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FORCE RESPONSIVE SWITCH

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2 Sheets-Sheet 2

FIG. 2.

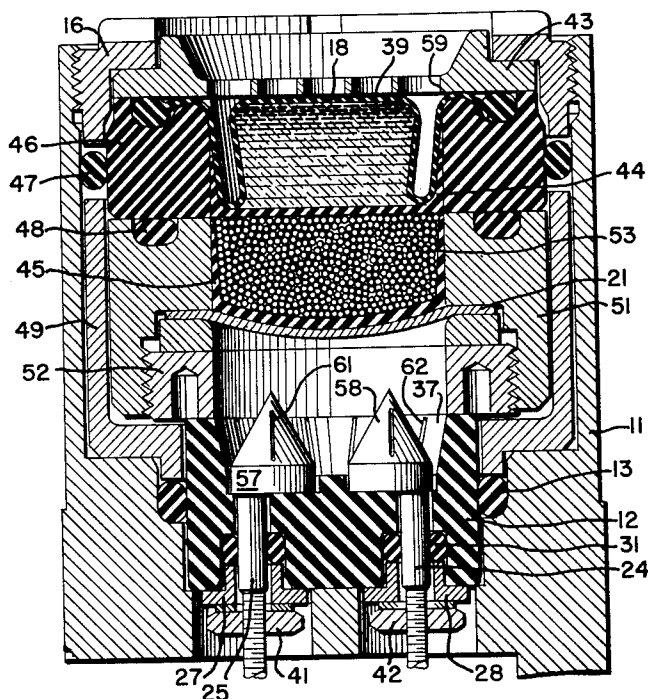
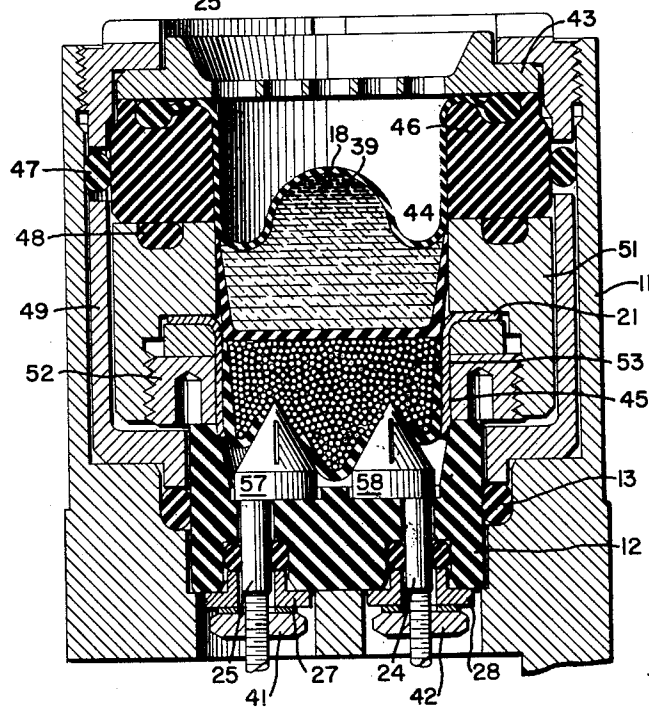


FIG. 3.



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FORCE RESPONSIVE SWITCH

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10 Claims. (Cl. 200—83)

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

This invention relates to switches and more particularly to pressure responsive switches.

Prior pressure responsive switches generally used a bellows to actuate an armature which in turn closed an electrical circuit. This type of arrangement was frequently costly and heavy for practical use. Also, prior pressure switches were not sufficiently reliable or rugged for many applications.

Accordingly, an object of this invention is to provide a new and improved pressure responsive switching apparatus.

Another object of this invention is to provide an improved hydrostatic switching apparatus that will function properly in any position.

A further object of this invention is to provide a cheap, reliable, light weight and rugged fluid pressure responsive switch.

Various other objects and advantages will appear from the following description of several embodiments of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

This invention contemplates the solution of the aforementioned objects by employing a pressure responsive frangible disc that is ruptured when the pressure applied thereto exceeds a predetermined value. When the disc ruptures a conducting medium is forced into contact with a plurality of terminals, electrically connecting them together.

Referring now to the drawings wherein:

FIG. 1 is an illustration of a sectional view of one embodiment of the invention using conducting particles;

FIG. 2 is an illustration of a sectional view of another embodiment of the invention using conducting balls;

FIG. 3 is an illustration of a sectional view of the embodiment shown in FIG. 2 after the mechanism has been actuated;

FIG. 4 is an illustration of a sectional view of a further embodiment of the invention using honeycomb conducting material; and

FIG. 5 is a greatly enlarged perspective view of the honeycomb conducting material utilized in the embodiment of FIG. 4.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 [which illustrates a sectional view of one of the preferred embodiments] a container 11 which may be secured to the bulkhead of a vehicle, such as a mine [not shown] by way of bolts which are inserted through the bores 34 and 35. A housing 12, made of an insulated material, is placed within container 11. A well 33 is placed in contact with a portion of the housing 12. A sleeve 17 is secured between the well and another portion of the housing by threads 40. Since the switch is to be used in a vehicle to be submerged in water, seals 13 and 14 are used to prevent water from entering the interior of the switching apparatus. The circular portion of diaphragm 36 is

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also used for sealing purposes. Seal 15 is located between the bulkhead [not shown] and container 11, seal 13 is fixed between the container and the housing 12, while seal 14 is located between the housing and the well 33. An end plate 16 is screwed into one end of the container 11 and fits over housing 12. A chamber 23 is thus formed within the switching apparatus by the interior walls of end plate 16, sleeve 17, well 33 and housing 12.

A thin, metal, rupture disc or frangible diaphragm 21 is located within the chamber 23. A fluid-like conducting medium 19, which may be iridited, aluminum particles, is retained in the chamber on one side of the rupture disc 21. The particles 19 are packed tightly in the chamber so that they contact rubber diaphragm 36. The diaphragm 36 is secured in place between sleeve 17 and housing 12 with the aid of ring 38. A packing 39 made of suitable material, such as silicone grease, is placed on diaphragm 36. The rubber diaphragm 18 communicates with the environment exterior to the switching structure, i.e. water when the device is being used, and presses against packing 39.

Located at one end of chamber 23 and on the other side of rupture disc 21 are a pair of contacts 26, 27 that are normally insulated from each other. These contacts are maintained insulated from each other since they are spaced apart in the insulated housing 12. A ring 37 made of a suitable insulated material is placed on the contacts 26 and 27 and prevents them from touching well 33. Lead 25 is electrically connected to contact 27 while lead 24 is electrically connected to contact 26. Leads 24 and 25 are respectively secured in place by insulated sleeves 28 and 29 in addition to nuts 41 and 42. Seals 31 and 32 located next to leads 24 and 25, respectively, will not allow pressure variations which may exist in the vehicle from acting against disc 21 so as to prevent it from rupturing when sufficient external pressure is applied thereto.

The operation of this embodiment of the switching apparatus will now be described in detail. When the vehicle containing the switch assembly is lowered into the water, rubber diaphragm 18, which is in contact therewith, will be pushed inwardly. As the assembly goes deeper into the water, the pressure exerted on diaphragm 18 will become greater causing greater force to be exerted on the disc. When this occurs, the silicone grease packing exerts a force against rubber diaphragm 36. Diaphragm 36 will exert a force on the aluminum particles 19. This force or pressure is transmitted to frangible diaphragm 21. Thus, it is apparent that the rubber diaphragms 18 and 36, silicone grease packing 39 and the conducting aluminum particles transmit the pressure external to the switch to rupture disc 21. When the pressure on disc 21 reaches a predetermined value, governed by the properties of the disc, the disc will break and the particles 19 forced between contacts 26 and 27. In this manner, a conducting path is established between the contacts. The dimensions of chamber 23, the volume of the particles 19, and the amount which diaphragm 36 will flex after disc 21 has ruptured are such that the conducting medium 19 will be forced between the contacts regardless of the switch position relative to earth.

Referring now to FIG. 2, of the drawings, there is disclosed a sectional view of another preferred embodiment of this invention. The switching mechanism is held in place by container 11, end plate 16, sleeve 49, retaining member 51, ring 52 and insulated housing 12. Water from the surrounding medium is prevented from reaching the interior of the switch by seals 13, 47 and 48. The apparatus may be secured to a vehicle by any suitable means such as shown in FIG. 1 or it may be at right angles thereto. Seal 13 is located between housing 12 and container 11, seal 47 is fixed between cylinder 46 and

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the container, while seal 48 is located between the cylinder and the retaining member. Disc 43 having a plurality of holes 59 therein is placed on top of the insulated cylinder 46. The holes allow diaphragm 18 to communicate with the environment exterior to the container.

A thin, metallic, frangible diaphragm 21 is located within the cavity formed by cylinder 46, retaining member 51, ring 52 and insulated housing 12. Diaphragm 21 is secured in place between ring 52 and retaining member 51. On one side of disc 21, a cup 45 made of a material which easily tears or is punctured, such as "Silastic" is placed snugly against the walls of member 51. Within this cup is located a fluid-like conducting medium comprising a plurality of gold-plated aluminum balls 53. The balls are flooded or lubricated with silicone fluid so that any pressure exerted thereon will be faithfully transmitted to the walls of the cup. Another cup or piston 44 made of a tear resistant rubber-like material, such as a silicone rubber, is mounted directly above the balls and cup 45. A sufficient amount of silicone grease packing 39 is placed in cup 44 so that folded rubber diaphragm 18 presses thereagainst. Diaphragm 18 is held in place between cylinder 46 and disc 43. The circular outer portion of diaphragm 18 also acts as a seal.

On the other side of rupture disc 21 a pair of conical contacts 57, 58 are held in position by insulated housing 12. A concave surface 37 exists in the upper portion of housing 12. Leads 24 and 25 are connected to the contacts and held in place by sleeves 28, 29 and nuts 41, 42 in a similar manner to that illustrated in the device of FIG. 1.

When the switch mechanism of FIG. 2 is immersed in water the pressure exerted by the water on diaphragm 18 is transmitted through packing 39, cup 44, the gold balls 53 flooded with silicone fluid, and cup 45 to rupture disc 21. When the pressure exceeds a certain predetermined value, the frangible diaphragm 21 breaks, rubber diaphragm 18 unfolds pushing packing 39, piston 44, cup 45 and the contents thereof against contacts 57, 58. When cup 45 is forced against the sharp points of contacts 57, 58 it will break and the gold plated balls 53 will be forced between the contacts. Grooves 61 and 62 in the contacts and concave surface 37, respectively, cause the fluid which the balls are immersed in, to leak partially out of cup 44 so that the cup will bear directly on the balls. This construction causes the balls to make better contact with members 57, 58. In this manner an electrical path is formed between the contacts through the balls when the pressure exterior to the switch assembly reaches a predetermined value.

FIG. 3 illustrates the switch of FIG. 2 after actuation. The unfolded position of rubber diaphragm 18 is to be noted as well as the shifted position of cups 44 and 45 and the contents thereof. Also the relationship of contacts 57 and 58 with respect to cup 45 and the gold-plated balls contained therein is apparent from FIG. 3. It is to be realized that members 57 and 58 each serve the dual purposes of a means to tear cup 45 and to provide a contact means.

Referring now to FIG. 4 there is shown another preferred modification of the invention. This embodiment is quite similar to that shown in FIG. 2. The primary difference between the two embodiments lies in the conducting medium utilized. In FIG. 4 the conducting medium 54, made of a suitable material such as aluminum, comprises a plurality of hollow interconnected tubes having honeycomb cross sections. A greatly enlarged view of the honeycomb medium is shown in FIG. 5. The medium is arranged in cup 55 so that each honeycomb tube runs substantially perpendicular to the center portion of rupture disc 21. A force transmitting medium such as silicone fluid is filled in the hollow sections and entirely permeates the volume between cup 44 and disc 21. The cup 55 is substantially the same as cup 45 of FIG. 2 except for a hole in the bottom. This hole enables the sil-

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cone fluid which is filled within the honeycomb material to communicate with frangible diaphragm 21. The honeycomb material will not be heavy enough to force cup 55 against diaphragm 21 and as a result the silicone fluid is used to transmit pressures. The operation of diaphragm 18, packing 39, and cup 44 in response to an applied pressure is identical to the operation of the same elements of the embodiment disclosed by FIG. 2 and need not be further described. The force developed by cup 44 in response to external pressure is transmitted to rupture disc 21 by way of the silicone fluid filled within honeycomb material 54 and contacting rupture disc 21. When the pressure exerted on frangible diaphragm 21 exceeds a predetermined value, the diaphragm breaks and the honeycomb section 54 is forced against contacts 52 and 53. Since the conducting medium 54 is easily crushed in a direction perpendicular to the honeycomb sections but is substantially incompressible in the direction parallel to the sections, the contacts 57, 58 will be buried therein. In this manner a path capable of carrying electricity is established between contacts 57 and 58 when the external pressure exceeds a predetermined value.

There has been disclosed a pressure or force responsive switch having a frangible diaphragm which breaks when a force applied thereto exceeds a predetermined value. A conducting medium is forced between a pair of contacts normally insulated from each other when the diaphragm breaks thus establishing an electrical path between the contacts. This apparatus will function properly regardless of the position thereof because it relies on hydrostatic forces rather than gravity to push the conducting medium against the contacts.

Many modifications of the invention should be apparent from the foregoing disclosure. For instance, the rupture disc may be designed to break at any predetermined value. In addition, the number of contacts used may be increased if it is desired to make a plurality of connections. It is also apparent that the principles utilized and the structure claimed in this invention may be used in any switch mechanism responsive to applied forces and pressures and is not limited to water pressure.

It will be understood that various other changes in the details, materials, steps and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principles and scope of the invention as expressed in the appended claims.

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

1. In a force responsive switch to be used in a sealed container, the combination which comprises a metal rupture disc, a pair of contacts located on one side of said disc and insulated from each other, a diaphragm contacting the environment exterior to the container, an electrical conducting medium located between the other side of said disc and said diaphragm, and pressure transmitting material located between said disc and said diaphragm, whereby said disc is broken and said medium is forced between said contacts when the pressure exerted by the environment on said diaphragm is of a predetermined magnitude.

2. The switch of claim 1 wherein said medium is a fluid-like medium.

3. The switch of claim 2 wherein said medium consists of iridized aluminum particles.

4. The switch of claim 2 wherein said medium consists of a plurality of gold plated aluminum balls.

5. The switch of claim 1 wherein said medium consists of a metal having a honeycomb pattern substantially perpendicular to said diaphragm.

6. In a pressure responsive switch to be used in a sealed container, the combination which comprises a metal rupture disc, a puncturable cup contacting one side of said disc, a conducting material located within said cup, a pressure transmitting fluid interposed within said material, a

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diaphragm contacting the environment exterior to the container, means contacting said material and said diaphragm for transmitting pressure exerted against said diaphragm to said material and to said fluid, a plurality of contacts normally insulated from each other and located on the other side of said disc, and means located on said other side of said disc for puncturing said cup, whereby said disc is broken and said medium is forced between said contacts when the pressure exerted on said diaphragm is of predetermined magnitude.

7. In a pressure responsive switch to be used in a sealed container, the combination which comprises a metal rupture disc, a puncturable cup contacting one side of said disc, a conducting material located within said cup, a pressure transmitting fluid interposed within said material, a diaphragm contacting the environment exterior to the container, pressure transmitting means contacting said material and said diaphragm for transmitting pressure exerted against said diaphragm to said material and to said fluid, a plurality of conically shaped contacts normally in-

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ulated from each other and located on the other side of said disc, whereby said disc is broken and said material is forced between said contacts when the pressure exerted on said diaphragm is of predetermined magnitude.

8. The switch of claim 7 wherein said pressure transmitting means comprises a tear resistant cup and silicone grease filling said cup.

9. The switch of claim 7 wherein said material comprises a plurality of gold plated balls.

10. The switch of claim 7 wherein said material comprises a metal having a honeycomb pattern substantially perpendicular to a center portion of said diaphragm.

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