Sept. 12, 1961 G. F. KINCAID ET AL 2,999,912

SWITCH

Filed Nov. 13, 1957 2 Sheets-Sheet 1

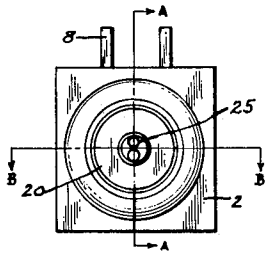

fig. 1

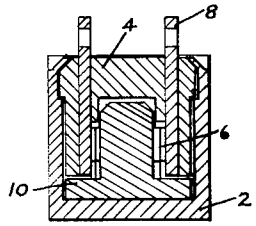

fig. 5

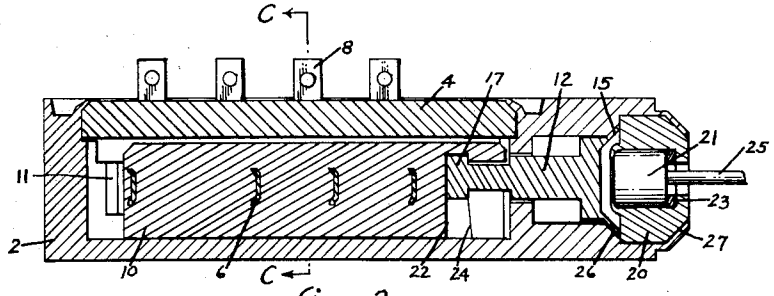

fig. 2

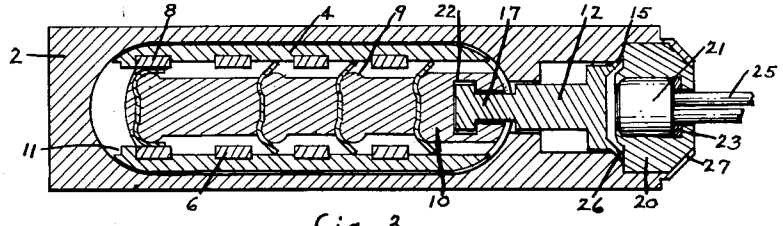

fig. 3

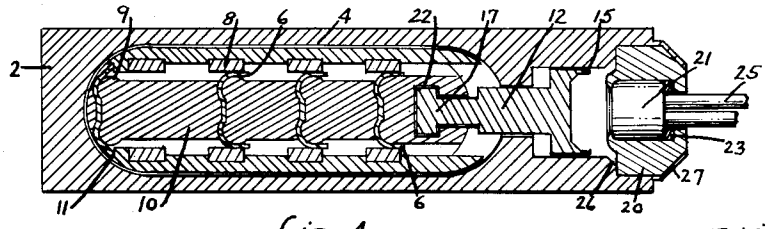

fig. 4

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SWITCH

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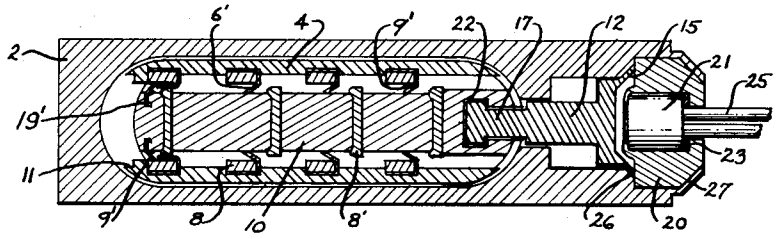

fig. 6

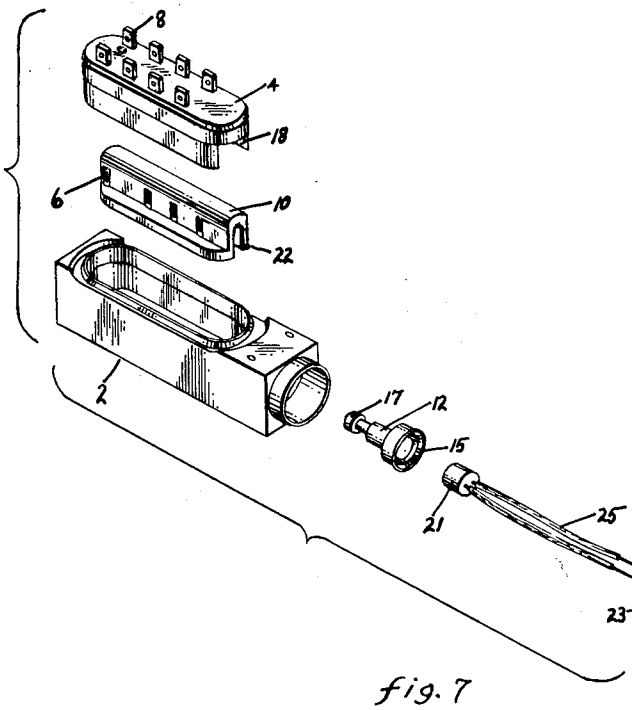

fig. 7

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SWITCH

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5 Claims. (Cl. 200—82)

This application relates to a switch and is particularly related to a squib-actuated, plunger-type switch of improved design possessing exceptional stability.

Certain types of projectiles and missiles adapted for travel at high speeds require the use of switches that are highly reliable and of outstanding stability. Such devices also require the use of switches that provide strong positive contact free from chatter or vibration and of low contact resistance. It is therefore an object of the present invention to provide a switch of extremely rugged construction which is able to withstand shock in all directions.

Another object of the present invention is to provide a switch that is highly reliable and capable of carrying high amperage and voltage without jump or breakdown.

A still further object of the present invention is to provide a switch of very small size and of low contact resistance.

The switch of the present invention comprises in combination a switch housing and at least one electrical contact member attached to said housing. At least one other electrical contact member is attached to a slide member mounted in the switch housing for longitudinal movement. The slide member is so shaped in relation to the housing that lateral and rotational movement in any direction within the housing is prevented. The slide member is provided as hereinabove set out with longitudinal movement within the housing such that electrical contact is made and broken between the electrical contact members attached to the switch housing and the electrical contact members attached to the slide member. A squib may be located within the switch housing in such manner that when the squib is fired a piston is driven forward. The piston is operatively attached to the slide member so that the flexible contactors which are mounted in the slide member make or break contact with the fixed contactors which are mounted in the switch housing.

The advantages and improvements in the switch of the present invention will be apparent from the following description of the invention taken in connection with the accompanying drawings wherein:

FIGURE 1 is a plan view of an embodiment of the invention.

FIGURE 2 is a view in section, taken along line A—A of FIGURE 1.

FIGURE 3 is a view in section, taken along line B—B of FIGURE 1.

FIGURE 4 is a view similar to FIGURE 3 except that the squib has been fired and the switch has been actuated.

FIGURE 5 is a section taken along line C—C of FIGURE 2.

FIGURE 6 is a section of an alternate embodiment of the invention.

FIGURE 7 is an exploded view of the switch.

Referring now to the drawings in which like numerals and references are employed to designate like parts throughout the several views; the numeral **2** refers to the switch casing and **4** is a flexible contactor holder, fabricated from Teflon, nylon, other plastic or suitable non-conducting material. The holder **4** when crimped into the switch casing **2** provides with the caisng a complete housing for the switch elements which is referred to throughout the specification and claims as the switch housing.

A plurality of fixed contact members **8**, are serially attached along the length of the fixed contactor holder **4**. The fixed contact holder **4**, containing the fixed contact members **8**, is assembled with the switch casing **2**, and forms the top element of the switch housing. Fixed contactor holder **4**, is further provided with a longitudinal groove **18**, which is adapted to receive and partially support a slide member **10**, also made of nylon or other suitable non-conducting material, said slide member **10**, having fixedly attached therein a plurality of serially arranged flexible contact members **6**, which are fabricated from a suitable electrical conducting material. The flexible contact members being so mounted in the slide member **10**, that they may be each operatively engaged or disengaged from the fixed contact members **8**, which are mounted in the fixed contactor holder **4**, upon forward movement of the slide member **10**, during the operation of the switch.

It will be noted that slide member **10**, is provided with opposed flat bearing surfaces which are closely adjacent to casing **2**, and contact pin holder **4** respectively. Slide member **10**, is also provided with opposed flat bearing surfaces at right angles thereto. Two of these flat bearing surfaces are on each side of slide member **10**. One such bearing surface is against switch casing **2**, and the other is against the side of fixed contact holder **4**. In this way, slide member **10**, is provided with a very great degree of stability against lateral motion, both of an up and down and side to side variety. Moreover, the bearing surfaces extend on both ends above and below the area in which contact members **6**, are located on slide member **10**. In this way stability against a twisting or cantilever action is provided in all directions.

The fixed contact holder **4**, is further provided with a retaining lip **11**, at one end thereof, which lip is adapted to receive the first or foremost flexible contact member **6**, mounted in the slide member **10**, after the slide member has been driven to its most forward position. Upon firing of the switch the two foremost contact members spring out into engagement with retaining lip **11**, thereby preventing the slide member **10**, from returning to its original position within the switch housing and providing positive locking of slide member **10**, against an inner wall of the switch casing **2**, when in the fired position (see FIGURE 4). It has been found desirable to gold plate the fixed contact members **8**, and the flexible contact members **6**, in order to provide for a lower resistance path for the electric current.

Behind each flexible contact member **6**, mounted in said slide member **10**, is located a projection or bead **9**, of such size that when said flexible contact members **6**, are flexed or bent in the normal operation of the switch, the flexible contact members **6**, are bent on a radius and retain their springiness and shape. The projections or beads **9**, also promote firm positive contact pressure between the flexible contact members **6**, and the fixed contact members **8**, and prevent the flexible contact members **6**, from cracking or breaking upon firing of the switch.

Slide member **10**, is provided with a key slot **22**, having a tapered or inclined surface **24**, adapted for receiving an enlarged section **17**, of a piston **12**. The other end of said piston **12**, is also enlarged and flared as at **15**. At least the flared portion **15**, of piston **12**, is made of soft malleable metal, as for example aluminum. In assembling piston **12** in the switch casing **2** and slide member **10**, enlarged section **17** is forced into key slot **22**, against inclined surface **24**, so that the flared surface **15**, of piston **12**, is seated firmly against a bearing surface **26** of switch casing **2**; and slide member **10** is held rigidly against an inner wall of switch casing **2**, Piston **12**, there-

fore is held under longitudinal tension between slide member **10** and switch casing **2**, prior to activation of the switch. Thus the slide member **10**, is positioned within casing **2**, with a high degree of longitudinal stability. The positive seating of flare **15**, within the switch housing provides a completely sealed enclosure for entrapping the gases which are expelled upon the firing of a squib **21**. Squib **21** is encased in squib holder **20**, and squib holder **20** is crimped into the switch casing **2** in gas tight manner. The power charge in squib **21**, is a low explosive gas-producing charge which when fired produces a sufficient quantity of gas to overcome the structural strength of flare **15**, and pushes the piston **12**, and the slide member **10**, to its forward limiting position.

It has been found desirable to fabricate squib holder **20** of metal; said holder having a cavity to receive the squib, which contains a gas-producing charge such as, for example, a mixture of lead mononitroresorcinate and potassium nitrate (95/5) pressed at approximately 5,000 p.s.i. in intimate contact with an electric igniter assembly, from which wire leads **25** extend through a hole in said squib holder.

In the normal operation of the explosive switch an electric current is brought, by means of lead wires **25**, to the squib **21**, said electric current firing the squib **21**. The gases produced by the firing of the squib **21** push against piston **12** with sufficient force that the flared portion **15** is deformed, and piston **12**, and slide member **10**, to which the piston is attached are driven to the forward position of slide member **10**, as illustrated in FIGURE 4. Thus, flexible contact members **6**, which are not in operative contact with fixed contact members **8**, are brought into contact, and at the same time those flexible contact members which were formerly engaged in operative contact with the fixed contact members and thereupon disengaged.

While the specific embodiment above illustrated shows a switch comprising a normally closed circuit and three normally open circuits capable of carrying high currents for a short period of time without jump or break-down, it is within the scope of the present invention to fabricate a switch comprising various combinations of open and closed circuits. In addition, two or more of such switches may be effectively joined together such that upon firing of the squib a number of slide members are driven forward carrying with them their respective contact members to thereupon close the normally open circuits and open the normally closed circuits.

It may also be desirable to incorporate a delay element in the operation of the above described switch. For example, a pyrotechnic delay element may be positioned ahead of the gas-producing charge of squib member **21**.

It is also within the scope of the present invention to provide other means of actuating slide member **10**, such as, for example, a triggered spring or compressed gas.

It will also be apparent that although in the specific embodiment of the invention of FIGURES 1 through 5 and 7 the flexible contactors **6**, have been described as being attached to the slide member **10**, and the fixed contact members **8**, have been described as being attached to the fixed contact holder **4**, the reverse arrangement is entirely possible and may be used. In this case, an embodiment of which is shown in FIGURE 6 wherein parts analogous to those on the other figures are given similar numbers, flexible contact members **6'** will be located on fixed contact holder **4**, instead of on the slide member **10**, and fixed contact members **8'** will be located on slide member **10** instead of on contact holder **4**.

It is noted that wherever flexible members, such as **19'** and **6'** are employed it has been found desirable to provide projections or beads for support of the flexible member such as shown at **9'** of FIGURE 6.

In addition to the reversal of the fixed and flexible contact members as illustrated in the specific embodiment shown in FIGURE 6 it will be seen that slide member **10** is provided with flexible locking members **19'** which upon activation of the switch will spring into engagement with retaining lip **11**, thereby preventing the slide member **10** from returning to its original position within the switch housing and providing positive locking of slide member **10** against an inner wall of the switch casing **2**, when in the fired position.

While a particular embodiment of the present invention has been illustrated and described wherein, it is intended to limit the invention to such a disclosure and changes and modifications may be incorporated and embodied therein within the scope of the following claims.

We claim:

1. A switch comprising in combination a switch housing, at least one electrical contact member attached to said housing, a rigid movable nonconducting slide member carrying a second electrical contact member, said slide member mounted in said housing for longitudinal movement and so shaped in relation to said housing that lateral movement in any direction within the housing and rotational movement within the housing is prevented, by means of rigid, contacting, bearing surfaces between said slide member and said housing and independent of said electrical contacts, said slide member being adapted for longitudinal movement within said housing to two positions, at one position said first electrical contact member and said second electrical contact member being operatively engaged and in the other position said first electrical contact member being disengaged from operative contact with said second electrical contact member, means for rigidly holding said slide member in one of said positions, and means for moving said slide member longitudinally within said housing from one of said positions to the other position which comprises a piston and an explosive squib.

2. An explosively operated switch which comprises in combination a switch housing, at least one contact member attached to said housing, a rigid, moveable, nonconducting slide member carrying a second contact member, said slide member being mounted in said housing for longitudinal movement to two limiting positions, at one position said first electrical contact member being operatively engaged, and in the other position said first contact member being disengaged, from operative contact with a second electrical contact member, said slide member being so shaped and mounted in relation to said housing that lateral movement in any direction within the housing and rotational movement within the housing is prevented, means urging said slide member in such manner that said slide member is pressed against said switch housing in one of said limiting positions, means for driving said slide member which comprises an explosive squib and means of firing said squib.

3. An explosively operated switch which comprises in combination a switch housing, a plurality of fixed electrical contact members fixedly attached to said housing and arranged serially along its length, a rigid non-conducting movable slide member carrying a plurality of flexible contact members arranged serially along its length said flexible contact members extending through said slide member to maintain electrical contact with said fixed electrical contact members as the slide member moves longitudinally within said housing, said slide member being supported in said housing against lateral and rotational movement by flat opposed surfaces on at least four sides at least two surfaces of which are arranged at right angles, a piston attached to said slide member in such manner that said slide member is wedged against said switch housing such that said piston is under longitudinal tension prior to activation of the switch, means of driving said plunger and said slide member which comprises an explosive squib and means of firing said squib.

4. An explosively operated switch which comprises in combination a switch housing, a plurality of fixed elec-

trical contact members fixedly attached to said housing and arranged serially along its length, a rigid non-conducting movable slide member carrying a plurality of flexible contact members arranged serially along its length, said flexible electrical contact members being further arranged to engage said flexible contact members as said slide member moves within said housing, said slide member being supported in said housing against lateral and rotational movement by flat opposed surfaces on at least four sides at least two surfaces of which are arranged at right angles, a piston affixed to said slide member by means of an inclined surface which serves to draw said slide member against said housing such that said piston is under longitudinal tension and said piston and said slide member are prevented from longitudinal movement in any direction prior to activation of the switch, said piston being further provided with lonigtudinal stability by means of a flange destructible upon activation of the switch means for driving said piston and said slide member carrying said contact members which comprises an explosive squib and means of firing said squib.

5. An explosively operated switch which comprises in combination a switch housing, a plurality of fixed electrical contact members fixedly attached to said housing and arranged serially along its length, a rigid non-conducting movable slide member carrying a plurality of flexible contact members arranged serially along its length and extending through said slide member, a plurality of projected surfaces, one of each of said surfaces being located behind each projecting fleixble contact member, the arrangement of said flexible contact members being

such that electrical contact is made and broken by sliding movement of said slide member within said housing, said slide member being supported in said housing against lateral and rotational movement by flat opposed right angle surfaces on at least two sides, a piston affixed to said slide member by means of a tapered key slot which serves to draw said slide member against said housing such that said piston is under longitudinal tension and said piston and said slide member are prevented from moving longitudinally in any direction prior to activation of the switch, a destructible flanged member attached to said piston in confined space relationship to an explosive squib and means for moving said piston and said movable slide member, and means for locking said slide member in its fired position.

References Cited in the file of this patent

UNITED STATES PATENTS

285,778	Adams	Oct. 2, 1883
453,484	Jewell	June 2, 1891
1,617,862	Pistor	Feb. 15, 1927
1,671,196	Larson	May 29, 1928
2,249,977	Penfold	July 22, 1941
2,521,561	Batcheller	Sept. 5, 1950
2,564,957	Cermak	Aug. 21, 1951
2,575,147	Unsworth	Nov. 13, 1951
2,594,644	Hansen	Apr. 29, 1952
2,712,791	Bleakney	July 12, 1955
2,816,196	Daudelin	Dec. 10, 1957