June 2, 1964 C. H. JACKSON 3,135,200

SQUIB

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FIG. 1

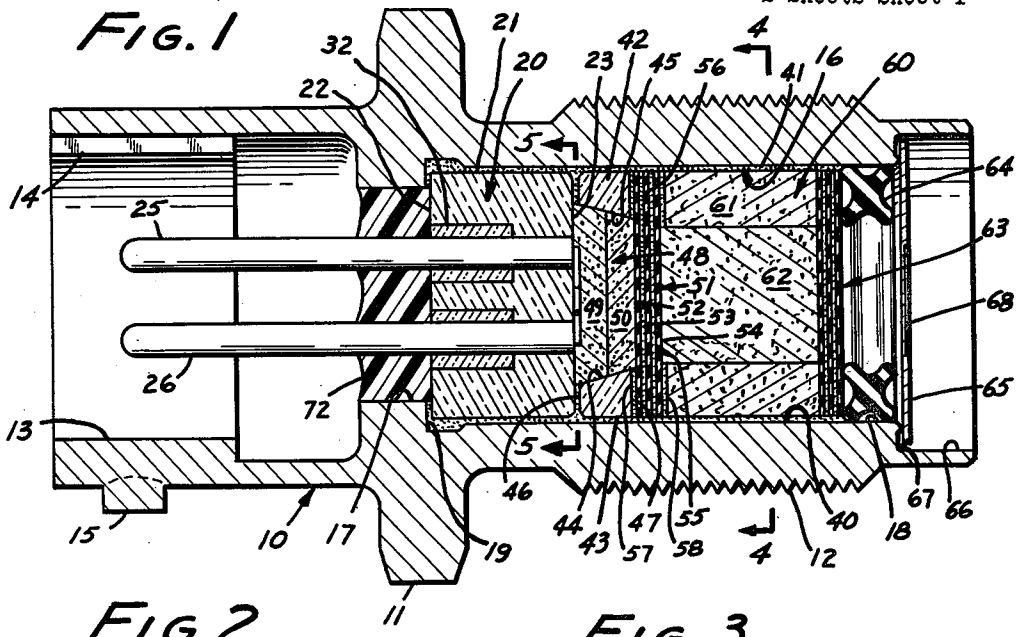


FIG. 2

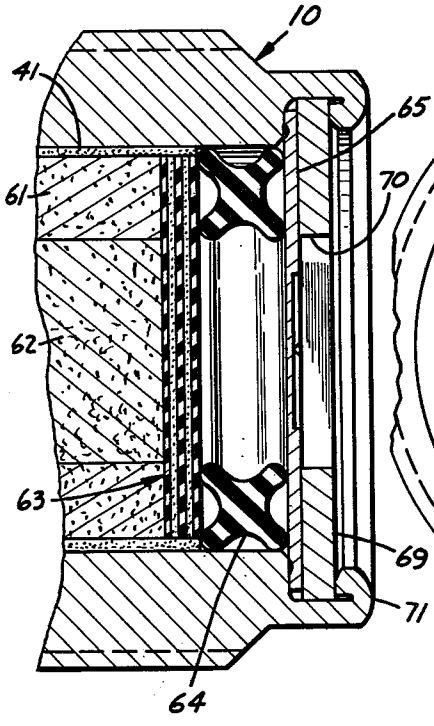
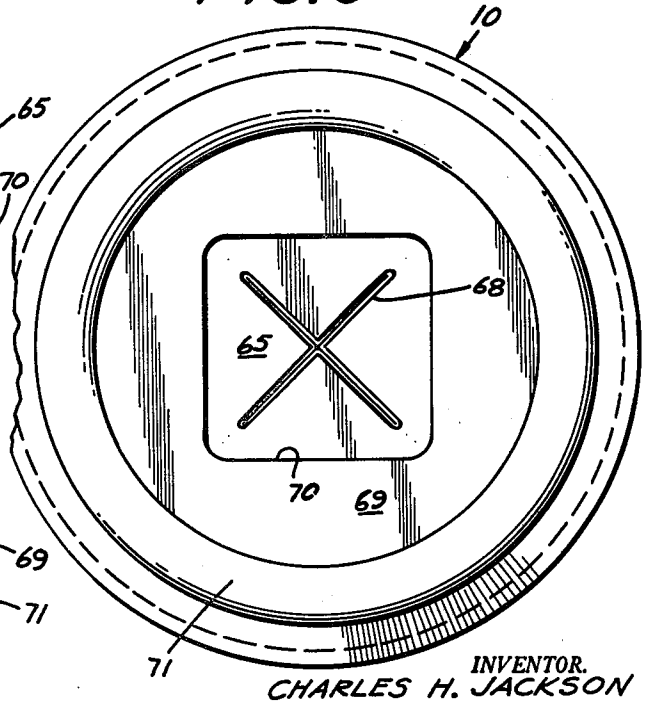


FIG. 3



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FIG. 5

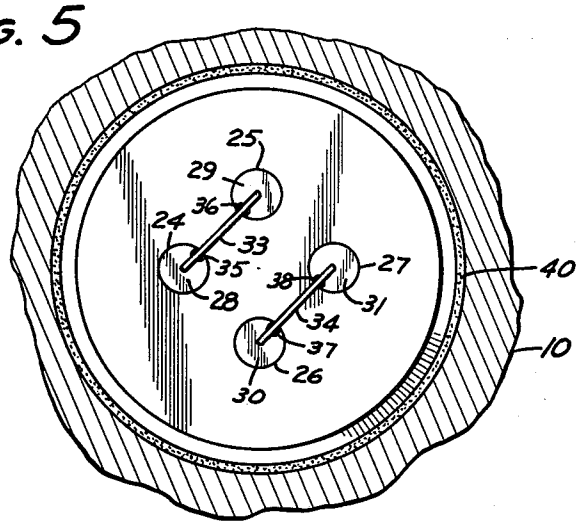
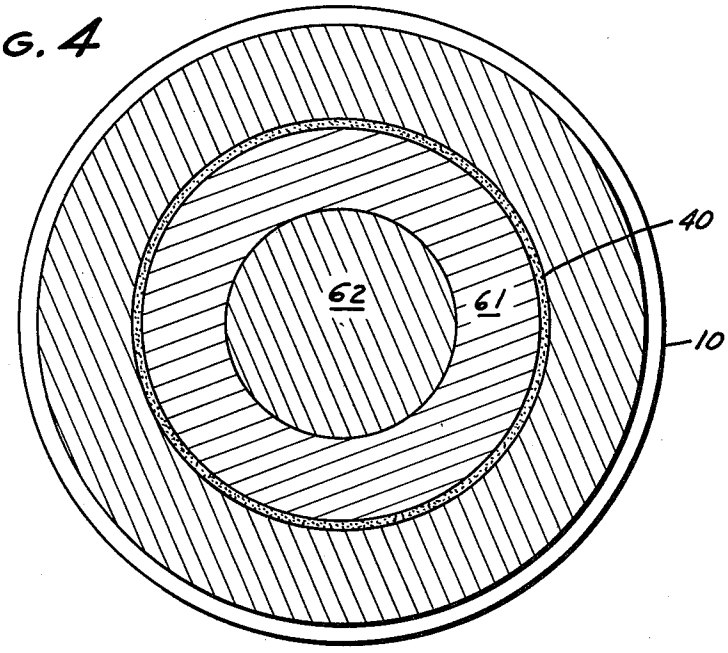


FIG. 4



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SQUIB

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5 Claims. (Cl. 102—28)

This invention relates to a squib which upon its ignition provides a quantity of gas.

Such squibs are often utilized for a source of gases for uses such as the actuation of mechanical devices. An example of such a contrivance is a separation nut of the type intended to be separated into a plurality of parts upon actuation of the squib, thereby to release from joinder assemblies which were held together by the nut. The gas is usually obtained from ignition of a charge.

Many squibs for these general purposes are known. However, as a rule they are difficult and expensive to manufacture, and are not sufficiently reliable. Particularly for missile applications, where the success of a whole system depends on the successful operation of every component, their reliability must be very high, and it is an object of this invention to meet this requirement.

A squib according to this invention includes a body having a charge cavity with a first and a second opening through the body. A shoulder is formed in the cavity surrounding the first said opening. A header, which is made of substantially insulating material is disposed at least in part in said cavity, and bears against said shoulder for locating the header. A plurality of conductors passes through the header and the first opening. A bridge wire is conductively connected between two of the conductors, and is disposed in the cavity. Sealing means seal the header at the first opening thereby making a hermetic seal at the first opening.

A retainer ring is disposed inside the cavity, and includes a tapered interior wall, the opening tapering toward the header so as to bear against a first charge that is contained therein and hold it pressed against the bridge wire. An insulating barrier is disposed contiguous to the first charge on the other side thereof from the header to complete the insulation of the first charge from the body. A second charge is provided in the cavity on the opposite side of the insulating barrier from the first charge, and a closure plate which is rupturable upon ignition of the charges closes the second opening.

According to a preferred but optional feature of the invention, the bridge wire is conductively attached to flush portions of each of the conductors.

According to still another preferred but optional feature of the invention, the first charge comprises an initiator portion of well consolidated, readily ignitable, material which produces a hot flame, bearing firmly against the bridge wire, and a sustainer portion in contact with the initiator portion which is slower burning and which sustains flame in the first charge until the insulating barrier is pierced and the second charge is ignited.

According to still another preferred but optional feature of the invention, the second charge is comprised of two portions: a first ring portion of well consolidated material forming a grain, and a core portion of material of lesser consolidation inside it. This arrangement results in a second charge which burns more slowly at the outside of the charge than at its center.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings in which:

FIG. 1 is a cross-section view of the presently preferred embodiment of the invention in an intermediate step of its manufacture;

FIG. 2 is a fragmentary cross-section of the right hand end of FIG. 1 showing that end in its completed configuration;

FIG. 3 is a right hand end view of FIG. 2; and

FIGS. 4 and 5 are cross-sections taken at lines 4—4 and 5—5, respectively, in FIG. 1.

In FIG. 1 there is shown an intermediate configuration of the preferred embodiment of the device during its manufacture. It includes a body **10** having a hexagonal wrenching shoulder **11** and external threads **12**. With these, the body can be attached at a threaded port to a device such as a separation nut which is to receive gas generated by the squib.

A receptacle **13** is provided for receiving mating plugs for supplying igniting current to the squib. If desired, splines **14** and studs **15** can be provided for aligning the plug, and for safety wiring. The splines, studs, wrenching shoulder and thread are not essential to the present invention but are usually provided so that it can readily be used.

The body includes a cavity **16** having a first opening **17** and a second opening **18**. An internal shoulder **19** faces into the cavity and surrounds the first opening. The cavity is preferably cylindrical, and the shoulders is preferably flat and disc-shaped.

A header **20** is made of a ceramic material which is insulating in nature. It has a cylindrical peripheral surface **21** and first and second faces **22**, **23**. Four conductors **24**, **25**, **26** and **27** pass through the header and have ends **28**, **29**, **30**, **31**, respectively, which lie flush with face **23** inside the cavity. Glass beads such as bead **32** in FIG. 1 hold the conductors in the headers.

The conductors are preferably in the form of parallel pins. Such pins are adapted to enter into sockets which are received by receptacle **13**.

Bridge wires **33**, **34** (see FIG. 5) are spot welded at welds **35**, **36**, **37**, **38** to ends **28–31**, respectively, of the conductors. These welds lie on the lines of centers of the respective pairs of conductors. In the device shown, two pairs of conductors and two bridge wires provide two circuits for redundancy purposes. It will be understood, of course, that only one pair of conductors and one bridge wire are necessary to the function of the device.

The header is cemented to shoulder **19** and to the internal wall **40** of the cavity by cement **41**. The thickness of this and all other layers of cement is very much exaggerated in the drawings so as effectively to show its existence. Actually only the very thinnest layer of cement lies between the header and shoulder **19** because it is intended that shoulder **19** align the header. The header is in substantial contiguity with the shoulder. However, it is impossible to illustrate the cement layer without showing some separation. The header is held in position by cement both between it and the shoulder, and between it and the internal wall. A suitable cement is a well-blended mixture of 100 parts by weight of EC1663B, and 10 parts by weight of EC1663A, obtainable from the Adhesives, Coatings and Sealers Division of Minnesota Mining and Manufacturing Company, St. Paul 6, Minnesota. Any other cement or adhesive not deleterious to the materials which it contacts may be used instead. The same substantance may be utilized for cementing wherever shown in FIG. 1.

A retainer **42** is cemented to the internal wall of the cavity and also to face **23** of the header. The retainer includes a cylindrical peripheral surface **43** and an interior wall **44** which forms a tapered retainer passage **45**. This passage enlarges toward the bridge wire and extends between faces **46** and **47** of the retainer.

Within, contiguous to, and retained by the said interior wall of the retainer there is a first charge **48** of ignitable material. This charge is conveniently provided in two

portions: an initiator portion 49, and a sustainer portion 50. The initiator portion lies flush against, contiguous to, and in contact with face 23 of the header and with the bridge wire. In fact, it is compacted into contact with the bridge wire as will be more fully described below.

The sustainer portion also lies within the tapered retainer passage, in full surface contact with the said interior wall. It terminates flush with face 47 of the retainer.

An insulating barrier 51 comprising three insulating discs 52, 53, 54 laminated with two layers 55, 56 of silicone are attached by cement 57 to face 47 of the retainer. Layer 57 of cement is shown greatly exaggerated in thickness. It is in fact extremely thin, and does not substantially space the insulating barrier from the retainer or from the first charge. Neither does cement layer 58 on the other side of the insulating barrier.

It will be observed that the insulating retainer, the insulating barrier, and the header break any circuit between the conductors and the wall of the body through the charge. The material of the charge is a poor conductor of electricity, but high electrostatic voltages could flow through if they reached it, and could then ignite it. The construction shown protects against ignition of the charge by electrostatic charges by breaking any possible circuit path.

A second charge 60 disposed in the cavity on the other side of the insulating barrier from the first charge. The second charge is preferably, although not necessarily, provided in two portions: a ring portion 61 firmly compacted into a grain, and a core portion 62 of material which is less compacted. In the preferred embodiment of the invention, the ring portion is preformed, placed in the cavity, and cemented in place. The core material is then poured in and tamped in place.

A flash barirer 63 is made identical to the insulating barrier, with discs and laminations. It need not be cemented to the charges. Also, it need not be cemented to the wall of the cavity, although it is in FIG. 1.

A quad section O-ring 64 (sometimes called a "resilient spacer") is placed in the cavity next to the flash barirer, and a closure plate 65 is placed next to it. When the device is assembled, the O-ring exerts a slight pressure on the flash barrier. Its resilience permits of some variation in the length of the stacked components inside the cavity, while still exerting end pressure on them. The O-ring also spaces the charge from the region of the body which carries appreciable current during a spotwelding operation described below.

At the right hand end of the body in FIG. 1 there is a counter-bore 66. A circumferential lip 67 is formed inside the counter-bore. The purpose of the lip is to form a peripheral line joint for flash welding the closure plate to the body. The closure plate is laid against the lip, and a spotwelding current is passed through the plate and body in order to weld the closure plate to the configuration as shown in FIG. 2. The closure plate then completely closes and hermetically seals the cavity at the second opening.

A cruciform impression 68 thins the closure plate at is center. As can best be seen in FIG. 3, a washer 69 with a square opening 70 is laid in the counter-bore adjacent to the closure plate with the arms of the cruciform impression pointing at respective corners of the square. The washer reduces the cross-section area of the second opening through which gases can escape. It aids in preventing expulsion of non-ignited material when the squib is actuated in a high vacuum such as in space. The right hand end of the body is formed into a crimp 71 as shown in FIG. 2, to hold the washer in place against the closure plate.

Closure of the first opening is accomplished by sealing means 72 comprised of a resin which fills the first opening and lies contiguous to and surrounds both face 22 of the header and the peripheries of the conductors. Any good epoxy-type potting compound will serve this purpose, such as Epoxylite 5302BA, sold by Epoxylite Corporation.

A suitable material for the header and for the retainer is 94 to 99.5% pure alumnina.

The conductors may conveniently be gold plated.

A suitable material for the discs such as disc 52 is isomica sheet approximately .004 inch thick which is sold by Minnesota Mining and Manufacturing Company, Mica Insulator Divisions, Schenectady, New York. The discs are laminated with a silicone rubber such as EC1663BA, which is sold by Minnesota Rubber Company, Minneapolis 16, Minnesota.

The initiator portion of the first charge is placed loosely in the region inside the retainer and is consolidated in place against the bridge wire or bridge wires. A charge of approximately 50 ± 2 mg. can be consolidated at 20,000 p.s.i. to the desired state of compaction.

The sustainer portion of the first charge is thereafter placed inside the retainer and is similarly compacted. A charge weight of approximately 60 ± 2 mg. may also readily be consolidated at 20,000 p.s.i., and this charge will neatly fill the retainer, and be tightly compacted.

The ring portion of the second charge may be consolidated in a mold by application of a pressure of approximately 10,000 p.s.i. to form an integral, self-supporting grain, weighing 500 ± 10 mg. It may be placed in the cavity and its central opening then filled with additional main charge material weighing 150 ± 5 mg. which will be pressed at about 5,000 p.s.i. until it is flush with the right hand end of the grain. It is less consolidated than the ring portion.

The above charge is suitable for use in a cavity whose internal diameter is 0.320 inch.

A suitable material for the initiator portion of the first charge is lead styphanate provided as a finely divided powder before consolidation. The material of the initiator portion is more readily ignited, and faster "burning" than the material of the sustainer portion and of the second charge.

The sustainer portion and both portions of the second charge may all conveniently be of the same material and can be of any powdered metal-oxidizing salt-organic binder type mixture, preferably in stoichiometric quantities. Suitable powdered metals are boron, zirconium, aluminum, and magnesium, or mixtures of them. Suitable oxidizing salts are barium nitrate, potassium nitrate, barium chromate and ferric oxide, or mixtures of them. A suitable organic binder is gum yacca, or BY–HL, sold by the Bakelite Corporation.

Where the terms "ignite" or "ignitable" and "burn" or "burning" are used herein, they relate to the ability of a material to react to provide gas. The terms are not restricted to reactions involving oxygen.

With the above description in mind, the advantages of this invention can now be appreciated. In conventional devices it is also customary to provide bridge wires at the bottom of a cavity. However, conventional techniques of manufacture have required the drilling of holes through the metal body to pass the conductors, and sealing them in place with glass seals. Then the wires were welded in place at the bottom of the cavity. This is a difficult procedure, and its difficulties lead to the possibility of malfunction. In the instant invention, the entire header assembly can readily be manufactured, including bridge wires as a separate and accessible part, and then simply be dropped into the body where it is cemented in place and sealed with the sealing means. It is obvious that a more accurate and reliable device can be made in this way.

Furthermore, conventional devices have suffered from liability to detonation by electrostatic charges. It will be seen that in this device there is no circuit path between the conductors and the body, and electrostatic charges therefore cannot set off the device.

By providing both an initiator and a sustainer portion in

the first charge, wherein the initiator is more sensitive to current, and provides a hot flame for igniting the sustainer portion, a first charge is provided which is quite certain to be ignited by a current through the bridge wire. Although the flame derived from the initiator charge is of short duration, still it will be enough to ignite the sustainer portion which will carry on long enough to ignite the main portion. There is thereby obtained a reliable first charge sure to ignite the device but which can still be separated by the insulator barrier from the main portion of the charge and also from the body.

The loading of this device is elegantly simple, it merely being necessary to stand the device with the second opening upward, load in the first charge and compact it in place. The insulating barrier is dropped in after the first charge is in place and then the ring portion of the main charge is dropped in and cemented in place whereupon the core portion is preferably tamped in place to a lesser degree of consolidation, and the flash barrier quad-ring are put in place.

The flash barrier enables the spotwelding operation to be carried out without the danger of igniting the device because while there is considerable heat generated locally, no flash or spatter will be able to pass through the flash barrier.

The restricted opening in the washer creates a restricted cross-section area through which the flaming gases can be discharged and thereby inhibits any tendency for the charge to simply blow itself bodily out of the cavity perhaps without the generation of gases, particularly in vacuo.

The device has considerable strength particularly at the pins derived from the shoulder to shoulder abutment between the header and the body, and the tapered ring effectively prevents the first charge from backing out of contact with the bridge wire which is a matter of considerable importance particularly when the squib goes through a number of temperature cycles of large range.

As can be seen from the foregoing, this device provides a simple, reliable squib which is readily manufacturable and which lacks many of the complications of conventional devices.

This invention is not to be limited by the embodiments shown in the drawings and described in the description which is given by way of example and not of limitation but only in accordance with the scope of the appended claims.

I claim:

1. A squib for providing upon its actuation a quantity of gas, comprising: a body having a cavity with an internal wall, and a first and a second opening through the wall and the body; a shoulder in said cavity adjacent to and encircling said first opening; a header made substantially of insulating material, said header being disposed at least in part in said cavity, in bearing contact with the shoulder, and cemented to the interior wall; a plurality of conductors passing through said header and the said first opening; a bridge wire conductively connected between two of said conductors, and disposed in said cavity in abutting relationship to the header; sealing means closing said first opening and sealing around the conductors to form a hermetic seal at the first opening; a retainer ring in said cavity having a pair of opposite faces, a periphery geometrically similar to that of the interior wall, and a tapered interior wall extending between the faces and forming a tapered retainer passage, the larger end of the retainer passage being the closer to the header, the periphery and the face contiguous to the said larger end being cemented to the internal wall of the body and to the header, respectively; a compact first charge contiguous to and in contact with the bridge wire and with that portion of the header which is adjacent to the bridge wire, and disposed within and in contact with the interior wall of the retainer, the said tapered interior wall restraining said first charge from movement away from the bridge wire; an insulating barrier contiguous to the first charge and to the retainer extending substantially across the cavity; a second charge in the cavity on the opposite side of the insulating barrier from the first charge; a flash barrier in the cavity adjacent to the second charge on the opposite side of the second charge from the insulating barrier; and a closure plate spaced from the flash barrier and welded to the body at the second opening to close and hermetically seal said second opening, the passage of an electric current through the bridge wire igniting the first charge, which in turn ignites the second charge, which in turn ruptures the closure plate and thereby supplies gas at the second opening.

2. A squib according to claim 1 in which the first charge is comprised of an initiator portion of readily ignited material in contact with the bridge wire, and a sustainer portion of slower burning material in contact with the initiator portion, and in which the second charge is comprised of a ring portion of firmly consolidated ignitable material and a core portion within the ring material of less consolidated ignitable material.

3. A squib according to claim 1 in which the conductors comprise pins which pass through, project beyond one side of, and are mounted in said header, and lie substantially flush with the other side of said header, the bridge wire being conductively attached to the flush portions of each of the conductors.

4. A squib according to claim 3 in which a resilient spacer is placed in compressive contact between the flash barrier and the closure plate to hold the contents of the body in compression.

5. A squib according to claim 1 in which a resilient spacer is placed in compressive contact between the flash barrier and the closure plate to hold the contents of the body in compression.

References Cited in the file of this patent

UNITED STATES PATENTS

405,646	Zalinski et al.	June 18, 1889
2,248,587	Seavey	July 8, 1941
2,878,752	Johnson et al.	Mar. 24, 1959
2,882,820	Young	Apr. 21, 1959
2,981,186	Stresau	Apr. 25, 1961
2,987,997	Ireland	June 13, 1961
2,996,987	Paul	Aug. 22, 1961