Jan. 24, 1967 A. G. BLOMQUIST ETAL 3,300,600

MINIATURE INTERLOCK SWITCH

Filed March 8, 1965

FIG. 1

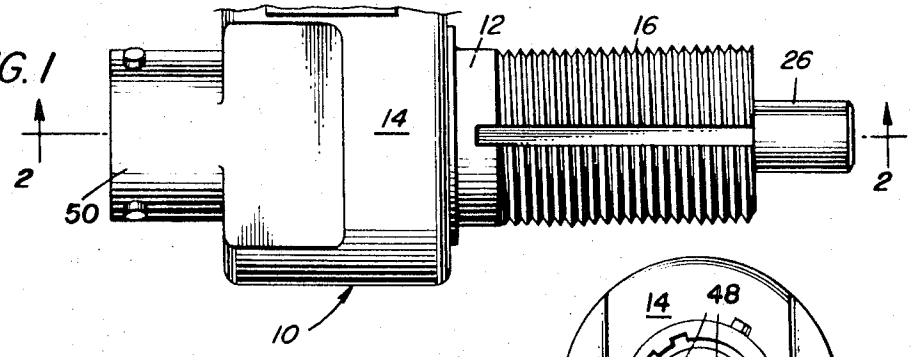


FIG. 3

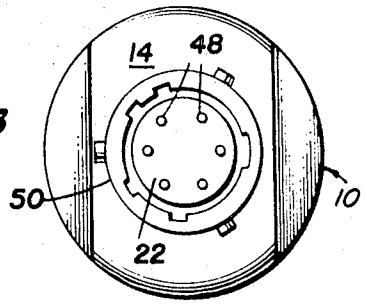


FIG. 2

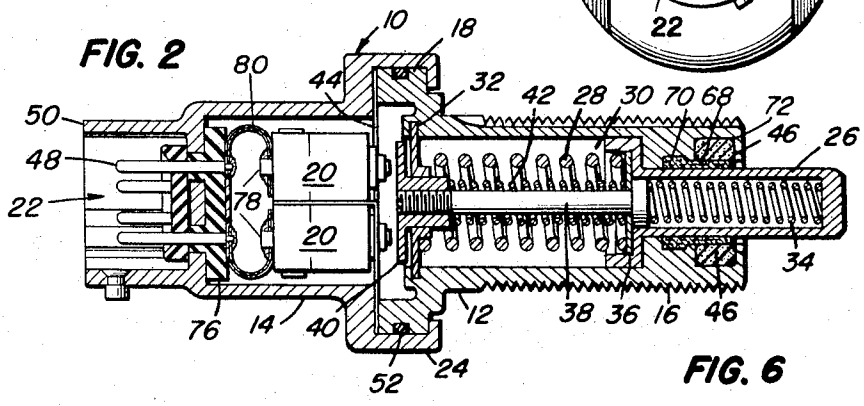


FIG. 6

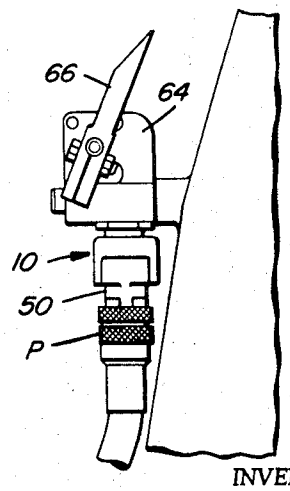


FIG. 4

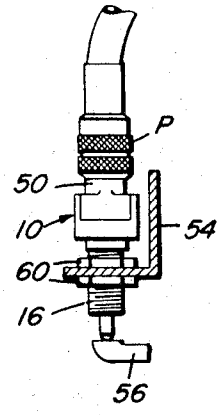
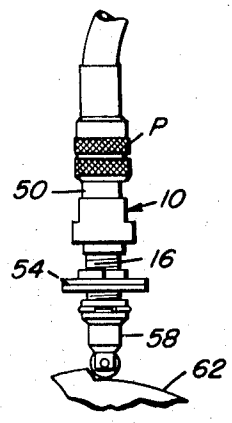


FIG. 5



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MINIATURE INTERLOCK SWITCH

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This invention relates generally to electric switches, and more particularly it pertains to a miniature multiple circuit plunger operated switch.

The involved circuitry of modern ordnance electronics involves the use of interlock switches to signal the position of a mechanical element. Quite commonly several circuits are required to be established simultaneously. The environment under which interlock switches are required to operate is not of the best involving high vibration, impact shock and subjection to liquids such as water and oil spray in congested areas. For the latter reason especially it is important to miniaturize. However miniature switches have previously had high rates of failure.

Accordingly, it is an object of this invention to provide a miniature multiple circuit interlock switch which is positive in action and adaptable to various types of assemblies.

Another object of this invention is to provide a miniaturized interlock switch assembly which is of reduced weight and size while still offering high impact shockproofness to a degree beyond that offered in the subminiature switch elements themselves.

Another object of this invention is to provide a compact, plural contact, plunger-actuated type miniature switch which is fluid tight and which provides for the direct use of a twistlock type of cable connector.

Yet another objective of this invention is the provision of a diaphragm and a bowed flexible printed circuit in an electronic housing for combined support and wiring of delicate electric elements therein so as to isolate them from damaging shock.

These and other objects and attendant advantages of this invention will become more readily apparent and understood from the accompanying specification and single sheet of drawings in which:

FIG. 1 is a side elevation of a miniature multiple circuit interlock switch incorporating features of this invention;

FIG. 2 is a longitudinal section of the miniature interlock switch taken along the line 2—2 of FIG. 1;

FIG. 3 is an end view locking into an electrical connector of the interlock switch illustrated in FIG. 1; and

FIGS. 4, 5, and 6 are side elevations depicting various mounting and actuating arrangements possible for the novel miniature interlock switch.

Referring now to the details of the drawings, there is shown in FIGS. 1, 2, and 3, a novel miniature multiple circuit interlock switch designated generally by reference numeral **10**. This interlock switch **10** consists generally of a pair of formed metal housings **12** and **14**. The smaller diameter housing **12** is machined to provide a threaded bushing **16** and an end flange **18**.

The larger housing **14** is recessed to receive a pair of adjacent subminiature switch elements **20** and an electrical connector body **22**. A cup **24** is formed at the subminiature switch element end of housing **14** to receive the end flange **18** of the housing **12**, while a bayonet joint (male) connector shell **50** is formed at the other end of housing **14**. The bayonet joint connector shell **50** of FIGS. 1 to 6 is illustrated as of a male type, although a female connector shell **50** can be used, if desired.

A compression coil spring **28** is provided in a bore **30** formed in bushing **16** of housing **12** and it is retained by a solid washer **32** at one end. The solid washer **32** is installed by rolling a lip of the housing **12** over it as shown best in FIG. 2. The other end of spring **28** presses against a flat washer **36** located at the opposite end of the bore **30** of housing **12**.

A flanged plunger **26**, which is slidably mounted in the end housing **16** behind the flat washer **36**, receives the thrust from spring **28**. This flanged plunger **26**, if desired, can be provided with a cylindrical flange at its end to form a peripheral flange about the flat washer **36**.

In order to provide a fluid seal and bearing for the plunger **26**, a seal consisting of a scraper seal **68** encompassed by an O-ring **46** located in an annular groove **72** is used to provide a fluid seal between the plunger **26** and the bushing **16**. This scraper seal **68** is provided with an annular flange **70** for fitting into an annular groove spaced from groove **72** provided in the inner surface of the threaded bushing **16**.

The flange **70** of scraper seal **68** is diametrically compressed and pushed within the bushing **16** until it snaps into its respective groove cut on the inside surface of the bushing **16**. The scraper seal is formed of a semi-resilient material, preferably fibre glass filled polytetraflouroethlene or pure polytetraflouroethylene.

The O-ring **46** in groove **72** is under compression and exerts a compressive load on the plain nonflanged end of seal **68** to affect an intimate scraper seal with plunger **26**. This fluid seal for the plunger **26** is discussed in greater detail in a co-pending U.S. patent application, Serial Number 33,786, filed June 3, 1960, for "Shaft and Piston Seal" invented by Milton C. Neuman and Kenneth A. Riach.

Another O-ring **52** is recessed in the periphery of the end flange **18** to provide a seal between the cup **24** of housing **14** and the flange **18** of housing **12**.

The plunger **26** is formed of hollow construction and it contains a compresion coil spring **34** which presses against a long, headed screw positioned in the axis of the bore **30** of bushing **16**. A thimble **40**, which extends through the washer **32**, is threaded at one end to receive the screw **38**. A small diameter compression coil spring **42** is positioned around the screw **38**, and it extends between the thimble **40** and the flat washer **36**.

Electrical connections or pins **48** are positioned in the electrical connector body to attach the subminiature switch elements **20**. These connections or pins **48** are maintained in an operative position by the dielectric pin receiving member **76**. The subminiature switch elements **20** are mounted on a thin flanged metal stamping **44** in the form and function of a diaphragm which becomes captured inside the cup **24** when the latter is roll sealed over the end flange **18** to complete the assembly of the interlock switch **10**.

Because the switch elements **20** are not shockproof in themselves this thin flanged metal stamping **44** provides a resilient mounting therefor which prevents damaging shock load being transmitted to them from such sources as gunfire.

Because such severe shock and vibration environments almost invariably result in a small movement of the switch elements **20** with respect to the small and large housings **12** and **14**, the electrical connections between pins **48** and the terminals of switch elements **20** comprises a flexible printed circuit **80**.

This printed circuit **80** is fabricated from flexible thin plastic sheet upon which all the interconnections are delineated in etched metallic foil. This circuit **80** is then

soldered in flat form to the pins 48 of the pin receiving member 76 and the terminal 78 of the switch elements 20 before positioning and attaching the latter to the stamping 44.

With switch elements 20 side-by-side, the thin printed circuit 80 assumes the bowed shape illustrated in FIG. 2. In this configuration of circuit 80 helps maintain the flexibly mounted condition of the switching elements 20 by permitting them to move independently of the pins 48. It also is much superior to stranded wire connections so often used, having no strands which might go astray and short circuit. Furthermore, experience has shown that the usual stranded connections tend to solidify by solder creepage along the strands which nullifies their use as vibration isolators especially in short lengths.

The miniature interlock switch 10 is quite versatile. Having the advantage of single hole mounting by means of the bushing 16, the miniature switch 10 can be supported from a structural angle 54, with the plunger 26 thereof being operated by an actuating lever 56 from adjacent structure as shown in FIG. 4. Adjustment of tthe plunger 26 of the switch 10 is provided for by suitable positioning of mounting locknuts 60 provided for the threaded bushing 16.

A roller attachment 58 of the miniature switch 10, as shown in FIG. 5, provides a cam follower use for the switch 10 in conjunction with a cam 62 of an adjacent structure. The miniature interlock switch 10 can be threaded into a lever box 64 as shown in FIG. 6 to provide tripping action from a lever 66. Many other arrangements and uses of the switch 10 can be provided, with the illustrations of FIGS. 4, 5, and 6, being only exemplary.

It will be noted that with a cable connector plug P attached to the bayonet joint connector shell 50, as shown in FIGS. 4, 5, and 6, no electrical connections or pins 48 are exposed. Further, the switch 10 is proof against the entry therein of moisture and oil. The mating half of the connector shell 50 can be used with a cable retainer as shown and described in a co-pending U.S. patent application, Serial Number 56,199 filed September 15, 1960, now Patent No. 3,116,945 for "Cable Retainer for Electrical Connector" invented by Arthur G. Blomquist, Ralph E. Eggers, and Paul J. Gobel.

Because of the unique arrangement of coil springs as related, the subminiature switch elements 20 are protected against excessive thrust from the plunger 26. The maximum load that can be applied to the subminiature switch elements 20 is the sum of the loads applied by the coil springs 34 and 42 which are mounted in tandem. The large coil spring 28 functions to return the plunger 26 after a stroke and can be made relatively powerful and sturdy.

Because the subminiature switch elements 20 are provided in plurality and are each single pole double throw elements, a number of circuits can be simultaneously switched with but one interlock switch 10 of this invention.

In summary, the novel miniature interlock switch 10 of this invention is characterized by the combination of a switch assembly having substantially reduced weight and size while still offering high impact shockproofness to rigid design specifications and to a degree beyond that offered in the subminature switch elements 20.

This is achieved by the manner in which the switch elements 20 are supported by the stamping 44 as previously described and also by the manner in which the terminal connections 48 are brought to them. Previously, in order to achieve a high impact shockproof interlock switch it was found necessary to provide substantial mass in the switch body and mounting shank. Consequently, prior designs were of unwieldly size and weight, not capable of effective miniaturization and still proof against gunfire and the like.

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

What is claimed is:

1. An interlock switch comprising structure defining a housing having electrical connectors communicating between the interior and exterior thereof, at least one electrical switch element positioned within said housing and electrically connected to said electrical connectors, an elongated member reciprocately mounted within said housing and having one end for contacting and thereby actuating said switch element upon reciprocation of said elongated member in one direction, a reciprocately mounted plunger in tandem with said elongated member, first spring means positioned at the opposite end of said elongated member in tandem therewith and engaging said plunger for transmitting the reciprocation of said plunger in one direction to the opposite end of said elongated member to reciprocate it in said first mentioned one direction, second spring means encompassing said elongated member and mounted to reciprocate with said elongated member for transmitting said reciprocation of said plunger to said one end of said elongated member, third spring means encompassing said second spring means and said elongated member and in engagement with said plunger and said housing for biasing said plunger in the opposite direction, a bowed flexible printed circuit connecting said electrical switch element to said electrical connector, and a resilient member secured to said housing positioning of said switch element.

2. The interlock switch as recited in claim 1 wherein said elongated element has a contacting element at said one end, said plunger has a washer element reciprocable therewith and encompassing said elongated element, and said second spring means is positioned between said contacting element and said washer element.

3. The interlock switch as recited in claim 1 wherein the entire force for reciprocating said elongated member in said first mentioned direction is obtained by said first spring means and said second spring means.

4. An interlock switch comprising structure defining a housing having electrical connectors, a resilient element positioned within said housing, an electrical switch element mounted to said resilient element, a flexible printed circuit disposed in a bowed shape and electrically connecting said switch element to said electrical connectors, plunger means for reciprocating in said housing to contact and actuate said switch element, with said plunger means including a reciprocable elongated member having an end portion for obtaining said contact to actuate said switch element, second and first springs in operative engagement with said end portion and the opposite end of said elongated member, respectively, and a plunger simultaneously compressing said first and second springs to obtain reciprocation of said elongated member in the opposite direction effecting said contact.

5. The interlock switch as recited in claim 4 wherein a fluid-tight seal is positioned between said plunger means and said housing.

6. The interlock switch as recited in claim 4 wherein said end portion of said reciprocable elongated member consists of a thimble element mounted at one end for obtaining said contact to actuate said switch element and an enlarged head at the other end thereof, said housing having a fixed washer element encompassing said thimble element, another washer element slidably mounted along said elongated element adjacent its enlarged head and spaced from said fixed washer, a plunger retained by said housing for sliding said another washer element along said elongated member in

the direction toward said switch element, a first spring positioned between said plunger and said enlarged head of said elongated member for urging said thimble element of said elongated member toward said switch element, a second spring positioned between said thimble and said another washer element for also obtaining said urging, and a third spring positioned between said fixed washer element and said another washer element for biasing said plunger in the opposite direction.

References Cited by the Examiner

UNITED STATES PATENTS

2,572,294	10/1951	Woodcock et al.	200—159
2,847,498	8/1958	Rosenberg	200—168 X
3,165,611	11/1965	Hagberg	200—159

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