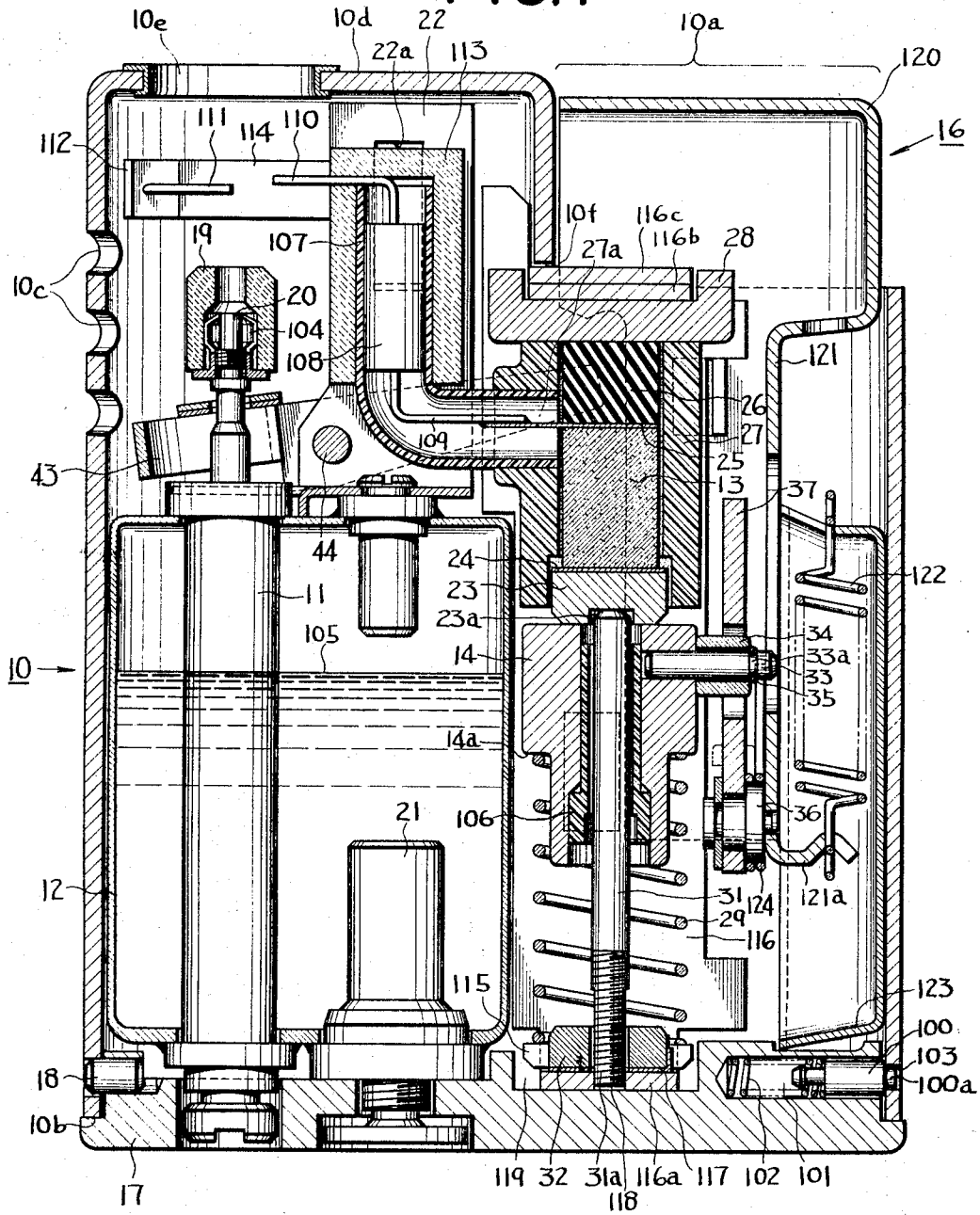
Feb. 4, 1969 KENJIRO GOTO 3,425,783

ELECTRIC GAS LIGHTER HAVING A PIEZOELECTRIC STACK

Filed Nov. 8, 1966 Sheet 1 of 3

FIG. 1



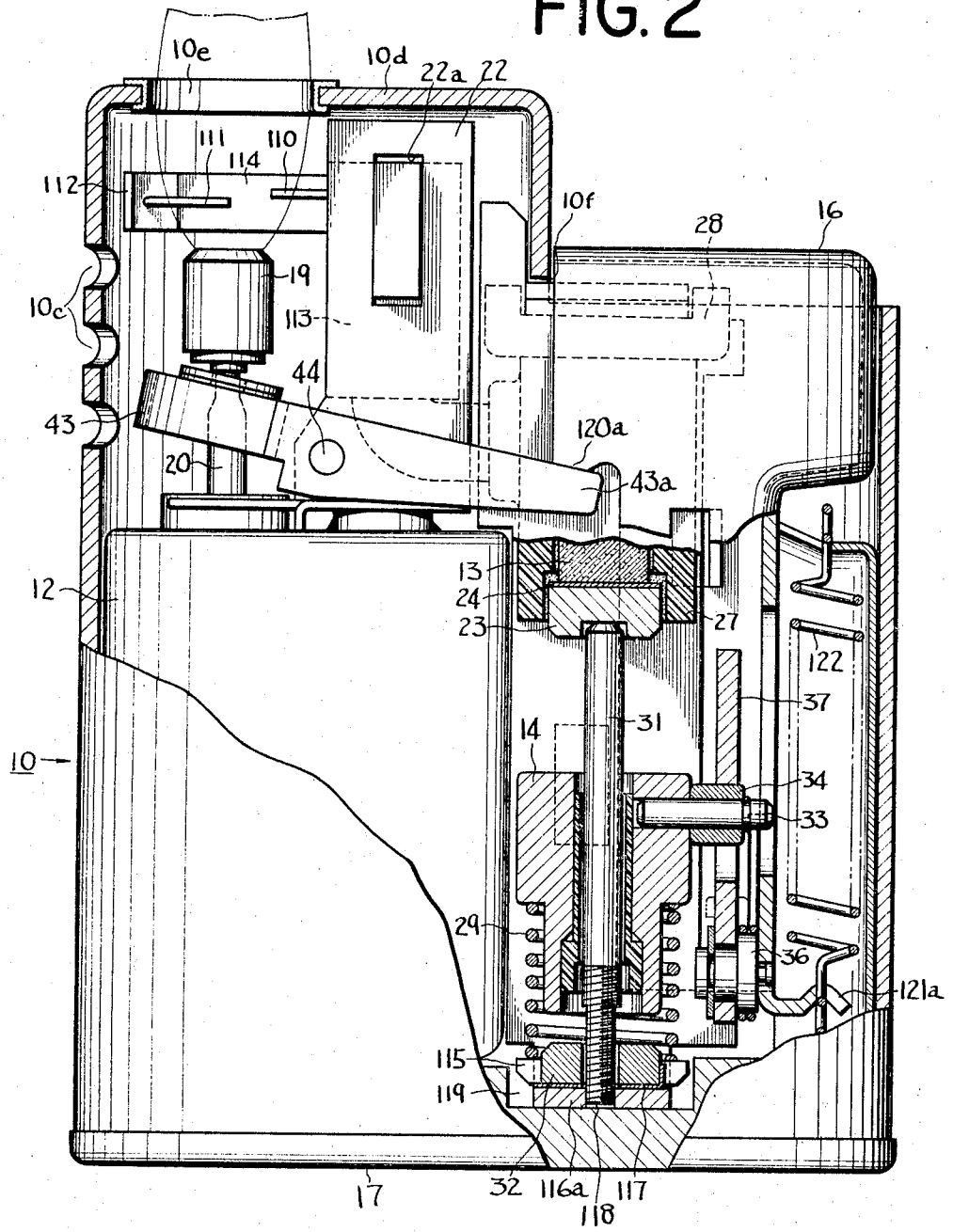
INVENTOR.
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ELECTRIC GAS LIGHTER HAVING A PIEZOELECTRIC STACK

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FIG. 2



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FIG.3

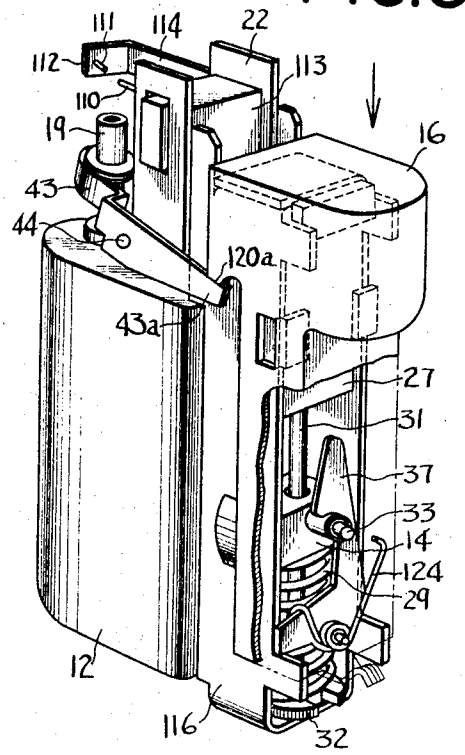


FIG.4

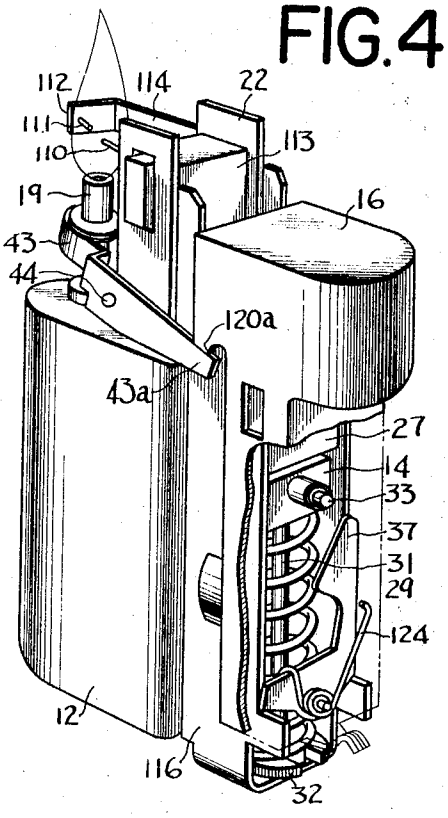


FIG.5

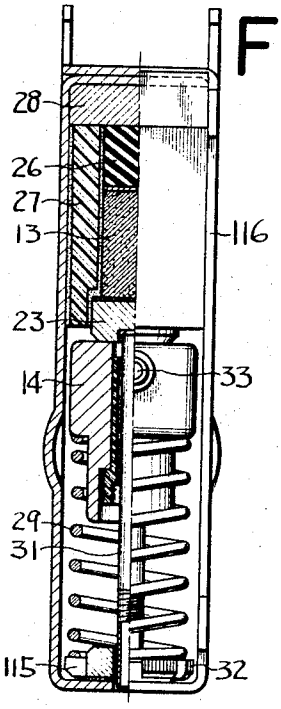


FIG.6

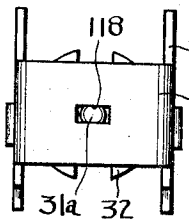
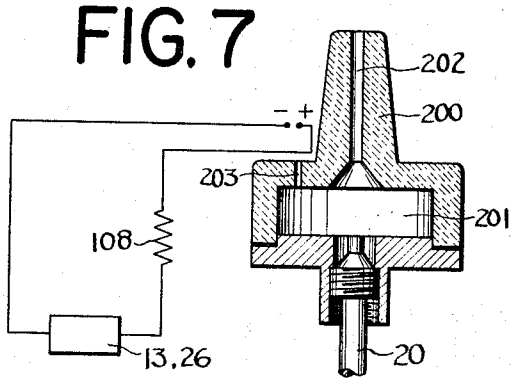


FIG.7



United States Patent Office

3,425,783

Patented Feb. 4, 1969

3,425,783

ELECTRIC GAS LIGHTER HAVING A PIEZOELECTRIC STACK

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U.S. Cl. 431—255

4 Claims

Int. Cl. F23g 2/16, 2/28, 7/18

ABSTRACT OF THE DISCLOSURE

An electric gas lighter having a piezoelectric stack and a pair of discharge electrode electrically connected to the poles of said stack. A movable hammer spring-biased to the stack, an actuator including a spring loaded cam plate for moving the hammer away from the stack and releasing it for rapid movement towards the stack and a pressure bar for constantly applying an adjustable, permanent pressure to the stack.

This invention relates to improvements in and relating to liquefied gas fueled cigarette lighters provided with piezoelectric spark ignition system.

It has been already known to equip the liquefied gas fueled cigarette lighter, referred throughout this specification briefly as "gas lighter" with piezoelectric crystal element for generating a high voltage ignition current by the application of a sudden and abrupt pressure onto the element, so as to generate ignition sparks between a pair of spark electrodes mounted in close proximity of the gas outlet opening of a conventional burner nozzle of the lighter.

According to my practical experiments, a shorter durable life of the piezoelectric element has been encountered on account of liable and frequent breakage of the element in the course of frequently repeated igniting manipulations of the gas lighter of the kind above referred to. Upon investigation, it was now found that this kind of breakage is attributable to eccentric pressurization of the piezoelectric crystal which leads in a gradual separation of the conventional blow-receiving metallic head fixedly attached, for instance, by the application of sticking agent, to the piezoelectric crystal, from the latter.

The main object of the present invention is therefore to provide a gas lighter, capable of minimizing the possibility of breakage of piezoelectric element during its usage to a minimum, so as to elongate its usable life and at the same time to assure a reliable and positive ignition of the gasified fuel at each application of a forced blow against the head of the piezoelectric element by a hammer arranged to cooperate therewith.

With use of the conventional gas lighter of the above kind, other drawback is encountered to avoid overheating of the spark gap electrodes by the issuing gas flame, because these electrodes are positioned in close proximity of the outlet end of the burner nozzle. According to a prior proposal, these electrodes are receded from their working position after the generation of igniting sparks for the purpose of avoiding overheating of the electrodes. Such a counter measure as this will invite a highly complicated mechanism for advancing and receding the electrodes upon each manipulation of the gas lighter for desired ignition.

A further object of the present invention is to provide an improved gas lighter, capable of avoiding any overheating of the spark electrodes even when the burning of

the fuel gas should extend for a long period of time, for instance, ten minutes or so.

Another object of the invention is to provide a gas lighter which is highly compact in its design, economical in its manufacture and efficient in its working efficiency.

The foregoing and other objects, features and advantages of the invention will become apparent from the following more particular description of substantially a preferred embodiment of the invention, as illustrated in the accompanying drawings only for the illustrative purpose and thus in no limiting sense of the invention.

In the drawings:

FIG. 1 is a longitudinal section of a preferred gas lighter embodying the novel teaching of the present invention, illustrating the non-operative conditions thereof.

FIG. 2 is a similar sectional view, yet somewhat simplified for the illustration of part of the outline configuration of the gas lighter, illustrating the working mode thereof.

FIG. 3 is a perspective view of several main working parts of the foregoing embodiment, wherein however a pusher type manipulating member is depressed to its intermediate position.

FIG. 4 is a similar view to FIG. 3, wherein the pusher has been depressed fully to its lowermost position.

FIG. 5 is a front view of several preferred working parts when seen from right to left in FIG. 4, wherein however substantially half of the figure is shown in its longitudinal section for the purpose of showing specifically inside hidden working parts.

FIG. 6 is an inverted plan view of the assembly shown in FIG. 4, wherein however the fuel container fitted therein has been omitted from the drawing for simplicity thereof.

FIG. 7 is a longitudinal section of a modified burner nozzle assembly wherein an ignition circuit is additionally and schematically illustrated.

Now referring to the accompanying drawings, especially FIG. 1 thereof, **10** denotes a substantially cylindrical casing of a liquefied gas fueled cigarette lighter, said casing being semiopened at **10***a* at its upper end and fully opened at its lower end at **10***b*, yet additionally closed by means of a bottom cover **17** which is positively kept in position at least a dowel pin **18** and a slidable pin **100**. This pin **100** is slidably mounted in a blind hole **101** cut horizontally in the cover **17** and urged resiliently by a compression spring **102** which is inserted in the hole. Pin **100** is formed with a reduced end **100***a* which is snugly received in an opening **103** boned through the casing wall in close proximity of its lowermost end **10***b*. The casing wall is formed with a plurality of air inlet openings **10***c* for the communication of the substantially closed upper space above a liquefied gas fuel container **12** which is positioned fixedly in the lower left corner of the interior space of the casing **10** as most clearly seen in FIG. 1, with the ambient atmosphere for supplying the combustion air, as will be more fully described hereinafter.

The closing upper casing wall **10***d* is formed with a flame outlet opening **10***e* kept in vertical alignment with flame guide mouth piece **19** which is made of a heat resistance material such as ceramic for instance steatite and fixedly mounted on a flange piece **104** fixedly attached to the upper end portion of a conventional fuel gas nozzle **20**. This nozzle **20** is slidably mounted with its lower end in the interior of a conventional nozzle valve **11**. With the nozzle **20** positioned as shown, the valve **11** is positively closed so that any gasified fuel can not be delivered from the interior of fuel container **12** through the valve **11**, nozzle **20** and mouth piece **19**. On the contrary, when the nozzle **20** together with mouth piece **19** and flange piece **104** is elevated intentionally as will be more fully described hereinafter, the liquid fuel at **105** contained in the fuel container **12** is led as conventionally into the nozzle

valve **11** and gasified therein, thence delivered from the mouth piece **19** through the intermediary of the burner nozzle **20**. There is provided a fuel charge valve **21** through the bottom of the fuel container **12**, so as to give a facility of charging the liquefied fuel as conventionally.

Numeral **13** denotes a piezoelectric element, preferably formed into a rigid circular cylinder made of, such as, for instance, balium titanate, lead zirkonate or the like ceramic material and polarized as conventionally, which element is rigidly fitted at its lower end with a rigid metallic head **23** through the intermediary of an aluminum sheet **24** tightly stuck on after another, for instance, by means of a convenient sticking agent.

Head **23** is formed on the lowermost or shock-receiving surface with a recess **23***a* which receives snugly the upper end of an elongated pressure bar **31**, the lower end part of which is formed with screw threads **31***a* kept in engagement with an adjusting nut **32**. By manipulating this nut **32**, the pressure bar **31** can be shifted along its longitudinal axis so as to modify the initial pressure acting against the piezoelectric element **13** by the pressure bar **31** through the intermediate of the head **23**.

14 represents a hollow hammer piece which is rigidly fitted with a sleeve slide **106** kept in sliding fit with the pressure bar **31** acting at the same time as a guide bar to the hammerslide assembly. When necessary, the slide can be dispensed with so as to form the hammer proper as the slide. Around the bar **31**, there is provided a pressure spring **29** which is tensioned between the hammer piece **14** and the adjusting nut **32**.

At the upper end or positive pole of the piezoelectric element **13**, there is provided a conductor plate **25** which is made of copper, bronze or the like conducting material and conductingly and tightly attached to the element and backed up by an insulator block **26**, preferably made of alumina, steatite or the like insulating material having a high mechanical strength.

A protecting cover sleeve **27** made of insulating synthetic resin such as tetrafluoroethylene, poly styrol, phenol resin or the like, is enclosing the piezoelectric assembly comprising head **23**, piezoelectric element **13**, conductor plate **25** and insulator block **26** upon application of liquid insulating agent such as silicon wax or the like, so as to unite the assembled constituent physically into a mechanical unit. The cover sleeve **27** is formed with a side opening **27***a* within which the free end of the conductor plate **25** projects.

A wire conductor **109** is fused at its one end with the projecting end of the plate **25**, while the opposite end of the conductor **109** is connected through a spark-stabilizing and retarding resistor **108** to a positive spark electrode **110**, said conductor **109**, resistor **108** and the root portion of spark electrode **110** being enclosed and maintained in position by a protecting bend tube **107** made preferably of an insulating synthetic resin material and extending from the aforementioned opening **27***a* in an outward and upward direction as shown. The protecting tube **107** is enclosed at its upper portion by a semi-closed ceramic insulator **113** and the electrode **110** passes the wall of the latter and protrudes a slight distance therefrom so as to form the positive electrode proper kept in substantially opposition to a cooperating or negative electrode **111** for establishing a permanent spark gap. The latter electrode **111** is rigidly supported on a horizontally projecting support arm **114** which is made of a rigid and conductive metal such as steel and protrude from a metallic mount **22** extending vertically from the tank top wall of the fuel container **12**. Said mount **22** serves for positively supporting the insulator **113** which is formed with suitable projection means **113** kept in engagement with substantially corresponding reception opening means **22***a* formed in the mount **22**, as will be most clearly seen from FIG. 2.

28 denotes a rigid back-up mount made of iron, zinc or other suitable metal or alloy, having an elongated channel in its cross-sectional configuration and being in pressure engagement with the upper extremities of both of insulator **26** and cover sleeve **27**. In a modification, the insulator **26** can be replaced by a second piezoelectric element arranged physically in series with, yet electrically in parallel to the first piezoelectric element **13**, so as to form a piezoelectric stack. In FIGS. 1 and 5, this modified arrangement has been illustrated in place of the basic embodiment so far described.

29 denotes an actuating spring for the hammer **14**, the upper end of the spring abutting against a shoulder **14***a* formed on the hammer and the lower end of said spring being kept in pressure engagement with a spring mount **115** which is made integral with adjusting nut **32** which abuts against a bottom wall **116***a* of mounting frame **116** through the intermediary of stopper **117**, said frame **116** representing substantially an elongated rectangular shape when seen from left or right in FIG. 1 or 2, as may be well supposed from the observation of FIGS. 3–6, especially FIG. 5.

The upper end of the mounting frame **116** represents an overlapped double wall construction comprising top wall parts **116***b* and **116***c* kept in pressure engagement with the recessed upper surface of the back-up mount **28**. The said frame **116** is mounted with its lowermost end at **116***a* in a recess **119** formed on the bottom cover, while the upper end of the frame is kept in position by engagement with the lowermost edge at **10***f* of the bent-down part of the top wall **10***d* of lighter casing **10**. The lower threaded end of bar **31** is kept in meshing relation with a female-threaded opening **118** boxed through the lowermost lateral wall **116***a*.

Manipulating pusher **16** comprises a button head **120** and a stem **121**, the latter having a channel-shaped cross-section when cut in a horizontal plane and being formed from a unitary sheet by pressing. The pusher **16** is mounted with its stem **121** in an overlapped and slidable relation with the mounting frame **116** which construction will be most clearly seen from FIGS. 3–4. The stem **121** is formed with a projection **121***a* to which one end of a return spring **122** is attached, while the opposite end of the latter is supported by the upper part of an elongated dish **123** kept in position on the bottom cover **17** and within the right lower corner of the interior space of casing **10**, when seen in FIG. 1 or 2, thus the pusher **16** being always subjected to an upwardly directing resilient force.

A stepped pin **36** is fixedly mounted by the lower part of stem **121** and a hook **37** is rotatably mounted on the said pin **36** and urged resiliently to rotate in the counterclockwise direction when in FIGS 3 and 4, under the influence of an urging spring **124**.

Motion-receiving pin **33** is fixedly attached to the hammer piece **14** and mounts rotatably a sleeve **34** which is normally kept in engagement with the hook **37**. For preventing unintentional stipping-out of the sleeve **34** from the pin **33**, there is provided a spring clip **35** which is received a circular groove **33***a* formed on the pin.

Operating lever **43** adapted for elevating the burner nozzle **20** in its position from that shown in FIG. 1 to that illustrated in FIG. 2 is pivotable about a pivot pin **44** mounted by side mount **22**, the motion-receiving end **43***a* of said lever being separated from the cooperating projection **120***a* depending from the button head **120**, when the gas lighter is kept in its non-operating position, as will be noted from corresponding dotted line representation shown in FIG. 1, while in the operating position these mating parts **43***a* and **120***a* are brought into engagement with each other, as shown in FIGS 3 and 4.

The operation of the gas lighter so far described is as follows:

When it is desired to initiate the ignition of the gasified fuel, finger pressure is exerted upon the button head **120** of manipulatable pusher **16** against the action provided by pusher-returning spring **122**, which pusher thereby accompanies the hook **37**. Downward motion is therefore

transmitted to the hammer piece through the hook **37** and follower pin **33** kept in engagement with each other, while the actuating spring **29** is compressed. In the course of this downward movement, the hammer piece is positively guided along the guide bar **31** always in a concentric relation with the longitudinal axis of the piezoelectric assembly comprising head **23**, piezoelectric element **13**, insulator **26** (which may be equally a piezoelectric element as was referred to hereinbefore) and back-up piece **28**. When the hammer piece has moved to a predetermined point through an intermediate stage shown in FIG. 3, the pin **33** with its rotatable sleeve **34** will slip out from the engageable recess formed on the hook **37**, thus the hammer piece **14** being released perfectly from the engagement with the manipulating pusher and subjected to the urging force provided by the now strongly compressed actuating spring **29**. Therefore, the hammer piece will strike rushingly against the motion-receiving lower surface of the head **23**, in a precisely concentric manner, thereby giving an evenly distributed pressure upon the head, and therefore, to the piezoelectric element **13**, or stack **13** and **26**.

By preliminarily adjusting the nut **32**, the bar **31** can be kept in a slightly pressurized relation with the piezoelectric assembly and therefore the head is kept always in pressure contact with the element **13**, which assures to prevent any unintentional physical separation of the head from the element, even though the head is subjected to frequent and severe blows provided by the hammer piece. In this respect, the aforementioned concentric guidance of the hammer relative to the piezoelectric assembly will contribute to prevent the aforementioned unintentional separation which will invite possible breakage of the piezoelectric element or elements.

Slightly before the aforementioned striking action by the hammer piece being brought into effect, the operating projection **120***a* of the button head is brought into engagement with the motion-receiving end **43***a* of the operating lever, which thereupon is caused to rotate in the clockwise direction when seen in FIGS. 3–4, so as to elevate the nozzle burner assembly **19–104–20** in its position against a returning spring, not shown, which is contained in the nozzle valve **11**, which is thus opened in the conventional way. Therefore, the liquid fuel contained in the container **12** will be evaporated in the valve and delivered therefrom through the nozzle **20** and mouth piece **19** in the form of a gas jet. After initiation of this gas jet flow to take place, say upon elapse of several microseconds from that initiation, the aforementioned striking action will be brought into effect.

The thus generated high pressure voltage, say, 7,000–10,000 volts, will be conveyed through conductor plate **25** from the piezoelectric element **13** or elements **13** and **20**, as the case may be, thence through wire conductor **109** and resistor **108** to the positive side spark electrode **110**. On the other hand, the negative potential is conveyed from the piezoelectric asssembly through the casing **10** and support arm **112** to the negative side spark electrode **111**, thus heavy sparks being generated through the spark gap defined by the both electrodes and serving to ignite the discharging gas jet stream, so as to produce a burning flame which will emerge from the flame guide opening **10***e*. Combustion air will be supplied from the ambient atmosphere through air inlet openings **10***c* assisted by the forced ventilation caused by the outgoing burning gas jet.

When the finger pressure exerted upon the pusher head is released, the moved parts occupying other position than that shown in FIG. 1 will be brought back to their initial one under the influence by the return spring **34** and nozzle-return spring contained in the burner nozzle **11**.

When it is desired to adjust the preliminary compressive force exerted by the bar **31** upon the metallic head **23**, the stopper **117** is flattened into a plane sheet by pulling the upwardly projecting end of the stopper by exerting a manual force. Then, the adjusting nut **32** can be turned in one or the other direction so as to tighten or loosen, as the case may be, for exerting any initial precompression axial force upon the head **23**. When the adjustment has been completed in this way, the flattened stopper end is again shaped into an angular projection so as to engage in one of the peripheral recesses formed on the nut. In the course of said adjustment, the actuating spring **29** serves for checking the upward movement of the nut, and thus the bar **31** can be advanced upwardly to increase its exerting pressure upon the head **23**, when the nut is turned in the so desired direction.

In the modified nozzle arrangement, the nozzle mouth piece **200** is formed with a gas expansion chamber **201** which is fluidly connected with the flow passage of a nozzle similar to that shown by **20** in the foregoing embodiment.

Mouth piece **200** is formed with a main gas passage opening **202** and an auxiliary gas passage opening **203**, said both openings being kept in fluid communication with the expansion chamber. In close proximity of the aux. opening 203, there is provided a pair of spark electrodes, which are only designated "+" and "—" signs and may be constructed in the similar manner as those designated by **110** and **111** in the foregoing embodiment, although their specific configuration and mounting means have been omitted for simplicity.

When the gasified fuel is supplied from the nozzle proper by opening the burner valve which may be similar to that shown in FIG. 1 by **11** and in the aforementioned manner, the gas will flow through the both passage openings **202** and **203**. When sparks will develop in the aforementioned manner, the aux. and weaker gas jet issuing from the smaller opening **203** is firstly ignited. The thus burned aux. gas jet will ignite the main gas jet issuing from the main passage opening **202**, the flow energy of which is thereby augmented and thus the aux. or pilot flame will be correspondingly weakened, so that disadvantageous heating effect provided by the burning flame upon the relatively sensible park electrodes can be substantially avoided. In this way, an efficient and durable sparking performance of the electrodes and thus the advantageous ignition performance of the burner assembly can be assured even when the gas lighter is utilized in a highly repeated and frequent manner.

While the invention has been particularly shown and described with reference to substantially a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

I claim:

1. A gas lighter comprising:

(A) a lighter casting;

(B) a liquefied gas fuel reservoir within said casing;

(C) a burner nozzle in fluid communication with said reservoir and having an outlet end for selective delivery of a gasified fuel stream;

(D) a piezoelectric stack having a metal head fixed thereto and electric poles;

(E) a pair of discharge electrodes mounted in said casing in close proximity of said nozzle outlet;

(F) a spring loaded hammer slidably mounted within said casing for movement toward and away from said metal head and carrying a pin extending in a direction perpendicular to the direction of hammer movement;

(G) current conducting means electrically connecting said poles to said electrodes;

(H) a pusher mechanism slidably mounted on said casing; and

(I) a spring loaded cam plate rotatably mounted on said pusher mechanism and adapted to engage said pin upon travel of said pusher mechanism in a direction withdrawing said hammer from said metal head

and to release said pin upon traveling over a predetermined distance in that direction whereby said hammer is released to collide with said metal head.

2. A gas lighter as defined in claim 1 further comprising a pressure rod having a threaded part and passing through a longitudinal bore in said hammer into contact with said metal head; a compression spring wound about said pressure rod and positioned between said hammer and said casing to bias said hammer in a direction toward said metal head; and a nut on said threaded part for adjusting the pressure effort exerted by said pressure rod onto said metal head.

3. A gas lighter as defined in claim 1 further comprising an insulator mount fixed on said reservoir and carrying one of said electrodes; a receiving recess formed on said mount and carrying the other of said electrodes; and a resistor carried on said receiving recess.

4. A gas lighter as defined in claim 2 further comprising a hollow sleeve made of synthetic resin material having a high lubricating characteristic and mounted in said longitudinal bore formed through said hammer for guiding said pressure rod with a light sliding resistance than otherwise.

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