

April 18, 1967

K. W. OLSON ETAL

3,314,361

MINIATURE TRIGGERED GAP IN COAXIAL SQUIB

Filed May 7, 1965

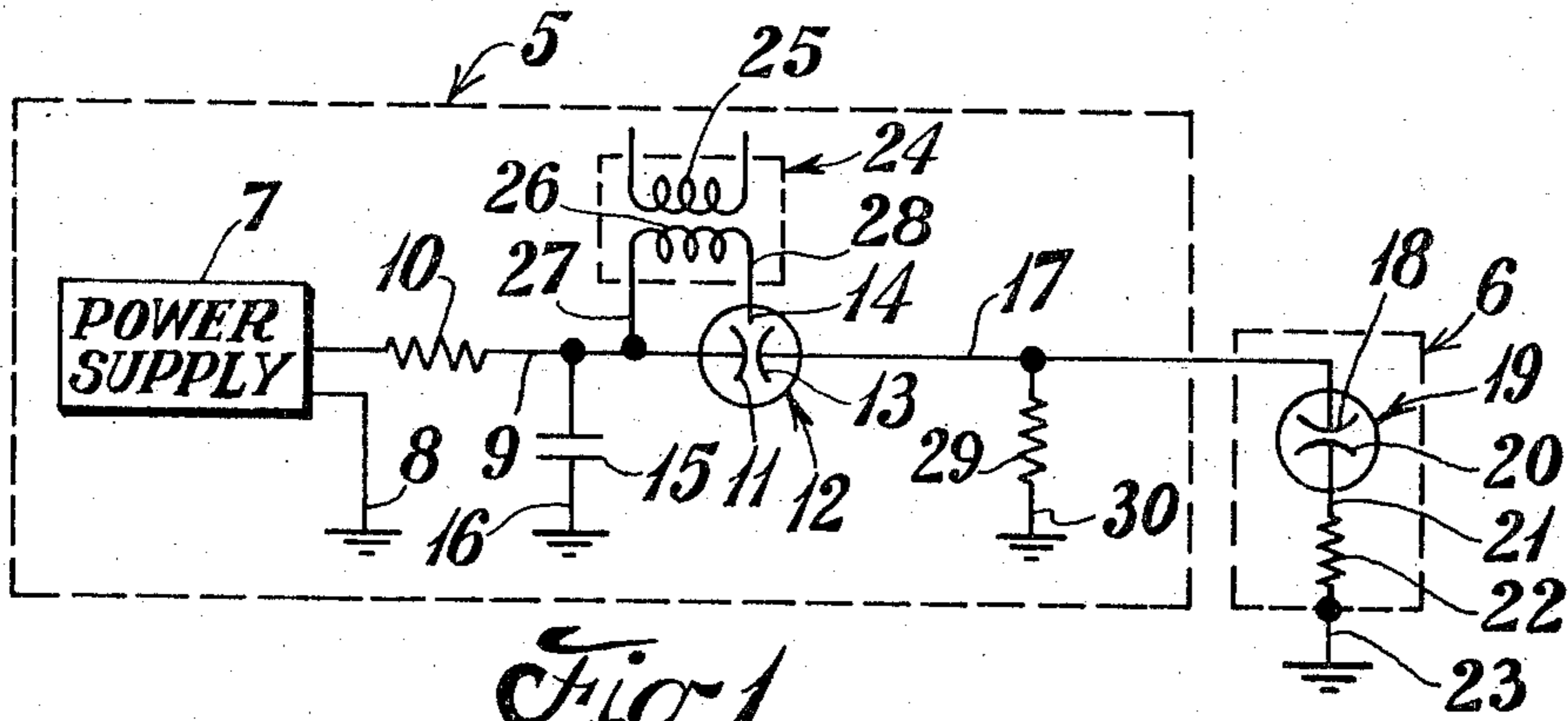


Fig. 1

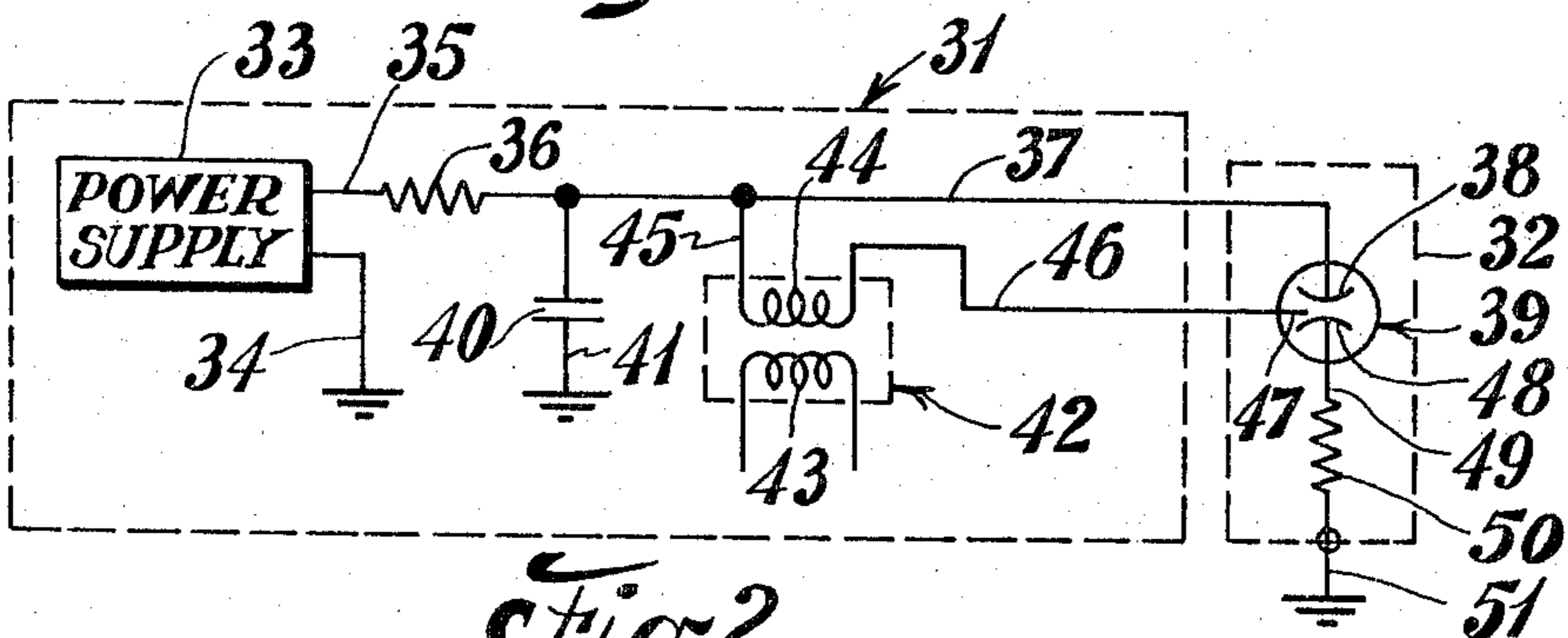


Fig. 2

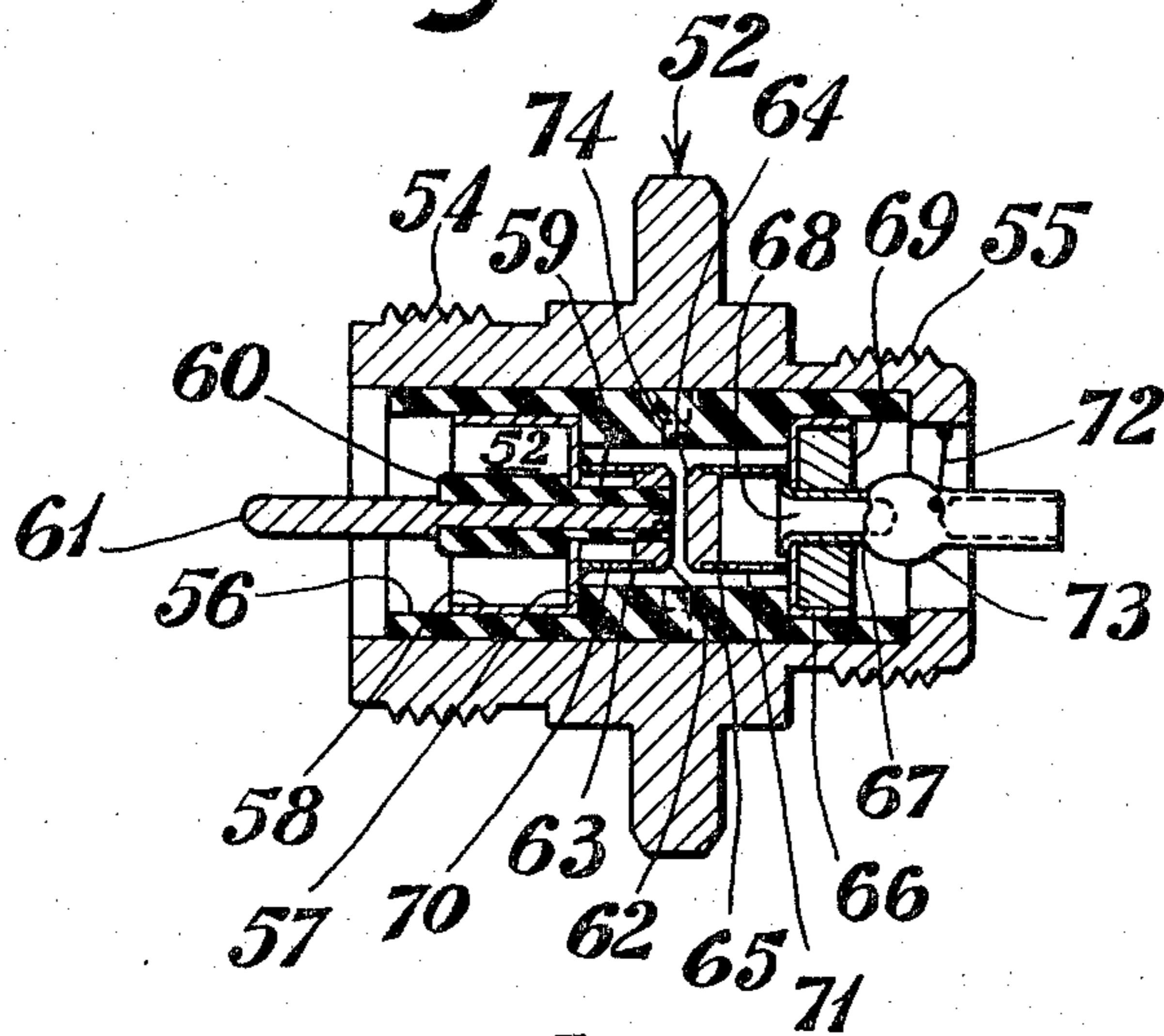


Fig. 3

INVENTORS
ALBERT V. BAZARIAN
JON M. COKEFAIR
BY KEITH W. OLSON

James M. Nichols

ATTORNEY

1

3,314,361

MINIATURE TRIGGERED GAP IN COAXIAL SQUIB

Keith W. Olson, Neptune, Albert V. Bazarian, Springfield, and Jon M. Cokefair, Pt. Pleasant, N.J., assignors to The Bendix Corporation, Eatontown, N.J., a corporation of Delaware

Filed May 7, 1965, Ser. No. 454,123

6 Claims. (Cl. 102-70.2)

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 conventional two electrode gaps, principally because 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

2

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 charged 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 prob-

ability 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.

References Cited by the Examiner

UNITED STATES PATENTS

3,288,068 11/1966 Jefferson et al. ----- 102---70.2

BENJAMIN A. BORCHELT, *Primary Examiner*,

W. C. ROCH, *Assistant Examiner*.