Oct. 23, 1962 A. E. HAEFNER 3,059,576

ELECTRICALLY FIRED DETONATOR

Filed Sept. 26, 1958

Fig. 1.

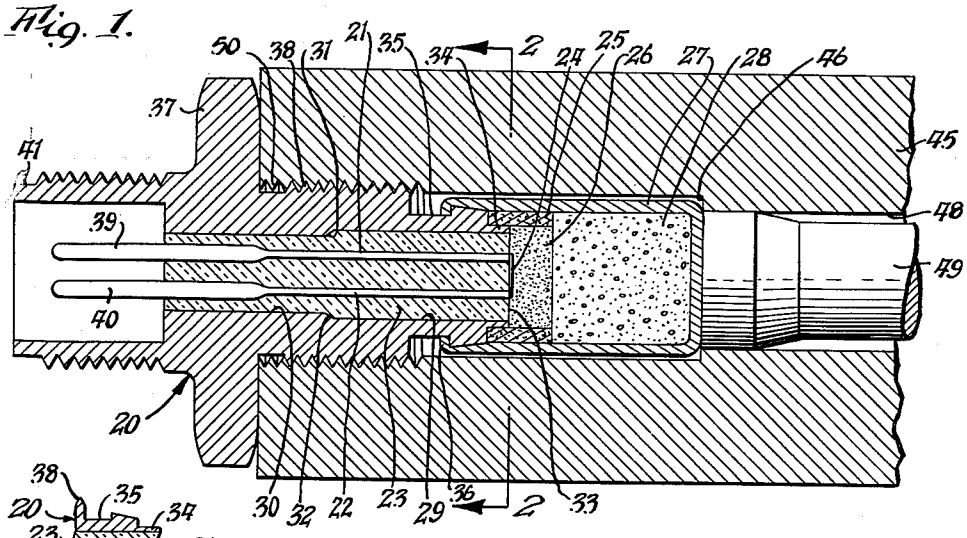


Fig. 3.

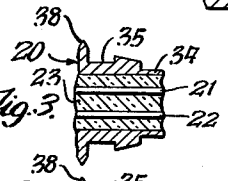


Fig. 4.

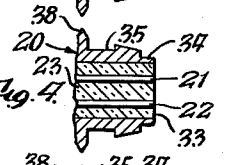


Fig. 5.

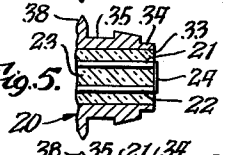


Fig. 6.

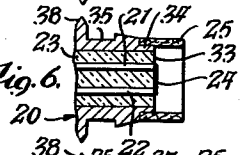


Fig. 7.

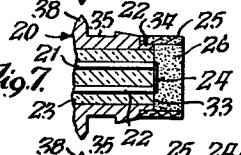


Fig. 8.

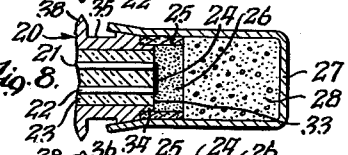


Fig. 9.

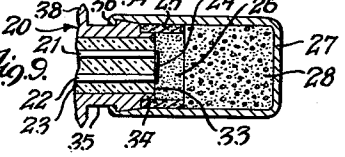


Fig. 2.

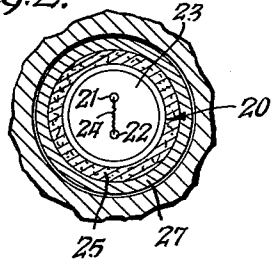


Fig. 13.

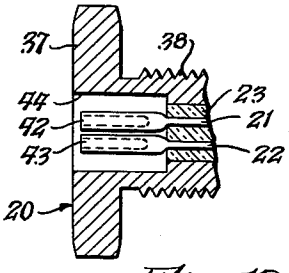


Fig. 10.

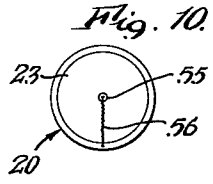


Fig. 11.

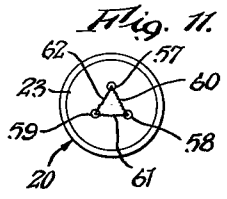
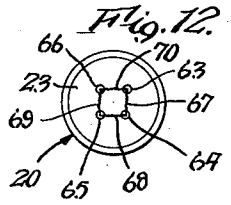


Fig. 12.



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United States Patent Office 3,059,576 Patented Oct. 23, 1962

3,059,576

ELECTRICALLY FIRED DETONATOR

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Filed Sept. 26, 1958, Ser. No. 763,700
6 Claims. (Cl. 102—28)

This invention relates to improvements in electrically fired detonators.

Electrically fired detonators are used for various purposes, such as in explosive actuated valves in which a ram is driven through a diaphragm separating inlet and outlet chambers of a normally closed valve, or the ram is driven to close off a passage in a normally open valve. Instead of using the ram to open or close a valve, it might be adapted as a pull-pin in an explosive latch pin device. An example of an electrically fired detonator used in a single operation normally closed explosive actuated valve is disclosed in United States Patent No. 2,815,882.

Detonators of this general class as heretofore constructed had various disadvantages which are overcome by a detonator constructed in accordance with the principles of the present invention. Some of these disadvantages included difficulty of manufacture to produce uniform firing characteristics from detonator to detonator of the same size and type, and blow back of gases around the lead in wires requiring special sealing means to prevent such blow back and involving the assembly of various parts when the detonator was mounted on a supporting member.

An important object of the present invention is to provide an improved electrically fired detonator in which when fired the escape of gases around the lead in wires is effectively sealed in a simple and improved manner.

Another object is to provide such a detonator which is compact in size and weight, this being an important advantage in certain applications such as on guided missiles and the like where available space is limited and weight is restricted.

Another object is to provide such a detonator which is a fully assembled unitary structure or instrumentality which can be quickly and easily attached to a member with which the detonator is intended to be operatively associated.

A further aim is to provide such a detonator which is easy to manufacture in quantity with the firing characteristics being uniform from one to another of the same lot and which is dependable in performance.

A further object is to provide such a detonator to which it is easy to make an electrical connection to a source of electrical energy.

Other objects and advantages of the present invention will be apparent from the following detailed description and accompanying drawing in which:

FIG. 1 is a longitudinal central sectional view of an improved electrically fired detonator constructed in accordance with the principles of the present invention and showing the same mounted on a supporting member illustrated as a cylinder for a ram.

FIG. 2 is a transverse sectional view thereof, taken on line 2—2 of FIG. 1.

FIGS. 3 through 9 are longitudinal central sectional views of an intermediate portion of the detonator of FIG. 1 but on a reduced scale as compared thereto, and illustrating various stages through which the detonator goes in its method of manufacture.

FIG. 10 is an end view, similar to FIG. 2, and showing a first modified form of detonator provided with a single lead in wire.

FIG. 11 is a similar view but showing a second modified form having three lead in wires.

FIG. 12 is a similar view but showing a third modified form having four lead in wires.

FIG. 13 is a fragmentary view of the left end portion of the detonator shown in FIG. 1 but modified to illustrate a socket type structure for electrical connection instead of a prong type structure as illustrated in FIG. 1.

Referring to FIG. 1, the improved detonator comprises a body **20**; one or more lead in wires, two being shown at **21** and **22**; a ceramic body **23** in which the lead in wires are embedded and housed within the main body **20**; one or more bridge wires connecting the ends of the lead in wires, one being shown at **24**; a sleeve **25** surrounding the bridge wire; an ignitor body **26** arranged in the sleeve **25**; and a cup-shaped shell **27** connected to the main body **20** and containing the main charge **28**.

The main body **20** is shown as an elongated tubular metallic member having a centrally located longitudinal cylindrical stepped bore, larger at its inner end as indicated at **29** than at its outer end **30** and connected by an intermediate annular shoulder **31** which faces inwardly or to the right as viewed in FIG. 1. Plugging this stepped bore is the ceramic body **23**, preferably glass, through which the lead in wires **21** and **22** extend longitudinally from end to end in spaced relation to each other. The ceramic plug **23** is fused to the surrounding wall of the detonator body **20** completely filling the stepped bore thereof and thereby having an annular shoulder **32** engaging the shoulder **31** on the body. The ceramic plug **23** is also fused to the lead in wires **21** and **22** and serves to insulate them from each other and from the detonator body.

The corresponding ends of the main body **20**, ceramic body **23** and lead in wires **21** and **22** lie in a common transverse plane forming a flat face **33** against which the bridge wire **24** is arranged. This bridge wire is very fine as compared to the lead in wires **21** and **22** and its ends are severally soldered to the exposed end faces of these lead in wires.

The sleeve **25** is a cylindrical tubular member, preferably made of fibre board, which embraces a neck portion **34** of reduced diameter formed on the inner end of the main body **20**. Adjacent the neck **34** but axially spaced therefrom and remote from the bridge wire **25**, the main body **20** is provided with an annular external groove **35** which receives the turned in annular flange **36** formed on the rim portion of the cup shaped shell **27**.

The main body **20** is shown as having an external thread **38** for a portion of its length and arranged intermediate the crimping groove **35** and an enlarged portion **37**. The root diameter of the thread **38** is slightly larger than the external diameter of the shell **27**. The periphery of the enlarged portion **37** is suitably formed to permit the application of a tool (not shown) for turning the main body **20** about its longitudinal axis. Conveniently such periphery may be hexagonal in shape in order to permit the application of an ordinary wrench.

In FIG. 1, the outer ends of the lead in wires **21** and **22** are shown as connected to prongs **39** and **40**, respectively, which form enlarged axial extensions of the lead in wires partially embedded in the ceramic body **23**. The main body **20** is shown as formed with an integral tubular, externally threaded, extension **41** which surrounds the exposed portions of the prongs **39** and **40** and in spaced relation thereto. This extension **41** is adapted to receive a receptacle (not shown) having sockets into which the prongs **39** and **40** will project and secured by engagement with the external thread on the extension **41**. In this manner, the lead in wires **21** and **22** can be disconnectably coupled to a source of electrical energy (not shown) for energizing the bridge wire **24** and thereby actuating the detonator.

As shown in FIG. 13, the detonator may be adapted for

a different type of electrical connection. As there shown, the outer ends of the lead in wires **21** and **22** may be formed as socket members **42** and **43**, respectively, arranged in an enlarged recess **44** in the tail or outer end of the detonator body **20** and adapted to receive the prongs of an electrical plug (not shown).

Referring again to FIG. 1, the detonator is shown as mounted on a cylinder **45** having a chamber **46** receiving the shell **27** of the detonator, a bore **48** of slightly reduced diameter in which a ram **49** is movably arranged and adapted to be driven to the right or away from the detonator when the latter is fired. In order to fasten the detonator to the cylinder **45**, the outer portion of the chamber **46** of the latter is internally threaded as indicated at **50** to receive the external thread **38** on the detonator body. It will be noted that the detonator is screwed into the ram cylinder **45** until the inner face of the enlarged portion **37** of the detonator body **20** abuts the outer end face of this cylinder, thereby giving good sealing to the outer end of the chamber **46**.

With the lead in wires **21** and **22** of the detonator connected to a source of electrical energy, as previously described, when a sufficient current is passed through the bridge wire **24**, depending upon its resistance, this wire glows and ignites the ignitor charge **26** which in turn sets off the main charge **28**. The resulting detonation ruptures and blows out the end wall of the shell **27** permitting the gases generated to drive the ram **49** or equivalent device forwardly.

Any suitable chemical or mixture of chemicals may be used for the ignitor charge **26** and main charge **28**. Excellent results have been obtained with diazodinitrophenol with 1% nitrostarch added as binder, for the ignitor charge **26**; and 100% diazodinitrophenol for the main charge **28**. The electrical input required to fire a detonator depends upon the bridge wire resistance and the composition of the ignitor charge. The power obtained from a detonator is determined by the size and composition of the base charge **28** which may be varied to meet particular needs.

The design of detonator described lends itself to an easy method of manufacture which assures uniformity in the firing characteristics of similar detonators and provides functional reliability. Firing characteristics, aside from the variables previously mentioned, depend upon the compaction or compression of the ignitor and base charges during assembly of the detonator; and dependability involves protection of the fragile one or more bridge wires.

The method of assembling the two lead in wire detonators shown in FIG. 1 is outlined in FIGS. 3 through 9. A preformed ceramic plug arranged in the stepped bore of the detonator body **20** and having spaced holes through which the lead in wires **21** and **22** extend, is heated to fuse the ceramic body **23** to the detonator body and also to the lead in wires, as depicted in FIG. 3. The end of this sub-assembly is then rendered smooth as by grinding to provide the flat transverse end face **33** shown in FIG. 4. The bridge wire **24** is then placed against the flat face **33** and soldered at its ends to the exposed ends of the lead in wires **21** and **22**. Following this the sleeve **25** is slipped on the neck **34**, as shown in FIG. 6. The outwardly projecting part of the sleeve **25** and the flat face **33** jointly form a recess into which the ignitor charge **26** is buttered, as shown in FIG. 7. The shell **27** which is preferably of copper and containing a predetermined amount of powder forming the main charge **28** is then slipped over the sleeve with the rim of the shell overlapping the crimping groove **35**, as shown in FIG. 8. With the ignitor and main charges compressed to a predetermined degree by pressing the shell **27** axially toward the detonator body **20**, the rim portion of the shell is rolled over or crimped in the groove **35**, as shown in FIG. 9, thus completing the assembly. Crimping may be effected by any suitable tool.

It is to be noted that the bridge wire **24**, or additional ones if used, are arranged against the supporting flat face **33**, facilitating soldering and also minimizing breaking or dislodgement of the wire or wires when the ignitor charge is subsequently applied or even when the ignitor and main charges are compressed against the wire or wires.

It will also be observed that the ceramic body **23** because of its inner end portion being larger than its outer end portion is prevented from being blown out of the detonator body when the detonator is fired. Also, because fused both to the detonator body and lead in wires, effective sealing is provided.

As previously explained, one or more lead in wires may be employed. Instead of the two lead in wires arrangement shown in FIGS. 1 and 2, there may be one, three or four lead in wires used as shown in FIGS. 10, 11 and 12, respectively. Multiple lead in wires may be desired to insure the detonator being fired.

In FIG. 10, the single lead in wire **55** is connected by a bridge wire **56** to the detonator body **20**. In this arrangement, the bridge wire is grounded to the detonator body.

In FIG. 11, three lead in wires **57**, **58** and **59** are shown as connected in a delta arrangement by three bridge wires **60**, **61** and **62**. Current passed through any pair of lead in wires and the associated bridge wire will fire the detonator.

In FIG. 12, four lead in wires **63**, **64**, **65**, and **66** are shown as connected in a square arrangement by four bridge wires **67**, **68**, **69** and **70**. Current through any pair of lead in wires and the intermediate bridge wire will fire the detonator.

In all the cases of FIGS. 2, 10, 11 and 12, the lead in wires are embedded in a ceramic body, in turn fused to the detonator body. This effectively prevents rearward escape of gases.

From the foregoing it will be seen that the construction of the detonator described achieves the various stated objects of the invention.

I claim:

1. In an electrically fired detonator, the combination comprising a mountable tubular main body, a ceramic body arranged completely within said main body and having an end face, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, at least one bridge wire arranged against said end face and electrically connected to said lead in wire, a shell embracing a portion of said main body and secured thereto, a main charge contained within said shell, and an ignitor charge arranged between said main charge and said bridge wire and in contact with both.

2. In an electrically fired detonator, the combination comprising a mountable tubular main body, a ceramic body arranged within said main body and having an end face, means arranged to prevent axial displacement of said ceramic body relative to said main body in at least one direction, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, at least one bridge wire arranged against said end face and electrically connected to said lead in wire, a shell embracing a portion of said main body and secured thereto, a main charge contained within said shell, and an ignitor charge arranged between said main charge and said bridge wire and in contact with both.

3. In an electrically fired detonator, the combination comprising a mountable tubular main body having a stepped bore larger at one end, a ceramic body plugging said bore and conforming to the shape thereof and having an end face flush with an end of said main body, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, at least one bridge wire arranged against said end face and electrically connected to said lead in wire, a shell embracing

a portion of said main body and secured thereto, a main charge contained within said shell, and an ignitor charge arranged between said main charge and said bridge wire and in contact with both.

4. In an electrically fired detonator, the combination comprising a tubular main body, a ceramic body plugging said body and having an end face flush with an end of said main body, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, at least one bridge wire arranged against said end face and electrically connected to said lead in wire, a reduced neck on the end of said main body, a sleeve member partially arranged on said neck, an ignitor charge surrounded by said sleeve member and contacting said bridge wire, a shell surrounding said sleeve member and secured to said main body, and a main charge contained within said shell and contacting said ignitor charge.

5. In an electrically fired detonator, the combination comprising a tubular main body, a ceramic body plugging said body and having an end face flush with an end of said main body, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, at least one bridge wire arranged against said end face and electrically connected to said lead in wire, a reduced neck on the inner end of said main body, a sleeve member partially arranged on said neck, an ignitor charge surrounded by said sleeve member and contacting said bridge wire, an annular groove arranged in the exterior of said main body adjacent said sleeve member, a cup-shaped shell surrounding said sleeve member and having an inturned rim portion received in said groove, and a main charge contained within said shell and contacting said ignitor charge.

6. An electrically fired detonator, comprising a tubular main body having an externally threaded portion and another external portion adapted to receive a tool for turning the same, a ceramic body arranged within said main body and having an end face, at least one lead in wire extending through said ceramic body to said end face, said ceramic body being fused to said main body and also to said lead in wire, means adapted to make an electrical connection with said lead in wire, at least one bridge wire arranged against said end face and electrically connected to the said lead in wire, a cup-shaped cylindrical shell embracing a portion of said main body and secured thereto, the outside diameter of said shell being no greater than the root diameter of said externally threaded portion, a main charge contained within said shell, and an ignitor charge arranged between said main charge and said bridge wire and in contact with both.

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