

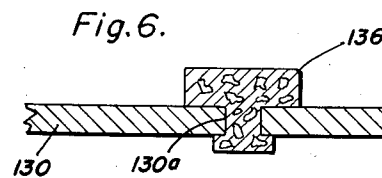
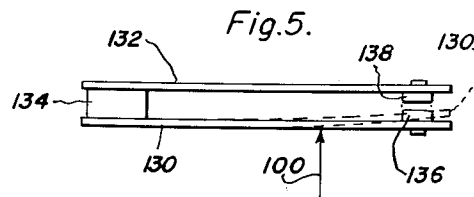
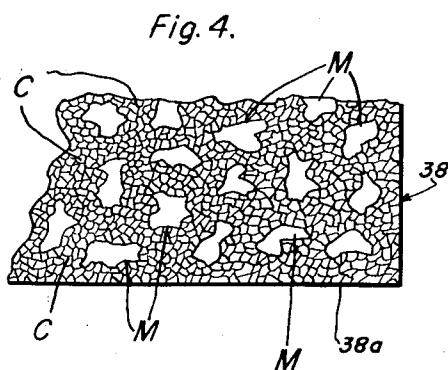
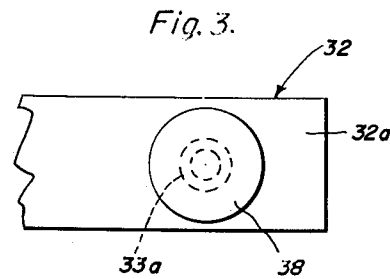
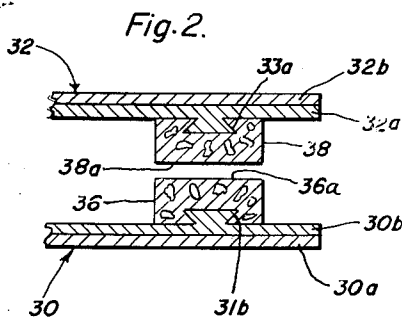
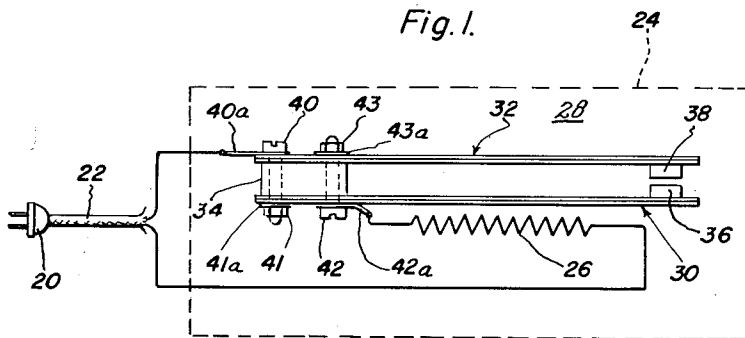
Dec. 19, 1961

J. D. COBINE ET AL

3,014,104

ELECTRICAL CONTACTS

Filed Dec. 12, 1958



Inventors:
James D. Cobine;
Emmet E. Burger,
Paul A. Frank
by Their Attorney.

1

3,014,104

ELECTRICAL CONTACTS

James D. Cobine, Rexford, and Emmett E. Burger,
Schenectady, N.Y., assignors to General Electric Com-
pany, a corporation of New York
Filed Dec. 12, 1958, Ser. No. 779,830
5 Claims. (Cl. 200-113)

Our invention relates to an improved small size snap acting control switch construction particularly suitable for use as a miniature thermostatic switch and to an electrical contact element therefor.

In certain electrical switch constructions, especially thermostatic switches, a pair of contacts are mounted on support elements which move in relation to each other as some condition (such as temperature) varies. In an electric heating pad, for example, at least one support arm is a bimetal arm which gradually approaches the other arm as temperature rises. The mating contact elements carried by the support arms are connected in series with the energizing circuit to the heating pad. The switch action thus serves as a control to maintain the pad temperature within predetermined limits.

In switch applications, such as electric blankets and heating pads, it is important that the control switch act positively and silently. Chattering of a control switch, particularly with respect to the electrical noise generated thereby is highly objectionable and intolerable. Such switches, however, exhibit a definite tendency to chatter or vibrate when contact is about to be made. This is due at least in part to the effect of sparking as the contacts approach each other. Each arc struck by the approaching contacts (which are then subject to very little pressure) gives rise to thermal air expansion tending to separate the contacts. Additionally, explosive vaporization at the point of first contact tends to force the contacts apart. Some switches—where substantial size and weight can be accepted—have been provided with attracting magnets or even with mechanical snap action devices. These expedients, however, are not normally practical in a very small unit, such as is required for an electric heating pad.

In accordance with the present invention, an improved control switch is provided which has one or more contacts made of a compressed mixture of granulated hard and soft materials. The switch elements are mounted upon and affixed to contact arms. One of the materials of the mixture, preferably the relatively soft component, is a good electrical conductor, such as silver. The other material, preferably the relatively hard component, is a permanently magnetizable material, such as an Alnico. The contacts are magnetized to define one or more attracting poles, so that as the arms (and hence the contacts) approach each other the magnetic attracting ultimately overcomes all other forces and brings the contacts together in a positive contact-making engagement by snap action. Since the current value and the magnetic field intensity are both relatively low—and the magnetic field is generally colinear with the direction of current flow—the magnetic action of the contacts does not significantly affect the current flow or impair the conductivity of the conducting component of the contacts.

It is, therefore, a general object of the present invention to provide an improved small size control switch and a contact element therefor in which magnetically active electrical contact elements serve to provide positive contact making.

A more particular object of the present invention is to provide an improved small size control switch and a contact element therefor in which a two component mixture of hard and soft granules is pressed about locking conformations on the switch arms to provide contact,

2

the granules of one component being magnetic and the granules of the other being a good electrical conductor, the contacts being magnetized in attracting relationship to provide positive contact making.

Still another object of the present invention is to provide an improved small size control switch and a contact element therefor in which the hardness inherent in Alnico and like hard magnetic materials and the softness inherent in silver and like soft conducting materials are utilized cooperatively to provide contact elements with both magnetic and conducting action to achieve positive contact making.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a circuit diagram of an electrical heating pad construction showing in side elevation a thermostatic control switch constructed in accordance with one form of the present invention;

FIGURE 2 is a fragmentary enlarged view with parts in cross-section of the contact elements of the control switch of FIGURE 1 and the associated portions of the contact arms;

FIGURE 3 is a top plan view of the portion of the switch shown in FIGURE 2;

FIGURE 4 is a very greatly enlarged partial cross-sectional view of a portion of one of the contact elements of the control switch of FIGURE 1;

FIGURE 5 is a fragmentary view generally like FIGURE 2 but showing an alternative form of the present invention; and

FIGURE 6 is a side elevational view of a control switch element constructed in accordance with the embodiment of the invention of FIGURE 4.

As shown in FIGURE 1, the complete electric heating pad assembly consists of an appliance plug 20 (to be inserted in a utility wall socket), an appliance cord 22, and the heating assembly indicated generally at 24. The latter consists of a blanket-like cloth pad having a series of resistance heating wires embedded therein and defining the electrical resistance indicated diagrammatically at 26. Current flow through these wires heats the pad to accomplish the desired heating action. A thermostatic switch indicated generally at 28 is connected in circuit with the heating pad resistance element 26 and serves to interrupt the flow of heating current when the temperature sensed by the switch exceeds a predetermined limit and to initiate heating current flow when this temperature falls below a predetermined limit. To this end, the switch 28 is located in the heating pad in thermal communication with the heated pad portion (as by enclosing it in a protective capsule in the pad itself) and has temperature responsive contact make and break action as hereinafter described.

The thermostatic control switch 28 consists of a pair of spaced bimetal arms 30 and 32 which straddle the insulating block 34 at one end and, at the other end thereof, carry the registered mating contacts 36 and 38. A pair of bolts 40 and 42 extend through the block 34 and the elements 30 and 32 and are drawn tight by nuts 41 and 43, respectively, to hold the arms firmly against the block 34 as shown. The head of the bolt 40 seats against the element 32 as shown to make electrical contact therewith. Similarly, the head of the bolt 42 seats against the element 30 to make electrical contact. Solder lugs 40a and 42a are sandwiched between the bolt heads and the respective contact arms and are connected to the appliance cord 22 and the resistance 26 as shown. Insulating washers

41a and 43a are located between nuts 41 and 43 and the contact elements 30 and 32, respectively. Electrical contact between elements 30 and 32 and the bolts 40 and 42, respectively, is further prevented by enlarged openings in each of these elements to clear the bolts as they pass through these arms. Thus, the electrical circuit extends from the appliance cord 22 to resistance 26, through element or arm 30 and contact 35 to contact 38 and element or arm 32, and thence back to the other conductor of appliance cord 22.

As best seen in FIGURE 2, the elements or arms 30 and 32 are each defined by a pair of metal strips 30a and 30b, and 32a and 32b, respectively. These are of metals having unlike coefficients of thermal expansion, elements 30a and 32b having a lesser coefficient of expansion than the elements 30b and 32a. In consequence, the element 32 bends downwardly as seen in FIGURE 1 as temperature falls and the element 30 bends upwardly. This action is progressive in that the contacts 36 and 38 progressively approach each other as temperature falls and ultimately touch each other without substantial pressure when a predetermined temperature is reached.

The contacts 36 and 38 are each made of a mixture of magnetic and nonmagnetic granules, pressed at room temperature or under heat to define the flat mating contact faces 36a and 38a. The inboard portions 30b and 32a of arms 30 and 32 each have a protruding key 31b and 33a, respectively. These keys each have overhanging portions defining locking conformations to anchor the contacts 36 and 38, respectively, to the elements 30 and 32, respectively. The keys 31b and 33a are embedded in the contacts 36 and 38 to achieve this anchoring action.

The composition of each of the contacts 36 and 38 is shown in enlarged cross-sectional view in FIGURE 4. Each is composed of magnetic particles M uniformly dispersed over the contact volume and conducting particles C likewise uniformly dispersed over the contact volume. In the preferred form of the contacts 36 and 38, the magnetic particles are of Alnico V and are of maximum dimension less than about a tenth of the smallest dimension of the contacts 36 and 38. Thus, if the contacts 36 and 38 are $\frac{1}{8}$ inch thick, the magnetic particles have perhaps $\frac{1}{100}$ inch maximum dimension. Thus, with a chance distribution of the magnetic particles there is a rather uniform magnetic effect over the contact volume and a uniform distribution of the conducting particles over the contact volume. In the preferred form of the contacts 36 and 38, the conducting granules or particles are of silver and are of substantially smaller size than the magnetic particles, as shown in FIGURE 4.

Alnico V is one of a family of aluminum, nickel, cobalt alloys characterized by high residual induction and stored magnetic energy. The composition of this specific alloy is about 8% aluminum, 14% nickel, 3% copper, 24% cobalt, and the balance iron. Its mechanical properties are characterized by extreme hardness and brittleness.

The contacts 36 and 38 are made by placing the Alnico V and silver granules in a suitable container, mixing them to provide a homogeneous mixture, and then placing the mixture in a suitable mold with the contact arm in place with its lock portion (31b or 33a, FIGURE 2) extending into the mixed particles. Pressure is then applied to the mold, preferably by a piston located against what becomes the contact face (36a or 38a) of the contact. Sufficient pressure is applied to force the relatively soft silver granules against each other and the Alnico V granules to deform the silver and pressure weld them together in a coherent dimensionally stable mass. If desired, heat can be applied during the course of this process to reduce the required pressure. The completely formed arm and contact assembly can then be removed from the mold. Alternatively, contacts 36 and 38 may be pressed into the desired size and shape separately and suitably fastened

to arms 30 and 32 as, for example, by soldering or brazing.

The magnetic particles are magnetized to define a pole of one polarity at the contact face 36a and pole of opposite polarity at the contact face 38a. This may be done by using magnetic particles having an initial magnetization and applying a magnetic field to the mixture while in the mold to orient the magnetic particles in pole-defining directions. Alternatively, the magnetic particles may be magnetized after the contacts are formed by application of a suitable magnetizing field. In another alternative, only one contact need be magnetized, the other merely containing a magnetic material.

FIGURES 5 and 6 show a switch embodying an alternative form of the present invention. In this structure relatively rigid contact element 132 carrying contact 138 is located in cooperative relation to the relatively flexible element 130 carrying contact 136. Contact 136 mates with and makes contact with the contact 138. The elements 130 and 132 straddle and are supported by the insulating block 134 which may be of any suitable insulating material. In the structure of FIGURE 5 the flexible element 130 is moved into and out of contact-making position by the actuator 100, shown in somewhat diagrammatic form in the figure. This actuator moves in response to some external condition, such as weight on a scale, humidity, air velocity, etc., to bring arm 130 progressively towards contact-making position as such condition varies in one sense and moves in the other direction when such condition varies in the opposite sense.

In the form of the structure shown in FIGURES 5 and 6, the elements 136 and 138 each have an opening such as 130a, FIGURE 6, that defines locking conformations to receive the contact button 136 or 138. As shown in FIGURE 6 the contact button extends on both sides of the opening to be locked in position. Preferably, the contact button is pressed into its final coherent shape with the contact element in place, thereby rendering a subsequent assembly operation unnecessary.

Preferably the magnetic granules of the contacts 136, 138, 36 and 38 are one of the Alnico alloys whose composition and characteristics are described at page 2-96 of Pender and Del Mar, "Electrical Engineers' Handbook" (1949). Other hard ferromagnetic materials may also be used, such as iron containing 1% carbon, iron containing 1% carbon and $3\frac{1}{2}$ % chromium, 36% cobalt chromium tungsten (0.85% carbon, 36% cobalt, 3.5% chromium, 3% tungsten, balance iron), an alloy of 12% cobalt, 17% molybdenum, balance iron, and others. Many of these alloys have the property of being magnetized more easily than the Alnicos, or being suitable for magnetization at relatively low temperatures.

The conducting granules used with the above hard magnetic materials may be any one of the many soft conducting materials such as silver, gold, copper, and the various relatively soft conducting alloys, such as German silver. In each instance the magnetic and the conducting particles are mixed to form a homogeneous mixture and pressed and magnetized, if desired, as described above to form the contacts.

The quantity of magnetic material and the degree of permanent magnetization provided in the contacts 36, 38, 136 and 138 is sufficient to provide effective snap action giving positive contact closing and opening. The exact quantities depend upon the required switch action, and especially on the extent snap closing and opening of the contacts is desired. The quantity of conducting granules used is chosen to provide the electrical conductivity necessary for the required current capacity, operating voltage, and contact life (taking into account the conductivity of the magnetic granules).

While the structures here shown and described use hard magnetic granules and relatively soft conducting granules, the desired action may be achieved through the use of hard conducting granules and relatively soft magnetic granules.

The magnetic granules may be magnetized prior to the pressing of the contacts. In this event an external magnetic field is applied prior to the pressing operation to orient these granules to define the necessary poles in the overall contacts. Alternatively, the contacts may be formed with the magnetic granules initially unmagnetized and the magnetizing field applied to the contact after formation.

In the above description and the appended claims the magnetic and conducting granules are described as "hard" or "soft" to indicate their action under the applied pressure (and in some instances heat) of the forming operation. That is, the hard granules retain their prior shape during this process and do not substantially deform, whereas the soft granules deform and adhere to each other and to the hard granules to form the cohesive unitary contacts.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A small size electrical contact mechanism characterized by positive circuit making and breaking action, comprising in combination: means defining a pair of relatively movable and relatively resilient contact support elements operable to approach each other progressively in a predetermined direction as a condition varies in one sense and to recede from each other in said direction as the condition varies in opposite sense; and a pair of integral contact elements carried by said contact support elements, respectively, said contact elements being in registering relation to make electrical contact therebetween when the support elements approach each other, each of said contact elements being composed of a unitary body having a plurality of hard granules of magnetic material uniformly distributed in a mass of relatively soft granules of electrically conducting material, the mixture being pressed to define a self-sustaining body integral with said support elements, the magnetic granules of at least one of said contact elements being magnetized with like polarities in said direction to define a pair of magnetic poles in said direction, whereby the magnetic action provides integral snap action and positive contact making and contact breaking.

2. A small size thermostatic switch comprising in combination: a pair of relatively movable and relatively resilient contact support arms operable to approach each other progressively in a predetermined direction as temperature varies in one sense and to recede from each other in said direction as temperature varies in opposite sense, and having aligned registering openings; and a pair of integral contact elements carried by said contact support elements, respectively, in registering relation to make electrical contact therebetween, said contact elements extending on opposite sides of said support arms through said holes to be anchored in position thereby, each of said contact elements being composed of a unitary body having a plurality of relatively hard magnetic granules uniformly distributed in a mass of granules of relatively soft electrical conducting material, the mixture being pressed to define a self-sustaining body, the magnetic granules of at least one of said contact elements being magnetized with like polarities in said direction to define a pair of magnetic poles in said direction, whereby the magnetic action of the magnetic granules provides integral snap action and positive contact making and breaking and the conducting material defines an electrically conducting path.

3. A small size thermostatic switch comprising in combination: a pair of relatively movable and relatively re-

silient contact support elements operable to approach each other progressively in a predetermined direction as temperature varies in one sense and to recede from each other in said direction as temperature varies in opposite sense and having aligned registering locking conformations; and a pair of integral contact elements carried by said contact support elements, respectively, and embracing and locking conformations, each of said contact elements being a two component homogeneous mixture of granules of a relatively hard material and granules of a relatively soft material pressed to define a unitary body, one of said materials being magnetic and the other of said materials having relatively good electrical conductivity, the contact elements having relatively good electrical conductivity, the magnetic granules of said contact elements being magnetized in a common polarity in said direction to define mutually attracting poles, whereby the action and positive contact making and breaking and the conducting material defines a good electrically conducting path.

4. In a small size switch construction of the type in which relatively movable and relatively resilient contact support elements approach each other progressively in a predetermined direction as a condition varies in one sense and recede from each other in said direction as the condition varies in opposite sense, the improvement comprising: a pair of integral contact elements carried by said contact support elements, respectively, in registering relationship to make electrical contact therebetween, each of said contact elements being composed of a unitary body having a plurality of Alnico granules uniformly distributed in a mass of granules of silver, the mixture being pressed to define a self-sustaining body, the Alnico granules of the cooperating pairs of contact elements being magnetized with like polarities in said direction to define mutually attracting poles, whereby the magnetic action of the Alnico granules provides integral snap action and positive contact making and breaking and the silver defines an electrically conducting path.

5. An electrical contact element for a small size switch having relatively movable contact-carrying arms that gradually approach each other in a predetermined direction to make contact, the contact element being adapted to engage another contact element and comprising a unitary body having a plurality of hard granules of permanent magnet material uniformly distributed in a mass of relatively soft granules of electrically conducting material, the mixture being pressed to define a self-sustaining body with a planar face adapted to mate in contact-making engagement upon movement with the similar face of the other contact, the element being magnetized for attraction by magnetic coaction with said other contact element to provide snap action and positive contact making and contact breaking.

References Cited in the file of this patent

UNITED STATES PATENTS

1,978,065	Twombly	Oct. 23, 1934
2,322,235	Howard	June 22, 1943
2,324,262	Lamb	July 13, 1943
2,493,899	Prouty	Jan. 10, 1950
2,553,768	Howell	May 22, 1951
2,694,126	Binstock	Nov. 9, 1954
2,731,529	Leins	Jan. 17, 1956

FOREIGN PATENTS

600,250	Great Britain	Apr. 5, 1948
608,695	Germany	Jan. 29, 1935
1,134,382	France	Dec. 3, 1956