Jan. 7, 1964 R. H. F. STRESAU, JR 3,117,194

EXPLOSION ACTUATED ELECTRIC SWITCH

Filed Sept. 26, 1960

FIG. 2

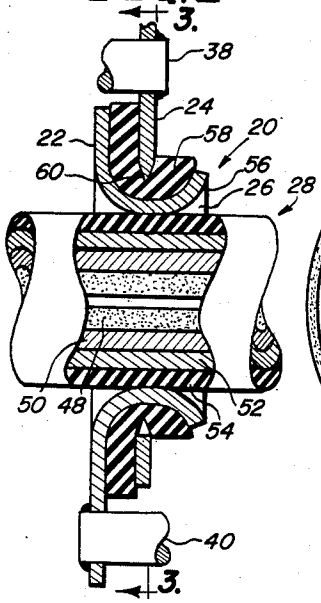



FIG. 3

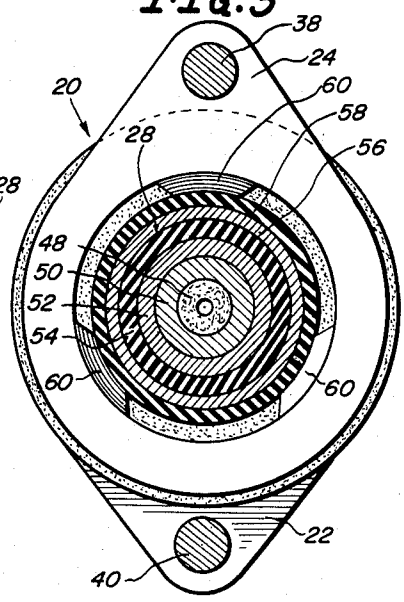



FIG. 4

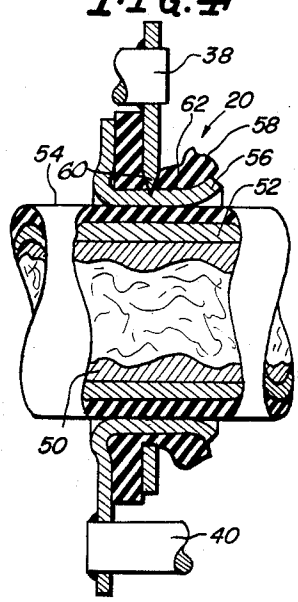



FIG. 5

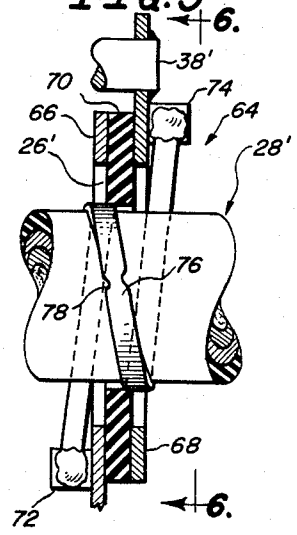



FIG. 6

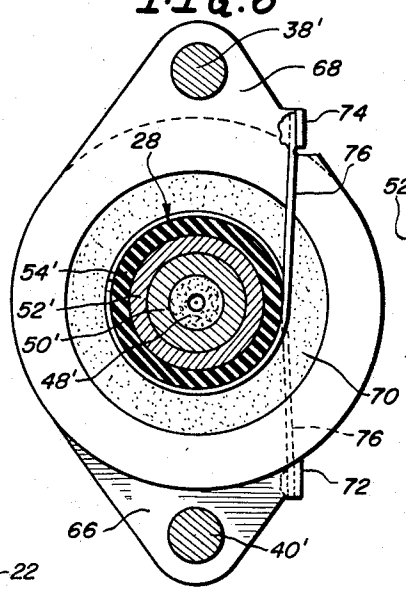



FIG. 7

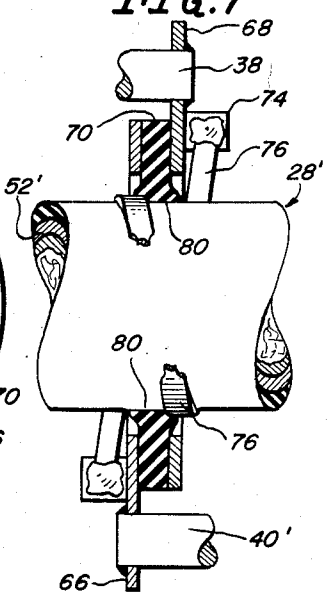
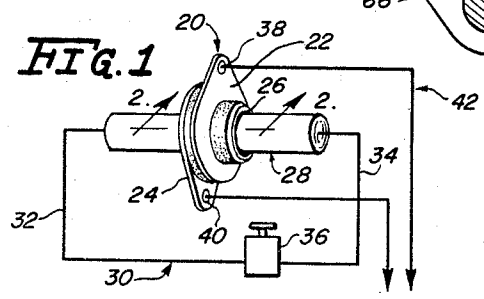



FIG. 1




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# EXPLOSION ACTUATED ELECTRIC SWITCH

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This invention is generally concerned with devices for completing and breaking electrical circuits and specifically relates to electrical switches which are actuated by energy liberated in the detonation of high explosives.

The usual type of an electrical switch is ordinarily actuated by a force which is applied by mechanical, electromagnetic, etc., means which are fairly reliable to change the status of an electrical circuit containing the switch. However, under some special applications, where a high reliability is required in affecting the electrical circuit, or accidental actuation of the switch by vibration or contact is undesirable, the ordinary switches do not possess the desired high statistical performance. This is of particular importance in applications such as missiles, where a malfunction of the switch is beyond control to effect corrective action.

An object of the invention is to provide a switch wherein the actuating force is so much greater than any conceivable accidentally applied force that the possibility of actuation by such accidentally applied force is substantially non-existent.

Another object of the invention is to provide a switch wherein a large number of independent switching functions are performed by a device of smaller dimensions than has heretofore been possible.

A further object of the invention is to provide an electrical switch in which both make and break functions are positive.

A still further object of the invention is to provide a switching system in which individual switch elements are so small that they may be connected serially or in parallel to each other, such redundancy insuring high reliability in a minimum of space.

Other objects and advantages will become apparent from a reference to the following description and the accompanying drawing, wherein:

FIGURE 1 is a pictorial view of an explosive operative electrical switch assembly forming the present invention, connected for an operative application;

FIGURE 2 is a cross-sectional view of one embodiment of a switch assembly along a longitudinal axis thereof, taken along the line 2—2 of FIG. 1;

FIGURE 3 is a transverse cross-sectional view of the switch assembly along the line 3—3 of FIGURE 2, prior to actuation;

FIGURE 4 is a longitudinal cross-sectional view of the switch assembly, similar to the view in FIGURE 2, but after actuation thereof;

FIGURE 5 is a partial cross-sectional view of the second embodiment of the switch assembly along a longitudinal axis thereof prior to actuation thereof;

FIGURE 6 is a transverse cross-sectional view of the switch assembly along the line 6—6 of FIGURE 5; and

FIGURE 7 is a longitudinal cross-sectional view of the switch assembly, similar to the view in FIGURE 5, but after actuation thereof.

In accordance with the teaching of this invention there is provided a switch assembly having an arrangement of elements which form a part of an electrical circuit, the status of which is changed by detonating an explosive core which is effective to change the previous arrangement of the elements.

Referring to FIGURE 1 of the drawing, there is disclosed a switch assembly 20 having a pair of contact



means, such as disk-like contact elements 22 and 24, adjoining each other and having an opening 26 therethrough for admitting an explosive means, such as an explosive element 28, connected in a detonating circuit 30 comprising lines 32 and 34 connected to a source of a detonating signal 36.

The contact elements 22 and 24 have terminals 38 and 40, respectively, connected in an electrical circuit, only partially shown, having lines 44 and 46.

The first embodiment of the invention is concerned with an electrical switch which, responsive to an explosion, effects an electrical contact between its elements to close an electrical circuit. This is shown in further detail in FIGS. 2, 3, and 4.

If reference be had to FIGURES 2 and 3, the explosive element 28 comprises a tubular explosive core 48, an attenuator 50 disposed externally and coaxially to said core, and a tubular container 52 disposed externally and coaxially to said attenuator. The container has a flexible covering 54 of electrical insulation material, such as polyethylene, vinyl resin, natural rubber, etc., disposed circumferentially about its outer surface.

The attenuator 50 is made of porous material, such as paper, for attenuating the explosive force resulting from the detonation of the explosive core 48. The explosive core 48 is a small linear explosive charge such as that of the material known in trade as Low Energy Detonating Cord or Mild Detonating Fuze. The container 52 is made of stainless steel, copper, aluminum or other ductile metal tubing.

The explosive element 28 passes through the opening 26 formed by a flange portion of the contact element 22, said flange portion abutting the covering 54 on the tubing 52. Disposed on the concave surface of the flange portion 56 is an electrical insulator 58 made of flexible material, such as polyethylene. This insulator extends between the contact elements 22 and 24 to electrically isolate said elements on a temporary basis as will be described hereinafter.

The contact element 24 has three arcuate knife edges 60 extending about the flange portion 56 but insulated therefrom by the insulator 58. It is to be understood that more than three individual knife edges may be employed. It is also possible to use a single knife edge having a 360° periphery.

FIGURE 4 shows the switch assembly 20 after it had been actuated by the explosion caused by the detonation of the explosive core 48. The explosion has expanded the ductile tubing 52 and the flange portion 56 of the contact element 22 driving the temporary insulator 58 before it in such a manner as to be perforated by any of the knife edges 60 on the other contact element 24. The expansion of the flange portion 56 is such as to result in permanent forcible contact with the knife edge 60 of such magnitude that the contact element 24 is partially imbedded in the surface 62 of the flange portion 56, as shown in FIGURE 4. This type of contact forming arrangement is reliable since one or more contacts may be established between the two contact elements 22 and 24 anywhere along the circumferential outline existing between the knife edge and the flange portion. The contact element 24 including its knife edges 60 is made from a hard metal such as tempered steel which is preferably gold plated to provide good electrical conductivity and the contact element 22 including the flange portion 56 is made of ductile metal preferably copper.

The second embodiment of the invention is concerned with an electrical switch having contact elements which are in a normally closed position, said switch being responsive to an explosion to open the connection existing between the contact elements to thereby open an electrical circuit connected thereto.

In reference to FIGS. 5, 6 and 7 there is disclosed a switch assembly 64' including an exposive element 28' which is identical in structure to the explosive element 28 described in conjunction with the embodiment disclosed in FIGS. 2, 3 and 4 and, therefore, the elements comprising the explosive element 28' are identified by similar reference numerals which are primed.

The explosive element 28' extends through a large opening 26' formed in disk-like contact elements 66 and 68 which are disposed adjacent each other with an intervening insulator 70 separating said elements and electrically insulating them from contact with each other, said insulator being cemented to said contact elements. The contact elements are preferably made of copper. The contact elements 66 and 68 have outwardly extending lugs 72 and 74, respectively, which have soldered thereto a connecting means such as link 76 which forms a single turn around the explosive element 28'.

The link 76 is preferably a ribbon or silver or other highly conductive metal of low mechanical strength to be stretched beyond its breaking point. To facilitate the disruption of the link 76, a portion of it is notched at point 78.

The insulator 70 is made of flexible material such as rubber and extends radially through the opening 26' to come in contact with the link 76. The switch assembly 64 is primarily supported on the explosive, co-axially thereto, by the link 76. The contact elements have terminals 38' and 40' attached thereto to which an electrical circuit may be connected.

The actuated position of the switch assembly 64 is shown in FIG. 7 wherein the link 76 has been disrupted by the expansion of the tubing 52' due to the detonation of the explosive core 48' within said tubing. The extent of the expansion of the tubing is readily apparent from the deformed shape of the insulator 70 at points 80.

As seen from the foregoing description, the actuating mechanism of the switch device is the expansion of a ductile metal tubing under the impetus provided by an internally contained column of explosive. A feature of the invention is the flexible insulating coating or covering on the tubing whereby its mechanical movement can be transmitted to electrical elements while precluding electrical contact between the tubing and the elements.

Two types of electrical elements have been described; elements which are forced together by movements to establish electrical contact therebetween, and elements which are forced apart by the movement to open an electrical connection existing between said elements.

The electromotive force which may be tolerated between contact elements before closure is greatly increased by separating them by means of an insulator through which the contact elements cut under the action of the actuation force.

Since the switch assemblies described herein are physically small, a large number thereof may be stacked one upon the other with insulating disks therebetween and used in conjunction with a plurality of circuits adapted to perform various functions. Furthermore, more than one switch assembly may be connected in a single circuit. For example, two or more switch assemblies 28 (FIG. 2) may be connected in parallel in an electrical circuit to increase the statistical reliability of closing the circuit. Similarly, the switch assemblies 28' (FIG. 5) may be serially connected with each other in series with an electrical circuit to further increase reliability of opening the circuit.

In one particular form of the first embodiment of the switch assembly 20 shown in FIGURES 1–4, the tubular explosive core 48 had ⅛ inch diameter, surrounded by the attenuator 50 having a 1/16 inch wall thickness and disposed within the tubing 52 made of 0.003" brass sheet. The tubing 52 was encased in the covering 54 made of 0.003 inch vinyl tubing. The contact elements 22 and 24 were made of .006 inch hard brass and possessed ap-



proximately ¾" diameters over the circular portions thereof.

In a particular form of the second embodiment of the switch assembly 64 disclosed in FIGURES 5–7, the explosive element 28' had an outside diameter of ¼" and supported the link 76 made of 0.006 inch thick silver sheet stock, ⅛ inch across its width. The entire switch assembly including a detonator (not shown) were mounted in a metallic rectangular case ½" x ½" x 1".

Although the source of detonating signal 36 is shown in FIGURE 1 as being separate from the switch assembly 20, it is to be understood that the detonating source may be of any form and can be disposed within the same housing with the switch assemblies 22 and 64 thus providing a compact unit.

Although the foregoing description sets out in detailed manner the nature of the present invention, it is to be understood that the constructional features thereof and the arrangements thereof may be varied without departing from the scope or spirit of the invention claimed.

I claim:

1. An explosion operated electrical switch comprising a hollow elongated container constructed of ductile metal, an explosive charge disposed within said container, an electrical insulating medium disposed on the exterior of said container, a first electrical contact element including a flange encompassing said container and disposed on said insulating medium, a second electrical contact element disposed adjacent said first electrical contact element and in contact establishing relationship with the flange thereof, and a flexible electrical insulating medium disposed between said first and second electrical contact elements, said second electrical contact element having a sharp edge adjacent said flange for piercing said flexible insulating medium to establish contact with said first electrical element.

2. An explosion operated electrical switch according to claim 1, including an operative electrical circuit connected across said contact elements, and means for detonating said explosive charge to drive the flange against said sharp edge to close said electrical circuit.

3. An explosion operated electrical switch comprising an outer cylindrical conductor, an inner cylindrical conductor, a solid insulating medium between said conductors and in snug fit relationship therewith, a cutting means on one of said conductors directed toward the other conductor, and an explosive device within the inner conductor, whereby, upon the explosion of said explosive device, the cutting means pierces said insulating medium to establish a permanent electrical contact between said conductors.

4. A switch as defined in claim 3, wherein said explosive device is an electrically ignitable detonator.

5. An electrical switch assembly, in combination, with an elongated explosive container, said container being a hollow tube filled with an explosive charge, said switch assembly comprising an outer hollow conductor, an inner hollow conductor, a solid insulating medium between said conductors in a snug fit relationship and forming an integral unit, said unit being adapted to slip over said tube to be supported thereby, cutting means on one of said conductors directed toward the other conductor, whereby, upon explosion of said charge, said cutting means pierces said insulating medium to establish a permanent electrical contact between said conductors.

6. An electrical switch assembly according to claim 5, including an operative electrical circuit connected across both of said conductors, and means for detonating said explosive charge to drive said inner conductor against said outer conductor.

7. A switch assembly comprising a pair of disk-like, centrally bored, contact elements adapted to be connected to an electrical circuit, means for establishing a predetermined electrical relationship between said contact elements, said contact elements and said means being perma-

nently attached to each other to form an integral unit, said means comprising a solid electrically insulating medium disposed between said contact elements and firmly secured thereto, and a cutting means disposed between said contact elements and adapted to pierce said insulating medium, and an explosively charged elongated member passing concentrically through said central bores to provide a sole support for said unit, whereby detonation of said explosive member ruptures said insulating medium by driving said cutting means therethrough, to thereby establish another predetermined electrical relationship between said contact elements.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 643,491 | De Froment | Feb. 13, 1900 |
| 2,920,166 | Geballe | Jan. 5, 1960 |
| 2,929,892 | Blomgren | Mar. 22, 1960 |
| 2,931,874 | Leaman | Apr. 5, 1960 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 808,698 | Great Britain | Feb. 11, 1959 |
| 832,837 | Great Britain | Apr. 13, 1960 |

# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,117,194 January 7, 1964

Richard H. F. Stresau, Jr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 4, for "(Star Rte., Spooner, Wash.)" read -- (Star Rte., Spooner, Wis.) --.

Signed and sealed this 11th day of August 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

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