Aug. 31, 1965 F. T. BILEK 3,204,053

MINIATURE PLUG AND JACK EXPLOSION PROOF CONNECTOR

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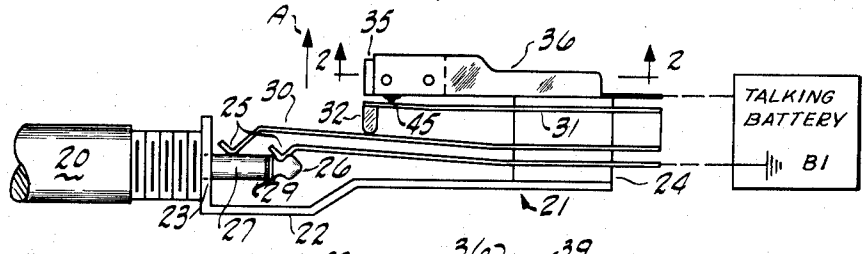

FIG. 1

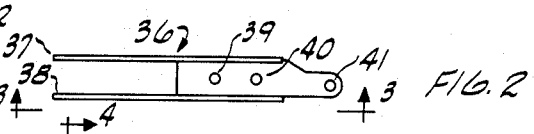

FIG. 2

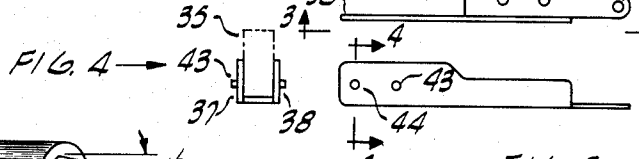

FIG. 4

FIG. 3

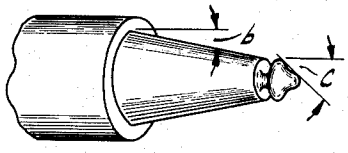

FIG. 5

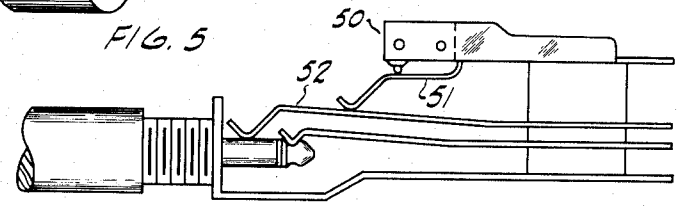

FIG. 6

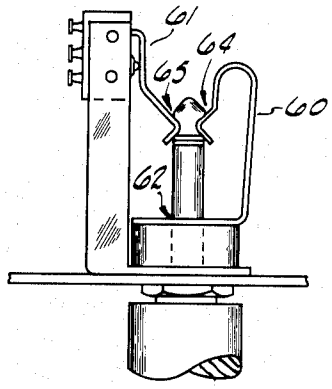

FIG. 7

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MINIATURE PLUG AND JACK EXPLOSION PROOF CONNECTOR

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This invention relates to explosion proof connectors and more particularly to miniature plug and jack arrangements.

Very often electrical connections must be completed or broken in an atmosphere laden with explosive gasses. If simple contacts are permanently wired in place, there are no great problems because the contacts may be sealed away from the atmosphere in explosion proof glass or metal containers. On the other hand, some contacts cannot be so sealed. For example, a plug and jack require physical separation between the contact elements.

The present day explosion proof connectors are extremely expensive devices which require considerable time to operate. A typical connector might, for example, include massive precision castings having gasketed openings and complicated twist locks. To this combination interlocking switches are added to prevent energization of electrical circuits until after a completion of the insulation between the contacts and the atmosphere. Additionally disadvantages grow out of the slow, time taking procedures required for making connections and the weight and space requirements of the massive explosion proof housings. Thus, there is a need for a simple, inexpensive, fast-operating, explosion proof plug and jack.

Accordingly, an object of this invention is to provide a new and improved explosion proof connector. A more particular object is to provide a simple and inexpensive explosion proof plug and jack combination which may be operated as quickly and easily as conventional plugs and jacks. In fact, an object is to provide such plugs and jacks with a space and weight advantage not found in conventional explosion proof equipment.

Yet another object is to provide such explosion proof plugs and jacks that are quickly and inexpensively made on conventional machine tools and of commercially available parts.

In keeping with one aspect of this invention, a plug and jack combination completes an electrical connection at a time when the connection making contacts are not energized. Near the end of plug travel and after all danger of an arc has passed, an explosion proof microswitch operates to energize the contacts. The plug does not have a perfectly cylindrical shape which has sometimes caused the jack spring contacts to bounce. On the contrary, the plug cross-section has a continuously inclining plane (with respect to jack spring travel) to prevent contact bounce.

The above mentioned and other features of this invention and the manner of obtaining them will become more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevation view which shows a first embodiment of a plug and jack combination incorporating the principles of the invention;

FIG. 2 is a top view of a switch holding bracket taken along line 2—2 in the embodiment of FIG. 1;

FIG. 3 is a side elevation of the switch holding bracket taken along line 3—3 of FIG. 2;

FIG. 4 is an end view of the switch holding bracket taken along line 4—4 of FIG. 3;

FIG. 5 is an isometric view of a plug made in accordance with the invention;

FIG. 6 is a side view of a second embodiment of the invention; and

FIG. 7 is a side view of a third embodiment of the invention which is a sub-miniature plug and jack combination.

As shown in FIG. 1, an explosion proof connector constructed in accordance with the teachings of this invention comprises a plug **20** and a jack **21**. The jack **21** includes a supporting plate **22** having a plug receiving, sleeve opening **23** on one end and a spring pile up **24** supported on the other end. As with conventional jacks, the pile-up includes a laminate of contact springs separated by insulating spacers bolted, or otherwise secured in any suitable manner to the plate **22**. The ends **25** of the contact springs are given a generally arcuate shape to guide the plug **20** into position. When in position, the plug is gripped by the contact spring tension.

The arrangement described thus far is subject to two faults. First, when used in telephone systems, the tip **26** and sleeve **27** of the plug **20** normally complete a 48 volt circuit to a talking battery B1. The plug completes this circuit at the ends **25** of the contact springs, sometimes with a resulting arc. The arc could, of course, cause an explosion. Second, the plug usually has a sleeve of a generally cylindrical shape terminated by an abrupt shoulder **29**. Thus, when the plug **20** is rapidly and forcefully inserted into the jack **21**, the arcuate ends **25** of the spring contacts ride up an effectively inclined plane on the plug leading to the shoulder **29**. At the top of the inclined plane, the arcuate end **25** hurdles over the shoulder **29** and bounces one or more times against the cylindrical section. Each bounce may also cause arcs. Again these arcs could cause an explosion.

In keeping with one aspect of this invention, means are provided for preventing arcs when the plug and spring contacts first meet. In greater detail, the electrical energy for the jack springs is supplied through a set of contacts which are open when the plug and jack first meet. Since there is no potential difference between the plug and jack at this time, no arc can form. As the plug moves to a resting position, the jack spring contact **30** is forced upward (as viewed in the drawing) in the direction of the arrow A.

Immediately above spring **30**, an actuator spring **31** is included as part of the pile-up **24**. This actuator spring **31** has no electrical connections (other than perhaps a ground wire) and is insulated from the contact spring **30** by a pusher **32**. The pusher may be made of any suitable non-conductive material such as nylon, for example. By an inspection of the drawing it should be apparent that the actuator **31** also moves in the direction of the arrow A as the plug is moved into position.

According to the invention, means, here shown as miniature snap action switch **35**, are provided for completing the electrical circuit after an arc is no longer possible. The micro switch **35** is an explosion proof, commercially available device, preferably held in place by a bracket **36** secured in the spring pile-up **24** in the same manner that all of the springs are secured.

The construction details of one exemplary bracket are given in FIGS. 2–4. As there shown, the bracket **36** is a punch press, piece part comprising a yoke made by folding sheet metal to provide two upwardly and outwardly extending arms **37**, **38**. The bracket is secured in the pile-up **24** by bolts passing through holes **39**, **40**. Preferably, a ground connection is made at lug **41**, an integral part of the yoke.

As shown in FIG. 3, the arms **37**, **38** have two bolt receiving holes **43**, **44** for securing the miniature snap switch **35**, when it is in position. Finally, as shown in the end view (FIG. 4) the arms **37**, **38** partially surround and snugly hold the switch **35**. Thereafter, pins or bolts

passed through the holes 43, 44 clamp the switch into position. Of course, the form shown in FIGS. 2–4 is exemplary only; other kinds of brackets may be used also.

The miniature snap switch 35 is opened or closed by operation of a single push button 45 (FIG. 1). When the actuator spring 31 moves upward responsive to plug motion, the miniature snap switch contacts close. When the actuator spring moves downward as the plug is removed, the miniature snap switch contacts open.

The operation should now be apparent to those skilled in the art. From an inspection of FIG. 1, it is seen that the plug 20 is inserted into the jack 21 at a time when the electrical circuit is open. A resulting spring motion forces the actuator spring 31 upward against the push button 45. After all danger of an arc has passed, the actuator spring moves the push button 45 far enough to close the miniature snap switch contacts and energize the plug and jack circuit. A principal design consideration is that the actuator spring must have enough mechanical excursion and spring tension to cause a full and complete push button travel. This insures against marginal switch operation. Conversely, the actuator excursion and spring tension must be small enough to guard against miniature snap switch damage if the push button bottoms and the actuator spring continues to urge upward push button motion.

Means are provided to guard against contact spring bounce. According to this aspect of the invention, the plug does not have a shoulder (such as 29) followed by a linear bounce causing surface. Quite the contrary, as shown in FIG. 5, the sleeve portion of the plug is a continuously inclining plane, relative to contact spring motion. Thus, regardless of the speed and force used to position the plug, the arcuate end 25 of the contact spring continues its upward motion. There is no hurdle over an abrupt shoulder followed by a downward, bounce causing, spring motion. This continuously inclining plane for the sleeve contact spring is shown in FIG. 5 by the angle *b*. The angle *c* indicates that the same continuously upward motion also occurs for the tip contact spring. Thus, the contact springs always move, and come to rest, on a continuously rising inclined plane, thereby eliminating the downward bounce motion.

An alternative embodiment of the invention is shown in FIG. 6. There the miniature snap switch 50 includes an integral actuator spring 51. This actuator spring bears against and rides upon the jack contact spring 52, with or without an insulator pusher, as required. (No pusher is here shown.) Preferably the actuator and contact springs 51, 52 are positioned and proportioned to provide a compound lever system for giving a desired force multiplication that converts horizontal plug motion into vertical micro switch push button motion. Again, the design considerations for this force multiplication lever system requires positive push button action without causing micro switch damage when the push button bottoms.

FIG. 7 shows a sub-miniature version of the plug and jack. Here the pile-up is eliminated. Instead, contact springs 60, 61 are arranged to extend outwardly from the jack sleeve opening 62. These springs are positioned to make contact on opposite sides of the plug. A plug and jack contact is made at 64, and the miniature snap switch push button is actuated at 65. Again, the explosion proof miniature snap switch is mounted on a bracket adjacent the contact spring.

In one particular instance, the following Minneapolis-Honeywell Regulator Company Micro Switches were used: FIG. 1, type 1SM1; FIG. 6, type 111SM1–T; and FIG. 7, type 1SX1–T.

The many advantages of this explosion proof connector are self-apparent. First, the parts are easily and inexpensively made on general purpose machine tools. Second, the purchased parts are readily available commercial components. Third, plug-and-jack connections may be made quickly and easily; there are no complicated twist locks. Fourth, there is no heavy and bulky, massive housings, thus the connector is ideal for airborne and similar installations. Of course, there are still other advantages which will be apparent to those skilled in the art.

While the principles of the invention have been described above in connection with specific apparatus and applications, it is to be understood that this description is made only by way of example and not as a limitation on the scope of the invention.

I claim:

1. An explosion proof telephone switchboard-type connector comprising a plug and jack combination for completing a connection between two telephone circuits, said plug having at least tip and sleeve contacts, said jack having at least one spring contact for mating with one of said plug contacts, means for precluding energization of said jack spring when said plug and jack first meet, and means comprising an explosion proof miniature snap switch operated responsive to movement of said jack spring caused by plug motion for energizing said jack spring from the talking battery of a telephone system after an arc is no longer possible.

2. The connector of claim 1 wherein said jack comprises a supporting plate with a plug receiving sleeve opening at one end and a spring pile-up including said jack spring, said pile-up being supported at the other end, said pile-up including an actuator spring insulated from and movable with said jack spring, and means responsive to said plug motion for causing said actuator spring to control said miniature snap switch.

3. The connector of claim 2 wherein said actuator spring has enough excursion and spring tension to cause a full and complete push button travel, said actuator spring excursion and tension being insufficient to damage said miniature snap switch by bottoming said push button.

4. The connector of claim 1 wherein the sleeve contact of said plug is shaped to provide a continuously inclining plane relative to said spring contact.

5. The connector of claim 1 wherein said miniature snap switch comprises a push button and an actuator spring, said actuator spring being positioned to bear against said spring contact, and means responsive to connection of said plug and jack for translating horizontal plug motion into vertical push button motion.

6. The connector of claim 5 wherein said actuator spring and said spring contact provide a force multiplying lever system for causing said vertical push button motion.

7. The connector of claim 1 wherein said jack comprises a base plate having a sleeve opening, and means for mounting said spring contacts and said miniature snaps switch adjacent said sleeve opening.

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