Oct. 25, 1955 R. C. KENT, JR 2,721,913

SHOCK AND STATIC PRESSURE DISCRIMINATING SWITCH

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FIG. 1.

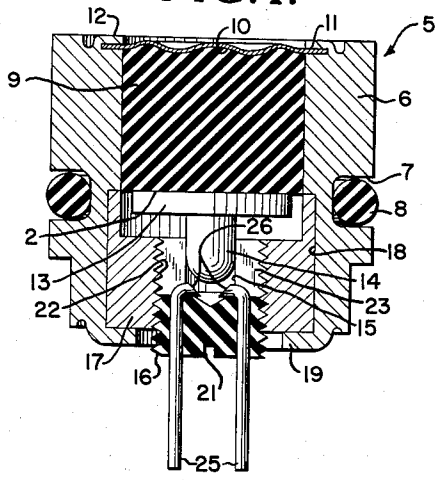


FIG. 2.

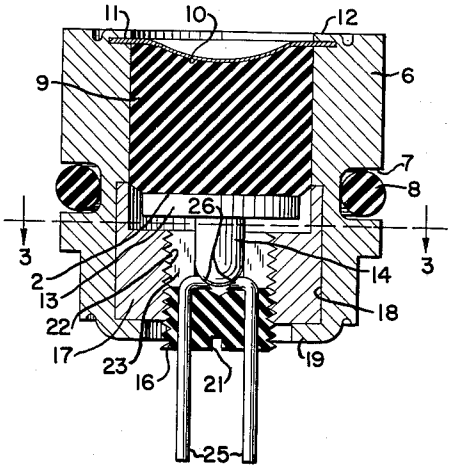


FIG. 4.

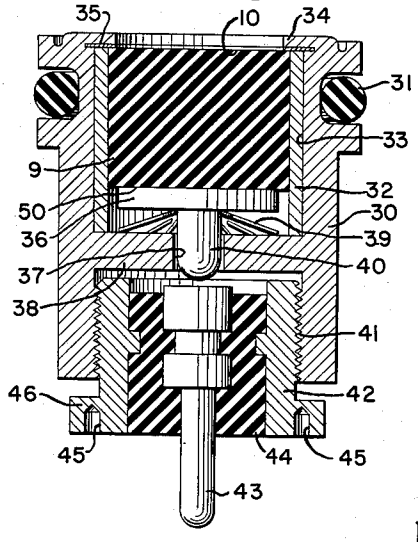
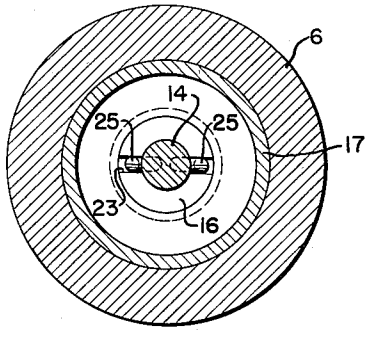


FIG. 3.



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SHOCK AND STATIC PRESSURE DISCRIMINATING SWITCH

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7 Claims. (Cl. 200—83)

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This invention relates generally to circuit makers and more particularly to a new and improved pressure responsive switch adapted to close an electric circuit in response to a predetermined hydrostatic pressure while also having the unique characteristics of remaining substantially unaffected by suddenly applied shock pressures which, if applied statically, would operate the switch to circuit closed position.

Hydrostatic switches of this general type have been extensively employed in various forms of underwater ordnance such, for example, as mines, torpedoes, depth charges and the like wherein these switches operate to electrically arm or render safe, as the case may be, such weapons as they reach a predetermined depth of submergence. In torpedoes, such switches have, of late, been so arranged with respect to the firing control system thereof that as the torpedo is launched from a submarine operating at a considerable depth below the surface of the water the surrounding pressure is effective to actuate these switches to close an electric shorting circuit across the firing circuit of the torpedo whereby premature firing thereof is prevented as the torpedo rises to striking position with the target vessel.

Although this arrangement in torpedoes of switches of this type for the purpose indicated has been found generally satisfactory there is always the possibility that anti-torpedo explosive devices, frequently found arranged about the target vessel and adapted to be detonated by acoustic signals received from the approaching torpedo will, when so detonated, produce within the surrounding water a pressure shock wave of such amplitude as to actuate these switches to circuit closed position thereby to again connect across the firing circuit of the torpedo the shorting circuit to render the torpedo inoperative at a time when the torpedo would otherwise be detonated by contact with the target vessel.

In an effort to forego the possibility of such a condition occurring, various forms of switches and mechanical lock-in arrangements therefor have been devised, tested and ultimately discarded in favor of the switch of the present invention which possesses the characteristics of responding readily to slowly applied pressures as may result from the launching of a torpedo from an undersea craft while remaining substantially unaffected by shock pressure as may be applied thereto from the detonation from close proximity therewith of counter mine apparatus.

It has been found that by providing a switch wherein the pressure responsive element thereof is composed of a suitable plastic material and so formed that the diameter thereof is substantially equal to or less than its thickness and secured fixedly, as by bonding, to the side wall sections of the switch housing rather than by crimping thereto in the conventional manner of such diaphragm securement, as is generally practiced in switches of this type heretofore devised, the material of the element is caused under pressure to flow gradually toward switch closing position at a rate controlled by the plastic flow

characteristics of the material of which the element is composed regardless of the rate at which the pressure is applied whereby a switch possessing wide ranges of pressure response and shock pressure resistance is provided.

It is an object of the present invention to provide a new and improved pressure responsive switch adapted to selectively distinguish between static and shock pressures of varying amplitudes and durations.

A further object is to provide a pressure responsive switch wherein the pressure response thereof is controllable by the plastic flow characteristics of the pressure responsive element thereof.

A further object is to provide a new and improved pressure responsive switch wherein the pressure sensitive element thereof is cast integrally with the switch housing.

It is a still further object to provide a pressure responsive switch wherein the pressure responsive element thereof is formed of resilient material having high plastic flow resistance characteristics and of a thickness substantially equal to or greater than the diameter thereof.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a sectional view through the switch of the instant invention according to the preferred embodiment thereof and showing the switch in its initial or open circuit position;

Fig. 2 is a sectional view of the switch of Fig. 1 as shown in operated or circuit closed position;

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 2; and

Fig. 4 is a sectional view of an alternate arrangement of the switch of the present invention illustrated in the open circuit position.

Referring now to the drawings for a more complete understanding of the invention and more particularly to Figs. 1, 2 and 3 thereof, the switch according to the preferred embodiment of the present invention is generally designated **5** and includes the cylindrical housing member **6** wherein an annular groove **7** is formed about the outer surface thereof for retaining therein a conventional O ring gasket **8** adapted to provide a high pressure seal between the switch and exploder mechanism, not shown, and by means of which the switch is generally mounted for assembly within the casing of a torpedo.

Preferably cast integrally with the switch housing is a pressure responsive element **9** of any suitable resilient plastic material having high plastic flow resistance characteristic such, for example, as silicon rubber or the like, the requirements for this element being to slowly respond to and recover from pressures applied thereto from the direction of the surface **10** thereof. The formation of this element **9** is such that the thickness thereof is substantially equal to or greater than its diameter, as has been hereinbefore indicated.

Arranged, as illustrated, over the element **9** is a protective cover plate **11** formed of thin corrugated beryllium copper or plastic impregnated fabric or the like and secured to the switch housing as by the crimped flange portion **12** of the latter. The material of the cover plate **11** by being thusly formed and so arranged offers relatively little resistance to pressure applied therethrough to the surface **10** of the element **9** and yet the cover serves to prevent possible damage being done to the element that could otherwise effect its pressure responsive characteristics.

Secured as by bonding to the inner surface **2** of the element **9** and movable inwardly by deformation of the latter is an annular member **13** having projecting downwardly therefrom a rounded end contact portion **14**

formed from suitable conductive material such, for example, as brass, copper or the like and preferably silver plated to provide a low resistance contact surface for a purpose which will become more clearly apparent as the description proceeds.

The arrangement of the member **13** with respect to the element **9** is such that, as the element is depressed inwardly responsive to pressure of the desired character being applied to the surface **10** thereof, the contact portion **14** of the member **13** is urged thereby downwardly within a guide bore **15** provided therefor in an insulating plug member **16** and which is secured for vertical adjustment within the switch housing by threadedly connecting with a sleeve member **17** secured, as illustrated, within a recessed portion **18** of the housing as by a crimped flange portion **19** of the latter.

The insulating plug **16** has provided in the lower portion thereof a transversely arranged slot **21** for receiving a screw driver or like tool for rotation of this plug for vertical adjustment within the threaded section **22** of the sleeve **17**.

The plug **16** is provided across its upper end portion with a transverse slot **23** within which is accommodated, at the time of assembly, the angular portions of a pair of terminal pins **25** as the elongated vertical portions of the pins are received for press fitting within parallel bores provided therefor in the lower or solid end section of the plug **16**, as illustrated. The angular portions of the pins are provided with chamfered end portions **26** and arranged in close but spaced adjacency whereby a bridging contact may be established therebetween as the contact member **14** is urged thereagainst by sufficient inward movement of the element **9**. The vertical adjustment of the plug **16** within the threaded section **22** of the sleeve **17**, as heretofore set forth, provides for increasing or reducing the gap between the contact portion **14** of the member **13** and the chamfered portions **26** of the pins **25** whereby the degree of deformation of the element **9** required for closing the switch may be selectively varied.

Fig. 2 illustrates the switch of Fig. 1 in operated position with the cover plate **11** and element **9** thereof deformed inwardly to the extent of bringing the contact member **14** into spanning connection with the contact portions **26** of the pins **25** whereby the circuit is thusly completed through the switch.

An alternative arrangement of a switch embodying the features of the present invention is shown in Fig. 4 to include a cylindrical switch housing **30** formed substantially in the same manner as that of Fig. 1 and including an O ring gasket **31** arranged as illustrated about the outer surface of the switch housing and whereby a pressure seal is maintained about the switch when mounted within the casing of a torpedo, not shown. Instead of the element **9** being cast integrally with the switch housing **30** as in the case of the switch of Fig. 1, the element **9** is secured as by bonding within a cylindrical insert **32** telescopically arranged within a closely fitting bore **33** provided therefor in the upper end portion of the switch housing and wherein the sleeve is secured by a flange portion **34** of the housing which is crimped thereover in the manner illustrated. A ring gasket **35** compressed by the flange **34** to the end of the sleeve **32** provides a pressure sealing connection therebetween whereby fluid to which the outer surface of the switch is exposed is prevented in this manner from entering the switch housing **30** between the sleeve **32** and the surface of the bore **33**.

Secured integrally with the element **9**, as by bonding thereto at **50**, is an annular member **36** having a contact portion **40** movable, responsive to inward deformation of the element **9**, downwardly through an annular opening **37** provided as a guide therefor in an internal flange section **38** of the switch housing **30**. An annular Bellsville spring washer **39** interposed between the member **36** and the flange **38** provides an electrical connection therebetween and whereby the housing **30** is in this manner made one terminal of the switch. The spring washer **39** may be formed from beryllium copper or like material having suitable resilient and electro-conductive characteristics.

Adjustably secured as by the threads **41** within the lower end of the switch housing **30** is an internally flanged sleeve **42** wherein is cast, integrally therewith and about a centrally grooved contact member **43**, a mass of insulating material **44** such, for example, as plastic or hard rubber or the like and adapted to electrically insulate the contact member **43** from the sleeve and switch housing **42** and **30** respectively. Bores **45** formed in the lower end of the flange portion **46** of the sleeve **42**, as indicated, permit the connection therewith of a spanner wrench or like tool whereby the sleeve may be rotated within the housing for decreasing or increasing the distance between the contact portion **40** of member **36** and the contact member **43** whereby the pressure response of the switch may in this manner be selectively regulated.

Referring now briefly to the operation of the device and more particularly to that shown in Fig. 1, the switch **5** when secured within an extender mechanism, not shown, and mounted conventionally within the side wall sections of a torpedo, likewise not shown, is so arranged that the outer surface of the element **9** of the switch is exposed at all times to the pressure of the surrounding water. As the torepdo is launched from a submarine submerged beneath the surface of a body of water, the relatively static pressure of the surrounding water operates to cause a flowing of the plastic material of the element **9** of the switch toward the switch closed position of Fig. 2 and, in which case, after a predetermined time as determined by the material from which the element is composed, the contact member **14** to which the element is secured is extended downwardly into spanning engagement with the contact portions of the terminal pins **25** whereby a circuit is completed through the switch pins to the heretofore mentioned, but not shown, shorting circuit of the torpedo fire control system for rendering the torpedo safe with respect to the launching craft as it rises to striking position with the target vessel. The structure of the switch is such that by proper selection of the material of the element **9**, the switch may be accurately adjusted by rotation of the plug **16** to close under relatively static pressure conditions within a satisfactorily time of approximately 500 milliseconds and at substantially any desired pressure while possessing the characteristics of remaining substantially unaffected by considerably greater shock pressures of less duration as, for example, 5 milliseconds, and such as may be produced within the surrounding water by the explosion of counter-mine or anti-torpedo apparatus. Thus, in response to counter-mine shock, for example, the contact member **14** does not move to bridge the contact surfaces **26**. It will be understood that the switch of Fig. 4 operates generally in the same manner as the switch of Figs. 1 to 3.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the present claims the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without payment of any royalty thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A switch of the character disclosed for discriminating between shock and static pressure and including, in combination, an elongated housing having an opening therethrough, a deformable plastic element of high plastic flow resistance characteristic and of a thickness not less than the width thereof and arranged for closing one

end of said opening, an insulating plug adjustably secured to said housing for closing the other end of said opening, normally open switching means including at least one switching element carried by said plug, and means on said plastic element for closing said switching means in response to a predetermined deformation of said plastic element.

2. A switch of the character disclosed for discriminating between static and shock pressure and including, in combination, a housing having therein an elongated bore, a cylindrical plastic element of a thickness substantially equal to or greater than its diameter arranged for closing one end of said bore, an insulating plug adjustably secured to said housing for closing the other end of said bore, a contact member carried by said plug and electrically insulated thereby from the housing, and a contact element carried by said plastic element and electrically connected to said housing and movable by pressure responsive deformation of said plastic element into circuit closing engagement with said contact member.

3. A static and shock pressure discriminating switch of the character disclosed including, in combination, a housing adapted for connecting within the casing of a torpedo and including an opening therethrough, a plastic element of high plastic flow resistance characteristics and of a thickness substantially equal to or greater than its width bonded to the housing within said opening for closing one end thereof, a contact element carried by said plastic element and movable thereby responsive to plastic deformation of the latter, a second contact element electrically insulated from said housing, and means for adjusting said second contact element for contact engagement by the first said contact element as said plastic element is deformed in response to a predetermined pressure applied thereto.

4. A static and shock pressure discriminating switch of the character disclosed including, in combination, a cylindrical housing having a centrally arranged opening therein, a cylindrical plastic element of high plastic flow resistance characteristic and of a length substantially equal to or greater than the diameter of said opening and bonded therein along its length for closing one end of said opening, a contact member carried by said element and movable longitudinally inwardly within said opening upon inward deformation of said element, an insulating plug secured for adjustable movement within the other end of said opening, and a pair of electrically spaced contact pieces carried by said plug and arranged for being connected in electrical contact by said contact member as the contact member is moved inwardly upon said inward deformation of the said plastic element in response to a predetermined pressure applied to the outer surface thereof.

5. A static and shock pressure discriminating switch of the character disclosed including, in combination, a cylindrical housing having a centrally arranged opening therein, a cylindrical plastic element of high plastic flow

resistance characteristic arranged within said opening and bonded to said housing throughout its length in a manner to close one end of said opening, a first contact member carried by said element and movable longitudinally by inward deformation of the element responsive to a predetermined hydrostatic pressure applied thereto, means electrically connecting said contact member with said housing, an insulating plug secured for adjustment within the other end of said opening, and a second contact member carried by said plug and electrically insulated thereby from said housing and arranged for contact engagement by said first contact member thereby to close said switch upon a predetermined inward deformation of said plastic element.

6. A static and shock pressure discriminating device of the character disclosed comprising, in combination, a plastic element having a predetermined plastic flow rate such that the element is caused to flow with resultant deformation in response to pressures which are static or change at a rate equal to or less than said flow rate of the element and the element is unaffected by pressures caused by shock or pressures which change at a rate which exceeds said flow rate of the element, means for supporting said element so as to subject one face thereof to said static and shock pressures, contact means carried by said supporting means and arranged in predetermined spaced relation with respect to the opposite face of said element, and movable means including a resilient member carried by said plastic element for establishing an electrical circuit through the device as said movable means is moved into engagement with said contact means in response to a predetermined deformation of the element.

7. A switch of the character disclosed for discriminating between shock and static pressure and including, in combination, an elongated housing having an opening therethrough, a plastic element of high plastic flow resistance characteristic and of a thickness substantially equal to or greater than its diameter and arranged within said opening and bonded to said housing throughout its length for closing one end of the opening, an insulating plug adjustably secured to said housing for closing the other end of said opening, normally open contact means carried by said plug and element and actuated to a closed position in response to deformation of said plastic element and a resilient member carried by said plastic element in engagement therewith and with said housing for establishing an electric circuit through said switch as said contact means moves to said closed position.

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