

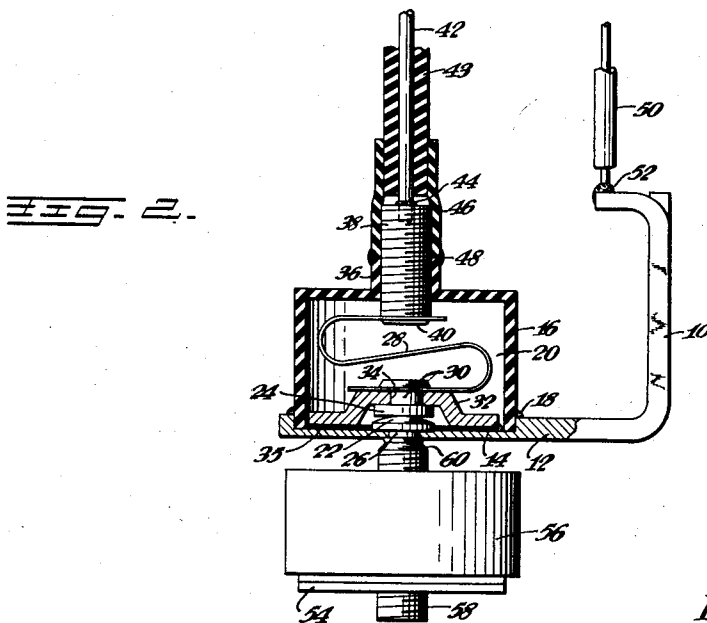
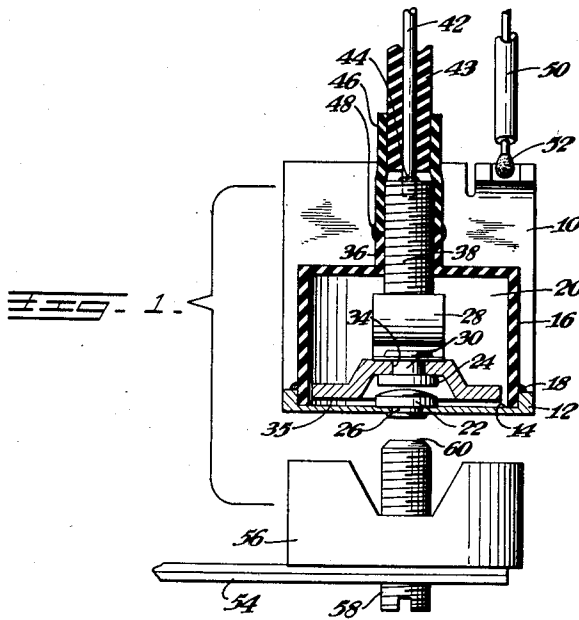
Jan. 26, 1960

R. W. HOUSER

2,922,858

MAGNETIC SWITCH

Filed March 3, 1958



INVENTOR

Roy W. Houser.

BY

Albert J. Anderson

ATTORNEY.

1

2,922,858

MAGNETIC SWITCH

Roy W. Houser, Anaheim, Calif., assignor to Robertshaw-Fulton Controls Company, Richmond, Va., a corporation of Delaware

Application March 3, 1958, Serial No. 718,580

10 Claims. (Cl. 200—87)

This invention relates to improvements in electric switches and more particularly to a magnet actuated switch.

An object of this invention is a thermostatic switch having low operating force and high contact force.

Another object of this invention is a thermostatic switch with means for simultaneously adjusting the operating force and the contact force.

A further object of this invention is a thermostatic switch having means for varying temperature differential thereof in a manner to maintain a preselected relationship between contact force and operating force.

It is another object of this invention to adjust contact pressure between a pair of switch contacts by varying the force biasing the contacts to an open position.

This invention has another object to maintain a high pressure between a pair of contacts by varying the magnetic force applied in opposition to a biasing force holding the contacts in an open position.

A further object of this invention is to adjust pressure between a pair of closed switch contacts by varying a tension force applied to one contact of the pair.

This invention comprises an electric switch housing having mounted therein a pair of contacts, one of which is fixed and the other of which is movable between an open and a closed position therewith. A magnetic keeper is mounted on the movable contact and resilient means having a predetermined spring rate support same and bias the movable contact to the open position. A permanent magnet mounted on a condition responsive member having a predetermined spring rate which is less than the spring rate of the resilient means is movable exteriorly of the housing to vary the magnetic flux encompassing the keeper.

An increase in flux causes movement of the keeper in a manner to close the contacts with a snap action and a decrease in flux allows the resilient means to return the keeper to a normal position opening the contacts with a snap action. Movement of the permanent magnet is within adjustable limits and an adjusting member is operable thereon to vary simultaneously the magnetic attractive force between the permanent magnet and the magnetic keeper and the contact force between the pair of contacts in a manner to maintain a predetermined relationship between these forces.

Additional features and advantages will become apparent from the following description of an embodiment of the invention taken in connection with the accompanying drawings, wherein:

Fig. 1 is a front elevation view of a switch embodying the present invention with certain parts shown in section and illustrating the switch in an open position; and

Fig. 2 is a side elevation view similar to Fig. 1 illustrating the switch in a closed position.

Referring more particularly to the drawing, a generally L-shaped bracket member of non-ferrous conducting material is provided in the position shown with a vertically disposed portion 10 and a horizontally dis-

2

posed portion 12. A recess 14 is formed in one surface of the horizontal portion 12 and inserted therein is a cup-shaped shell 16 of glass or plastic material. Shell 16 is secured in recess 14 by any suitable means such as a bonding material 18 to form a hermetically sealed switch housing, the interior of which is indicated by reference numeral 20.

A pair of switch contacts 22, 24 are disposed within the housing 20 and are operable between an open and a closed position to control an electric circuit. Contact 22 is generally in the form of a rivet having an enlarged diameter head and a reduced diameter shank portion 26. Shank 26 is inserted into a suitable aperture centrally disposed in recess 14 and fixed therein in a conducting relationship by any suitable means such as by peening the outwardly extending portion of shank 26 over the surface of the horizontal portion 12 opposite the recess 14.

Contact 24 is disposed in housing 20 in opposed relation to fixed contact 22 and movable relative thereto into and out of engagement therewith in a manner to be hereinafter described. Contact 24 which can be generally in the shape of a rivet with a shank portion 30 is mounted on one end of an S-shaped spring member 28 made of conducting material and fixed thereto in a conducting relationship by any suitable means, such as by peening the shank portion 30 over the surface of spring member 28 opposite the contact 24. Mounted upon contact 24 is a movable keeper 32 consisting of a magnetic iron ring which movably fits within the confines of the housing 20 and which is provided with a centrally located aperture 34 adapted to receive shank portion 30. An electrical insulating material 35, which may be in the form of an insulating varnish, is applied to that surface of keeper 32 which makes engagement with recess 14 to prevent conduction of electric current through keeper 32.

Centrally disposed projection 36 integral with shell 16 is bored and threaded to receive a threaded adjusting stud 38. One end of stud 38 extends into switch housing 20 and attached thereto by any suitable means, such as a rivet 40, is the other end of spring 28. With the other end of spring 28 thus secured to the stud 38, the keeper 32 and the contact 24 will be supported in some relative spaced position with respect to fixed contact 22 as determined by the resiliency of the spring 28 and the position of stud 38 in projection 36.

A lead wire 42 covered with an electrical insulating material 43 is secured to stud 38 on the end thereof extending outwardly of housing 20 by any suitable means, such as a soldered joint 44. Force fitted about the insulating material 43 is a sleeve member 46 of any suitable material, such as flexible plastic, which is pulled down over stud 38 and secured to projection 36 by any suitable means, such as bonding material 48, to hermetically seal housing 20 at the point of entry of stud 38.

The vertical portion 10 of the L-shaped bracket serves as a mounting bracket for the housing 20 and also as an electrical terminal to which is attached a lead wire 50 by any suitable means, such as a soldered joint 52.

Exterior of the switch housing 20 is a switch actuating member 54 which has one end fixed to any suitable support or casing, not shown. While member 54 may be the actuating member of any condition responsive device, it is shown as a flat bimetal strip whose free end moves in response to temperature variations as is well known in the art. Member 54 has a spring rate which is less than the spring rate of spring 28. Spring rate, as herein used, is the elastic force stored in a spring by physical deflection of the spring a unit distance and is considered to be a straight line function. A permanent magnet 56 is rigidly secured to bimetal strip 54 adjacent its free end and positioned in proximity to and in align-

3

ment with housing 20. An adjusting screw 58 threadedly extends through bimetal strip 54 and the center of magnet 56 and has an abutting end 60 engageable with the peened portion of shank 26. An electrical insulating material (not shown), which may be in the form of an insulating varnish, is applied to either the peened over portion of shank 26 or the abutting end 60 of screw 58 to prevent conduction of electric current therebetween.

The housing 20 and the actuating member 54 are separately fixed within any conventional casing (not shown) in such relative positions that the adjusting screw 58 is in alignment with the shank 26. With the switch in the open position (Fig. 1), the movable contact 24 is supported in a spaced open relation to the fixed contact 22 by spring 28. The magnetic keeper 32 being mounted on movable contact 24 is also supported by spring 28 to some relative position with respect to fixed contact 22 as determined by the bias of spring 28.

The operation of the switch in the embodiment disclosed is responsive to temperature changes so that as temperature varies in one direction, the bimetal actuating member 54 causes movement of the magnet 56 toward the fixed housing 20. As a consequence, the magnetic field of magnet 56 permeates the magnet keeper 32 and the closer the magnet 56 moves toward the housing 20, the greater the amount of magnetic flux induced in keeper 32. The magnetic attractive force between magnet 56 and keeper 32 increases exponentially as the distance between magnet 56 and keeper 32 decreases. At a point (the snap point of bimetal 54) where the magnetic attractive force between magnet 56 and keeper 32 increases at a greater rate than the spring rate of bimetal 54, the magnet 56 will snap in toward the keeper 32, its movement being limited by engagement of abutting end 60 and shank 26.

As the magnet 56 snaps in, the magnetic attractive force between magnet 56 and keeper 32 increases at a greater rate than the spring rate of spring 28 causing keeper 32 to snap in toward magnet 56 causing engagement of contact 24 with contact 22, as illustrated in Fig. 2, to close an external electrical circuit therebetween. It should be noted that even though the temperature variation is a gradual change resulting in a gradual increase in the magnetic attractive force between magnet 56 and keeper 32, the final movement of magnet 56 and keeper 32 is accompanied with a snap action due to the final deflection of bimetal 54 and the final tensioning of S-shaped spring 28.

In order to prevent arcing across contacts 24, 22 when contact 24 is approaching closure to contact 22, it is necessary that the spring rate of spring 28 be sufficiently high to prevent the contact 24 from approaching closer than a certain minimum distance to contact 22 before magnet 56 snaps.

It should be noted that when keeper 32 is actuated to close contacts 22 and 24, spring 28 is deformed from its normal position to that shown in Fig. 2 and it exerts a force in opposition to the magnetic attractive force between keeper 32 and magnet 56. The difference between the magnetic attractive force acting between keeper 32 and magnet 56 and the retractive or tension force of spring 28 acting on keeper 32 will determine the contact pressure or contact force acting upon contacts 22 and 24 when they are in their closed position.

An operating force is generated by bimetal 54 in response to temperature change. When contacts 22 and 24 are in an open position, magnet 56 moves freely in response to temperature change of bimetal 54 and during this time the spring force stored in bimetal 54 is always equal to the magnetic attractive force between magnet 56 and keeper 32. This relationship between spring force stored in bimetal 54 and the magnetic attractive force between magnet 56 and keeper 32 exists until the snap point of bimetal 54 is reached at some predetermined temperature. When the snap point of bimetal 54 is reached, it is caused to deflect and the spring force therein builds up

4

to a maximum value and acts in opposition to the magnetic attractive force between magnet 56 and keeper 32. The difference between spring force stored in bimetal 54 and the magnetic attractive force between magnet 56 and keeper 32 is equal to the operating force which must be generated by temperature change in bimetal 54 to open contacts 22 and 24 and determines the force of engagement between abutting end 60 and shank 26.

When the temperature varies in the opposite direction, bimetal 54 will exert an operating force on magnet 56 which aids the spring force stored therein. When the sum of the operating force and the stored spring force equals the magnetic attractive force between magnet 56 and keeper 32, the snap point of bimetal 54 will be reached and magnet 56 will snap away from housing 20. The magnet attractive force between magnet 56 and keeper 32 will decrease and spring 28 will snap keeper 32 away from contact 24 opening contacts 22 and 24 with a snap action.

As is well known in the art, a high contact pressure between switch contacts is important to switch life and in particular to contact life for it eliminates burning and poor conductivity which is present when there is insufficient contact pressure. It is also well known in the art that a bimetal is a relatively weak operator. In order to have an effective and efficient switch utilizing switch contacts operable by a bimetal operator, low operating force is desirable and yet high contact force is also desirable.

With the arrangement of contacts and bimetal as disclosed herein, the relationship of high contact pressure and low operating force can be achieved and always preserved because of the relative spring rates of spring 28 and bimetal 54. The biasing action due to the physical bending or deflection of bimetal 54 by the magnet 56 at its snap point operates to reduce the pressure between magnet 56 and stud 26 whereas the biasing action of spring 28 due to physical tensioning or deflection at its snap point operates to reduce the pressure between contacts 22 and 24. The magnetic attractive force acting upon magnet 56 and keeper 32 is the same when contacts 22 and 24 are in a closed position and since spring 28 has a high spring rate and bimetal 54 has a relatively low spring rate, bimetal 54 will always exert more force on magnet 56 than spring 28 will exert on keeper 32 and movable contact 24. Thus, high contact force will exist between contacts 22 and 24 and a low operating force generated by temperature change on bimetal 54 will cause switch actuation.

Operating force determines the extent of variation in temperature required to operate the switch, or in more common terms, the sensitivity or temperature differential of the thermostat. Adjusting member 58 is provided for the purpose of adjusting operating force by adjusting the proximate position of magnet 56 with respect to housing 20. When contacts 22 and 24 are in a closed position, a small displacement of magnet 56 will cause a large change in magnetic attraction between magnet 56 and keeper 32 whereas the spring force stored in bimetal 54 will be virtually unaffected because of its low spring rate.

The operating force of this switch can be thus adjusted by member 58 to cause switch actuation in response to infinitesimal temperature change on bimetal 54. Since any adjustment in the proximity of magnet 56 to housing 20 effects the magnetic attractive force acting between keeper 32 and magnet 56 in the same manner and in the same amount without effecting the spring rate of spring 28 or bimetal 54, any adjusting in the proximity of magnet 56 to the housing 20 will also vary the contact force between contacts 22 and 24. It is important to note that any adjustment in member 58 will preserve the essential relationship of high contact force and low operating force at all times. Thus,

by limiting the range of possible adjustment of member 58, contact force and operating force can be kept within the bounds desired to provide a simple, efficient, and effective switch.

Threaded stud 38 can be adjusted to vary the contact pressure between contacts 22 and 24 by varying the force that spring 28 will exert in opposition to the magnetic attractive force between keeper 32 and magnet 56. Movement of contact 24 away from contact 22 by stud 38 results in a greater deformation of spring 28 when keeper 32 is actuated to close contacts 22 and 24. This greater deformation of spring 28 will decrease the contact pressure between contacts 22 and 24. Conversely, as contact 24 is moved closer to contact 22 by stud 38, the deformation of spring 28 will be less and contact pressure between contacts 22 and 24 will increase. A desirable preselected contact pressure can thus be established during manufacture of this switch and if desired, stud 38 can also be used to compensate for wear to the contacts during usage of the switch thereby providing for long switch and contact life.

Another feature of this switch is that the S-shape of spring 28 causes near parallel movement of the keeper 32 with respect to the fixed contact 22. This near parallel movement permits contact 24 to wipe across contact 22 when the contacts are being moved into their open or closed positions reducing any tendency of contact 24 to bounce on contact 22 and maintaining the contacting surfaces of contacts 22 and 24 in a condition to provide for excellent electrical conductivity therebetween. Wear and tear on contacts 22 and 24 is further reduced by the relationship of the supporting spring rates of bimetal 54 and spring 28. Contact pressure is always maintained at a high value and never drops to zero except momentarily when contact 24 is being moved between open and closed position with respect to contact 22.

Only one embodiment of the invention has been shown and described herein and inasmuch as this invention is subject to many variations and modifications and reversals of parts, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an electric switch, the combination comprising a pair of contacts disposed in opposed relation, resilient means mounting one of said contacts biasing same to an open position, first magnetic means mounted on said one contact, second magnetic means mounted adjacent said first magnetic means on a condition responsive actuating member and adapted to cooperate with same, said actuating member being operable in response to condition changes to vary the distance between said first magnetic means and said second magnetic means, said second magnetic means being first attracted upon a decrease of the distance causing attraction of said first magnetic means and movement of said one contact to a closed position, said first magnetic means being released upon an increase of the distance to allow the said one contact to be moved to the open position by the bias of said resilient means, and means on said actuating member for varying the operating force of the switch and the contact force between said contacts in a manner to maintain a preselected relationship between the forces.

2. In an electric switch, the combination comprising a fixed contact, a movable contact disposed in an opposed relation to said fixed contact and operable with relation to said fixed contact between an open and a closed position, resilient means mounting said movable contact biasing same to the open position, first magnetic means mounted on said movable contact, second magnetic means mounted adjacent said first magnetic means on a condition responsive actuating member and adapted to cooperate with same, said actuating member being operable in response to condition changes to vary the distance

between said first magnetic means and said second magnetic means, said second magnetic means being first attracted upon a decrease of the distance causing attraction of said first magnetic means and movement of said one contact to a closed position, said first magnetic means being released upon an increase of the distance to allow said one contact to be moved to the open position by the bias of said resilient means, and means on said magnetic means adjustable to vary the distance through which said actuating means must move to cause operation of said contacts between the open and closed positions and to vary the contact force between said contacts.

3. In an electric switch, the combination comprising a housing, a pair of contacts disposed in said housing in opposed relation, a spring mounting one of said contacts biasing same to an open position, a magnetic keeper mounted on said one contact, magnetic means positioned exterior to said housing and adjacent said magnetic keeper on a condition responsive actuating member and adapted to cooperate with said magnetic keeper, said actuating member being operable in response to condition changes to vary the distance between said magnetic keeper and said magnetic means said magnetic means being first attracted toward said magnetic keeper upon a decrease of the distance causing attraction of said magnetic keeper and movement of said one contact to a closed position, said magnetic keeper being released upon an increase of the distance to allow the said one contact to be moved to the said open position by the bias of said spring, and single means on said actuator for adjusting simultaneously the magnetic attractive force between said magnetic keeper and said magnetic means and the contact pressure between said contacts.

4. In an electric switch, the combination comprising a housing, a pair of contacts disposed in said housing in opposed relation, spring means having a predetermined spring rate mounting one of said contacts biasing same to an open position, a magnetic member mounted on said one contact, magnetic means mounted exterior to said housing and adjacent said magnetic member on a bimetal element and adapted to cooperate with same, said bimetal element having a predetermined spring rate which is less than the predetermined spring rate of said spring means and operable in response to temperature changes to vary the distance between said magnetic member and said magnetic means, said magnetic member being attracted toward said magnetic means upon a decrease of the distance causing movement of said one contact to a closed position and said magnetic member being released upon an increase of the distance to allow said one contact to be moved to the said open position by the bias of said spring means, and single means on said magnetic means for adjusting simultaneously the temperature differential between the open and closed positions of said contacts and the contact force between said contacts.

5. In an electric switch, the combination comprising a pair of contacts disposed in opposed relation, resilient means having a predetermined spring rate mounting one of said contacts biasing same to an open position, adjusting means mounting said resilient means and operable thereon to vary the contact pressure between said contacts, a magnetic keeper mounted on said one contact, magnetic means mounted adjacent said magnetic keeper on a condition responsive actuating member and adapted to cooperate with same, said actuating member having a predetermined spring rate substantially less than the predetermined spring rate of said resilient means and being operable in response to condition changes to vary the distance between said magnetic keeper and said magnetic means, said magnetic keeper being attracted upon a decrease of the distance to overcome the bias of said resilient means to move said one contact to a closed

position and being released upon an increase of the distance to allow said one contact to be moved to open position by the bias of said resilient means, and threaded means on said magnetic means to vary the distance between said magnetic means and said magnetic keeper independently of the movement of said condition responsive actuating member.

6. In a thermostatic switch, the combination comprising a cup-shaped shell of plastic material, a non-ferrous cover member of conducting material, said shell and said cover member hermetically sealed together to form a housing, a fixed contact mounted on said cover member within said housing, a movable contact disposed in said housing in opposed relation to said fixed contact and operable between a closed position therewith and a variable spaced position relative thereto, an S-shaped spring of conducting material having one end connected to said movable contact to move same from said closed position to said variable spaced position, a threaded stud of conducting material connected to another end of said S-shaped spring and disposed in a threaded opening in said shell and adjustable therein to vary the spaced position of said movable contact relative to said fixed contact, a magnetic keeper mounted on said movable contact and movable therewith between positions and operable to move said movable contact to the said closed position, a permanent magnet positioned exterior to and adjacent said housing, a bimetal supporting said permanent magnet and movable in response to temperature variations to move said permanent magnet toward said housing causing attraction of said magnetic keeper to move said movable contact to its closed position with said fixed contact with a snap action and away from said housing causing release of said keeper and movement of said movable contact to its spaced position with a snap action under the bias of said S-shaped spring, and adjusting means on said permanent magnet for varying the magnetic attractive force between said permanent magnet and said keeper.

7. In an electric switch, the combination comprising fixed contact means, movable contact means disposed in opposed relation to said fixed contact means, means operable to move said movable contact means into engagement with said fixed contact means, means for biasing said movable contact means away from engagement with said fixed contact means and including a resilient element carrying said movable contact means, and adjustable means for supporting said resilient element and being operable to position said movable contact means relative to said fixed contact means to vary the deformation of said element upon contact engagement and thereby vary the contact pressure between said fixed contact means and said movable contact means.

8. In a switch, the combination comprising a housing, a fixed contact means disposed in said housing, a mov-

able contact means disposed in said housing in opposed relation to said fixed contact means, a magnetic keeper mounted on said movable contact means, means including adjusting means operable external to said housing for actuating said magnetic keeper to thereby move said movable contact means into engagement with said fixed contact means, means for biasing said movable contact means away from engagement with said fixed contact means and including a resilient element carrying said movable contact means, and adjustable means mounting said resilient element and being operable to position said movable contact means relative to said fixed contact means to vary the deformation of said element after contact engagement and thereby to vary the contact pressure between said fixed contact means and said movable contact means.

9. In a switch, the combination comprising a housing, a fixed contact disposed in said housing, a movable contact disposed in said housing in opposed relation to said fixed contact, a magnetic element mounted on said movable contact, means including adjusting means operable external to said housing for actuating said magnetic element to thereby move said movable contact into engagement with said fixed contact, a resilient S-shaped spring of conducting material biasing said movable contact away from engagement with said fixed contact and effecting movement thereof to cause said movable contact to wipe across the surface of said fixed contact when moved into and out of engagement therewith, and a threaded stud threadedly adjustable in an opening in said housing mounting engaging said resilient means and operable thereon to vary the contact pressure between said fixed contact and said movable contact.

10. In a switch, the combination comprising a housing, a portion of the surface of which is an electrical terminal, a fixed contact mounted within said housing on said electrical terminal portion thereof, a movable contact disposed in opposed relation to said fixed contact and operable with relation to said fixed contact between a spaced position and a closed position, a resilient conducting spring mounting said movable contact and biasing same for movement to said spaced position, a magnetically attractable keeper mounted on said movable contact and operable to move same to said closed position, and a terminal stud engaging said resilient conducting spring and threadedly adjustable in an opening in said housing to vary said spaced position of said movable contact with respect to said fixed contact.

References Cited in the file of this patent

UNITED STATES PATENTS

953,584	Bishop et al.	Mar. 29, 1910
1,230,728	Laycock	June 19, 1917
1,958,482	Leins	May 15, 1934