July 28, 1970 KENJIRO GOTO 3,521,987

ELECTRIC GAS LIGHTER WITH MANUALLY OPERABLE PIEZOELECTRIC IGNITION DEVICE

Filed Aug. 5, 1968 3 Sheets-Sheet 1

FIG. 1.

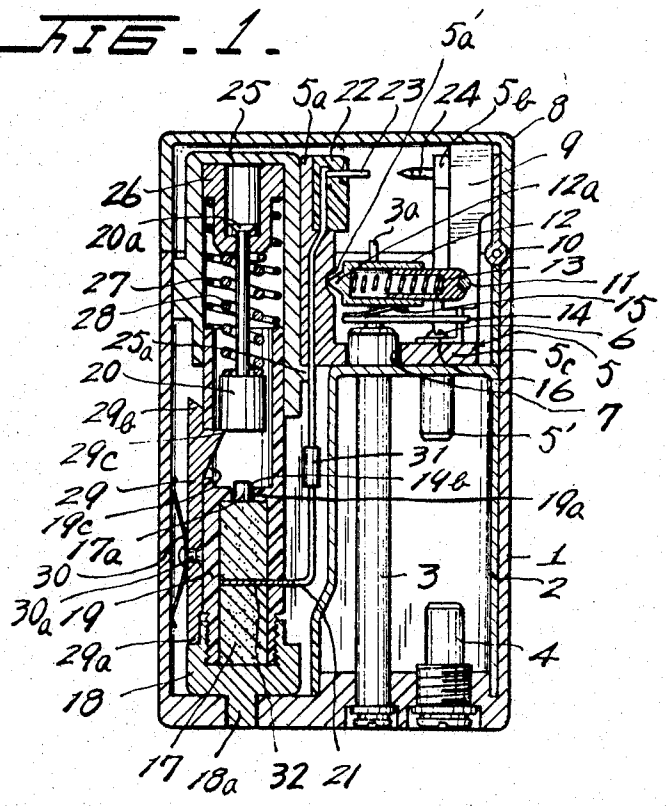

FIG. 2.

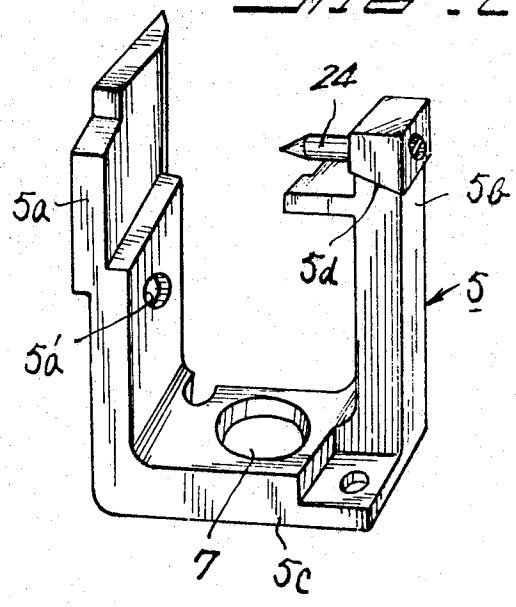

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FIG. 3.

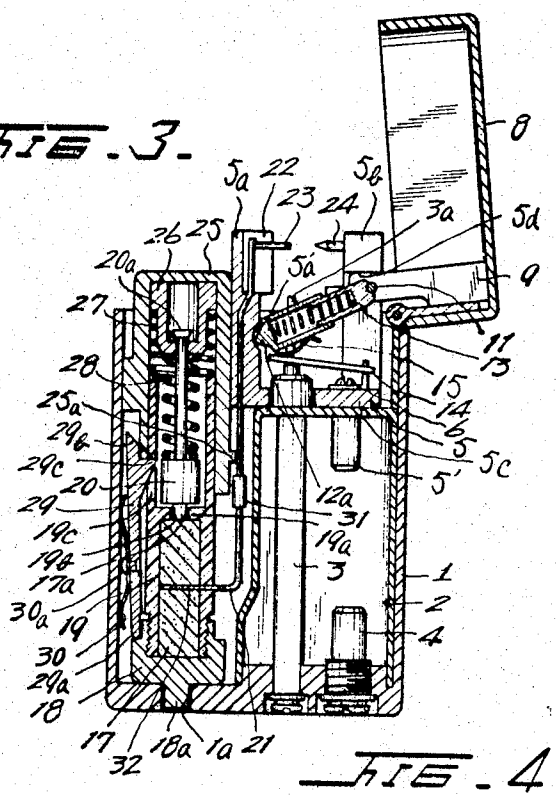
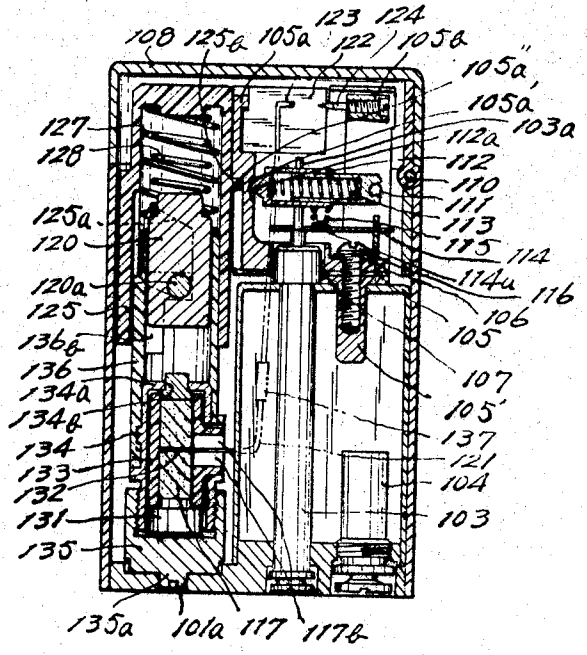


FIG. 4.



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ELECTRIC GAS LIGHTER WITH MANUALLY OPERABLE PIEZOELECTRIC IGNITION DEVICE

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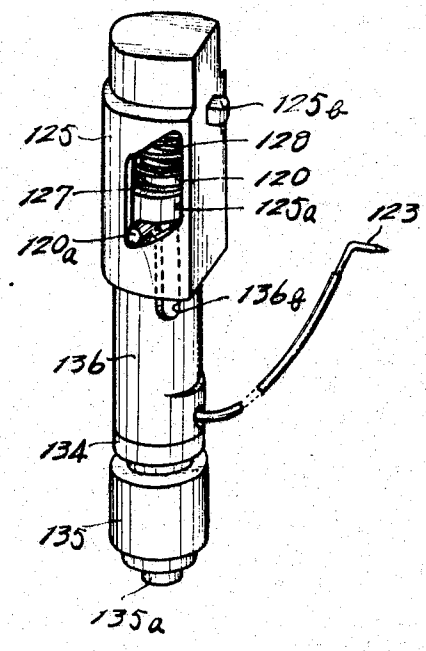
FIG. 5.



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3,521,987

ELECTRIC GAS LIGHTER WITH MANUALLY OPERABLE PIEZOELECTRIC IGNITION DEVICE

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Int. Cl. F23g 2/28, 3/01
U.S. Cl. 431—255 12 Claims

ABSTRACT OF THE DISCLOSURE

A liquefied gas-fueled lighter for cigarettes, cigars and the like having a piezoelectrically-energized high voltage generation device as the fuel ignition source in which a fuel tank is located within a casing and a fuel gas discharge valve device is disposed within said tank in fuel transfer relation thereto. A fuel gas injection valve is disposed in a spaced relation to said discharge valve device within said tank in fuel transfer relation to the tank and a cap is pivotally secured to said casing. A spouting valve control device operates in response to the pivotal movement of said cap to control the nozzle of said discharge valve device. A high voltage generation device having piezoelectric elements and electrodes adapted to provide a spark to ignite the fuel gas which, is adapted to discharge from said tank through said discharge valve device upon the operation of said cap.

BACKGROUND OF THE INVENTION

There have been proposed various types of liquefied gas-fueled lighters which utilize piezoelectric elements as their gas ignition means and some of the prior art lighters of the above type have been disclosed in U.S. Pats. Nos. 3,200,295; 3,167,687 and 3,295,024. The lighters of these patents have placed their principal importance on improvements of only the mechanisms which deliver impact or depressing force to piezoelectric elements and therefore the impact delivery mechanisms incorporated in such lighters have satisfied only the requirements that sparks can be struck in the spark gaps between sparking electrodes in a timed relation to the discharge of fuel gas from the tanks through the discharge valve devices and nozzles as the result of depression of the discharge valve actuating member against the force of the springs in the valve devices. These prior art lighters of the above-mentioned U.S. patents have not given any consideration to the relative arrangement or disposition of the fuel gas tanks, discharge electrodes, high voltage generation devices and so on within the casings and also as to the manner by which these lighter components can be easily and economically fabricated. Therefore, such prior art lighters have required complicated and troublesome procedures and consumed considerable time in assembling. Furthermore, when these lighters were out of order or damaged in order to adjust or repair them the entire lighters had to be dismantled into individual component units or parts which made the repair work very inconvenient.

SUMMARY OF THE INVENTION

The present invention relates to an improved liquefied gas-fueled lighter which utilizes a piezoelectrically energized high voltage generation device as the fuel gas ignition source and which can effectively eliminate the above-mentioned defects of the prior art lighters.

One object of the present invention is to provide an

improved liquefied gas-fueled lighter which utilizes a piezoelectrically energized high voltage generation device as the fuel gas ignition source and which has an improved arrangement of various structural components within the casing whereby a discharge electrode supporting member can be mounted on the top of a fuel tank and a high voltage generation device can be mounted in side by side relation with respect ot the electrode supporting member.

Another object of the present invention is to provide an improved high voltage generation device for a liquefied gas-fueled lighter utilizing piezoelectric elements as its energizing source in which said high voltage generation device is so designed that the device can be easily incorporated into the casing of the lighter and the device can be also easily removed from the lighter casing for inspection and repair purposes.

The above and other objects and advantages of the present invention will be more readily apparent to those skilled in the art from a reading of the following description referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section view of one preferred form of lighter constructed in accordance with the present invention showing the lighter in its normal closed state;

FIG. 2 is a fragmentary perspective view on an enlarged scale of an electrode supporting member to be suitably employed in the lighter of FIG. 1;

FIG. 3 is a vertical section view of said lighter of FIG. 1 showing the lighter in its fully opened state;

FIG. 4 is a vertical section view of a modified form of lighter construcuted in accordance with the present invention which employs a modified form of high voltage generation device; and

FIG. 5 is a fragmentary perspective view on an enlarge scale of said modified high voltage generation device shown in FIG. 4.

EMBODIMENTS OF THE INVENTION

Referring first to FIGS. 1 to 3, inclusive, wherein a preferred form of liquefied gas-fueled lighter constructed in accordance with the present invention is illustrated, the lighter generally comprises a conventional casing **1** which houses all of the component parts of the lighter therein. A liquefied gas fuel tank or reservoir **2** is fixedly provided within the casing **1** and extends vertically and upwardly from the inner bottom of the casing along one end wall of the latter by a distance in excess of one half of the height of the casing and is adapted to receive and discharge a supply of fuel under pressure. The tank **2** has a conventional fuel discharge valve device **3** extending vertically through the tank which has a conventional nozzle return spring (not shown) received therein and which is provided with a nozzle **3***a* at the upper end thereof in fuel transfer relation to the valve device **3**. The device **3** is further provided in the periphery with an opening through which the valve device communicates with the tank **2** for receiving the fuel from the tank. The lower end of the valve device **3** is fixedly received in the bottom of the casing **1** which also constitutes the bottom of the tank **2** and the upper end of the valve device extends through the top wall of the tank so as to position its nozzle **3***a* above the tank top wall. The tank **2** has a conventional fuel injection valve device **4** extending upwardly from the inner bottom of the casing **1** at a point laterally spaced from the valve **3** into the interior of the tank. The injection valve device **4** has a center opening through the length thereof for a fuel supply relation to the tank **2** and the bottom of the injection valve device **4** is also fixedly received in the bottom of the casing **1**. Since the construction and operation of the fuel discharge and injection valves **3** and **4** are conventional and do not constitute part

of the present invention, detailed descriptions of these valves are omitted herein. An electrode supporting member **5** is fixedly mounted on the top wall of the fuel tank **2** by means of a set screw **6** which is threaded into a threaded bore (not shown) formed in the tank top wall and an inner threaded depending extension **5'** thereof extends downwardly from the underside of the tank top wall into the tank **2**. The electrode supporting member **5** generally has at a point laterally spaced from the depending extension **5'**, a circular through bore **7** through which the upper portion of the valve **3** extends and a pair of parallel and laterally spaced arms **5***a* and **5***b* which extend vertically and upwardly at the opposite ends of a bight portion **5***c* which connects the arms **5***a* and **5***b* at their lower ends. The detailed construction and function of the electrode supporting member **5** will be described hereinbelow. A cap or discharge valve operating member **8** having a support bracket **9** fixedly secured to the inner surface of the cap is pivotally secured at one end of the upper edge of the casing **1** by means of a hinge **10**. The support bracket **9** fixedly supports a transverse shaft **11** extending through laterally of the bracket **9** and received in a recess formed at one end of a substantially horizontal two-part construction cylinder **12** which is positioned laterally displaced relative to the nozzle **3***a* and in which a coiled spring **13** is received. The spring **13** normally urges the two parts of the cylinder **12** outwardly in opposite directions to each other so as to extend the cylinder so that the shaft **11** pivotally receives the adjacent end of the cylinder at the recess, but limits the extending movement of the latter. The other end of the cylinder **12** remote from the shaft **11** is pointed as shown at **12***a* and the pointed end **12***a* is slidably received in a conical recess **5***a'* formed on the inner side of the arm **5***a*. A horizontal discharge valve control member **14** is supported at one end on the upright portion of a substantially L-shaped stationary support piece **16** with the horizontal portion thereof being fixedly secured to the upper surface of the bight portion **5***c* by means of the set screw **6**. The supported end of the control member **14** is provided with an opening larger than the size of the cross section of the support piece **16**. A leaf spring **15** is secured at one end to the upper surface of the member **14** and the other end thereof abuts against the underside of the cylinder **12**. The other end of the control member **14** has an opening in which the nozzle **3***a* of the valve **3** is received for normally urging the nozzle **3***a* to the valve closing position under the force of the spring **15** which opposes the force of the nozzle return spring (not shown) received in the valve **3** and normally tending to urge the nozzle to the valve opening position. The control member **14** is so designed that when the cap **8** is in its closed position as shown in FIG. **1**, the control member **14** urges the nozzle **3***a* to the discharge valve closing position assisted by the spring **15** which then opposes the force of the inner return spring of the valve **3**. According to the present invention, a high voltage generation device is provided within the casing and which extends upwardly from the inner bottom to a position slightly short of the inner side of the top wall of the cap **8** to a position adjacent to the inner side of one wall of the casing **1** remote from the fuel tank **2**. The high voltage generation device generally comprises a piezoelectric element assembly **17** having an impact receiving reduced diameter top end **17***a* and a periphery surrounded and protected by a suitable insulation material with the lower end of the element assembly being covered or protected by a suitable cup-shaped positioning member **18** which has a depending extension **18***a* fixedly received in a bore **1***a* in the bottom of the casing **1** to hold the assembly **17** in position. The piezoelectric element assembly **17** includes a pair of conventional piezo electric elements with a suitable conductive terminal piece **32** interposed between the adjacent ends of the two elements. One pole of the pieoelectric assembly **17** is connected to a lead wire **21** leading to an electrode **23** which is fixedly supported on a suitable insulation material electrode mount **22** which is in turn fixedly supported on the arm **5***a*. A suitable resistance **31** is disposed on the lead wire **21** between the piezoelectric element assembly **17** and the electrode **34**. The other pole of the piezoelectric element assembly **17** is electrically connected through the casing **1** to another electrode **24** which is adjustably inserted through the other arm **5***b*.

As seen in FIG. **1**, the electrodes **23** and **24** are arranged in alignment with each other in a spaced relation so as to form a spark gap therebetween. The adjustable electrode **24** is so inserted in the arm **5***b* that the electrode may be moved toward or away from the opposite electrode **23** to adjust the distance of a spark gap between the electrodes as desired or necessary. The piezoelectric element assembly **17** is surrounded by a sheath **19** which has a peripherally threaded lower end portion threadedly received in the threaded interior of the cup member **18**. The sheath member **19** has a transverse partition **19***a* extending thereacross and provided with a center bore **19***b* through which the impact receiving top end **17***a* extends. The sheath member **19** further has, in the upper portion of its periphery, a vertically extending elongated slot **19***c* for a purpose to be described hereinbelow. A spring-loaded striking member or impact delivery depending member **20** is suitably supported for rapid vertical movement in a suitable cup-shaped member **26** which is, in turn, disposed within an inverted cup-shaped finger piece **25**. The striking member **20** includes a lower larger diameter head portion and a reduced diameter shank portion having one end integrally connected to the head portion and a flared upper end portion received in the opening of the cup-shaped mounting member **26**. A compressed coil spring **28** is disposed around the striking member shank having an end abutting against the inner or upper end face of the striking member head portion and the other end against and secured to the underside of the bottom of the member **26** by means of a securing or caulking pin **20***a*. A further coil spring **27** is disposed in a compressed state between the sheath member **19** and the inverted cup-shaped finger piece **25** with one of the upper end encircling the reduced diameter lower portion of the mounting member **26** and the other or lower end abutting against the upper edge of the sheath with the spring serving as a return spring for the finger piece **25**. A stop pawl or lateral projection **25***a* is provided on the finger piece **25** at a position adjacent to and inwardly spaced from the lower end thereof and adapted to allow the finger piece **25** to move a substantial distance downwardly when the finger piece is depressed against the force of the spring **28**, but to abut against the lower edge of the arm **5***a* and limit the upward movement of the finger piece when the piece is released so that the finger piece is effectively prevented from springing out of the casing **1** when the finger piece is released. A cam member **29** is movably disposed along the outer side of the sheath member **19** extending by a substantial distance of the height of the sheath member and has lower end **29***a* seated on the top of the cup-shaped member **18** and a slanted upper or cam end **29***b* adapted to engage the lower edge of the finger piece **25** when the piece is depressed to a predetermined distance for actuating the striking member **20**. The upper end **29***b* is bevelled as shown in FIG. 1 so as to form a cam for the purpose to be described hereinbelow. The upper bevelled end or cam **29***b* extends inwardly and laterally to provide a striking member seat **29***c* on which the lower end of the striking member **20** normally seats. The seat **29***c* is normally received in an opening **19***c* formed in the adjacent side in the periphery of the sheath member **19**. A leaf spring **30** is secured at a substantially mid point between the opposite ends to the outer side of the cam member **29** as shown at **30***a* in FIG. 1 between the inner surface of the adjacent end wall of the casing **1** and the cam member **29**. The spring normally urges the cam member

against the sheath member **19** so that the head portion of the striking member **20** may normally seat on the seat **29***c*. However, when the finger piece **25** is depressed for energizing the high voltage generation device and as a result, the lower end of the finger piece **25** engages and frictionally slides down the bevelled upper end or cam **29***b*, the cam member **29** is caused to pivot with the lower end **29***a* as its fulcrum to displace the upper end **29***b* outwardly relative to the striking member **20** against the force of the leaf spring **30** coming off the seat **29***c* out of the opening **19***c* and resulting in a disengagement of the cam member **29** and striking member **20**. In such a case, as will be easily understood, when the cam member **29** comes out of its engagement with the striking member **20** in the manner mentioned above, the striking member **20** strikes against the top **17***a* of the piezoelectric element assembly **17** with a high energy so as to energize the high voltage generation device.

In operation, the cap **8** is first manually pivoted about the hinge **10** by the user's thumb, for example to the position as shown in FIG. 3 in which the cap is in a substantially upright or fully open state. In pivoting the cap **8** from its closed position of FIG. 1 to the fully open position of FIG. 3, the user releases the cap after the cap has been pivoted by a predetermined angular distance or a portion in its full rotational movement whereupon the cap is allowed to rapidly move to the substantially upright or fully open position of FIG. 3 by virtue the arrangement of the spring-loaded two-part cylinder **12** whose pointed end **12***a* frictionally slides in the conical recess **5***a'* in the electrode supporting member arm **5***a* and the recess at the other end of the cylinder **12** pivots about the transverse shaft **11** supported in the mounting bracket **9**. The thus opened cap **8** is maintained in the open position by the extension of the two-part cylinder **12** under the force of the coil spring **13** and in this position of the cap, the cylinder **12** assumes an inclined position relative to its normal substantially horizontal position as seen in FIG. 3. Simultaneously, the spring **15** which has been depressed by the cylinder **12** in the horizontal position is released whereby the valve actuating member **14** and accordingly, the nozzle **3***a* is allowed to move upwardly by the force of the internally disposed spring of the valve **3** so as to open the valve **3** to allow the fuel gas under pressure to discharge from the tank **2** through the valve and nozzle. When the finger piece **25** is manually depressed until the lower end thereof abuts against and slides down the bevelled upper end **29***b* of the cam **29** to cause the head portion of the striking member **20** to disengage from the seat **29***c* of the cam member **29** against the force of the springs **27** and **28**, the cam upper end **29***b* is caused to displace relative to the sheath member **19** toward the adjacent end wall of the casing **1** against the force of the spring **30** which is now forcing the cam member away from the wall and the actuating member head portion strikes against the receiving top **17***a* of the assembly **17** with a high striking energy. The assembly **17** sequeezes its piezoelectric elements together with the conductive terminal piece **32** therebetween to provide a potential difference between the opposite electrodes **23** and **24** which then strike a spark in the spark gap between the electrodes. The spark ignites the fuel gas which is now discharging from the nozzle **3***a* as the result of the opening of the actuating member **8** in the manner above mentioned. After a cigarette, for example, has been lit by the ignited fuel gas, the user releases the finger piece **25** to allow the finger piece to return to the normal upper or inactive position by virtue of the return spring **27** and at the same time the cup-shaped mounting member **26**, and accordingly, the striking member **20** also return to the normal upper or inactive position until the stop extension **25***a* abuts against the lower end of the arm **5***a* by the force of the spring **28** in which the top of the finger piece **25** engages the inner surface of the top wall of the actuating member **25**. As the mounting member **26** is returning to the upper or inactive position, the striking member **20** is also being returned to the upper or inactive position because the flared upper end of the striking member **20** is received within the opening of the mounting member **26**. As soon as the lower end of the finger piece **25** has cleared the upper bevelled end or cam **29***b* of the cam member **29**, the cam member **29** is caused to automatically pivot from its displaced position to its normal upright position by the force of the leaf spring **30** until the lower end or head portion of the striking member **20** seats again on the lateral extension or seat **29***c* at the end **29***b*. However, since the gas discharge mechanism and the high voltage generation or ignition mechanism are separately or independently operated from each other, even when the high voltage generation mechanism has returned to its inoperative or deenergized position, as long as the cap or valve actuating member **8** is maintained in its open position the discharge valve and nozzle are maintained open and the fuel continues to discharge from the tank and sustain its flame. In order to extinguish the flame, the user manually pivots the cap **8** in the direction opposite to the arrow direction of FIG. 1 to the closed position and as the cap **8** is pivoted to the closed position the pointed end **12***a* and the other recessed end of the cylinder **12** are caused to frictionally slide on the conical recess **5***a'* in the electrode mounting member **5** and pivot about the shaft **11** supported in the mounting bracket **9**, respectively until the two-part cylinder **12** returns from its inclined position to its horizontal position against the force of the spring **13**. The leaf spring **15** is depressed by the underside of the cylinder **12** and the depressed spring in turn depresses the valve actuating member **14** whose free end receives the nozzle **3***a*. The depressed actuating member **14** closes the nozzle **3***a* and valve **3** against the force of the internally disposed spring of the valve and the discharge of the fuel from the tank **2** through the valve and nozzle ceases.

FIGS. 4 and 5 illustrate a modified form of lighter constructed in accordance with the present invention which generally comprises a casing **101** housing all the component parts of the lighter therein. A liquefied gas fuel tank or reservoir **102** is fixedly mounted within the casing **101** and extends vertically and upwardly from the inner bottom of the casing along one end wall of the latter by a distance in excess of one half of the height of the casing and is adapted to receive and discharge a supply of liquefied gas under pressure therein. The tank **102** includes a conventional fuel discharge valve device **103** having a conventional nozzle return spring (not shown) received therein and the valve device is provided with a nozzle **103***a* at the upper end thereof in fuel transfer relation thereto. The valve device **103** is provided with an opening (not shown) for fuel receiving relation with the tank **102** and has the lower end fixedly received in the bottom of the casing **101** which also constitutes the bottom of the tank **102** with the upper end extending through the top wall of the tank **102** into the upper portion of the interior of the casing and terminating at the nozzle **103***a*. The tank **102** also has a conventional fuel injection valve device **104** extending vertically and upwardly through the bottom of the casing **101** into the interior of the tank at a position laterally spaced from the valve device **103**. Since the construction and operation of the valve device **103** and valve device **104** are conventional and the same as those of the corresponding devices of the first embodiment, a detailed description of these devices are omitted. An electrode supporting member **105** is fixedly mounted on the top wall of the tank **102** by means of a set bolt **106** which is threaded through a threaded bore (not shown) in the top wall of the tank **102** into an internally threaded depending extension **105'** of the member **105** which extends downwardly through the tank top wall into the tank **102**. The electrode supporting member **105** generally has, at a point laterally spaced from the depending extension **105'**, a circular

through bore **107** through which the upper portion of the valve device **103** extends and a pair of parallel and laterally spaced arms **105***a* and **105***b* which extend vertically and upwardly above the open top of the casing **101** and connected at the lower ends by a bight portion **105***c*. The detailed construction and operation of the electrode supporting member **105** will be further described hereinafter. A cap or discharge valve actuating member **108** having an integral mounting bracket **109** is pivotally secured at one end of the upper edge of the casing **101** by means of a hinge **110**. The mounting bracket **109** has a transverse shaft **111** fixedly secured thereto and which extends horizontally and laterally and transversely of the casing **101**. A two-part construction extensible cylinder **112** is pivotally supported on the shaft **111** by means of a substantially circular recess at one or the outer end of the cylinder which pivots about the shaft **111** and the other or inner end of the cylinder **112** is pointed as shown at **112***a*. When the cylinder **112** is in its inoperative position, the cylinder is maintained in a substantially horizontal position as shown in FIG. 4. A coil spring **113** is received within the cylinder **112** for normally urging the two parts thereof outwardly in the opposite directions from each other to maintain the cylinder in its extended condition when the lighter is in its inoperative position. The extent of extension 7 of the cylinder **112** by the spring **113** is limited by the recess in the outer end which pivots about the shaft **111** and by the pointed other or inner end of the cylinder which is slidably received in a conical recess **105***a'* formed in the inner side of the arm **105***a*. A normally horizontal discharge valve operating or control member **114** is supported at one end by the upright portion of a substantially L-shaped mounting member **116** with the horizontal portion thereof being fixedly secured to the bight portion **105***c* by means of the set bolt **106**. The above one end of the operating member **114** is formed with a suitably shaped opening (not shown) having a size for loosely receiving the upright portion of the mounting member **116** for the purpose to be described hereinbelow. The free end of the operating member **114** is also formed with a suitably shaped opening having a size for receiving the nozzle **103***a* of the valve device **103**. The operating member **114** is further provided at a suitable point on the upper surface with an upwardly extending boss **114***a* around which the lower end of a coiled spring **115** is snugly fit and the other or upper end of the spring **115** abuts against the underside of the two-part cylinder **112** so that the spring is normally held in a compressed state for normally urging the nozzle **103***a* to the valve closing position against the force of the nozzle return spring (not shown) received in the valve device **103** when the cap **108** is in its closed position of FIG. 4.

The spring **115** is provided for the purpose that even if the component parts of the lighter have dimensions slightly differing from the requisite specifications called for, the parts the valve operating member and the cap may effectively perform their operations without difficulties. The modified high voltage generation device of this embodiment generally comprises a piezoelectric element assembly **117** including a pair of upper and lower piezoelectric elements with an electrode or terminal piece **132** interposed between the adjacent ends of the piezoelectric elements. The assembly **117** has an impact receiving top **117***a* and is surrounded by a suitable electric insulation member **133**. The lower end of the assembly **117** seats on a rigid supporting block **131**. Each of the upper and lower piezoelectric elements has a lateral extension **117***b* between which the terminal piece or electrode **132** extends. A metallic sheath member **134** surrounds the insulation member **133** except for the free end face of each of the lateral extensions **117***b*. The lower portion of the member **134** is provided with an outer thread for threaded engagement with the threaded inner periphery of a substantially cup-shaped stop member **135** which has a center depending extension **135***a* fixedly received in a through bore **101***a* in the bottom of the casing **101**. A synthetic resin outer sheath member **136** surrounds a substantial height of the member **134** and extends from a mid point to a point substantially beyond the top of the member **134**. The sheath member **136** has a lateral hollow extension in which the lateral extensions **117***a* are received. The member **134** further has a transverse portion **134***a* formed with a center opening **134***b* through which extends the top impact receiving top of the piezoelectric element assembly. The member **136** is provided in its peripheral wall with inverted L-shaped slots **136***b* at diametrically opposite points for guiding the pin of a striking member to be described hereinafter. An impact delivery or striking member **120** having a transverse pin **120***a* with the opposite ends extending through the opposite slots **136***b* is mounted within the outer sheath member **136** with the upper portion normally projecting beyond the top of the member **136**. A synthetic resin high voltage generation device actuating member or finger piece **125** in the form of an inverted cup shape is provided with an open lower end partially overlapping and slightly spaced from the upper portion of the member **136**. The finger piece is provided in the diametrically opposite positions of the peripheral wall with substantially parallelogram guide slots **125***a* for the pin **120***a* of the striking member **120**. As clearly shown in FIG. 5, the area of each guide slot **125***a* is substantially larger than that of the inverted L-shaped slot **136***b* in the outer sheath **136** with the longer sides of the slot **125***a* extending in the longitudinal direction with the shorter sides extending at an angle with respect to the longer sides. The finger piece **125** has a lateral projection **125***b* on the side facing the arm **105***a* of the electrode supporting member **105** and the projection is adapted to serve as a stop for limiting the upward movement of the finger plate **125**.

For this purpose, the arm **105***a* is offset in the lower portion on the outer side to form a shoulder **105***a''* against which the projection **125***b* abuts so that the finger piece **125** may be effectively prevented from leaving the casing **1** when the latter is opened. The finger piece **125** is outwardly protruded in the lower portion on the side opposite to the lateral projection **125***b* and the protruded portion is adapted to slide in contact with the inner surface of the adjacent end wall of the casing **101** for guiding the finger piece **125** in its upward and downward movement. A return spring **127** is provided between the finger piece **125** and outer sheath member **136** with one end abutting against the inner surface of the top wall of the finger piece **125** and the other end against the upper edge of the outer sheath member **136**. A second spring or striking energy accumulating spring **128** is disposed between the actuating member **125** and striking member **120** with one end snugly fitting around the center boss on the underside of the top wall of the finger piece **125** and the other end abutting against the upper edge of the striking member **120**. A lead wire **121** extends from the electrode **132** to a discharge electrode **123** fixedly supported on an insulated electrode mounting block **122**. The block **122** is fixedly supported on the arm **105***a* of the member **105** and the electrode **123** is connected to the positive side of the piezoelectric element assembly **117** via the electrode **132**. Disposed in opposition to the electrode **123** is another adjustable discharge electrode **124** which is threaded through a threaded opening formed in the other arm **105***b* of the electrode mounting member **105**. The second electrode **124** is connected to the negative side of the piezoelectric element assembly **117** via the casing **101**. The position of the electrode **124** relative to the electrode is adjustable by moving the former toward or away from the latter as in the first embodiment.

The arm **105***b* of the member **105** is provided with a recess **105***b'* which is adapted to engage the supporting bracket **109** of the cap **108** to limit the pivotal movement of the cap in the opening direction. The operation of this

form of lighter is substantially the same as that of the first embodiment except for the operation of the modified high voltage generation device and a brief explanation. The user manually pivots the cap **108** to open the cap and then depresses the actuating member **125** to a portion of its full downward movement against the force of the spring **127**. In such a case, the striking energy accumulating spring **128** is simultaneously compressed for accumulating the striking energy because the opposite ends of the pin **120***a* of the striking member **120** are disposed within the lateral shorter portions of the outer sheath slots **136***b* and at the lowermost edge of the respective lower sides of the parallelogram slots **125***a* when the cap is closed. Thereafter, the finger piece **125** is further depressed for the remaining portion of the downward movement until the upper shorter sides of the parallelogram slots **125***a* abut against the pin **120***a* whereupon the opposite ends of the pin **120***a* rapidly displace from the lateral portions to the vertical portions of the slots **136***b* and the compressed spring **128** instantaneously releases all of its accumulated energy to deliver the energy to or strike against the striking member **120**. The member **120** in turn strikes against the piezoelectric element assembly **117** with the delivered striking energy whereby a potential difference may be provided between the opposite electrodes **123** and **124** to strike a discharge spark in the discharge gap between the opposite electrodes **123** and **124**. The struck spark ignites the fuel gas which is now discharging from the tank **102** through the valve device **103** and nozzle **103***a* as the result of the opening of the cap **108**. After a cigarette, for example, has been lit by the ignited fuel gas, the user releases the finger piece **125** so that the piece may be returned to its inoperative or upper position by the force of the spring **127** and as the finger piece **125** is returned, the striking member **120** is simultaneously returned to its inoperative or upper position. This is due to the fact the pins **120***a* of the striking member **120** are pushed up by the lower shorter sides of the parallelogram slots **136***a* of the rising finger piece **125** into the initial lateral portions of the slots **125***c* by the combined force of both the springs **127** and **128** whereupon the high voltage generation device is deenergized to extinguish the flame. Thereafter, the cap **108** is manually pivoted to the closing position in which the cylinder **112** assumes the substantially horizontal position whereby the spring **115** may be compressed by the cylinder to urge the valve control member **114** to close the valve and nozzle against the inner return spring of the valve. It should be noted that the pin **120***a* of the striking member **120** connects the outer sheath member **136** and finger piece **125** by means of their respective slots **136***b* and **125***a*, and the sheath member and finger piece may be effectively prevented from inadvertently displacing with respect to the stationary parts of the high voltage generation device.

Although two preferred embodiments of the present invention have been described and illustrated in detail herein, it is to be understood that these are illustrative in nature and not necessarily limiting upon the scope of these teachings in their broader aspects. Many additional variations within the scope of the appended claims will occur to those skilled in the art.

What is claimed is:

1. A liquefied gas-fueled lighter which utilizes a piezoelectrically energized high voltage generation device as the fuel ignition source, a casing; a fuel gas tank disposed within said casing for receiving and discharging fuel gas; a fuel gas discharge valve device disposed within said tank in fuel transfer relation thereto; a cap pivoted to said casing adapted to open said discharge valve device as the cap is pivoted to its open position and to close the valve device as the cap is pivoted back to its closed position; a pair of spaced opposite electrodes provided right above said discharge valve; a high voltage generation device including piezoelectric elements electrically connected to said electrodes; a striking member disposed in a position to strike against said piezoelectric elements when the striking member is actuated; a striking energy accumulating spring abutting at one end against said striking member and at the other end against a finger piece which is operatively connected to and encircles said striking member; and a cap member normally holding said striking member in its inoperative position and adapted to compress said spring when said finger piece is depressed so as to cause the spring to accumulate an energy for driving the striking member and then after release of said finger piece to rapidly drive the striking member against said piezoelectric elements whereby a potential difference is caused to momentarily generate between said electrodes so as to strike a spark therebetween for igniting the fuel which is discharging from said tank through said valve device as the result of the pivotal movement of said cap to the open position.

2. The liquefied gas-fueled lighter as set forth in claim **1**, in which a gas discharge valve device control member engages a portion of a cylinder which has one end pivotally supported by said pivotal cap and the other end slidingly engaging a portion of a support member for said electrodes, said control member being adapted to be actuated in response of the pivotal movement of said cap.

3. The liquefied gas-fueled lighter as set forth in claim **2**, in which a gas discharge nozzle of the gas discharge valve device is positioned laterally spaced from said cylinder and adapted to frictionally move vertically in response to the pivotal movement of said cap.

4. The liquefied gas-fueled lighter as set forth in claim **1**, in which an electrode support member provides an atmosphere of the gas discharging from said tank through said discharge valve device therein and is fixedly mounted the top of said fuel tank which houses said fuel discharge valve device with a fuel discharge nozzle projecting above said tank top, said support member supporting a pair of opposite and spaced electrodes at points remote from the pivot point of said cap to the casing and having an engaging recess in one portion below said electrodes along which recess one end of said cylinder may slidingly engage.

5. The liquefied gas-fueled lighter as set forth in claim **4**, in which one of said pair of opposite electrodes is adapted to strike a fuel ignition spark in corporation with the other electrode in response to the energization of said high voltage generation device in corporation with the other electrode and disposed within said atmosphere of fuel gas discharging from said tank through said discharge valve device and the other element is supported in said electrode support member in an adjustably displacable relation to said first-mentioned electrode for adjusting the distance of a discharge gap to be formed between the two electrodes.

6. The liquefied gas-fueled lighter as set forth in claim **4**, in which said electrode support member fixedly mounted on the top of said fuel tank further has an engaging portion which is adapted to limit the movement of a finger piece or high voltage generation device actuating member in one direction in cooperation with a projection formed with said finger piece.

7. The liquefied gas-fueled lighter as set forth in claim **1**, in which said high voltage generation device further includes a vertically movable striking member positioned laterally spaced from an electrode support member for delivering an impact force against said piezoelectric elements and a striking energy accumulating spring disposed between said finger piece and striking member, said finger piece being adapted to be exposed as said cap is pivoted to its open position.

8. The liquefied gas-fueled lighter as set forth in claim **1**, in which said high voltage generation device includes at least one piezoelectric element mounted within a stationary sheath member and a piezoelectric element supporting cup member in threaded connection with the lower end portion of said sheath member, said cup mem-

ber having a positioning portion for said high voltage generation device connected to a portion of said casing.

9. The liquefied gas-fuel lighter as set forth in claim **1**, in which said striking member has a pin extending transversely of said striking member and a sheath member has a pair of diametrically opposite slots formed in the peripheral wall for receiving the opposite exposed ends of said pin, said pin and slots cooperating with each other in accumulating and releasing said striking energy in said spring disposed between said finger piece and striking member.

10. The liquefied gas-fueled lighter as set forth in claim **9**, in which said finger piece and sheath member are formed of synthetic resin.

11. The liquefied gas-fueled lighter as set forth in claim **9**, in which said high voltage generation device comprises a piezoelectric element positioning section and an impact force delivery section including said striking member, said sheath member for the striking member, and a spring for returning said finger piece to its inoperative position, said two sections being telescopically connected to each other.

12. The liquefied gas-fueled lighter as set forth in claim

1, in which said pivotal movement of the cap and the operation of said finger piece are effected independently of each other and a lead wire extends from said high voltage generation device to said electrodes mounted in an electrode support member, said lead wire having a resistance connected thereto for extending the holding time of said spark to be struck between said opposite electrodes.

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V. Y. MAYEWSKY, Primary Examiner

U.S. Cl. X.R.

317—81, 96; 431—264

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,521,987 Dated July 28, 1970

Inventor(s) Kenjiro Goto

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, lines 10 and 11, change "finger piece"

to -- striking member --

Signed and sealed this 29th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents