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MINIATURE TRIGGERED GAP IN COAXIAL SQUIB

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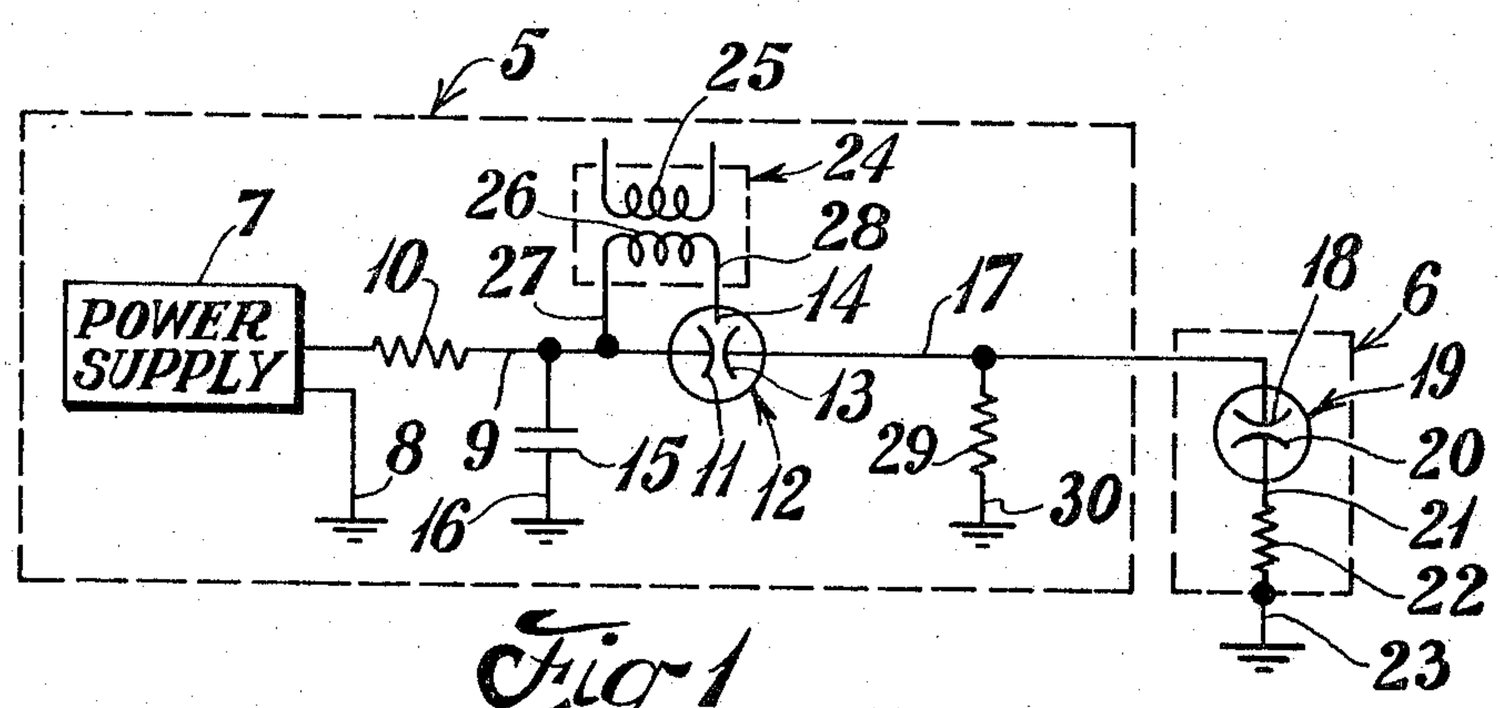

Fig. 1

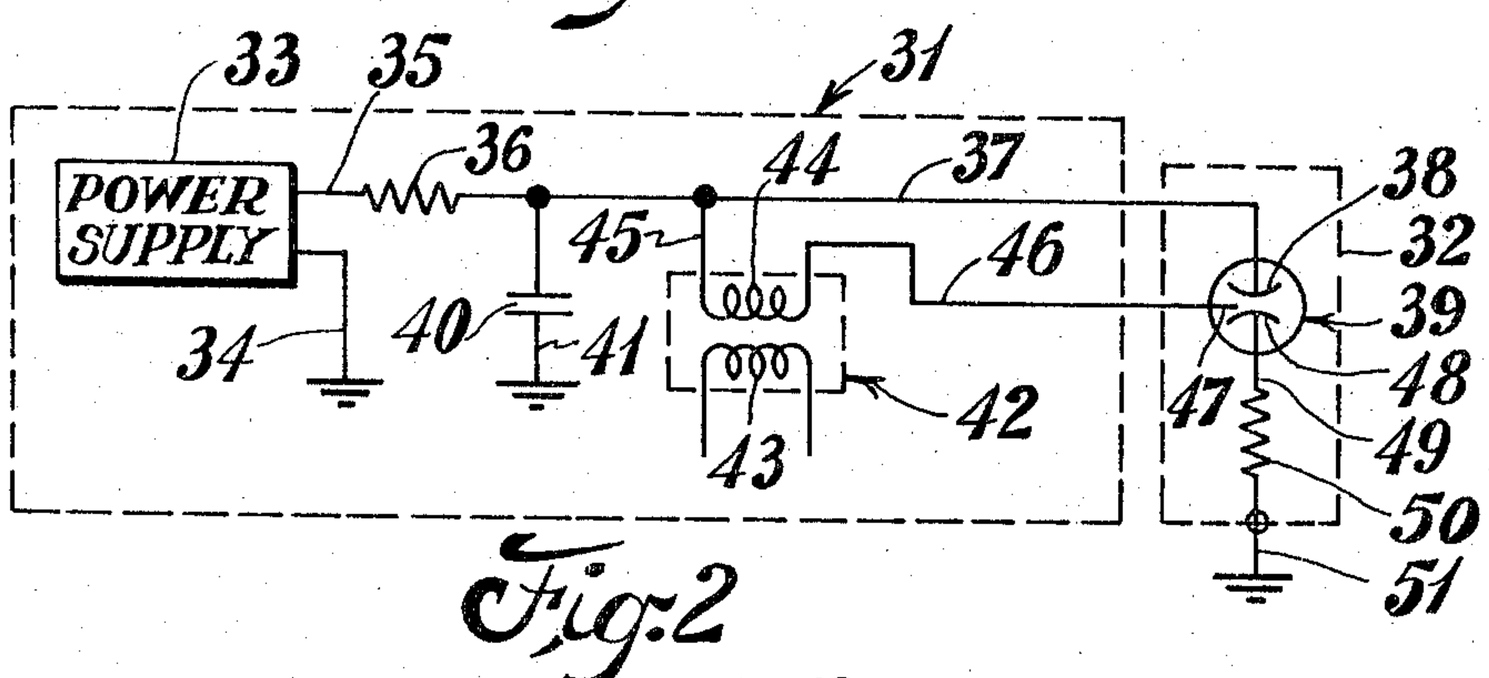

Fig. 2

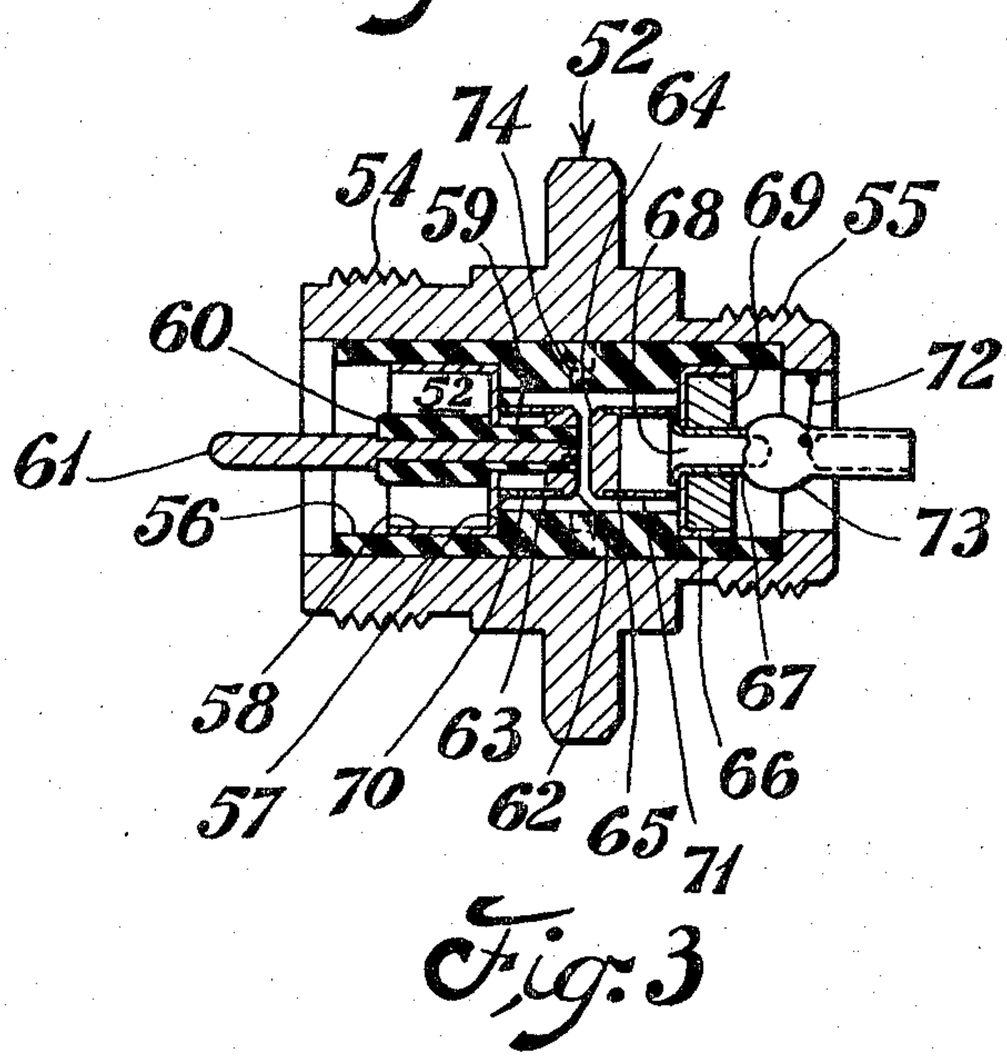

Fig. 3

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MINIATURE TRIGGERED GAP IN COAXIAL SQUIB

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ABSTRACT OF THE DISCLOSURE

A spark gap assembly mounted in a coaxial having two main electrodes and a trigger electrode.

The present invention relates to spark gaps and more particularly to miniature triggered gaps in coaxial squibs.

In the present exploding bridge wire systems, commonly known as EBW, two components are required to perform the basic functions of switching on command and to provide protection against spurious voltages. A triggered gap is utilized to provide the holdoff characteristics necessary to permit an energy storage condenser to charge up to the desired voltage. A small two electrode gap, normally built into the squib, is connected in series with the trigger gap to protect against spurious voltages and premature firing of the EBW. The two electrode gaps normally used in squibs are not as reliable as the conventinoal two electrode gaps, principally bebause of size. This lack of reliability manifests itself as a wide range of firing voltages which permits some of the gaps to fire when they are supposed to be protecting. The two electrode gap has a slow speed of response to the rapidly rising pulse presented by the triggered gap when it discharges the condenser with consequent loss of some of the energy available to be delivered to the EBW. A further disadvantage is the short life caused by surface leakage after a few discharges to the high energies required to explode the wire. Further, the two gaps in series requires an additional resistor between the triggered gap and ground to permit adequate current to be drawn through the triggered gap so that it does not self-quench during the relatively long time required for the two electrode gap to fire.

The present invention provides a coaxial triggered gap that is mounted directly in the squib and has the same hold off characteristics as the separate triggered gap. Further it provides for better protection than the two electrode gap. As an example, in a 2 kv. firing system the coaxial triggered gap will have a D.C. (or 60 cycle A.C.) breakdown of 2.5 to 3 kv. D.C., whereas the maximum D.C. breakdown of a series 2 electrode gap is limited to the region of 400 to 800 volts in order to insure firing on command due to the delay time problem. By eliminating the two electrode gap, the speed of response is increased and the resistor heretofore used to insure reproducible firings is no longer necessary.

It is an object of the invention to provide an improved spark gap.

Another object of the invention is to provide an improved EBW system.

Another object of the invention is to provide an improved EBW squib.

Another object of the invention is to provide a novel coaxial spark gap.

Another object of the invention is to provide a novel spark gap and squib assembly.

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection

with the accompanying drawings wherein one example is illustrated by way of example.

FIGURE 1 is a schematic diagram of a conventional system.

FIGURE 2 is a schematic diagram of a system embodying the invention.

FIGURE 3 is a sectional view of a device embodying the invention.

Referring now to FIGURE 1, in order to explain the invention, a prior art system is illustrated and includes two basic units, a firing unit **5** and a squib unit **6**. The firing unit **5** includes a power supply which may be a battery or any other suitable source of current. One output terminal of the power supply **7** is connected to ground by a conductor **8** and the other output terminal is connected by conductor **9** and resistor **10** to an electrode **11** of a triggered spark gap **12**. In addition to the electrode **11**, the gap **12** has an electrode **13** and a trigger electrode **14**. A condenser **15** is connected by conductor **16** between the conductor **9** and ground.

The electrode **13** of the gap **12** is connected by conductor **17** to electrode **18** of a two electrode spark gap **19** which is mounted in the squib **6**. The gap **19** also has an electrode **20** connected by conductor **21** to one side of EBW **22**. The other side of the EBW **22** is connected by conductor **23** to ground. A trigger (command) pulse transformer **24** includes an input primary winding **25** and an output secondary winding **26**. One side of the winding **26** is connected by conductor **27** to the electrode **11** of the gap **12**. The other side of the winding **26** is connected by conductor **28** to the trigger electrode of the gap **12**. The winding **25** of the transformer **24** is connected to a suitable signal source (not shown). A resistor **29** is connected by conductor **30** between the conductor **17** and ground.

In operation the gap **12** provides the hold off necessary to permit the condenser **15** to be charged from the power supply **7** through the resistor **10**. The two electrode gap **19** protects against spurious voltages entering the line and prematurely firing the EBW. A pulsed command signal is impressed on the primary winding **25** of the transformer **24** which in turn is applied to the trigger electrode **14** through the secondary winding **26**. The resistor **29** is necessary in order that adequate current is drawn through the gap **12** so that it does not self-quench during the relatively long time required for the gap **19** to fire.

Referring now to FIGURE 2, a system embodying the invention includes a firing unit **31** and a squib unit **32**. The firing unit has a power supply **33** which may be any suitable source. One output from the power supply is connected by conductor **34** to ground. The other output of the power supply **33** is connected by a conductor **35** to one side of a resistor **36**. The other side of the resistor **36** is connected by conductor **37** to an electrode **38** of a triggered spark gap **39**. A condenser **40** is connected between conductor **37** and ground by a conductor **41**. A trigger (command) pulse transformer **42** has a primary winding **43** and a secondary winding **44**. The primary winding **43** is connected across a suitable signal source (not shown). One end of the secondary winding **44** is connected by a conductor **45** to the conductor **37**. The other end of the secondary winding **44** is connected by conductor **46** to trigger electrode **47** of the gap **39**.

In addition to the electrodes **38** and **47**, the gap **39** has another electrode **48**. The electrode **48** is connected by conductor **49** to one end of EBW **50**. The other end of the EBW **50** is connected to ground by conductor **51**.

In operation, the gap **39** not only provides the hold off required but also provides protection against spurious voltages. The condenser **40** in the firing unit **31** is changed to a predetermined voltage, for example, 2000

volts. The hold off characteristics of the gap **39** are greater than the desired voltage in condenser **40**, for example, 2500 volts so that the gap will not break down upon the condenser **40** being charged to the 2000 volts. A pulsed command signal of a short duration is applied between the trigger electrode **47** and the electrode **38** which causes a breakdown therebetween with subsequent follow through of a breakdown between the electrodes **38** and **48**. This establishes a continuous path for the stored energy from the condenser **40** to the EBW **50**.

A feature of the invention is the construction of a squib and gap assembly **51** illustrated in FIGURE 3. The assembly **51** includes a housing **52**, which may be of a suitable metal, and a spark gap assembly **53**. The housing **52** may be a metallic cylinder having a threaded portion **54** on one end adapted for engagement with a coaxial conductor (not shown). The other end of the housing **52** also has a threaded section **55** for mating with an explosive chamber (not shown).

The spark gap assembly **53** is adapted to fit into the housing **52** and is secured therein by brazing, soldering or in any other suitable manner. The gap assembly **53** includes a main insulator **56** which may be a ceramic or other suitable material. The insulator **56** has a shoulder **57** adapted to position a cup-like member **58** therein The cup-like member **58** is of a suitable conducting material and has an opening **59** concentric therewith. The member **58** is secured to the insulator **56** by brazing or any other suitable manner to form a vacuum tight joint therewith. Extending through the opening **59** is a trigger electrode insulator **60** which surrounds and is sealed to a trigger electrode **61** which may be an extension of a coaxial pin. The insulator **60** is sealed to the cup-like member **58** forming a vacuum tight joint therewith. An adjacent main electrode **62** is positioned around the trigger electrode insulator **60** at the end thereof. The electrode **62** is secured to a ring-like member **63** of a conducting material which in turn is secured to the bottom of the cup-like member **58**.

An opposite main electrode **64** is positioned in operative relationship adjacent the electrode **62** and is positioned by a ring-like member **65** which is mounted on the back of a cup-like member **66**. The cup-like member **66** is of a conducting material and is secured in the insulator **56** and a vacuum tight seal is formed therebetween. A tubulation **67** extends from an opening **68** in the cup-like member **66**. A heavy backing plate **69** is provided to prevent displacement of the electrode from shock. Openings **70** and **71** are provided in the ring-like members **58** and **65** to permit outgassing and filling with gas. An EBW **72** is connected between the exhaust tubulation **67** and the housing **52**. After exhausting and filling with a suitable gas, the tubulation **67** is sealed off at **73**.

While the insulator **56** has been illustrated as being of one piece, it is understood that it could be made of two pieces as indicated by the dashed lines **74**.

The cup-like member **58** is adapted to contact a ring of a triaxial connector (not shown) to provide a current path to the electrode **62**. The exhaust tubulation provides a current path from the electrode **64** to the EBW **72**. The housing **52** is grounded which lowers the probability of the gaps reacting in an uncontrolled manner to spurious voltages generated inside the firing unit and radiated to the gap.

Although only one embodiment of the invention has been illustrated and described, various changes in the form and relative arrangement of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention.

What is claimed is:

1. A spark gap assembly comprising a cylindrical housing, a cylindrical insulator positioned in said housing, a first cuplike member positioned in one end of said cylindrical insulator and secured thereto to form a vacuum tight joint therewith, said first cuplike member having an opening in the bottom thereof, a trigger electrode, an insulator surrounding said trigger electrode and secured thereto, said trigger electrode and insulator being positioned to extend through said opening in said first cuplike member and forming a vacuum tight joint therewith, a second cuplike member positioned in the other end of said cylindrical insulator and forming a vacuum tight joint therewith, a first electrode, means including supporting members secured to said first cuplike member positioning said first electrode around said trigger electrode, a second electrode, means including a second supporting member secured to said second cuplike member positioning said second electrode a predetermined distance from said first electrode, and tubulation means for exhausting and filling said assembly with a gas.

2. A coaxial spark gap assembly comprising a cylindrical metallic housing, a cylindrical insulating lining secured in said housing, a trigger electrode, an adjacent main electrode surrounding said trigger electrode and concentric therewith, insulating means between said adjacent main electrode and said trigger electrode, a cuplike member supporting said adjacent main electrode and said trigger electrode in said insulating lining and forming a hermetic seal therewith, an opposite main electrode, an inverted cuplike member supporting said opposite main electrode adjacent to and concentric with said adjacent main electrode in the insulating liner opposite said first cuplike member and forming a hermetic seal therewith, and a tubulation extending from said inverted cuplike member.

3. The combination as set forth in claim **2** in which an exploding bridge wire is connected between said opposite main electrode and said housing.

4. The combination as set forth in claim **2** in which said first cuplike member is adapted to contact a ring of a triaxial connector.

5. The combination as set forth in claim **2** in which said trigger electrode is an extension of a coaxial pin.

6. The combination as set forth in claim **2** in which said inverted cuplike member is reinforced by a backing plate.

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