PEZOELECTRICALLY IGNITED GAS TORCH

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Claims

This invention relates broadly to torches and more particularly to a piezoelectrically ignited gas burning torch. The invention can be adapted to cutting as well as welding torch equipment.

Conventional torch equipment using liquid or gas fuel is initially ignited by matches, cigarette lighters, or other igniting devices. The art is saturated with accounts of the various shortcomings of the devices of the prior art. Suffice it to say that very serious work problems arise in connection with igniting the fuel especially when interrupted service is required.

The present invention is directed toward a novel torch construction in which the igniter becomes an integral part of the torch. A piezoelectrically responsive element is used to generate a spark to ignite the combustible fluid. The employment of piezoelectricity presents some unique problems. Thus, a gradual application of a compressive force (to prevent shock waves and other hammering effects) upon the piezoelectric element will, at ambient temperatures, produce an electric potential capable of establishing a spark near the tip of the torch that will ignite the gases. However, it should be required to re-ignite the torch while the tip portion of the torch is hot, an adequate potential cannot be obtained to cause ignition because the electrical resistance of insulating materials used in such devices is substantially reduced at elevated temperatures. This occurs because the time constant of the circuit is reduced so that the electrical charge will be dissipated through the circuit at a rate that prevents the accumulation of a charge sufficiently large to produce the necessary spark.

The arrangement in accordance with this invention solves this problem by suddenly releasing the force upon the piezoelectric element. The release must occur during a period of time which is less than the time constant of the circuit so that the charge is generated more rapidly than it can be dissipated until it is sufficient to produce the igniting spark. For an expanded discussion on gradual squeezing and sudden release of a piezoelectric element see pending application U.S. Ser. No. 120,808 assigned to the same assignee.

Another characteristic of this invention is the compactness of the torch. This is in part accomplished through the use of "hydraulic multiplication" to obtain a mechanical advantage.

The application of "hydraulic multiplication," in accordance with this invention, follows the following principle. An elastomer is completely confined and fills a chamber and is in contact with two pistons with different areas. The smaller piston is forced in to the chamber and penetrates into the space normally occupied by the elastomer, displacing the volume of the elastomer equal to the volume of piston penetration. This displaced volume is redistributed over a larger area of the second piston as it is moved by the pressure of the displaced medium. The distance moved being inversely proportional to the areas of the pistons; the force multiplication being, of course, directly proportional to the effective areas of the pistons and the energy transmission being the force multiplied by the distance travelled and will be the same for both pistons, except that some energy is stored in the elastomer itself because of the low percentage of compressibility and because some energy is lost in the form of heat due to the hysteresis of the elastomer. These losses are small in proportion to the total energy expended.

It is therefore the primary object of this invention to provide a torch avoiding the shortcomings of the prior art and to improve work efficiency and cost factors by providing a piezoelectric igniter as an integral part of the torch which is operable under adverse working and/or weather conditions.

It is another object of this invention to provide a compact and relatively simple piezoelectric device by taking advantage of the hydraulic force multiplication principle to obtain mechanical advantage.

It is still another object of this invention to provide a torch employing an elastomer for hydraulic force multiplication to avoid sealing problems normally associated with any hydraulic system.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawing:

FIGURE 1 is a side elevational view of the improved torch with parts broken away and shown in section; and FIGURES 2 and 3 are views similar to FIGURE 1 showing particular stages of the operating sequence. FIGURE 3 also illustrates a modified device in accordance with this invention.

An aspect of the present invention resides in the provision of a piezoelectrically ignited gas burning torch which is connectable to a source of combustible gas. The torch comprises a housing arrangement which includes a gas conduit for gas transmission. Piezoelectric means is operably disposed in relation to this housing arrangement and this means is piezoelectrically responsive to compressive stress. Another means is structurally associated with the housing arrangement for establishing a jet of gas in flow communication with the gas source, the jet is located in an environment of substantially atmospheric pressure. Still another means is mechanically connected to the piezoelectric means for applying a compressive force to the piezoelectric means to generate an electric potential; this invention also includes a conductive circuit including a spark gap connected in series with the piezoelectric means, the spark gap being located in operable proximity to the gas jet.

Another aspect of the present invention resides in the provision of a piezoelectrically hydro-actuated device which includes abutment means which is fixedly disposed against displacement. There is also provided piezoelectric means which is responsive to compressive stress and has one end restrained against displacement by this abutment means, and volume displacement force multiplying means is provided for applying a compressive force to the other end of the piezoelectric means and wherein the volume displacement medium is a suitably confined elastomer.

Referring now to FIGURE 1 of the drawing there is illustrated a torch 10 having a handle 12 and a nozzle portion 14. The foregoing may be broadly classified as the housing of the device. The handle has three circular conduits 16, 18 and 20 extending through the handle. Conduits 16 and 18 are connected to a supply of oxygen and conduit 20 is connected to a supply of combustible gas such as butane, propane, etc., (not shown). The conduit system includes tube 17a, 18a and 20a and the further details may be seen in FIGURES 2 and 3. The cylinder 14 constitutes a hollow, elongated body provided with an internal thread 22 to receive an insert 24 which has three internal conduits 16a, 18b and 20b in flow communication with the conduits of handle 12 by way of tubes 16a, 18a and 20a, respectively. Conventional valving means (not
The insert 24 includes an insulator member 26, consisting of a narrow circular disc 26a and a flanged sleeve 26b abutting the disc 26a and defining a hollow space into which is secured a tubular stem 28 and more particularly a flanged end 30 thereof which is formed at one end of the stem 28. The flanged end 30 is thus engaged solely by members composed of insulating material for reasons which hereafter will become more apparent although it should be noted at this point that the invention requires that the stem be constructed of highly conductive (electricity) material.

The various components of the insert 24 and the stem 28 have apertures or passageways 16c, 18c and 20c, as the case may be, as shown, which cooperate and register with the respective passageways 16b, 18b and 20b.

The stem 28 has, opposite from flanged end 30, a circularly enlarged end 29 which terminates adjacent to tip 15 of nozzle 14. This enlarged end 29 includes a detachable portion 29a which is provided with a plurality of annular grooves 32 constituting orifices. The stem end 29 is supported and surrounded by a circular member 31 also constructed of insulating material which is freely mounted within the interior of the nozzle 14. The space between the enlarged end 29 of stem 28 and the insert 24 constitutes the mixing chamber 33. The gas mixtures thus escaping from the orifices 32 are discharged into an environment of substantially atmospheric pressure.

Integral with the main body of the handle 12 there is provided a hollow elongated housing 34 of generally cylindrical configuration. A piezoelectric element 36 is mounted within the housing 34. The element 36 may be composed of crystal elements but is, preferably, made of piezoelectrically responsive ceramics such as barium titanate, lead titanate-zirconate or the like. The element 36 is suitably polarized and electroded to be piezoelectrically responsive in compression so that upon application of a compressive force a voltage potential is generated.

A cylindrical disc 38 of conductive material abuts the element 36 to facilitate an electrical connection between one electrode (not visible) engaging the element and a lead wire 40 and also to provide a rigid seat for the piezoelectric element 36. An insulating sleeve 42 encloses the element 36 and the disc 38 except at one end where a disc 44 of conductive material abuts the element 36 and is in electrical contact with a second electrode (not visible) on the element. The sleeve 42 insulates the piezoelectric element from the housing 34 and the disc 44 establishes electrical ground connection.

An outwardly extending tubular stem 46 integral with sleeve 42 protrudes through an externally threaded plug 48. The plug is detachably inserted in the housing 34 and can be used to pre-stress the piezoelectric element. The lead wire 40 extends through the stem 46 and the sleeve 42 properly and is electrically connected with disc 38; at the opposite end the lead wire 40 extends transversely into nozzle 14, by way of an insulating tube 54 mounted in the nozzle, and is electrically coupled with stem 28. A protective and insulating rubber sleeve 50 surrounds the lead wire between tube 54 and stem 46.

The volume displacement force multiplying arrangement for applying a compressive force to the piezoelectric element includes a body of elastomer 58 interposed between the end wall 35 of the housing 34 and the disc 44. Between the disc 44 and the elastomer 58 there is located a circular washer 60 of soft leather or plastic to prevent extrusion of the elastomer 58 into the clearance space between the outer rim of disc 44 and the inner wall surface of housing 34. Another sealing washer 62 is disposed between the elastomer 58 and the end wall 35 of the housing 34. A plunger 64 extends axially and slidably through opening 66 in the end wall 35; the washer 62 is fitted tightly onto plunger 64 to prevent extrusion of the elastomer 58 into the clearance between the plunger and the guide opening 66.
considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim as my invention:

1. A piezoelectrically ignited gas burning torch connectable to a source of gas comprising, in combination: housing means including a conduit for gas; piezoelectric means operably disposed in relation to said housing means and piezoelectrically responsive to compressive stress application; means structurally associated with said housing means for establishing a jet of gas in flow communication with the gas source, said jet being located in an environment of substantially atmospheric pressure; means connected to said piezoelectric means for applying a compressive force thereto over a relatively long period of time to permit dissipation of a substantial part of the piezoelectric charge generated by the stressing of said piezoelectric means, then to suddenly relieve the stress over a period of time which is short compared to that of the aforesaid period of time and adapted to generate an electric potential; a conductive circuit including means electrically connected with said piezoelectric means to effect said dissipation, and a spark gap connected in series with said piezoelectric means, said spark gap being located in operable proximity to said gas jet; and wherein said means for applying a compressive force to said piezoelectric means includes a hydraulic fluid volume displacement force multiplying means for transmitting and intensifying the compressive force.

2. In a piezoelectric device: abutment means fixedly disposed against displacement; piezoelectric means responsive to compressive stress and having one end restrained against displacement by said abutment means; and an elastomer volume displacement force multiplying means including a confined elastomer of predetermined cross-section and a plunger of comparatively smaller cross-section facing said elastomer and penetrable thereinto for applying an intensified compressive force to the other end of said piezoelectric means.

3. A piezoelectric device comprising, in combination: housing means having at least portions thereof disposed against displacement; piezoelectric means within said housing means responsive to compressive stress, said piezoelectric means having one end restrained against displacement by said housing means; an elastomer suitably confined within said housing and spaced relative to the other end of said piezoelectric means; a piston interposed between said elastomer and said piezoelectric means, said piston having a predetermined cross-sectional area and being in actuating engagement with said elastomer; and a plunger of a predetermined but comparatively smaller cross-sectional area than said piston in contact with said elastomer and adapted to be forced thereinto to establish intensified pressure in the elastomer which acting on said area of said piston establishes a differential force ratio between said piston and the relatively smaller cross-sectional contact face of said plunger which ratio substantially corresponds to the ratio of their respective aforesaid areas.

4. A piezoelectrically hydro-actuated device comprising, in combination: housing means at least portions thereof disposed against displacement; piezoelectric means within said housing means responsive to compressive stress, said piezoelectric means having one end restrained against displacement by said housing means; hydraulic fluid suitably confined within said housing and spaced relative to the other end of said piezoelectric means; a piston interposed between said hydraulic fluid and said piezoelectric means, said piston having an area of predetermined size in actuating contact with said hydraulic fluid; and a plunger adapted to be forced into a portion of the space normally occupied by said hydraulic fluid to displace a portion of the hydraulic fluid and for establishing pressure in the hydraulic fluid which acting on said area of said piston establishes a force ratio between said piston and said plunger corresponding to the ratio of their respective aforesaid areas.

5. In a piezoelectrically hydro-actuated device: abutment means fixedly disposed against displacement; piezoelectric means responsive to compressive stress and having one end restrained against displacement by said abutment means; and hydraulic fluid volume displacement force multiplying means for applying compressive force to the other end of said piezoelectric means.

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