reed switch body at desired variation of temperature in accordance with the mode of combination of the reed switch body and two permanent magnets. First, the construction of combination of a reed switch body and two permanent magnets, which are to be a basical construction of the invention, will be described.

Referring now in detail to the drawings, a reed switch body is designated generally at (**1**) as a reed switch, comprising a glass frame body (**2**) formed by a hollow cylindrical of a glass tube of a desired length, both opened ends of which are sealed. On both ends of the glass frame body (**2**) there are deposited and secured by molding contact pieces (**3***a*) and (**3***b*) made lengthwise of an electrically conductive and magnetizing material with their lengthwise sides run along the longitudinal axis of the glass frame body (**2**) and with their ends (**3***a*′) and (**3***b*′) overlap as near as possible to the middle position inside the glass frame body (**2**) and are separated.

In the vicinity of both ends of said reed switch body (**1**), that is, on the peripheral ends of the glass frame body (**2**), there are secured permanent magnets (**4***a*) and (**4***b*) provided with holes made for receiving the glass frame body (**2**) in the middle portion between both ends thereof. The permanent magnets (**4***a*) and (**4***b*) having the same magnetic force and the same shape and dimension. In these permanent magnets (**4***a*) and (**4***b*), the longitudinal axis of the reed switch body (**1**) is perpendicular to a straight line connecting both poles (**4***a*.N) and (**4***a*.S) or (**4***b*.N) and (**4***b*.S). The permanent magnets (**4***a*) and (**4***b*) are mounted so that poles having an opposite polarity of the permanent magnets (**4***a*) and (**4***b*) are on the same side of the longitudinal axis of the reed switch body, that is, a pole (**4***a*.N) of the permanent magnet (**4***a*) and a pole (**4***b*.S) of the permanent magnet (**4**b) are positioned at the same time on a straight line in parallel with the longitudinal axis of the reed switch body, and the pole (**4***a*.S) of the permanent magnet (**4**a) and the pole (**4***a*.N) of the permanent magnet (**4***b*) may be positioned at the same time on a straight line in parallel with said longitudinal axis. Thus the magnetic poles are positioned in a linear symmetrical position relative to the center axis of the reed switch body (**1**).

Accordingly, the combination of the reed switch body (**1**) and two permanent magnets (**4***a*) and (**4***b*) forms a magnetic bridge ciucuit (FIG. **9**) having permanent magnets (**4***a*) and (**4***b*) serve as a source of magnetic force, a magnetic path A from the pole (**4***a*.N) through air to the pole (**4***b*.S), a magnetic path B from the pole (**4***b*.N) through air to the pole (**4***a*.S), and a magnetic path C passing through contact pieces (**3***a*) and (**3***b*) of the reed switch body (**1**).

In this magnetic bridge circuit, if reluctance (Z*a*) of magnetic path A is same in value as reluctance (Z*b*) of magnetic path B, magnetic fluxes, each passing through the magnetic path A and magnetic path B, are the same value because of the value for permanent magnets (**4***a*) and (**4***b*) are the same. The magnetic fluxes passing through the magnetic path C formed by contact pieces (**3***a*) and (**3***b*) of the reed switch body (**1**) would be substantially zero since the amount from permanent magnet (**4***a*) to permanent magnet (**4***b*) is exactly same as the amount from permanent magnet (**4***b*) to permanent magnet (**4***a*). Thus the overlapping ends of contact pieces (**3***a*′) (**3***b*′) will not be magnetized at all and the reed switch body (**1**) will remained in an OFF condition. (This condition, that is, a condition in which overlapping ends (**3***a*′) (**3***b*′) of both contact pieces are not magnetized at all, or a condition in which magnetic flux is not substantially passed in the magnetic path C, is the equilibrium state or condition of the magnetic bridge circuit.)

On the other hand, if a value of reluctance (Z*a*) in magnetic path A is not equal to that of reluctance (Z*b*) in magnetic path B, for example, if the reluctance (Z*b*) is greater than the reluctance (Z*a*) the magnetic flux from permanent magent (**4***a*) to permanent magnet (**4***b*), via the magnetic path A becomes greater than the magnetic flux from permanent magnet (**4**b) to permanent magnet (**4***a*), via the magnetic path B, and thus the amount of magnetic flux flowing in and out of permanent magnets (**4***a*) and (**4***b*) are unequalized. A small portion of magnetic flux passing through the magnetic path B from permanent magnet (**4***b*) to permanent magnet (**4**a) flows into the permanent magnet (**4***a*) through the magnetic path C so as to equalize the amount of magnetic flux flowing in and out of both permanent magnets (**4***a*) and (**4***b*). Therefore, the magnetic flux from permanent magnet (**4***b*) to permanent magnet (**4***a*) rapidly increases, and by this passage of

magnetic flux from permanent magnet (4*b*) to permanent magnet (4*a*), the end (3*b'*) of contact piece (3*b*) is magnetized to N-pole and the end (3*a'*) of contact piece (3*a*) to S-pole. The magnetic attraction produced between overlapping ends (3*a'*) and (3*b'*) of both contact pieces causes them to come into contact with each other in the opposition to the rigidity of the cantilever mounting of contact pieces (3*a*) and (3*b*). That is, the reed switch body (1) is on a ON condition. (This condition, in which the overlapping ends (3*a'*) and (3*b'*) of contact pieces are magnetized in the opposite polarity, or a condition, in which more magnetic flux is passed from one of permanent magnets (4*a*) and (4*b*) than is passed from the other, is the unequilibrium state or condition of the magnetic bridge circuit.)

One embodiment will now be described with reference to FIGS. **1, 2,** and **3,** which illustrate a combination of a reed switch body (1) and two permanent magnets (4*a*) and (4*b*), arranged so that, a switching operation is performed with the reed switch body (1) at one predetermined temperature within the range of normal temperatures.

In FIGS. **1** and **2,** numeral (5) designates the aforesaid heat-sensitive ferrite having its curie point at a predetermined temperature t_1(° C), which is (1) within the normal temperature range at which reed switch body (1) performs its switching operation. The heat-sensitive ferrite (5) is securely mounted in contact with permanent magnets (4a) and (4*b*) between poles having opposite polarity and which poles are located on the same side of the longitudinal axis of the reed switch body (1), for example, between poles (4*a*.N) and (4*b*.S). Thus the reed switch mechanism comprises a heat-sensitive ferrite (5), a reed switch body (1), and two permanent magnets (4*a*) and (4*b*).

With the embodiment shown in FIGS. **1** and **2** constructed as described above, when the atmospheric temperature of reed switch mechanism (strictly speaking, it means a temperature of heat-sensitive ferrite (5) itself, but "the atmospheric temperature of reed switch mechanism" hereinafter refers to a temperature of heat-sensitive ferrite (5) itself) is less than a predetermined temperature t_1(° C), which is the heat-sensitive ferrite's (5) curie point. Heat sensitive ferrite (5) has an extremely high permeability. Thus the value of reluctance (Z*a*) of magnetic path A in the magnetic bridge circuit (See FIG. **9**) is extremely small as compared with reluctance (Z*b*) of magnetic path B passing through air. Therefore, magnetic flux passing through the magnetic path A from permanent magnet (4*a*) to permanent magnet (4*b*) is far greater in amount that the magnetic flux passing through the magnetic path B from permanent magnet (4*a*) to permanent magnet (4*b*), and only magnetic flux, which moves from permanent flux (4*b*) to permanent magnet (4*a*), is made to be substantially passed through the magnetic path C, that is, both contact pieces (3*a*) and (3*b*). Namely, the magnetic bridge circuit is in an unequilibrium condition. Accordingly, overlapping ends (3*a'*) and (3*b'*) of contact pieces are in contact, and the reed switch (1) is in an ON condition. This ON condition of reed switch body (1) is self-maintained till the atmospheric temperature of reed switch mechanism reaches the predetermined temperature t_1(° C).

When the atmospheric temperature of reed switch mechanism is elevated from the condition above and and reaches the predetermined temperature t_1(° C), the heat-sensitive ferrite'(5) rapidly reduces and thus rapidly increasing the value of reluctance (Z*a*) in the magnetic passage A up to the value equal to the reluctance (Z*b*) of the magnetic passage B.

The rapid increase of reluctance caused by reduction of permeability of the heat-sensitive ferrite (5) at the predetermined temperature t_1(° C) places the magnetic bridge circuit as shown in FIG. **9** in an equilibrium condition and and magnetic flux passing through the magnetic path C, that is, both contact pieces (3*a*) and (3*b*) becomes substantially zero. Thus the magnetization for the overlapping (3*a'*) and (3*b'*) of contact pieces disappear and they are separated because of the rigidity canti-lever mounting of both contact pieces (3*a*) and (3*b*). That is, the reed switch body (1) is in an OFF condition. This OFF condition of reed switch body (1) is self-maintained as far as the atmospheric temperature of feed switch mechanism is in excess of the predetermined temperature t_1(° C).

In the mode of switching operation in the embodiment as shown in FIGS. **1** and **2,** it is in a switch-ON condition within the range of atmospheric temperature less than the predetermined temperature t_1(° C) and in a switch-OFF condition within the range of atmospheric temperature in excess of predetermined temperature t_1(° C). To reverse this mode of switching operation, a permeable body (6) is merely securely mounted in the same manner as heat-sensitive ferrite (5) between poles (4*b*.N) and (4*a*.*S*) as shown in FIG. **3.** However, this permeable body (6) is a "soft ferrite," simlar to the heat-sensitive ferrite (5), which has a high permeability and small coercive force, while its curie point is far high in temperature (generally, from 700° C to 800° or so).

With the heat-sensitive ferrite (5) mounted between poles (4*a*.N) and (4*b*.S) and at the same time the permeable body (6) between poles (4*b*.N) and (4*a*.S), and when the atmospheric temperature of reed switch mechanism is less than the predetermined temperature t_1(° C), both heat-sensitive body (5) and permeable body (6) have an extremely high permeability, so that reluctances (Z*a*) and (Z*b*) are extremely small and substantially equal. Thus the magnetic bridge circuit is in equilibrium and magnetic flux is not substantially passed through the magnetic paths so that the overlapping ends (3*a'*) and (36*b'*) of contact piece are separated and the reed switch body (1) is in a switch OFF condition. When the atmospheric temperature of reed switch mechanism is elevated from the above condition and in excess of the predetermined temperature t_1(° C), only the heat-sensitive ferrite (5), among the heat-sensitive ferrite (5) and permeable body (6), rapidly reduces its permeability so that reluctance (Za) rapidly increases relative to the reluctance (Zb) and the magnetic bridge circuit is in a a state of unequilibrium. Then, the magnetic flux from permanent magnet (4*a*) to (4*b*) rapidly increase in the magnetic path C so that the end (3*a'*) of contact piece (3a) is magnetized to N polarity and the end (3*b'*) of contact piece (3*b*) to S polarity, and therefor are drawn into contact by mutual magnetic attraction. Thus the reed switch body (1) being in a switch-ON condition.

Now, an embodiment will be described with reference to FIGS. **4, 5** and **6,** in which a predetermined temperature t_1(° C) is to freely be controlled by use of heat-sensitive ferrite (5) having a curie point of a constant value.

In an embodiment shown in FIGS. 4, 5 and 6, the mode of incorporating the combination of a reed switch body (1) and two permanent magnets (4*a*) and (4*b*) into the heat-sensitive ferrite (5) is the exact same as that of embodiment as shown in FIGS. 1 and 2, however the permeable body (6) of FIG. 3 is not secured to the two permanent magnets (4*a*) and (4*b*), but is adjustably secured directly above the poles (4*b*.N) and (4*a*.S) and spaced by a distance (*l*) between both poles (4*b*.N) and (4*a*.S). That is, in the embodiment shown in FIGS. 4, 5 and 6, the magnetic path A in the magnetic bridge circuit is formed by a heat-sensitive ferrite 5, while the magnetic path B is formed from the permanent magnet (4b) through a space and then passing the permeable body (6) and again passing through another space, reaching the permanent magnet (4*a*). The embodiment shown in FIGS. 4, 5 and 6 has a construction as described above, and the temperature characteristic of permeability for the heat-sensitive ferrite (5) is extremely rapidly reduced and varied at its curie point, but is reduced and varied gradually to some extent. Thus by suitably setting a distance (*l*) the predetermined temperature t_1(° C) serving for a switching operation of reed switch mechanism is within the range of gradual reduction of characteristic curve of permeability and temperature for to the heat-sensitive ferrite (5). When the atmospheric temperature is sufficiently lower than the curie point of the heat-sensitive ferrite (5), the heat-sensitive ferrite is still extremely high in permeability, and thus the value of reluctance (*Za*) in the magnetic path A is far smaller than that of reluctance (*Zb*) in the magnetic path B, with a space of "*l*", whereby the magnetic bridge circuit being in unequilibrium, thus the reed switch body (1) being in a switch-ON condition.

When the atmospheric temperatures of reed switch mechanism is elevated from the above condition and becomes a value in the vicinity of curie point of the heat-sensitive ferrite (5), the permeability of heat-sensitive ferrite (5) begins to reduce. When the value of reluctance (*Za*) increased by reduction of permeability of the heat-sensitive ferrite (5) and becomes equal to that of reluctance (*Zb*), the magnetic bridge circuit is an equlibrium condition, and the reed switch body (1) is in a switch OFF condition.

The value of reluctance (*Zb*) in the magnetic path B may freely be set between maximum value to be determined by the permeability of the permeable body (6) and the maximum value of distance (*l*) which is limited to the a distance between poles (4*b*.N) and (4*a*.S).

The distance (*l*) is to be determined such that the value of reluctance (*Za*) is made equal to that of reluctance of (*Zb*) at the desired temperature t_1(° C). First obtain a value of reluctance of heat-sensitive ferrite (5), which varies in reverse proportion to variation of permeability with temperature variation of heat-sensitive (5), that is, the value of reluctance (*Za*) in the magnetic path A, and then obtaining a value of reluctance (*Za*) from the value of permeability of heat-sensitive ferrite (5) at the time of a desired temperature, that is, at the predetermined temperature t_1(° C). By adjusting (*l*) until the reluctance value of Z(b) equals the reluctance value of Z(a) at the predetermined temperature, the reed switch mechanism changes over the reed switch body (1) to the OFF condition at the time when the atmospheric temperature reaches the predetermined temperature t_1(° C).

Although the predetermined temperature t_1(° C) is surely a value in the vicinity of curie point of the heat-sensitive ferrite (5), it is not always to be same value as that of curie value but can be suitably set. However, the range of temperature in the gradual reducing region in the vicinity of curie point among the characteristic curve of permeability and temperature for the heat-sensitive ferrite (5) is extremely limited. In the case the heat-sensitive ferrite's curie point is more or less 100(° C), the range of temperature is more or less 10(° C), and in the case the heat-sensitive ferrite has a curie point in the vicinity of 4(° C), the range of temperature in more or less 20(° C). Therefore, the range of predetermined temperature adjustable of reed switch mechanism by adjustment of distance (*l*) is limited within the range ±5(° C) with the heat-sensitive ferrite having a curie point in the vicinity of **100** (° C), and the range ± **10** (° C) with the heat-sensitive ferrite in the vicinity of **4** (° C).

Finally, an embodiment shown in FIGS. 7 and 8 will now be described, in which the switchin device is in one condition within a given temperature range and in a second condition for temperatures, which are lower or higher than said given range.

In the embodiment shown in FIGS. 7 and 8, a construction of a combination of a reed switch body (1) and two permanent magnets (4*a*) (4*b*) is exactly same as that of the combination of a reed switch body (1) and two permanent magnets (4*a*) (4*b*) in the reed switch mechanism shown in FIGS. 1 to 6.

A heat-sensitive ferrite (5*a*) is in the exact same form as the heat-sensitive ferrites (5) in the embodients shown in FIGS. 1 to 6 and is securely mounted between poles (4*a*.N) and (4*b*.S).

On the other hand, a heat-sensitive ferrite (5*b*) is in the same form as the permeable body (6) in the embodiment shown in FIG. 3 and is securely mounted between poles (4*b*.N) and (4*a*.S).

If curie points for heat-sensitive ferrites (5*a*) and (5*b*) are to have different values, the relation between curie point t_a (° C) of heat-sensitive ferrite (5*a*) and curie point t_b (° C) of heat-sensitive ferrite (5*b*) is given by $t_a = t_b$. The heat-sensitive ferrite (5*a*) and (5*b*) have equal permeability at an atmospheric temperature less than the both curie points and at an atmospheric temperature in excess of both curie points.

With the embodiment shown in FIGS. 7 and 8 constructed as above, the relation between curie point t_a (° C) of heat-sensitive ferrite (5*a*) and curie point t_b(° C) of heat sensitive ferrite (5*b*) is given by $t_a < t_b$, and in the case the atmospheric temperature in the switch mechanism is within the temperature less than t_a (° C), both heat-sensitive ferrites (5*a*) and (5*b*) have an extremely high value and equal permeability so that reluctance (*Za*) in the magnetic path A has a value equal to that of reluctance (*Zb*) in the magnetic path B, and thus the magnetic bridge circuit is in equilibrium. Accordingly, magnetic flux is not substantially passed in the magnetic path C, and the overlapping ends (3*a*′) and (3*b*′) of contact pieces are mutually separated, that is, the switch body (1) being in an OFF condition. When the atmospheric temperature of reed switch mechanism is elevated from said condition and reaches the value within the range of temperatures determined by the curie point temperature t_a (° C) of heat-sensitive ferrite (5*a*) and the curie point temperature t_b (° C) of heat-sensitive (5*b*), said heat-sensitive ferrite (5*a*) rap-

idly reduces its permeability while said heat-sensitive ferrite (5*b*) maintains its high permeability so that a value of reluctance (Z*a*) in the magnetic path A rapidly increases while reluctance (Z*b*) remains to be extremely low in its value, and thus the magnetic bridge circuit is in an unequilibrium state. This unequilibrium of the magnetic bridge circuit causes the magnetic path C to rapidly increase magnetic flux from permanent magnet (4*a*) to permanent magnet (4*b*), and the end (3*a'*) of contact piece (3*a*) is magnetized to N polarity while the end (3*b'*) of contact piece (3b) to S polarity so that the overlapping ends (3*a'*) and (36*b'*) come into contact with each other by means of a force of magnetic attraction against the rigidity of contact pieces (3*a*) and (3*b*). That is, the reed switch body (1) is in an ON condition.

When the atmospheric temperature of reed switch mechanism is further elevated and reaches a temperature in excess of curie point temperature t_b (° C) of heat-sensitive ferrite (5*b*), the heat-sensitive ferrite (5*b*) rapidly reduces its permeability down to a value equal to that of the already reduced permeability of heat-sensitive ferrite (5*a*). Therefore, the value of reluctance (Z*b*) in the magnetic path B will increase to the same value as that of reluctance in the magnetic path A, and this increase of reluctance (Z*b*) causes the magnetic bridge circuit to place again in an unequilibrium condition. When the magnetic bridge circuit is returned to the equilibrium condition, magnetic flux is not substantially passed passed through the magnetic path C, so that magnetization of both utmost ends (3*a'*) and (3*b'*) of contact pieces disappear and the ends (3*a'*) and (3*b'*) separate in response to the rigidity of contact pieces (3*a*) and (3*b*), thus the reed switch body (1) being placed in a switch-OFF condition.

As is described above, the embodiment shown in FIGS. 7 and 8 has a mode of automatic switching operation in such that within the range of temperature having the curie point temperature t_a (° C) of heat-sensitive ferrite (5*a*) as a lower limit and with the curie point temperature t_b (° C) of heat-sensitive ferrite (5*b*) as an upper limit, the reed switch body (1) is placed in a switch-ON, while outside this range of temperatures, the reed switch body (1) is placed in a switch-OFF condition.

The range of temperatures in the form of a switch-ON of the reed switch mechanism according to the embodiment shown in FIGS. 7 and 8, that is, the range of temperature to be determined is set by both curie point temperatures t_a (° C) and t_b (° C) of heat-sensitive ferrites (5*a*) and (5*b*), is not always limited by way of the curie point temperatures t_a (° C) and t_b (° C) of both heat-sensitive ferrites (5*a*) and (5*b*). The temperature may be controlled and varied by the technique used in the embodiments shown in FIGS. 4, 5 and 6, that is, by interposing reluctance elements such as air gaps, for example, in magnetic path A or B, in a suitable manner though temperature is limited.

In the foregoing description, a reed switch body (1) in each embodiment has been described in the form of constant open type contact, but the constant close type contact may be used also for the reed switch body. In which case switching condition may be reversed but there is nothing in particular to be different in switching operation of the switch mechanism according to the present invention.

As is apparent from the foregoing, the present invention has a construction in such that a reed switch body (1) is incorporated with a combination of two permanent magnets (4*a*) and (4*b*) in a desired relation of position and in a mutual posture, and the combination is incorporated with heat-sensitive ferrites (5), (5*a*) and (5*b*), and permeable body (6) so as to form a magnetic bridge circuit with both contact pieces (3*a*) and (3*b*) of reed switch body (1) made as a magnetic path C, thereby providing an invention extremely valuable and wide in its application as a switch mechanism having its purpose of temperature control and temperature monitoring with such advantages as insuring an accurate switching operation at the time when the atmospheric temperature reached the predetermined temperature, making a predetermined temperature freely changeable by means of an extremely simple operation, providing a specific and widely applicable switching operation which maintains the switching condition only within the range of temperature predetermined, providing a switch mechanism extremely simple in construction and easily assembled, and providing an easily changeable design adapted for the object of its use and in the optimum condition for the using condition because of its simple construction.

What is claimed is:

1. A reed switch mechanism making use of heat-sensitive ferrites comprising permanent magnets each having the same magnetic force, dimension and configuration, said magnets being secured in the vicinity of both ends of a reed switch body in such a manner that a straight line connecting both magnetic poles for individual permanent magnets is perpendicular to and symmetrical about a longitudinal axis of the reed switch body and magnetic poles having opposite polarity are on the same side of said longitudinal axis, and at least one heat-sensitive ferrite having a curie point within the range of normal temperature, said ferrite being mounted between opposite magnetic poles of said permanent magnets.

2. The reed switch mechanism making use of heat-sensitive ferrites as claimed in claim **1**, wherein between magnetic poles of permanent magnets opposite to magnetic poles, to which the heat sensitive ferrite is mounted, a permeable body having a curie point well above the expected maximum temperature to which said reed switch mechanism will be exposed, is provided.

3. The reed switch mechanism making use of heat-sensitive ferrites as claimed in claim **1**, wherein between magnetic poles of permanent magnets opposite to magnetic poles to which the heat sensitive ferrite is mounted, a heat sensitive ferrite, having a curie point in an expected temperature range to which said reed switch mechanism will be exposed and different in value from that of the other heat sensitive ferrite is mounted.

4. The reed switch mechanism making use of heat sensitive ferrites as claimed in claim **1**, wherein an adjustable means, for setting a predetermined temperature for a switching operation of the reed switch body different from that of the curie point of said heat sensitive ferrite, is provided between magnetic poles of said permanent magnets opposite to the magnetic poles to which heat sensitive ferrite is mounted.

5. A temperature responsive magnetic bridge comprising:

two permanent magnets being parallel and spaced, and their pole polarities inverted;

a reed switch, having its longitudinal axis perpendicular to said magnets, connecting said magnets at their centers;

at least one heat-sensitive ferrite mounted, substantially parallel to said longitudinal axis, between opposite poles of said permanet magnet;

said reed switch assuming a first state at a temperature below a curie point of said heat-sensitive ferrite and a second state at a temperature above said curie point.

6. A temperature responsive magnetic bridge as in claim **5** including a second heat-sensitive ferrite having a curie point different from that of the other heat-sensitive ferrite mounted to remaining pair of opposite poles;

said reed switch assuming a first state at temperatures between said two curie points and a second state for all other temperatures.

7. A temperature responsive magnetic bridge as in claim **5** including a permeable body adjustably mounted substantially parallel to said longitudinal axis and spaced from remaining pair of opposite poles;

said reed switch changes states at a temperature which is other than said heat-sensitive ferrite's curie point and is determined by said spacing.

8. A temperature responsive magnetic bridge as in claim **5** including a permeable body, having a curie point substantially higher than said ferrite's curie point, mounted to the remaining pair of opposite poles so that

said reed switch assuming said first state at a temperature above said ferrite's curie point and said second state at a temperature below said ferrite's curie point.

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