Aug. 6, 1957 M. W. CARLSON ET AL 2,802,076

NON-BOUNCING SNAP SWITCH

Filed April 30, 1956

Fig. 1

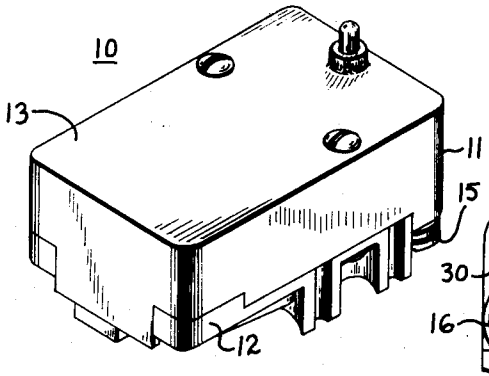


Fig. 2

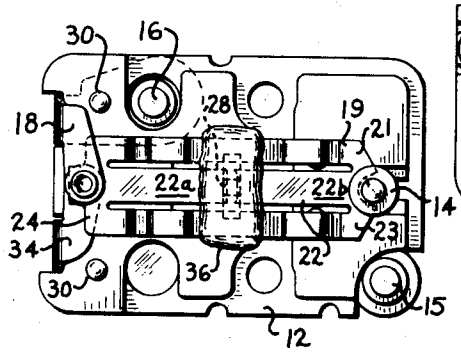


Fig. 4

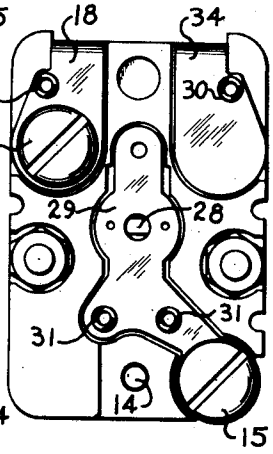
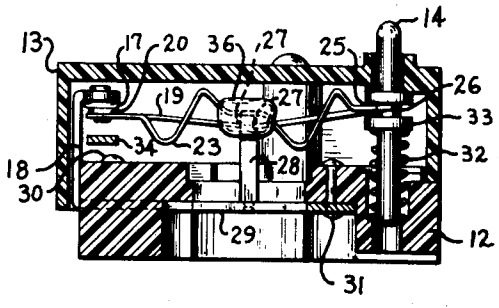


Fig. 3



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NON-BOUNCING SNAP SWITCH

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11 Claims. (Cl. 200—67)

Our invention relates to electric snap switches and, more particularly, to electric snap-acting switches which utilize a leaf-spring member in the contact-actuating mechanism.

One of the most difficult problems in small snap-acting electric switches is their tendency to weld upon contact engagement under load. This problem of contact welding is particularly prevalent where small snap-acting electric switches are utilized to control the operation of electric motors since the in-rush of starting current when the switch contacts engage is several times greater than the normal load current.

One of the chief causes of such welding is believed to be due to the bouncing of the contacts when they engage under high velocity. Many expedients such as damping pads have been utilized to reduce contact bounce in relatively large switches or contactors but these expedients are generally inapplicable to switches of the small snap-acting leaf-spring variety.

Accordingly, an object of the invention is to provide improved snap-acting switches characterized by greatly increased life before the occurrence of a failure due to contact welding.

Another object is to provide snap-acting electric switches having reduced bouncing of the contacts.

A further object is to provide an improved vibration-damping mechanism for operating the contacts of an electric switch.

In general, in accord with the invention, an electric switch is provided in which a flat-strip member carries a movable contact into engagement with a stationary contact, and a cold-pliant, plastic material envelops this flat-strip member in a region removed from the contacts which tends to move as a result of reaction forces developed upon contact engagement. The phrase, "cold-pliant plastic materials," is used to connote pliable solid materials which may easily be formed or molded at normal room temperatures and which retain their plasticity even at low temperatures in the neighborhood of zero degrees centigrade. For optimum results this cold-pliant plastic material is preferably thixotropic and has high viscosity and low elasticity. By using such materials in accord with the invention, it has been found possible to increase the number of switch operations without failure due to welding to many times the number of operations without the presence of such material.

The novel features believed characteristics of the invention are set forth in the appended claims. The invention itself, however, together with further objects and advantages thereof may be easily understood by referring to the following description taken in connection with the accompanying drawing.

Figure 1 is a perspective view of a switch embodying the invention,

Figure 2 is a plan view of the switch of Figure 1 with the cover removed, and

Figure 3 is a cross-sectional side view of the switch of Figure 1, and

Figure 4 is a bottom plan view of the switch showing the terminal connections thereof.

Referring to the drawing, we have shown our invention in one form embodied in snap-acting switch **10** including a generally rectangular insulating housing **11** divided into a base member **12** and a cover member **13**. The switch mechanism is mounted within the housing and arranged to be actuated by a push-button type rod or plunger **14** extending through the top of cover member **13**. Screw-down terminals **15** and **16** are provided within suitable recesses of the base member **12** for making connection to an electric circuit whose current is to be interrupted.

Within housing **11** at one end is provided a stationary contact **17** connected by terminal strip member **18** to terminal **16**. A snap-acting-switch mechanism including a leaf-type-spring member **19** carries a second or movable contact **20** at one end into high velocity engagement with stationary contact **17** during movement into its contact-making position. Strip member **19** is preferably composed of a resilient or spring-type conductive metal such as berryllium copper.

In the particular snap-acting mechanism shown in the drawing, strip member **19** includes three generally parallel arms **21**, **22** and **23** all joined together at both ends and with the central arm split into two longitudinally extending sections **22***a* and **22***b* respectively. One end **24** of strip member **19** carries movable contact **20** while the other end **25** partially encircles a shouldered-portion **26** of actuating rod **14**. The outer arms **21** and **23** are pressed into a corrugated or undulating configuration, as shown in Figure 3, in order to produce an end-to-end tension in the member **19**. The inner ends of the two sections **22***a* and **22***b* of the central arm **22** fit within notches **27** on opposite sides of a central conductive metal post **28** about which the strip member **19** stresses and pivots. Metal post **28** is fastened to terminal strip member **29** upon which screwdown terminal **15** is mounted. The terminal strip members **18** and **29** and the components mounted thereon are firmly held in place on base member **12** by virtue of suitable rivets **30** and **31** respectively. A coil spring **32** beneath a shoulder **33** of actuating rod **14** tends to keep rod **14** in its elevated position.

As is well known, depression of actuating rod **14** causes the contact-carrying end **24** of strip member **19** to move away from stationary contact **17** with a snap action until the end **24** comes to rest against a back stop member **34**. When push button **14** is released the actuating rod **26** and button **14** are elevated by the action of spring **32** carrying the adjacent end **25** of strip member **19** upward above the pivot points represented by notches **27** on post **28** thereby causing contact-carrying end **24** to close contacts **17** and **20** with a snap action.

The snap-acting switch mechanism described above is not our invention but represents one of many similar types of snap-acting switch devices which may suitably embody our invention. A snap-acting switch of the general type described above is described and claimed in United States Patent 2,332,911, granted to G. M. Hausler on October 26, 1943, and assigned to the present assignee.

In accord with our invention, a body of cold-pliant plastic material **36** is applied to strip member **19** in a region remote from movable contact **20** where the reaction forces of contact engagement tend to cause movement of the strip member **19**. In the snap-acting switch shown in the drawing, this comprises the central region of strip **19** in the vicinity of post **28**. The material of body **36** adheres to and embeds this central region. Preferably body **36** extends across and envelops all three arms **21**, **22** and **23** of strip **19** in this central region of strip **19** so that the body **36** tends not only to absorb reaction forces but also to impede the speed of relative movement between the central arm portions **22***a*, **22***b* and

the outer arms **21**, **23**. However, considerable improvement in reducing contact bounce is achieved by applying plastic bodies between any pair of members having relative motion. For instance, plastic body **36** can be applied between any pair of legs **21**, **22** and **23** or between the strip member **19** and the base member **12**. The body is preferably applied, however, so as also to embed the region of loose mechanical coupling at the pivots between the inner ends of central arm portions **22***a* and **22***b* of strip member **19** and the notches **27** on post **28**. This pivotal region may be embedded within plastic body **36** regardless of whether post **28** is stationary as described above in connection with switch **10** or is utilized for actuating strip member **19** by reciprocation as described in the above-mentioned Hausler Patent 2,332,911. The purpose of the plastic body is to dissipate energy in excess of that required to merely close the contact, which would ordinarily be stored in vibrations of spring member **19**, and result in contact bounce until the energy was dissipated by hysteresis and friction.

Although some measure of improvement is observed with any cold-pliant plastic material, for example—putty or clay, optimum results are achieved if the material is (*a*) "thixotropic," i. e., retains its molded shape and exerts no force upon a stationary embedded object but flows as a result of movement of such embedded object; (*b*) has "high viscosity," i. e., generates a force opposing the movement of an embedded object in a flowing material to a degree considerably above the opposing force generated by water; and (*c*) has "low elasticity," i. e., does not tend to resist deformation or to recover its original shape when deforming forces are removed as would be the case, for example, with vulcanized rubber-like materials. This is important, since otherwise the minimum allowable contact force, so essential to reliable switch operation, would be reduced. Further improvement in the physical characteristics, especially with respect to reducing or eliminating static flow is achieved if the plastic body contains added inert fillers, such as cotton fibers, as a strengthening and viscosity-increasing agent.

Illustrative of the phenominal improvement resulting from the invention are the results of the following tests. Five electric switches **10** utilizing a plastic body **36** consisting of a putty-like material known as "Duxseal" manufactured by John Mansfield Company were connected to operate a ½ horsepower motor load in a circuit having about 44.4 amperes in-rush current for 1/10 second, and carrying 7.4 amperes full-load current at 115 volts. Without such plastic body **36** these switches normally have an average life of from 10,000 to 15,000 operations before welding when tested with this load. These five switches utilizing this "Duxseal" plastic body **36** failed by welding at 315,058; 243,273; 145,477; 61,572; and 52,234 operations respectively.

Another specific material found particularly suitable for use as plastic body **36** is a silicone compound, type S–2706, commercially available from the Dow Corning Corporation. Analysis of this material indicates that it is a dimethyl silicone gum compounded with silica fillers without a vulcanizing agent. This material should have a plasticity in the range of 60 to 90 mils, as measured on a Williams Plastometer. Preferably this Dow-Corning S–2706 compound is thoroughly mixed with medical cotton fibers in a ratio of 80 parts compound to one part fibers by weight. This mixture is particularly suitable because it neither hardens, flows, decomposes or otherwise changes for a long-life period, for example 20 years. In addition, it does not flow even under conditions of relatively high temperature, for example 200 degrees Fahrenheit, and does not produce vapors which may contaminate the switch contacts.

The surfaces of strip member **19** should be thoroughly clean before plastic body **36** is applied. The body **36** is pressed into place by suitable pressure around its periphery to assure good adherence between the plastic body **36** and the portion of strip member **19** embedded thereby.

Tests upon switches utilizing this silicone compound plastic body **36** have indicated that the number of average operations under load was increased from about 12,500 to 135,000 operations before welding when used in a motor-starting circuit as described above in connection with the Duxseal tests.

Although we have described our invention above in connection with specific materials and specific switch mechanisms it will be understood that the invention involved is equally applicable to many other similar types of materials and switch mechanisms. It is to be understood, therefore, that we intend by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

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

1. An electric switch comprising a first contact, a strip member having a second contact mounted thereon, means acting upon said strip member for rapidly moving said second contact into engagement with said first contact and producing upon said contact engagement reaction forces tending to cause movement of said strip member in a region removed from said contacts, and a body of cold-pliant plastic material adherent to a portion of said region of movement of said strip member for absorbing some of said reaction forces.

2. The electric switch of claim 1 wherein said plastic body includes a small percentage of cotton fibers.

3. The electric switch of claim 1 wherein said plastic body comprises a puttylike material of high viscosity.

4. The electric switch of claim 1 wherein said plastic body is thixotropic with high viscosity and low elasticity.

5. The electric switch of claim 1 wherein said plastic body comprises a dimethyl silicone gum compounded with silica fillers and free of vulcanizing agents.

6. The electric switch of claim 5 wherein the plastic body contains a small percentage of cotton fibers.

7. An electric switch comprising a first contact, a resilient flat strip member having a second contact mounted thereon, means acting upon said strip member for moving said second contact with snap-action into engagement with said first contact and producing upon said contact engagement reaction forces tending to cause flexure of said resilient strip member in a region removed from said contacts, and a body of cold-pliant plastic material surrounding and adhering to a portion of said region of flexure of said strip member for reducing bouncing of said contacts.

8. An electric switch comprising a first contact, a flat strip member having a second contact mounted thereon, said strip member being pivotally mounted, means acting upon said strip member for rapidly moving said strip member about its pivot to bring said second contact into engagement with said first contact, and a cold-pliant plastic body surrounding and adhering to a portion of said flat strip member and the pivotal mounting thereof.

9. An electric switch comprising a first contact, a flat metal strip member having a second contact mounted thereon, a post member loosely coupled mechanically to said strip member in a region remote from said second contact, means for producing relative movement between said strip member and post member to bring said second contact rapidly into engagement with said first contact, and a body of cold-pliant plastic material adhering to and embedding said strip member and post member in the region of said loose mechanical coupling.

10. An electric switch comprising a first contact, a flat metal strip member having a pair of parallel arms joined together at one end, a second contact mounted at said one end, operating means acting upon said strip member for moving one arm relative to the other arm to snap said second contact into engagement with said first con-

tact, and a body of cold-pliant plastic material extending across and adherent to a portion of said relatively moving parallel arms.

11. An electric switch comprising a base member, a first contact mounted on said base member, a flat metal strip member having a second contact mounted at one end, operating means acting upon said strip member for moving the second contact rapidly into engagement with said first contact, and a body of cold-pliant plastic material extending between a portion of said strip member and a component of said switch having considerable movement relative to said strip member portion during actuation of said operating means.

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