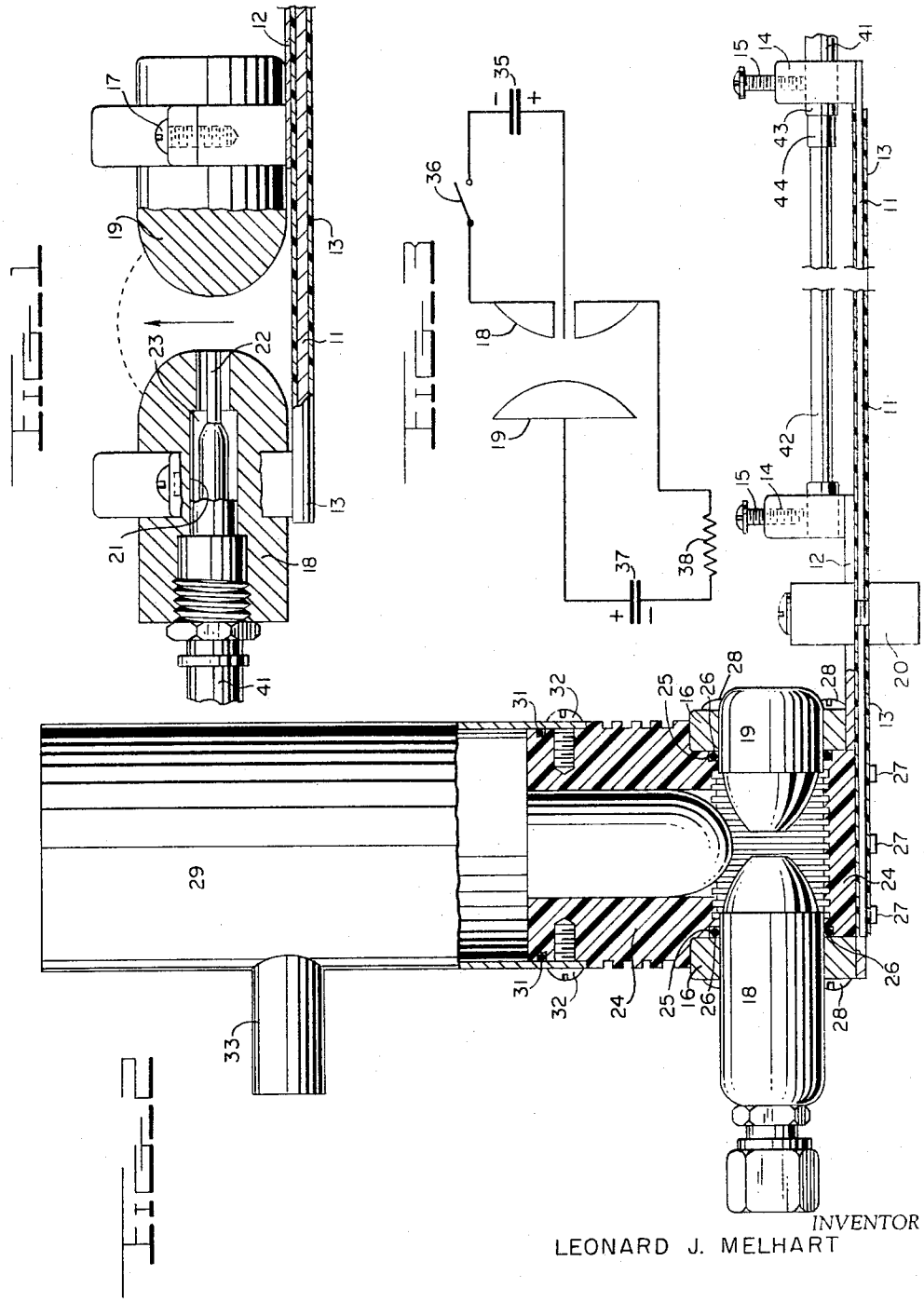
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MAGNETIC BLOWOUT SPARKGAP SWITCH

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INVENTOR
LEONARD J. MELHART

BY Melvin L. Crane, Agent
Richard A. Reed ATTORNEY

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MAGNETIC BLOWOUT SPARK GAP SWITCH

Leonard J. Melhart, Oxon Hill, Md., assignor to the United States of America as represented by the Secretary of the Navy

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to arc discharge switches and more particularly to an improved high current, low inductance arc discharge switch.

The present invention is an improvement over the type of switch disclosed in Patent No. 2,936,390, providing longer life, convenient spacing of the switch gap and simplifies fabrication of the switch electrodes. The operation of the switch follows somewhat the principle of operation as set forth in the above noted patent.

It is therefore an object of the present invention to provide a simple long lasting, relatively inexpensive spark gap or an arc type switch.

Another object is to provide a switch which is readily adjustable, simple to assemble and install in a circuit.

Still another object is to provide a long lasting switch which may be fired in the open, in an enclosed, in a pressurized, or in an evacuated chamber.

Yet another object is to provide a switch which is operable for low current as well as very high current with a very low inductance.

The nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which:

FIG. 1 is a plan view partly in cross section to illustrate one switch arrangement;

FIG. 2 is an arrangement similar to that of FIG. 1 including an evacuated or pressure housing; and

FIG. 3 is a simple diagram of one circuit which may be used with the switch.

The spark gap switch of the present invention is made with elongated symmetrical electrodes positioned in spaced relationship relative to each other. An electrical conductor electrically connected to one electrode and insulated from the other electrode parallels the electrodes and the gap between the electrodes. When a current flows through the conductor, a magnetic field is set up about the conductor which forces the spark and gases produced between the electrodes away from the conductor and outwardly from the electrodes. For the purpose of minimizing inductance, the conductors to the electrodes can be constructed of flat plates with appropriate service lines connected to the flat plates. In order to initiate the firing across the switch gap, a tickler electrode is added to the cathode electrode which on discharging a current, ionizes the air in the air gap causing a discharge across the main electrodes.

Now referring to the drawings, there is shown by illustration examples of differently arranged switches made in accordance to the present invention. As shown, the switch comprises electrical conductors in the form of transmission plates **11** and **12** which are insulated from each other by any suitable insulation such as sheets of Mylar **13** which, as shown, surrounds conductor plate **11**. The transmission plates have secured thereto at one end suitable electrical wire connectors **14** provided with wire holder screws **15** and at the other end suitable electrode holders or clamps **16** which as shown have a lower and upper section which are held together by screws **17** that

secure the electrodes **18** and **19** in place. As shown the transmission plate **11** extends beyond the end of transmission plate **12** in order to provide suitable spacing between the electrode holders and thereby provide a gap between the electrodes when they are assembled in place. The transmission plates are held together by clamps **20** made of an insulating material or if made of metal are provided with suitable insulation between the clamp and the metal plates. The electrodes **18** and **19** are made from elongated round metal stock of copper, brass, nickel, tungsten-copper alloy or any other suitable metal depending on the current flow and the number of firings to be made. The electrodes are symmetrically formed with semispherically rounded ends and are held within the electrode holders with their rounded ends facing each other and in axial alignment. Since the electrodes are independent of the electrode holders the electrodes can be adjusted for spacing and if erosion or wear takes place due to use, the electrodes may be rotated relative to the blowout path shown by dotted line in FIG. 1 for additional use and for longer life.

For the purpose of triggering the spark gap to break down the air between the gap switch electrodes, tickler electrodes may be provided. A hole **21** is drilled through the cathode electrode along the axis and a small metal rod **22** is secured therein by use of an insulating sleeve **23** with one end of the rod being even with the gap end of the electrode. The metal rod tickler electrode is secured axially in the insulating sleeve **23** to insulate the rod from the electrode. A material such as alumina oxide (Al_2O_3) has been used satisfactorily with great success. Operation of the tickler electrode will be explained later.

FIG. 2 illustrates a switch as shown in FIG. 1 which may be used in an evacuated chamber or in a chamber under pressure, if desired. The metal rod tickler electrode **22** is sealed into the alumina oxide sleeve **23** which in turn is sealed into hole **21** by insulating varnish or an epoxy resin to maintain the vacuum tightness. The chamber includes a housing portion **24** in the vicinity of the electrodes made of an insulating material such as nylon or an inorganic material such as Pyrex or alumina oxide for outgassing purposes and has a hole through the housing for reception of the electrodes. The housing is provided with a shoulder **25** against which a gasket **26** surrounding the electrodes fit. The housing is held to the plate **11** by suitable bolts or screws **27** passing through the plate. The spark gap switch electrodes extend into the housing into a cylindrical portion which meets with an upright extending cylindrical opening. The electrode frame holders are secured to the housing by screws **28** to hold the electrodes in a vacuum tight seal against the gasket seal **25**. The holes in electrode holders through which screws **28** pass are somewhat like a slot extending perpendicular to the plates such that the housing can be moved slightly toward the bottom by bolts **27** without stressing the screws **28**. The screws **28** are the last to be tightened. An upper section **29** preferably made of metal of suitable strength and of any desired length or size is secured to the upper portion of the housing in a vacuum tight fit against seal **31** by screws **32** to complete the chamber. The chamber may be evacuated through tube **33** or pressure may be applied in the chamber through the tube **33**. The inside of the insulated housing portion of the chamber in the vicinity of the electrodes is provided with ribs as well as the outside of the housing near the electrodes to prevent creepage of an electrical current along the surface of the chamber, when the operating voltage is sufficiently high that the current would likely creep along the surface of the housing. When used as a vacuum switch the insulated housing portion of the chamber would preferably be made of an inorganic material such as Pyrex or alumina oxide (Al_2O_3) so as to minimize the

outgassing of the housing when the electrical discharge occurs. It is to be understood that the structural limitations of inorganic materials may cause variation in connection details. For example, a very effective vacuum switch has been constructed using a standard 2" I.D. Pyrex plumbing T according to the general arrangement described, but with the connections and fastening methods adapted to this Pyrex housing.

FIG. 3 represents a simple circuit diagram illustrating the electrical connections of the spark gap switch and the tickler electrodes to operative power sources. As shown, the tickler electrode is connected with the positive side of power source **35** and the negative side of the power source is connected with the cathode electrode of the spark gap switch. The electrical circuit is controlled by any suitable switch **36** including switches based on designs described herein and completed between the end of the tickler electrode and the cathode electrode through the air in the vicinity of the electrodes. The positive side of power source **37** is connected with the anode electrode of the spark gap switch and the negative side of the power source **37** is connected with the cathode electrode of the spark gap switch through a load represented by a resistor **38**. The cathode electrode of the spark gap switch is the electrode in which the tickler electrode is secured.

In operation, each of the capacitor power sources **35** and **37** are charged and prepared for operation. The switch that controls the tickler electrode circuit is closed causing a discharge between the end of the tickler electrode and the cathode electrode of the spark gap switch. This discharge ionizes the gases between the spark gap electrodes which permits a discharge between the electrodes of the spark gap switch. The time of firing of the main circuit depends on the initiating spark and the spacing between the electrodes of the spark gap switch. A discharge across the gap between the spark gap switch electrodes permits a current flow through the load. At the time of discharge between the main electrodes, a magnetic field is set up about the conductor **11** backing the switch gap, this magnetic field forces the spark discharge away from the backing conductor. Since the electrode ends are made symmetrically and are of semispheres the spark will be forced upwardly on the surface of the electrodes as shown in dotted line in FIG. 1. Thus the most severe erosion or burning effects that occur will take place away from the immediate adjacent ends of the electrodes. The construction of the electrodes permits one to rotate the electrodes in their holders such that if excessive erosion takes place the electrodes can be rotated to provide a new surface. Turning the electrode through 90° rotation has been found to be adequate to provide a new and clean surface. The magnetic field set up about the backing conductor not only forces the spark away from the ends but forces any contaminants outwardly away from the electrodes such that the area between the electrodes is not contaminated. It is to be understood that the rounded or semispherical electrode ends permit an asymmetrical discharge between the spark gap switch electrodes and rotation of the electrodes permits many discharges at very high currents. They also give a long surface creepage path between the electrodes along the back of the insulated chamber, and the rounded portion of the electrodes may be elongated to increase this distance thereby enabling the switch to be used with higher voltage.

Switches such as described and set forth above can be made in any desired diameter depending on the current to be used. As an example, cylindrical cathode and anode electrodes of 3.18 cm. diameter of brass stock with a trigger electrode of about 2.5 mm. diameter of copper stock have been fired several thousand times with a current of 80,000–100,000 amperes with very little deleterious effect on the electrodes. Since the electrodes can be rotated through 90° each of four times during the life of the electrode, the electrodes can be fired many thousands of times.

With a chamber such as shown in FIG. 2 the switch may be operated from a low vacuum pressure to high pressure gases depending on the use.

It will be obvious to make different electrical connections with the electrodes, however, it is important for long life operation of any spark gap switch to make the switch with one conductor backing the gap to provide a magnetic field that blows any contaminants and the spark away from the ends of the electrodes. The electrical connections in the illustrated switch are for illustrative purposes only and this is by no means the only manner by which electrical connections can be made with the spark gap switch. As shown a coaxial cable **41** having an inner conductor **42** insulated from the outer conductor **43** by insulation **44** is used for the electrical connection to the spark gap switch conductor plates and also for the tickler electrodes. Also many coaxial lines may be connected with the conductor plates by use of a bus-bar or any other suitable arrangement.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An air gap switch adapted to be connected into the conductor lines of an electric circuit which comprises first and second elongated cylindrical electrodes formed with semispherical ends, first and second electrode holders adapted to secure said first and second electrodes, respectively, in spaced relationship in end to end axial alignment with a spacing gap therebetween such that said electrodes are adjustable for rotational and axial movement relative to each other, first and second flat plate electrical conductors secured respectively to said first and second electrode holders, said first electrical conductor extending parallel to the axis through said electrodes along said electrodes in close proximity thereto and across the spacing therebetween and electrically insulated from said second electrode holder and said second electrical conductor.

2. An air gap switch as claimed in claim **1** wherein said first electrode includes an axially aligned tickler electrode secured therein.

3. An air gap switch as claimed in claim **2** wherein said first and second electrodes are symmetrical and secured in said first and second electrode holders with their semispherical ends adjacent to each other in spaced relationship.

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JOHN W. HUCKERT, *Primary Examiner.*

J. D. KALLAM, *Assistant Examiner.*