Dec. 19, 1961 L. H. SEGALL 3,014,151

ELECTRICAL APPARATUS

Filed Sept. 29, 1955

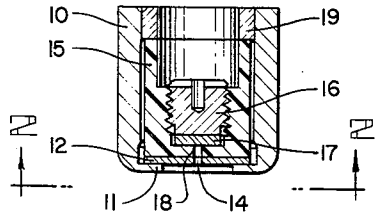



FIG. 1

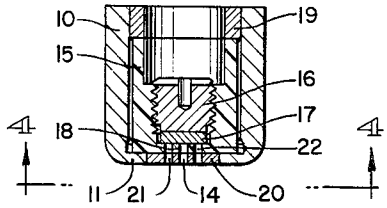



FIG. 3

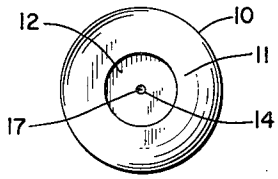



FIG. 2

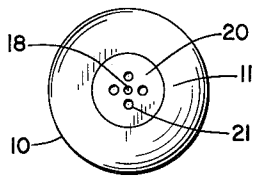



FIG. 4

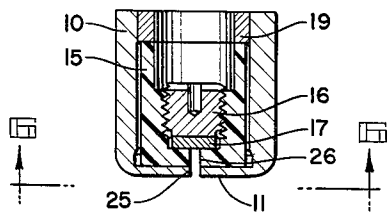



FIG. 5

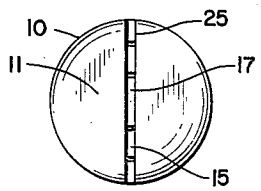



FIG. 6

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United States Patent Office

3,014,151

Patented Dec. 19, 1961



3,014,151

# ELECTRICAL APPARATUS

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Filed Sept. 29, 1955, Ser. No. 537,502
18 Claims. (Cl. 313—130)

This invention relates to electrical apparatus and more particularly to spark gaps for ignition circuits and the like.

One of the objects of the present invention is to provide a spark gap device of novel and simplified construction.

Another object of the invention is to provide a novelly constructed spark gap which is highly efficient in the conversion of the energy of the source of electrical energy into heat energy in the form of a spark or arc.

A further object is to provide a novel apparatus for producing electrical sparks which is so constructed that the spark or arc is automatically propelled a substantial distance into a gaseous or other combustible charge to be ignited.

Still another object is to provide a novel spark gap structure which is particularly adapted for use in initiating combustion in the burners of so-called jet or gas turbine type engines and in the cylinders of reciprocating engines.

The above and further objects and novel features of the present invention will more fully appear from the following detail description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for purposes of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a sectional view of one form of spark gap device embodying the invention;

FIG. 2 is a bottom view of the device of FIG. 1;

FIGS. 3 and 5 are views similar to FIG. 1 showing other forms of spark gap devices embodying the invention; and,

FIGS. 4 and 6 are bottom views of the devices of FIGS. 3 and 5, respectively.

The several embodiments of the invention illustrated in the drawings, by way of example, are in the form of tip or electrode assemblies adapted for use in spark or igniter plugs of the type disclosed in pending application Serial No. 221,435, filed April 17, 1951 (now Patent No. 2,786,158). Structures of this type are particularly adapted for use in the ignition systems of combustion engines wherein it is advantageous to have a concentrated hot spark projected into the combustible charge.

In the embodiment shown in FIG. 1, a tubular metal shell 10 has an internal flange 11 at one end which supports the electrode assembly and which may also serve as one of the gap electrodes. Shell 10 is usually grounded to an engine casing or other structure which serves as a connection to one terminal of a source of electrical energy. In the specific form shown, however, a separate plate or washer 12 is seated on flange 11 to serve as the ground electrode. The latter has a relatively small diameter central opening 14 and is preferably made of a metal, such as tungsten, which has high resistance to erosion by electrical sparks.

Seated on electrode 12 is a novel center electrode assembly comprising an insulator 15 and a center electrode 16, 17 which, in the form shown, consists of two metallic members 16 and 17 preferably welded together. Member 16 is threaded into the bore of insulator 15 to hold member 17 in firm engagement with an internal flange at the



lower end of the insulator. The latter has a small central opening 18 that is concentric with and preferably the same size as opening 14. If desired, the diameter of opening 14 may be slightly greater than the diameter of opening 18, but the edge of electrode 12 should preferably not overlap any part of the opening 18. Like electrode 12, the center electrode member 17 is preferably made of a metal which has high resistance to erosion by electrical sparks. The center electrode assembly may be held in shell 10 in any suitable manner, such as by a ring 19 which may have a press fit in the shell or be otherwise suitably secured therein.

For best results the diameter of hole 14, 18 should be within the range of about .005 inch to about .060 inch. A diameter of about .025 inch has been found to be very practical from a manufacturing point of view as well as from an operational point of view in present day ignition systems for aircraft engines. The proper distance between ground electrode 12 and center electrode 17 along the surface of opening 18, that is, the width of the spark gap, will depend upon other factors, such as the magnitude of the available voltage and the character of the bridging surface 18. If high voltages are available, the surface within hole 18 may have good insulating qualities, whereas if only low voltages are available, such as in some known types of condenser discharge ignition circuits, such surface should be rendered semiconductive in any manner now well understood in the art, that is, in the art of so-called shunted-surface spark gaps of the character shown in the above-mentioned application Serial No. 221,435. For conventional present day ignition systems the axial width of the spark gap in the illustrated device may vary from about .015 inch to about .090 inch. The axial thickness of ground electrode 12 is determined primarily by its ability to resist wear under operating conditions, but it should be chosen to avoid the absorption thereby of too great an amount of heat and, hence, energy from the sparks.

The embodiment of FIG. 3 differs from that above described only in that the wear resistant ground electrode plate 20 is of reduced diameter and silver soldered or otherwise suitably secured within the inner periphery of flange 11 and is provided with a plurality of holes 21 in addition to the central hole 14. The ceramic piece 15 is also provided with additional holes 22 in registry with openings 21, thereby forming a plurality of constricted or constrained spark gaps having substantially the same characteristics as the single gap of FIG. 1. In this type of construction the sparks will occur in different openings as the electrodes are worn away, thereby increasing the efficiency and the effective operating life of the unit.

The embodiment of the invention illustrated in FIG. 5 is likewise similar in many respects to the two above described, except that body flange 11 serves as the ground electrode, and the communication between the electrodes is through and along the walls of a narrow slit 25, 26 cut transversely across shell 10 and insulator 15. The gap surface is thus increased while providing a restricted or constrained channel or slot in which the spark is more efficiently formed and from which the spark is propelled into the combustion chamber. If desired, more than one slit or slot 25, 26 may be provided, in which event the same may intersect at the center axis or extend parallel to one another. Thus, increased sparking surface is provided so that as the metal of the electrodes is eroded at one sparking path, the sparks will occur along a different path, thereby increasing the effective operating life of the unit. The width of slot 25, 26 may be on the order of from .010 inch to .060 inch. For some jet type engine ignition systems, a width of about .020 inch to .025 inch has been found most practical. As in

the other embodiments, the walls of slot 26 in insulator 15, which walls bridge the gap between the electrodes 11 and 17, may be either semi-conductive or non-conductive, depending upon the type and magnitude of the available voltage.

It will be understood that in each of the embodiments illustrated and described, the center electrode is to be connected by a suitable conductor (not shown) to a source of electrical energy which may be in the nature of a storage condenser or any other known type of source. The other electrodes 12, 20 and 11 are generally connected to the other terminal of the source through so-called ground or if desired, a return conductor may be provided.

Although only a limited number of embodiments or modifications of the invention have been illustrated in the drawings and described in the foregoing specification, it is to be expressly understood that the invention is not limited thereto. For example, the separate plate type of ground electrode 12 shown in FIG. 1 may be adapted to the embodiments of FIGS. 3 and 5, the composite type of electrode 11, 20 of FIG. 3 could be adapted to the other embodiments, and the unitary flange type of electrode 11 in FIG. 5 could be used in the other two embodiments. The slit 25 in the ground electrode of FIG. 5 may be slightly wider than the slit 26 in the ceramic part 15, but there should be no overlap of the latter by the ground electrode. Various changes may be made in the specific design and arrangement of the parts illustrated without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art.

What is claimed is:

1. A spark gap device comprising an insulator having oppositely disposed surfaces and at least one narrow cylindrical passage connecting said surfaces, an electrode engaging one said surface and having a substantially plane surface extending substantially directly across and bridging one end of said passage, and electrode means engaging the other said surface and having a narrow cylindrical passage which is in substantial registry with and forms a continuation of said first-named narrow passage in said insulator, the diameter of said narrow passages being within the range of .005 inch to .060 inch.

2. A spark gap device as defined in claim 1 wherein there are a plurality of said narrow passages in the insulator each having one end bridged by said electrode and a corresponding plurality of registering narrow passages in said electrode means.

3. A spark gap device as defined in claim 1 wherein the gap between said electrode and said electrode means along the wall of the passage in said insulator is within the range of .015 inch to .090 inch.

4. A spark gap device as defined in claim 1 wherein said narrow passages have diameters of the order of .025 inch.

5. A spark gap device comprising an insulator having oppositely disposed surfaces and at least one narrow passage in the form of an elongated transversely extending slot connecting said surfaces, an electrode engaging one said surface and having a surface extending directly across and bridging one end of said passage, and electrode means engaging the other said surface and having a narrow passage which is in substantial registry with and forms a continuation of said first-named narrow passage in said insulator.

6. A spark gap device as defined in claim 5 wherein said slot has a width within the range of .010 inch to .060 inch.

7. A spark gap device as defined in claim 1 wherein the surface portion of said insulator within said first-named passage is semi-conductive.

8. In a spark gap device, two electrodes spaced in spark gap relation to each other, and an insulator interposed between said electrodes and bridging the gap there-



between, said insulator having at least one narrow cylindrical passage therein within which sparks between the electrodes are constrained to occur, one of said electrodes having a substantially plane surface extending substantially directly across and closing said passage at one end thereof and the other of said electrodes having at least one cylindrical passage constituting an extension of the internal surface of said first-named passage, the diameter of said passages being of the order of about .025 inch.

9. A spark gap device as defined in claim 8 comprising a tubular shell in which said insulator is supported, said shell having an internal flange at one end thereof which constitutes at least a support for said other electrode.

10. A spark gap device as defined in claim 9 wherein one of said electrodes is interposed between said insulator and said internal flange on said shell.

11. A spark gap device as defined in claim 9 wherein one of said electrodes is secured to the inner periphery of said flange.

12. In a spark gap device, a tubular metallic shell having an internal flange, a first metallic electrode and an insulator supported by said flange in the shell, and a second metallic electrode insulated from said shell and spaced from said first electrode by said insulator, said first electrode and insulator having narrow cylindrical openings therein in substantial registry to provide a constricted passage closed at one end by a substantially plane surface of said second electrode and through which arcing may occur between said electrodes, the diameter of said passage being less than .060 inch.

13. A spark gap device as defined in claim 12 wherein said narrow openings have diameters of the order of about .025 inch.

14. In a spark gap device, a tubular metallic shell having an internal flange, a first metallic electrode and an insulator supported by said flange in the shell, and a second metallic electrode insulated from said shell and spaced from said first electrode by said insulator, said first electrode and insulator having narrow openings therein in the form of elongated transversely extending slots and in substantial registry to provide a constricted passage closed at one end by said second electrode and through which arcing may occur between said electrodes.

15. A spark gap device comprising two spaced electrodes, and an insulator bridging the gap between said electrodes, the active surfaces of said electrodes and the bridging surface of said insulator forming a cylindrical recess in which the sparks between the electrodes are constrained to occur, the closed end of said recess being formed by one of said electrodes and the diameter of said recess being within the range of .005 inch to .060 inch.

16. In a spark gap device, a tubular metallic shell having an internal flange, an insulator supported by said flange in the shell, and a metallic electrode mounted in said insulator, said insulator and flange having narrow cylindrical openings therethrough in substantial registry to provide at least one constricted passage covered at one end by a substantially flat end surface of said electrode and through which arcing may occur between said flange and electrode, the diameter of said constricted passage being within the range of .005 inch to .060 inch.

17. A spark gap device comprising an insulator having oppositely disposed surfaces and at least one narrow passage in the form of an elongated transversely extending slot connecting said surfaces, an electrode engaging one said surface and having a substantially plane surface extending substantially directly across and bridging one end of said passage, and electrode means engaging the other said surface and having a narrow passage which is in substantial registry with and forms a continuation of said first-named narrow passage in said insulator, the

transverse width of said narrow passages being within the range of .005 inch to .060 inch.

18. In a spark gap device, a tubular metallic shell having an internal flange, a first metallic electrode and an insulator supported by said flange in the shell, and a second metallic electrode insulated from said shell and spaced from said first electrode by said insulator, said first electrode and insulator having narrow openings therein in the form of elongated transversely extending slots in substantial registry to provide a constricted passage closed at one end by a substantially plane surface of said second electrode and through which arcing may occur between said electrodes.

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