Feb. 4, 1964 H. W. LEWIS ETAL 3,120,591

ELECTRICAL CONNECTOR OF THE PRESSURE-ACTUATED TYPE HAVING FAST-ACTING SWITCHING UNIT

Filed April 23, 1962

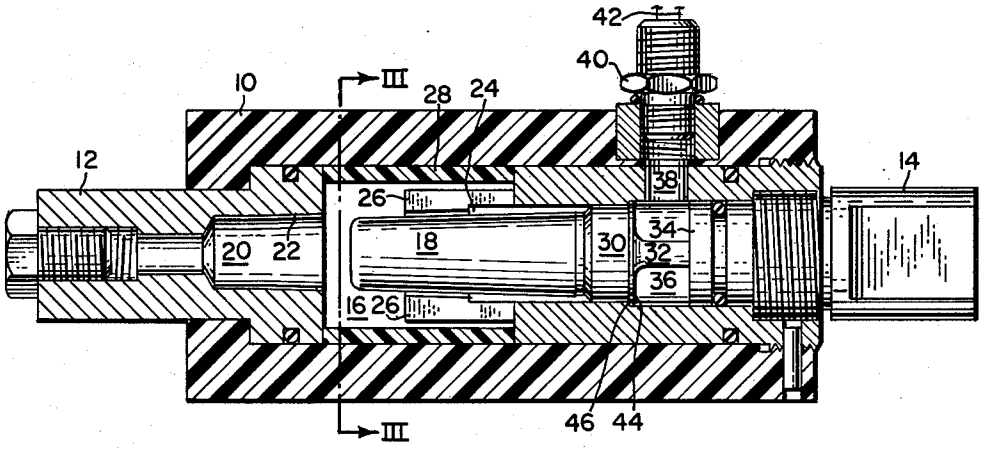


Fig. 1

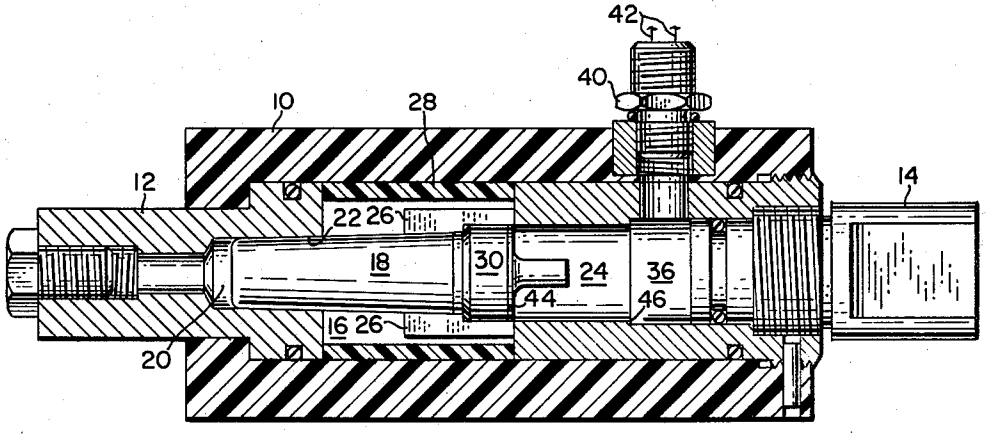


Fig. 2

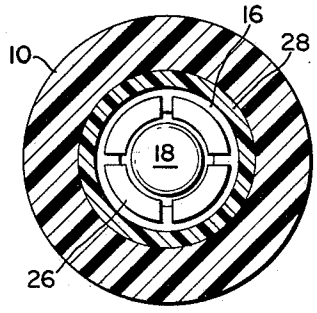


Fig. 3

INVENTORS
HENRY W. LEWIS
LAYTON A. BERGEN

BY Howard J. Murray Jr. AGENT
George J. Ruben ATTORNEY

United States Patent Office 3,120,591 Patented Feb. 4, 1964

3,120,591

ELECTRICAL CONNECTOR OF THE PRESSURE-ACTUATED TYPE HAVING FAST-ACTING SWITCHING UNIT

Henry W. Lewis, Seattle, and Layton A. Bergen, Mercer Island, Wash., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Filed Apr. 23, 1962, Ser. No. 189,654
3 Claims. (Cl. 200—82)

The present invention relates to electrical switches, and more particularly to a fast-acting connector adapted to operate in response to changes in pressure developed therewithin.

Switching units of the type employed in environments where operating conditions are especially severe must be designed to incorporate a number of features which would not be required in less demanding situations. For example, electrical connectors installed on aircraft and underwater missiles must withstand extremely severe shocks without change in circuit status, particularly when an aircraft is engaged in combat or when an underwater missile is being launched or fired, as the case may be. To the above requirement is frequently added the necessity of conducting large currents, especially during that period of time when a control impulse is transmitted therethrough. It is also apparent that switches to be employed for military purposes must be compact, light in weight, and self-contained. Still further, it is essential that when the switch is incorporated as part of the structure of a missile, no fragmentation or venting of gases can occur, since this would have an adverse effect upon other components of the assembly. If the switch is to be employed in any considerable numbers, the cost thereof should be reasonably low and it should be capable of being readily fabricated without employing any special equipment or tools. As a final factor, the extreme complexity of contemporary missile design will not allow the use of any component the operating reliability of which does not reach an arbitrarily high level. All of the above points must be taken into consideration in the design of an electrical connector of the type to which the present invention relates.

Many electrical connectors employed in underwater torpedoes, for example, are required to carry relatively high currents (such, for example, as 600 amperes) and to almost instantaneously close a circuit while at the same time remaining water-tight both before and after operation. As heretofore designed, such connectors were frequently based upon principles carried over from aircraft techniques, and made use of a plurality of individual contacts arrangements in parallel relationship. This was considered necessary in order to assure sufficient current-conducting capability. Subsequently, this type of connector was modified to consist of a number of groups of parallel contacts with the groups connected in series. However, these arrangements did not eliminate such disadvantages as pitting and burning of the contact surfaces. Still further, it was extremely difficult to provide a satisfactory mechanical latching mechanism to hold the contacts closed.

To overcome the above disadvantages, a number of expedients were investigated, such as the use of mercury contacts, knife-blade type contacts, co-axial tubes, and so-called "stud-driven" arrangements. Each of the above, however, was either impracticable from a design standpoint or could not be manufactured in the required quantity.

The means for actuating such an electrical connector was also placed under intensive study. Various types of controlling mechanisms were reviewed, among which were the use of compressed gas for closing the electrical circuit through the actuation of a piston. This proposal

was discarded, due to the difficulty of electromechanically controlling the gas flow. Flash heating of carbon dioxide was also considered, as was the use of mechanical springs for energy storage. The latter, it was found, require the added complication of some type of electrical trip mechanism.

It was decided that the most feasible method of actuating a circuit connector having the stated requirements was to employ means which would generate a relatively high pressure within the connector so as to move a contact from open to closed position. It was found that such a pressure-generating means was readily available in the form of a so-called "squib" containing a charge of powder which is caused to explode upon the application thereto of an electrical impulse. Extensive tests of a contactor incorporating such a squib gave excellent results, and hence this component was integrated into the overall connector assembly described herein.

In accordance with one feature of the present invention, there is provided an electrical contactor of the pressure-actuated type, this contactor incorporating a generally tubular body member composed of electrically non-conductive material, a first terminal element partly contained within this body member and extending axially outwardly from one end thereof, and a second terminal element also partly contained within said body member and extending axially outwardly from the opposite end thereof. These two terminal elements are spaced apart to define a closed chamber within the tubular body member, and a generally cylindrical contact is disposed within this chamber and designed for slidable movement axially of the body member. This contact is initially positioned to be out of electrical engagement with both of the terminal elements, so that there is no electrical circuit through the contactor unit. Means are then provided for producing a pressure within the closed chamber to effect a slidable movement of the contact to bring the latter into electrical engagement with both of the terminal elements and consequently complete an electrical circuit through the connector unit.

One object of the present invention, therefore, is to provide an improved form of electrical contactor of the pressure-actuated type.

Another object of the present invention is to provide a pressure-actuated electrical contactor in which an explosive pressure generated within the contactor body causes the contactor to operate from an initially open position to an electrically closed position.

A further object of the invention is to provide an electrical connector of the pressure-actuated type, in which a pair of terminal elements are spaced apart to establish a closed chamber within the connector, and in which a contact is slidably disposed within this closed chamber and movable from a position where it is out of electrical engagement with both of said terminal elements to a position where an electrical circuit is established between such terminal elements through the movable contact.

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 longitudinal sectional view of a pressure-actuated electrical contactor designed in accordance with a preferred embodiment of the present invention, this view showing the contactor in its initially open position;

FIG. 2 is a view of the contactor of FIG. 1 following its actuation to closed position; and

FIG. 3 is a sectional view of FIG. 2 taken along the line III—III.

Referring now to the drawing, there is shown in FIG. 1 a preferred form of pressure-actuated contactor designed

in accordance with the present invention. This contactor includes a generally tubular body member 10, composed of some electrically non-conductive material such, for example, as a nylon-base Micarta. At one end of the tubular body member 10 is a first terminal element 12, which is partly contained within the body member 10, as illustrated, and which extends axially outwardly to permit connection thereto of a conductor (not shown) forming part of an electrical circuit. At the other end of the body member 10 is a second terminal element 14, also partly contained within the body member and similarly extending axially outwardly therefrom. As will be seen in the drawing, the two terminal elements 12 and 14 project toward, and are spaced apart from, one another so as to define therebetween a closed chamber 16 within the body member 10.

Disposed within this chamber 16 is a movable contact assembly generally identified by the reference numeral 18. This contact assembly 18 is designed for slidable movement axially of the body member, and is initially positioned as shown in FIG. 1, in which position no electrical circuit is completed through the assembly.

The first terminal element 12 is generally cylindrical in configuration and is provided with a central recess or reentrant portion 20 the inner surface 22 of which is in part tapered for a purpose which will subsequently become clear.

The second terminal element 14 is also generally tubular in design and incorporates an axial opening 24 arranged to receive therewithin a portion of the slidable contact 18. The terminal element 14 is further formed with a plurality of circumferentially arranged fingers 26 which extend inwardly as shown and lie essentially parallel to the longitudinal axis of the body member 10. Both of the terminal elements 12 and 14 are preferably composed of some electrically-conductive material such as commercial hard copper. A tubular sleeve 28 of some electrically non-conductive material, such as Teflon, lies longitudinally between the two terminal elements 12 and 14 and, in effect, forms the outer wall of the closed chamber 16 in the manner illustrated in the drawing.

The outer surface of the slidable contact 18 is configured so as to possess a taper identical to the taper possessed by the inner surface 22 of the recess 20 formed in the terminal element 12. Although the main body portion of the slidable contact 18 is composed of some electrically-conductive material such, for example, as the same commercial hard copper of which the terminal elements 12 and 14 are fabricated, the right hand portion (in the drawing) of this contact assembly includes a "piston" 30 preferably composed of some plastic substance such as nylon. This piston 30 is attached to the conductive portion of the contact assembly 18 by some suitable internal means (not shown), such as a screw thread. As brought out in the drawing, the piston 30 incorporates an axially extending projection 32 which serves as a spacer to maintain the contact assembly 18 a predetermined distance from one wall portion 34 of the terminal element 14 when the components are in their open circuit position, as shown in FIG. 1.

Due to the relatively small diameter of the extending portion 32 of piston 30, a chamber 36 exists between the piston 30 and the wall 34 of the terminal 14. Communicating with this chamber 36 is a radially-extending passageway 38 formed both in the body member 10 and in the terminal element 14. At the outer extremity of this passageway 38 is disposed a pressure-generating means such as an electrically-activated squib 40 containing a charge of powder which is detonated upon the application to squib 40 of an electrical impulse over the conductors 42. Squib 40 may be of conventional design (such, for example, as one known as the Model 1440, manufactured by Holex, Inc., of Hollister, California) and hence the details of squib 40 will not be set forth herein.

It has been stated that the projecting portion 32 of the piston 30 acts as a spacer as a result of its contact with the surface of wall 34. This precludes any movement of the contact assembly 18 to the right (in the drawing) when the assembly is in the open-circuit position of FIG. 1. To preclude movement of the contact assembly to the left under such conditions, the piston 30 is fabricated with a flange 44 of greater diameter than the remaining portion of piston 30, this flange 44 engaging a shoulder 46 formed in the interior surface of the generally tubular terminal element 14. Flange 44 is intentionally designed to be relatively thin, so that it will break away from the main body of the piston 30 when the squib 40 fires to operate the assembly from an open to a closed position in a manner now to be set forth.

When it is desired to actuate the contactor of FIG. 1 from an open to an electrically closed position, a pressure is generated within the chamber 36. Although this pressure may be produced in any suitable manner, a preferred means of accomplishing this objective includes the detonation of the explosive charge contained in the squib 40. When this squib 40 fires, pressure is applied through the conduit 38 to the chamber 36 to act upon the movable contact assembly 18. Specifically, pressure upon the surface of piston 30 is sufficient to shear the flange 44 and permit the contact assembly 18 to move to the left (in the drawing). When this movement occurs, a portion of contact 18 enters into the recess 20 of terminal element 12. Following this entry, a "wedging" occurs between the respective tapered surfaces of these components to insure a tight physical and electrical engagement therebetween. At the same time, another surface portion of contact 18 engages the fingers 26 which extend circumferentially from the terminal element 14. Electrical engagement is thus established between these portions of the assembly, and hence current may be conducted through the unit over a path which includes the terminal element 12, contact 18, fingers 26, and terminal element 14 to an output circuit.

It might be mentioned that with a properly designed taper (such, for example, as that known in the art as a "Morse" taper) the "wedging" action by which engagement is established between the interior surface 22 of terminal 12 and the exterior surface of contact 18 is such that subsequent shocks or vibration applied to the unit following the above described piston movement will not cause any disengagement of the members. This has been shown in practice by extensive tests which have included the application of shocks to the assembly of a magnitude as high as 135 g's. As a result of these tests, it has been found that the force necessary to open the circuit through the assembly following an actuation of the piston in the manner above described is in the neighborhood of 3,400 pounds.

Overall reliability of an assembly of the type herein described is well in excess of 99.9%. Furthermore, the unit is capable of carrying over 300 volts at 600 amperes without any fragmentation or gas venting. It is completely watertight as well as being resistant to the corrosive action of liquids in which it may be immersed.

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 appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. In an electrical contactor of the pressure-actuated type, the combination of a generally tubular body member composed of electrically non-conductive material, a first terminal element partly contained within said body member and extending axially outwardly from one end thereof, said first terminal element having an axial recess formed therein of progressively increasing diameter inwardly of said tubular body member, a second terminal element also partly contained within said body member and extending

axially outwardly from the opposite end thereof, second terminal element being of generally tubular configuration and having a plurality of inwardly-extending fingers formed integrally therewith, the two said terminal elements being spaced apart to define a closed chamber within said tubular body member, a generally cylindrical contact disposed within said chamber and designed for slidable movement axially of said body member, said contact having a tapered outer surface corresponding to the taper of the axial recess formed in said first terminal element, said contact being initially positioned out of electrical engagement with said first terminal element and so that the inwardly-extending fingers of said second terminal element encircle but do not electrically engage said contact, and means for producing a pressure within said closed chamber to effect a slidable movement of said contact, whereupon said contact will enter the axial recess formed in said first terminal element and also will be brought into electrical engagement with the inwardly-extending fingers of said second terminal element, thereby establishing an electrical path between said two terminal elements through said slidable contact.

2. A device according to claim 1 in which said tubular body member is formed with a radially-extending opening communicating with the chamber within which said slidable contact is disposed, and in which said pressure-producing means comprises a squib located in the radially-extending opening formed in said tubular body member.

3. A device according to claim 1 in which said slidable contact incorporates means for maintaining such contact in its said initial position until operaton of said pressure-producing means, such contact-position-maintaining means comprising a frangible radial extension of non-conducting material formed on said contact and designed to engage the wall of said chamber until slidable movement of said contact is initiated.

References Cited in the file of this patent

UNITED STATES PATENTS

2,142,383	Smith	Jan. 3, 1939
2,816,196	Daudelin	Dec. 10, 1957
2,931,874	Leaman	Apr. 5, 1960
2,938,976	Wilson	May 31, 1960
2,978,559	Caswell	Apr. 4, 1961