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ELECTRICAL DISCHARGE DEVICE

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Fig. 1

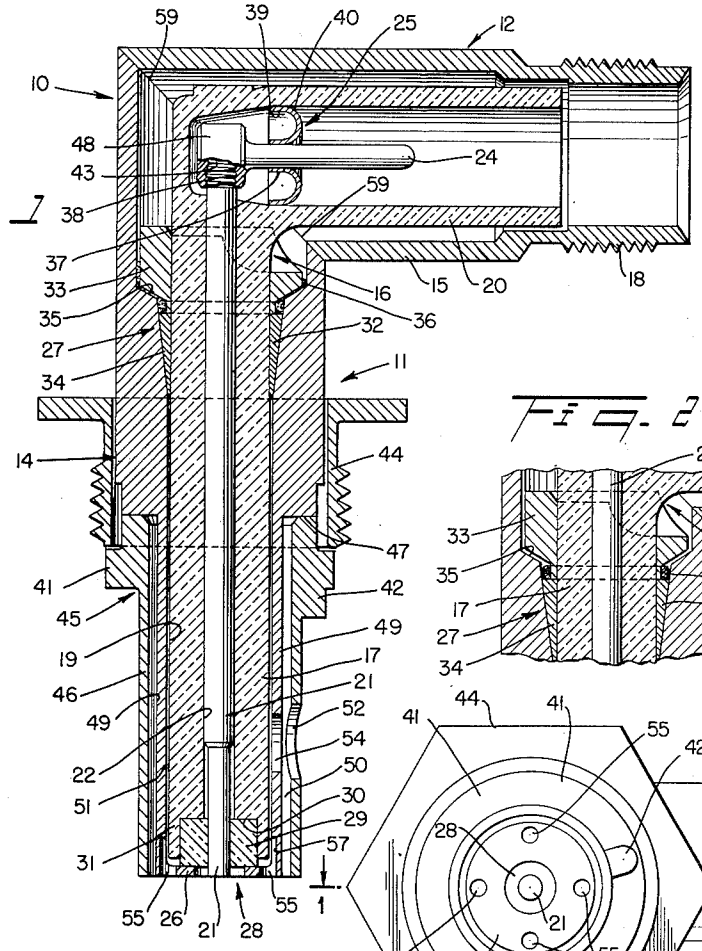



Fig. 2







Fig. 3

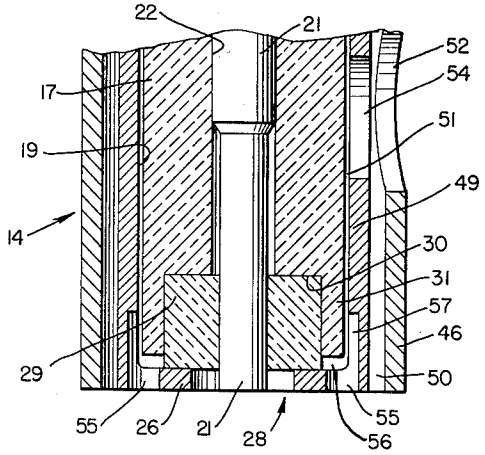



Fig. 4

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# ELECTRICAL DISCHARGE DEVICE

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This invention relates to electrical apparatus, and more particularly relates to an improved spark discharge device.

The invention has among its objects the provision of an improved spark discharge device.

Another object of the invention is the provision of a novel gas cooled spark discharge device.

A further object of the invention is the provision of an improved spark discharge device of the shunted gap type.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose 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 view in axial section through an illustrative spark discharge device made in accordance with the invention, certain of the parts being shown in elevation;

FIG. 2 is a fragmentary view in section of a portion of the device of FIG. 1 in the condition it has prior to heating the shell of the device to effect a seal between the central insulator and the shell of the device;

FIG. 3 is a fragmentary view in bottom plan of the device of FIG. 1; and

FIG. 4 is an enlarged fragmentary view in axial section of the lower end of the device of FIG. 1, the central electrode being shown in elevation.

The spark discharge device of the invention may be used to advantage in various types of engines. Among such engines are those of the jet or ram jet type. The spark gap providing end of the spark discharge device is mounted within the combustion chamber of the engine, and is thus subjected to high temperatures during use. The device of the invention is designed to make efficient use in a novel manner of the cooler gases, removed from the immediate combustion zone in the engine chamber, in cooling the spark gap providing end of the device.

Turning now to the drawings, the spark discharge device, which is generally designated 10, has a first, spark gap portion 11 and a second, connector portion 12 disposed at a right angle to portion 11. The device 10 has an integrally connected outer metal shell or housing, made, for example, of heat resistant nickel alloy, which protects and supports the parts therewithin, and also shields the device from transmitting radio-interfering electromagnetic disturbances. The portion of the shell which is disposed vertically in FIG. 1 is designated 14, and the portion of the shell which is disposed horizontally is designated 15. The lower or inner end of shell 14 is of a somewhat reduced diameter.

Within the shell there is disposed an integral, right-angular hollow, dense, impervious ceramic insulator 16, made, for example, of alumina. The vertical leg 17 of insulator 16 fits with a small clearance within the passage 19 in portion 14 of the shell. The horizontal leg 20 of insulator 16 is hollow, and is disposed coaxially of leg 15 of the shell, being spaced appreciably from the shell in the portion thereof adjoining vertical leg 14 of the shell and lying closer thereto but still spaced therefrom at the outer end of insulator leg 20 where shell portion 15 is necked in, as shown. The outer end of shell leg 15 is threaded at 18, to receive the retaining nut of a



second connector part (not shown) which carries a socket receiving the connector pin 24.

The insulator 16 serves to support and locate a central electrode 21, the main, upper portion of which is snugly received in a central passage 22 through leg 17 of the insulator 16, and to support and locate a connector pin 24 connected to the upper end of the central electrode. The connector pin 24, which is located within leg 20 of the insulator, and coaxially thereof, is sealed to such leg by a flexible annular diaphragm generally designated 25.

The insulator 16 is maintained in place within the shell of the device by a flange 26 projecting radially inwardly from the lower end of leg 14 of the shell, and by an annular wedge and solder means, generally designated 27, interposed between the vertical leg 17 of insulator 16 and the portion 14 of the shell adjacent the upper end of such leg. The flange 26, as will appear, forms an outer annular electrode for the discharge device, the other electrode being formed by the lower end of central electrode 21, which terminates flush with the lower surface of flange 26. An electrically semi-conductive annular body 29 tightly embraces the lower end of the central electrode 21 and overlies flange 26, so as to form a semi-conductive shunt across the annular gap 28 between the electrodes. Body 29 is received in an annular central recess 30 in the lower end of leg 17 of insulator 16, and is preferably bonded thereto in a manner to be described. A depending flange 31 bounding recess 30 terminates somewhat short of the lower surface of insert 29.

The arrangement 27 is made up of an annular member 32, made of a metal such as copper, the outer wall of which is slanted to converge downwardly toward the inner wall, and a rigid upper compression ring 33, made of a metal such as stainless steel. The inner surface of shell portion 14 confronting the outer surface of member 32 is similarly frusto-conical at 34. Above zone 34 the inner surface of shell portion 14 is formed with a second shallow frusto-conical zone or seat 35, which receives the similarly shaped lower surface of compression ring 33. Members 32 and 33 are held in place by a layer of hard solder 36 which was assembled as a solder ring 36′ (FIG. 2) between members 32 and 33 and, after members 32 and 33 had been pressed downward strongly, was melted to bond the members to each other and to the portion 14 of the shell.

The upper end of central electrode 21 is threaded at 38, and is threaded into a passage 43 in an enlargement 48 on the inner end of pin 24. Preferably the central electrode and the connector pin are also brazed together, in a manner to be explained. The diaphragm 25, which may be made, for example, of a heat resistant nickel iron alloy, is bonded to the pin 24 by having its inner flange 37 brazed thereto, and by having its outer flange 39 soldered or brazed to the metallized inner wall surface 40 of the insulator portion 20.

The spark discharge device 10 is designed to be mounted in an opening through the side wall (not shown) of an engine housing. A flange 41, at the upper end of the reduced diameter portion of leg 14 of the shell, is adapted to be received in a counterbore at the outer end of such opening in the housing. A key or lug 42 projecting from the housing portion 14 below flange 41 is adapted to be received in a device locating recess in the engine housing. A nut 44, rotatable on shell 14 above flange 41, is designed to engage the internally threaded outer end of the opening in the engine housing, the nut engaging flange 41 to retain device 10 in the opening in the engine housing.

The spark discharge device is so constructed and arranged as to provide access for gases within the engine housing to the outer surface of the leg 17 of insulator 16 throughout the major portion of the length thereof in-

wardly of the spark gap, thereby to prevent the undue progressive build-up of temperature in the insulator, and the consequent damage thereof. Further, the lower end of the wall of shell portion 14 is circumferentially divided for a substantial length upwardly from the spark gap, so as to allow engine gases also effectively to cool the lower end of the shell.

As shown in FIGS. 1 and 4, the outer portion of the leg 14 of the shell from the lower end thereof to a level somewhat above flange 41 is initially formed as a separate tube-like member 45 having a relatively thin wall 46 below flange 41. Intermediate the ends of the leg 14 the main body of the shell has a shoulder 47 below which the main body is markedly reduced in diameter to form an inner wall 49 having a thickness about equal to that of outer wall 46. Member 45 is integrally connected to the main body of the shell at shoulder 47, as by welding in a manner to be described.

As shown, the circular cylindrical outer and inner walls 46 and 49, respectively, which terminate flush with the bottom of flange 26, are coaxial, and are spaced to form an annular space 50 between them. The inner diameter of wall 49 is such as to provide a relatively radially thin annular space between the inner surface of wall 49 and the outer surface of portion 17 of insulator 16. To provide access for the engine gases to spaces 50 and 51, the walls 46 and 49 are each provided with a lateral opening therethrough. Such openings, which are designated 52 and 54, respectively, are aligned; opening 52 somewhat exceeds opening 54 in diameter.

The above described flange 26 is integral with the inner wall 49 at the lower end of leg 14 of the shell. A free opening is thus provided at the lower end of the outer annular space 50. To provide bottom openings into the inner annular space 51, the flange 26 has passages 55 (four shown) therethrough which underlie annular space 51. In the embodiment shown the passages 55 are symmetrically arranged as regards the inner and outer boundaries of the space 51 (FIG. 4). The space 56 between the lower end of flange 31 on insulator portion 17 and the upper surface of flange 26 allows the gases to flow more freely through passages 55. Further to aid such gas flow, the lower end of the inner surface of the inner wall 49 is relieved at 57 to form a further annular space overlying passages 55.

It will be understood that during operation of the device the inner end of leg 14 thereof adjacent the spark gap is positioned close to the flame in the engine, and becomes highly heated. The device of the invention prevents the progressive build-up of the temperature of such portion of the device to degrees which would seriously shorten the operating life of the parts of the device, including the insulator and the shell. The gases in the combustion chamber which are spaced from the flame or immediate zone of combustion are cooler than those at the tip or spark gap end of the device. Such cooler gases are allowed to flow through the annular spaces 50 and 51. In a jet-type engine such cooler gases are, in the main, led into spaces 50 and 51 through openings 52 and 54, and discharged therefrom through passages 55. Such cooler gases abstract heat from the parts of the device, and thus keep their temperature within safe operating limits. It will be understood that in some engines, particularly those operating with varying combustion chamber pressures in different parts of the operating cycle, the flow of gas through spaces 50 and 51 may be, in the main, in the reverse direction from that above described, or that such direction of gas flow may reverse once or several times in each operating cycle.

A preferred manner in which the described spark discharge device may be assembled is as follows:

The inner surface 40 of leg 20 of insulator 16 is metallized in a conventional manner. A silver paste is applied to threads 38 on central electrode 21 and to the threads in passage 43 in enlargement 48 on contact pin 24. Such silver paste may be composed of precipitated silver powder in a suitable vehicle such as 1:5 solution of pyroxylin and anyl acetate. The contact pin and the electrode are placed in the proper position in insulator 16, and the electrode is screwed into enlargement 48 on the contact pin to engage approximately one half of the threads.

The metallized area 40 of the insulator is coated with nickel oxide paint. The diaphragm 25 is inserted and pressed into place. The electrode 21 is now screwed into its final position with respect to insulator 16. Nickel oxide paint is applied to the joint between flange 37 of the diaphragm and contact pin 24, and that between flange 39 of the diaphragm and metallized surface 40 of insulator 16. A thin wire ring of silver of the correct size is then placed in position at such joints, excess nickel oxide paint, if any, is removed from insulator 16, and the assembly is then heated in a dry hydrogen atmosphere to melt the silver rings and to reduce the nickel oxide to form gas impermeable joints. Preferably in the last step the assembly is positioned with the pin 24 vertical and with the free end of the pin up.

The bushing 32 is now cleaned of all traces of grease and oil by using a suitable solvent. After cleaning, the bushing 32 is coated with a suitable liquid flux and allowed to dry. The outer cooling shell 45 is assembled onto the leg 14 of the main shell body in the manner shown and is arc welded thereto along the junction between the upper end of the cooling shell and shoulder 47 on the main shell body. Preferably a suitable jig is employed to hold the parts accurately during the welding operation. The retaining nut 44 is then assembled over the end of leg 20 of insulator 16 so as to lie upon flange 41.

The semi-conductive body 29 is inserted in recess 30 at the lower end of portion 17 of insulator 16, the contacting surfaces of body 29 and recess 30 being first coated with a refractory cement such as "Sauereisen Cement." The above described assembly of insulator 16, central electrode 21, and contact pin 24, a copper bushing 32, a silver solder ring 36' (FIG. 2), and a compression ring 33 are then assembled into a leg portion 14 of the shell as above prepared.

The assembly is mounted in a suitable fixture which locates the insulator 16 in the proper relationship and maintains spark gap 28 concentric. The fixture is mounted under the ram of a hydraulic press, and a load is slowly applied to compression ring 33 until 1400 lbs. is applied on bushing 32. While such load is maintained, the area of the outer wall of the shell portion 14 adjacent bushing 32 is heated, as by a four flame gas burner with burners set 90° apart, to a dull red heat. The heat source is removed from the assembly, and the assembly is allowed to cool appreciably before the applied load is removed.

The leg portion 12 of the shell is now assembled upon leg 14. As shown, legs 12 and 14 are so formed as to meet at an annular junction 59 lying in a plane at 45° with respect to the axes of legs 12 and 14. The assembled shell is held in a suitable fixture which holds the internal diameter of leg 12 of the shell concentric with the outer diameter of insulator portion 20. The legs 12 and 14 of the shell are now welded, as by heliarc welding, along their outer surfaces at junction 59.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be expressly understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention as will now be apparent to those skilled in the art.

What is claimed is:

1. Electrical apparatus having inner and outer ends, the inner end of the apparatus being subjected to high

temperature during operation of the apparatus, said apparatus comprising in combination an elongated ceramic member extending within the inner, hot end of the apparatus, a ceramic member-supporting and protecting metal wall member having an end portion parallel to and spaced a short distance from a surface of the ceramic member at the inner, hot end of the apparatus, the space between the ceramic member and the wall member being open at the said inner, hot end of the apparatus, an opening of appreciable size through the wall member at a location removed from the open end of the space between the ceramic member and the wall member, means forming a seal between the wall member and the ceramic member at a location spaced from the said inner end of the apparatus and outwardly beyond the opening through the wall member, a flange on the inner end of the wall member underlying and abutting the inner end of the ceramic member, and at least one aperture through the flange communicating with the space between the ceramic member and the wall member.

2. Electrical apparatus as defined in claim 1, comprising a second wall member having a portion overlying, spaced from, and generally parallel to the said end portion of the first recited wall member, there being a second space, between the first and second wall members, and a second opening of appreciable size through the second wall member at a location removed from the open end of the space between the ceramic member and the first recited wall member.

3. An electrical discharge device, comprising an elongated ceramic electrically insulating member, a central passage through the insulating member, a central electrode disposed in said central passage, a protective metal shell about the ceramic member, the shell having a plurality of radially spaced, generally parallel wall members at a zone adjacent the inner end of the device, the inner wall member of said shell in said zone being radially spaced from the ceramic member, the inner end of the inner wall member having an inwardly directed flange underlying and abutting the inner end of the ceramic member, at least one aperture through the flange communicating with the space between the ceramic member and the inner wall member, and at least one aperture through each of the inner and outer wall members, the inner edge of the flange constituting an outer annular electrode cooperating with said central electrode.

4. An electrical discharge device as defined in claim 3, comprising means appreciably spaced from the inner end of the device to form a seal between the metal shell and the ceramic member and to thrust the inner end of the ceramic member against the flange.



5. An electrical discharge device as defined in claim 4, wherein the inner end of the ceramic member is electrically semi-conductive and bridges the central electrode and the flange forming the outer annular electrode.

6. An electrical discharge device, comprising a hollow ceramic electrically insulating member having two legs disposed at a marked angle with respect to each other, a central passage through each of the legs of the insulating member, a central electrode disposed in one of said central passages, a metal shell provided with legs which closely surround the respective legs of the ceramic member, the shell having a plurality of radially spaced, generally parallel wall members at a zone adjacent the inner end of one leg thereof, the inner wall member of said shell in said zone being radially spaced from the ceramic member, the inner end of the inner wall member having an inwardly directed flange constituting an outer electrode underlying and abutting the inner end of the ceramic member, said flange cooperating with the inner end of the central electrode to form a spark gap, at least one aperture through the flange communicating with the space between the ceramic member and the inner wall member, and at least one aperture through each of the inner and outer wall members, an electrical connector part within the other leg of the device, said central electrode extending from the connector part to the spark gap, and a flexible sealing means between the connector part and the insulating member.

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