United States Patent [19]

Ballantyne

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[45] **Dec. 18, 1973**

[54] **LIGHTER WITH A CAPACITOR DISCHARGE IGNITION SYSTEM**

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[73] Assignee: **Dunhill Lighters Limited,** London, England

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[21] Appl. No.: **271,266**

[30] **Foreign Application Priority Data**

July 13, 1971 Great Britain 32,869/71

[52] **U.S. Cl.** **431/266,** 431/255, 431/132, 317/95, 317/96

[51] **Int. Cl.** **F23q 3/01**

[58] **Field of Search** 317/81, 93, 95, 96; 431/68, 130, 132, 255, 266; 292/251.5

[56] **References Cited**

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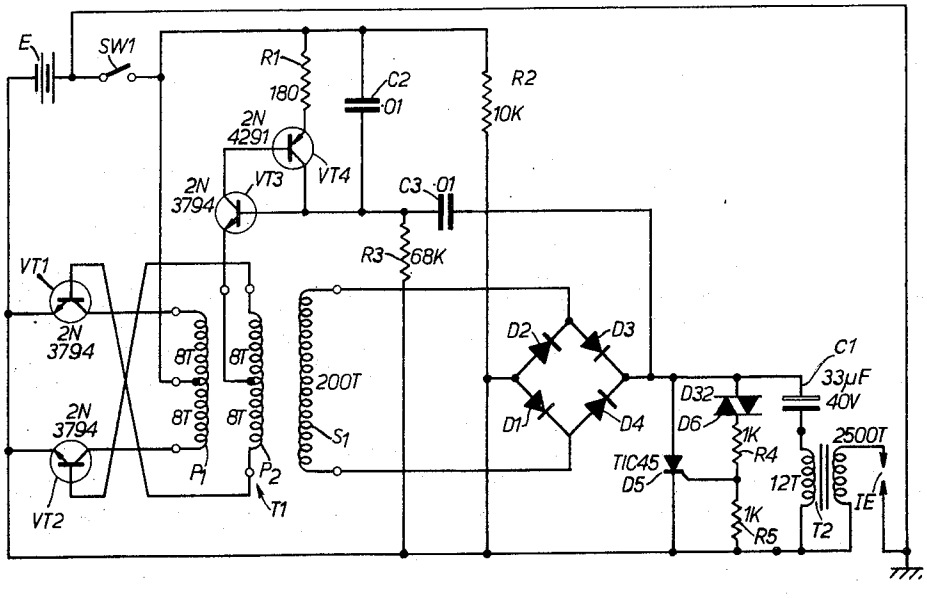
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Primary Examiner—Volodymyr Y. Mayewky
Attorney—Joseph F. Brisebois et al.

[57] **ABSTRACT**

A smoker's lighter with a capacitor discharge ignition system is provided with a transistorised multivibrator and step-up transformer to increase the level of voltage from internal cells to a higher level for charging the capacitor. The output of the transformer is connected to a full-wave rectifier and an automatic discharge circuit is provided to discharge the capacitor when a predetermined voltage is reached.

9 Claims, 20 Drawing Figures



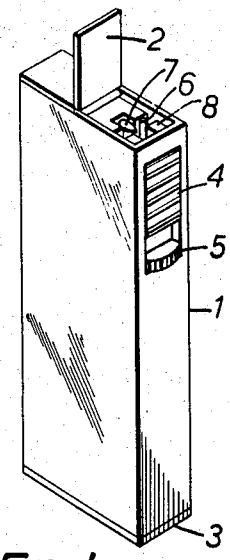


FIG. 1.

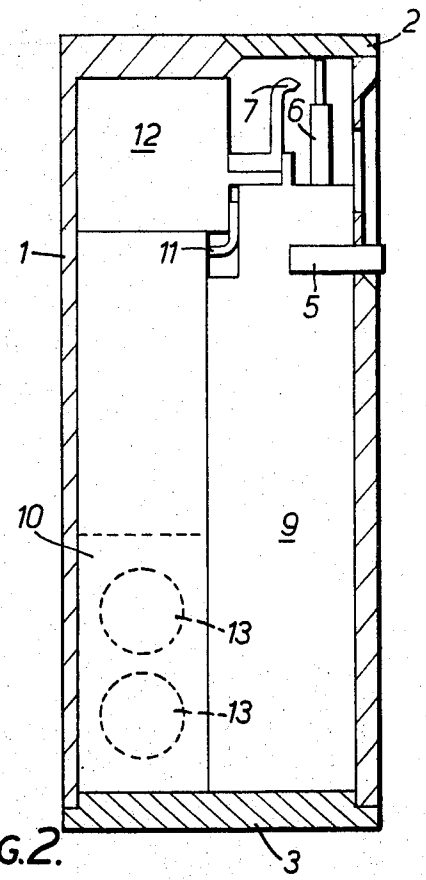


FIG. 2.

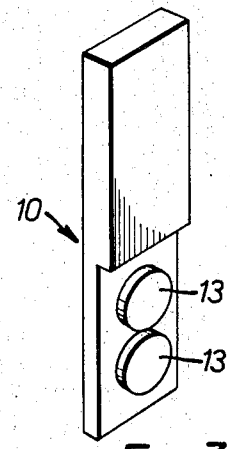


FIG. 3.

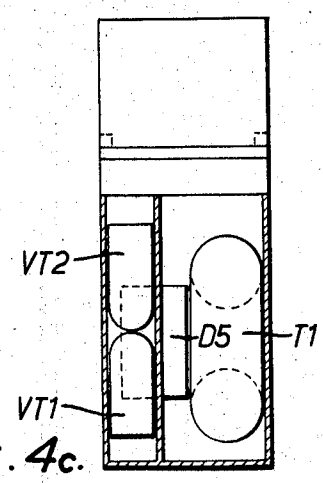


FIG. 4c.

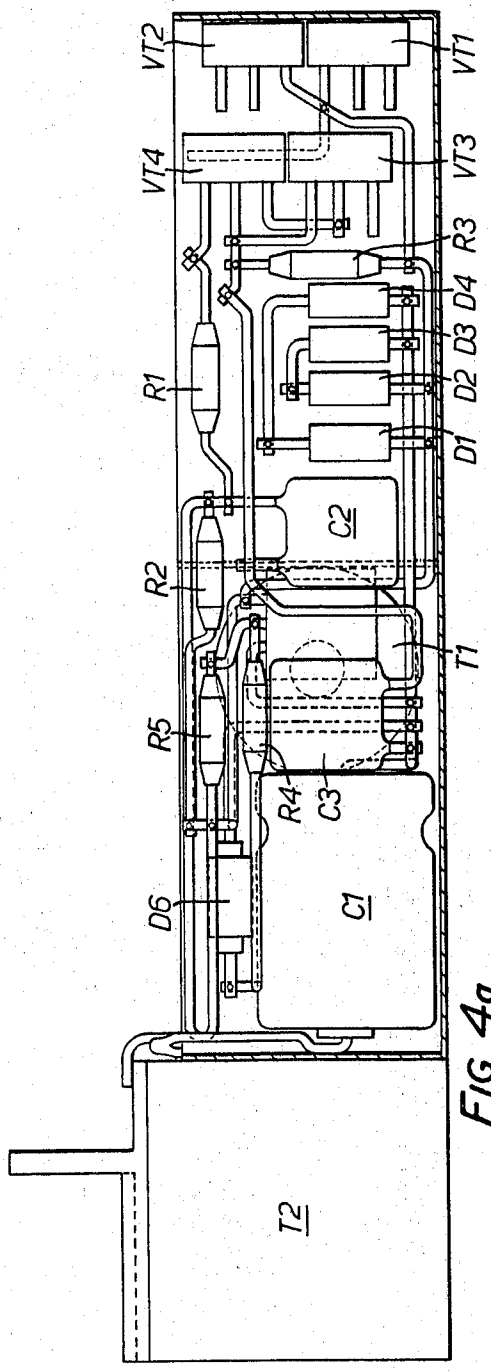

VT2
VT1
VT4
VT3
R3
D4
D3
D2
D1
R1
C2
R2
T1
R5
R4
C3
C1
D6
T2

FIG. 4a.

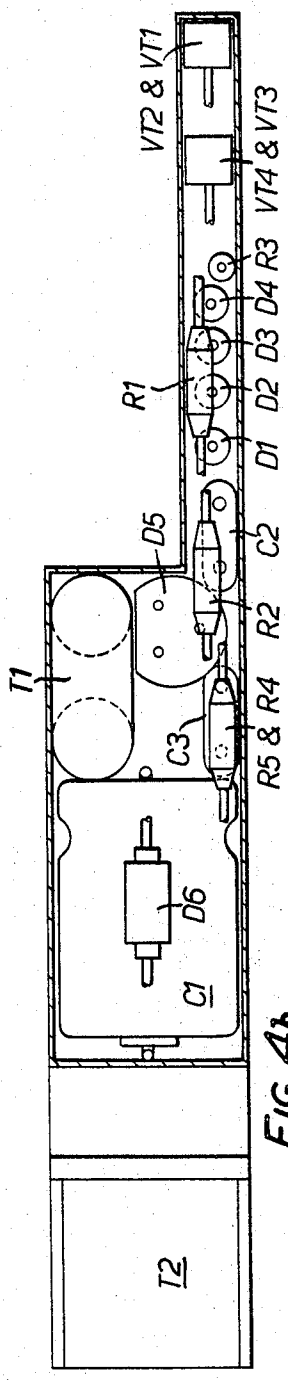

VT2 & VT1
VT4 & VT3
R3
D4
D3
D2
D1
R1
D5
C2
R2
T1
R4
R5 & R4
C3
D6
C1
T2

FIG. 4b.

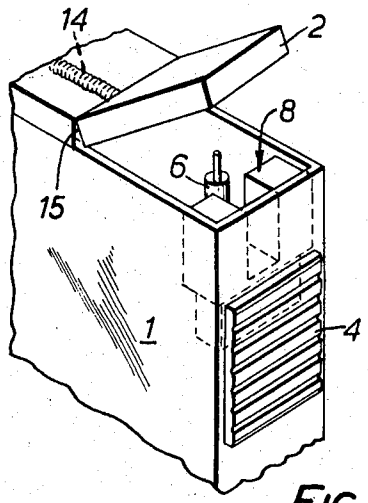


FIG. 5.

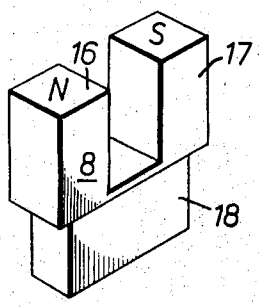
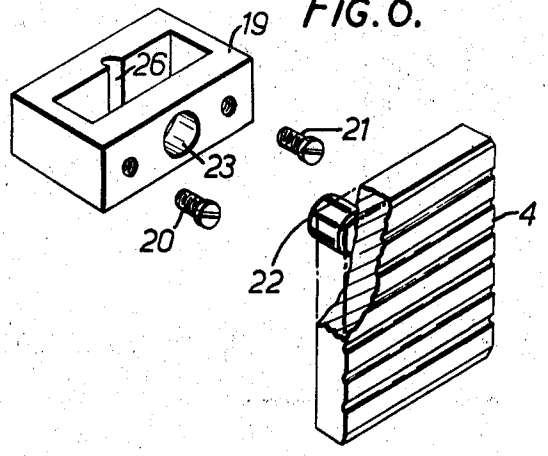


FIG. 6.



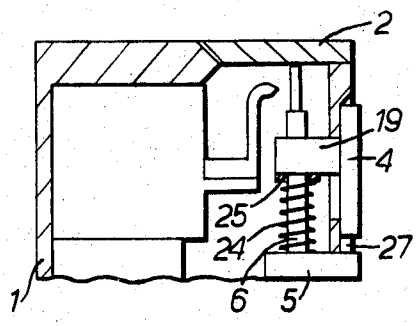


FIG. 7.

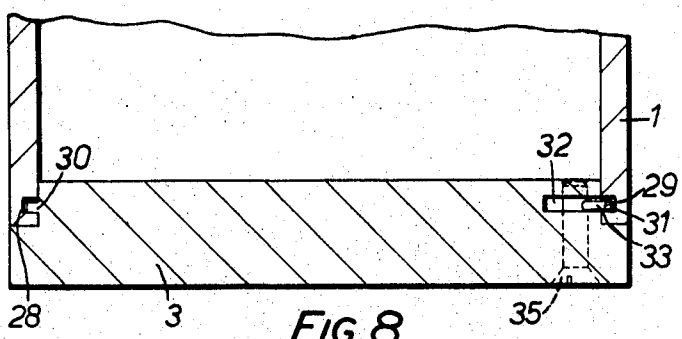


FIG. 8.

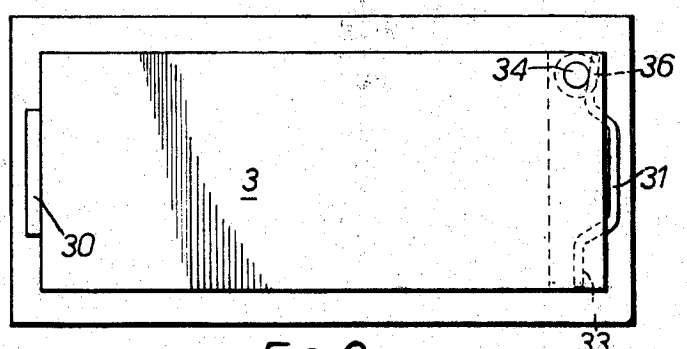


FIG. 9.

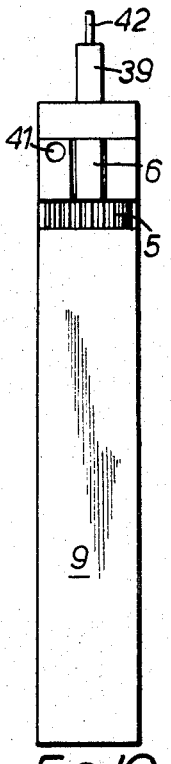


FIG. 10.

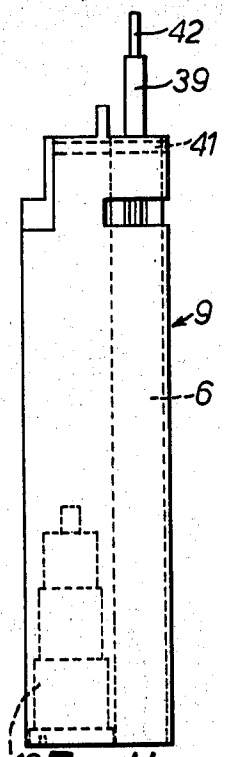


FIG 11

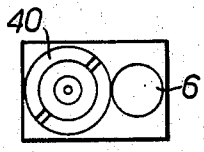


FIG. 12.

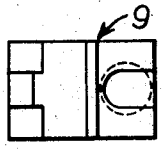


FIG. 13.

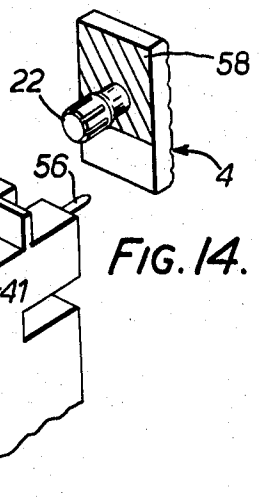


FIG. 14.

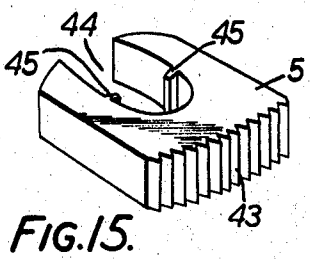
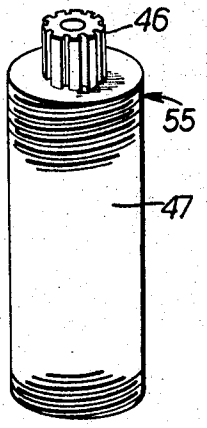


FIG. 15.



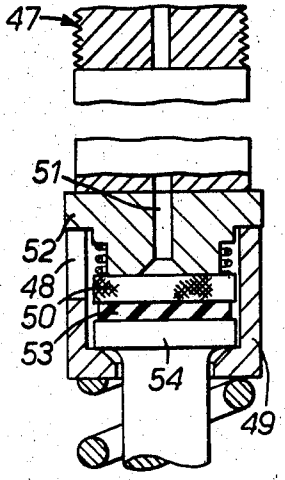


FIG. 16.

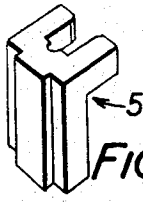


FIG. 17.

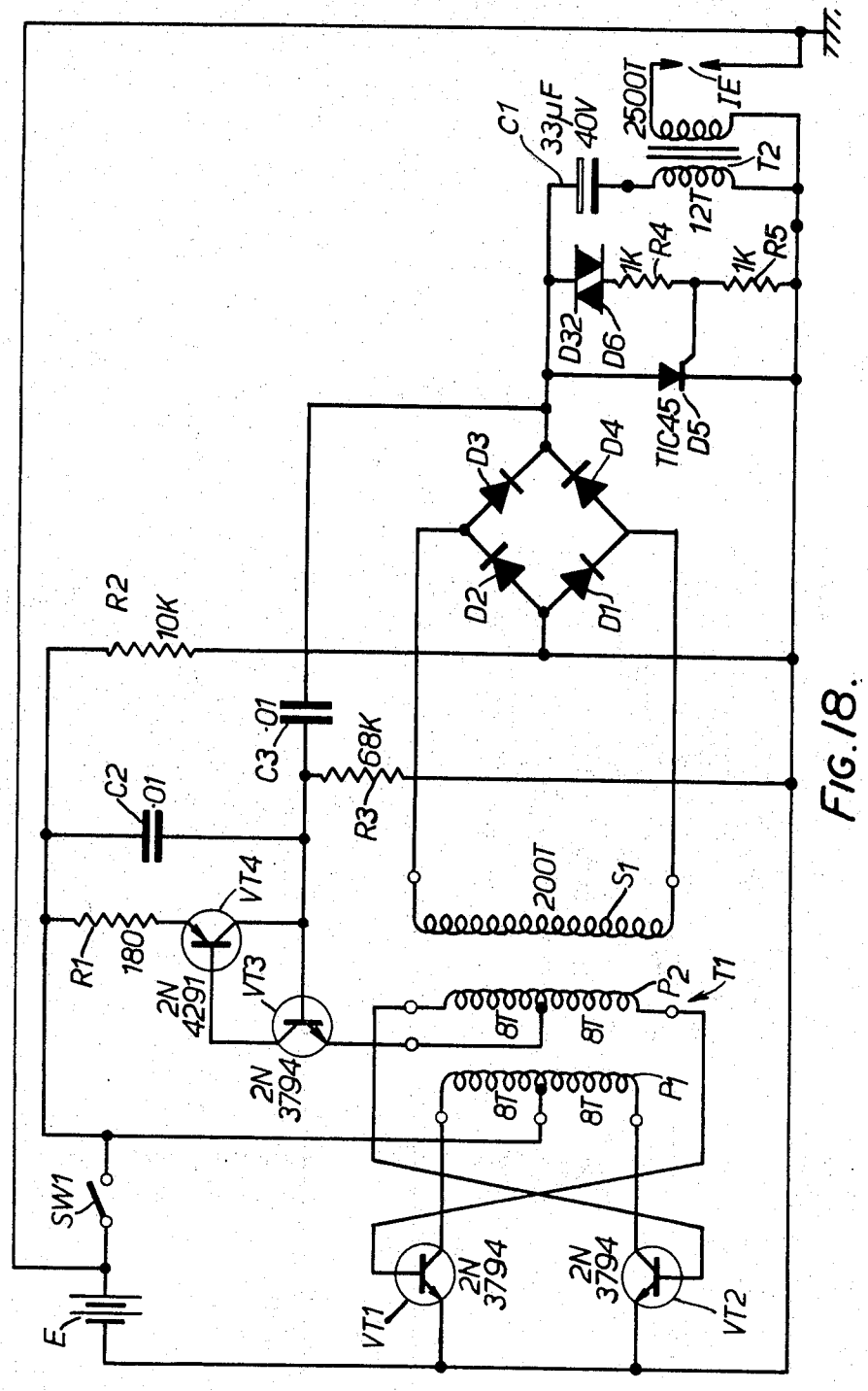

C1
33μF
40V
2500T
1E
T2
12T
R4
1K
R5
1K
D32
D6
TIC45
D5
D3
D4
D2
D1
R2
10K
C3
.01
68K
R3
C2
.01
VT4
R1
180
2N
4291
VT3
2N
3794
200T
S1
P2
T1
8T
8T
8T
8T
P1
SW1
E
VT1
2N
3794
2N
3794
VT2

FIG. 18.

LIGHTER WITH A CAPACITOR DISCHARGE IGNITION SYSTEM

This invention relates to electric lighters of the type having an internal fuel reservoir and primarily intended for lighting such items as cigars, cigarettes and pipes. Such a lighter will be termed herein a "smoker's lighter."

It is known to use an electric spark discharge to ignite the fuel of a butane gas smoker's lighter and arrangements are known in which a capacitor is discharged into the primary winding of a step-up pulse transformer to provide the necessary high voltage for spark generation. In order to obtain a rapid discharge of the capacitor it has been proposed to employ a transistor as an electronic switch but difficulties have remained in the known lighters in relation to the charging of the capacitor before ignition. The usual method of charging the capacitor is by use of a battery contained within the body of the lighter, but such batteries have significant internal resistance, particularly in pocket lighters where the battery must be small. Furthermore as the battery ages with use its internal resistance rises. It will be appreciated that the internal resistance of the battery limits the rate at which the capacitor can be charged. It is very desirable to charge the capacitor rapidly since the charging time will impose a minimum time limit between consecutive successful operations of the lighter. Further, if charging of the capacitor does not commence until the user begins to operate the lighter sufficient delay must be provided to allow the capacitor to charge fully before ignition. Such delays and failures to operate successfully can be very vexing to the user. Some prior art lighters have employed circuits in which the capacitor is connected in the battery circuit even when the lighter is not in use. However, any leakage current taken by the capacitor imposes a steady drain on the battery and shortens its life. High quality (for example, tantalum electrolytic) capacitors may be chosen to minimise leakage but such components are relatively expensive. While such permanent connection of the battery does obviate delay on first operation after a period of non-use it does not improve the minimum time between consecutive successful operations of the lighter. It has also been proposed to employ a separate switch in table lighters so that the capacitor is only connected in circuit when the lighter is lifted from the surface on which it is standing. While this arrangement improves battery life again it does not improve the performance of the lighter in respect of repeated consecutive operations.

It is an object of the invention to provide an improved smoker's lighter with electric ignition.

The present invention provides a smoker's lighter having an electric ignition system for operation from one or more electric cells and including a capacitor to store energy for the production of a fuel igniting spark, the ignition system being characterised by the provision of means to change the level of voltage supplied, during use, by the cell or cells to a substantially higher level for charging the capacitor.

The means to change the level of voltage can comprise inverter means (that is, a direct voltage to alternating voltage converter) connected to rectifier means.

The inverter means can comprise a multivibrator oscillator connected to a step-up transformer. The output of the transformer can be connected to a full-wave rctifier. A thyristor can be provided to discharge the capacitor into a pulse transformer when a predetermined voltage across the capacitor is reached.

In a smoker's pocket-lighter embodying the invention it is preferred that the inverter, capacitor and a pulse transformer shall be arranged in tandem fashion along the length of the lighter. It is also preferred that the lighter shall include a fuel tank for butane gas fuel moulded to correspond to the contours of adjacent components.

The invention can equally well be embodied in a table lighter, in which case the greater available space compared with a pocket lighter allows the use of larger electric cells and greater fuel capacity. A more squat arrangement of internal parts than in a pocket lighter can prove desirable in a table lighter.

It is to be understood that the term "smoker's lighter" is intended to embrace an assembly of lighter parts for insertion in an outer casing or sheath.

By way of example only, a preferred embodiment of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 shows an isometric view of a pocket smoker's lighter embodying the invention,

FIG. 2 is a part sectional view illustrating the internal arrangement of parts of the lighter with certain parts omitted for clarity,

FIG. 3 shows an isometric view of potted electronic circuitry employed in the lighter and cells used for powering the lighter,

FIGS. 4*a*, *b* and *c* show the arrangement of components in the potted electronic circuitry,

FIG. 5 is a diagrammatic isometric view of a lid catch for the lighter,

FIG. 6 is an "exploded" view of some of the component parts of the lid catch

FIG. 7 corresponds generally to FIG. 2 but shows different details of construction,

FIGS. 8 and 9 show to an enlarged scale details of construction of a base plate used in the lighter, FIG. 8 being a sectional view and FIG. 9 a plan view,

FIG. 10 illustrates the fuel tank and burner assembly of the lighter,

FIG. 11 shows a side elevation of the fuel tank,

FIG. 12 shows a view from beneath of the fuel tank,

FIG. 13 shows a plan view of the fuel tank,

FIG. 14 shows an "exploded" isometric view of the top of the fuel tank and part of a switch mechanism,

FIG. 15 shows an "exploded" isometric view of flame regulation components,

FIG. 16 shows a partly sectional view of flame regulation components,

FIG. 17 shows an insulator used in the lighter and

FIG. 18 shows the electronic circuit of the lighter.

It should be noted that the Figures are not all to the same scale and that in the interests of clarity parts may be omitted or simplified.

Referring to FIG. 1, the butane gas smoker's lighter there shown comprises a hollow rectangular casing 1 having a sprung lid 2 and base plate 3, a slide switch 4, a flame adjustment wheel 5, a burner assembly 6 (only a part of which can be seen in FIG. 1) and an ignition electrode 7. When the lighter is not in use the sprung lid 2 is retained closed by a magnet 8. As will be appreciated the external parts of the lighter are desirably given a high quality ornamental finish to appeal to the eye. In particular the casing 1 and base plate 3 can be

made of, or plated with, a precious metal. The lid **2** is required to be in part at least of a ferromagnetic material so as to be attracted by the magnet **8** but can of course be plated with a precious metal.

Assuming the lid **2** to be closed, the lighter is operated by depressing the slide switch **4** towards the base of the lighter whereupon the lid **2** flies open, an electrical contact is made within the lighter and a valve in the burner assembly **6** opens to allow gas to exit for ignition. The slide switch is maintained in a depressed condition and after a very short period of time (scarcely perceptible to the user) a spark is generated at the ignition electrode **7** and the gas ignites. The flow of gas is pre-set to some convenient level by means of the flow adjustment wheel **5.** Pipe smokers will generally use a higher flow rate setting than cigarette smokers. After use of the lighter the sprung lid **2** is manually closed and the magnet **8** retains the lid closed until the next occasion on which the slide switch **4** is operated. Closure of the lid **2** stops the flow of gas through the burner assembly **6.**

Now that a general description of the lighter has been given its component parts will be described in detail. For this purpose the description can be dealt with under several separate headings, viz. general internal layout; lid catch; fuel tank; base-plate; gas control mechanism; electronic circuitry and mechanical aspects of the electronic circuitry.

GENERAL INTERNAL LAYOUT

FIG. **2** show most the major internal component parts of the lighter although certain parts are omitted for clarity of illustration. Most of the internal space is taken up by a gas tank **9** and electronic circuitry **10** plotted in an epoxy resin or other suitable material. The electronic circuitry **10** is connected to a switch contact wire **11** and to a transformer **12** (T2 in the circuit diagram). The electronics circuitry **10** is potted so as to be in the shape of a rectangular box with a "step" therein as can be seen in FIG. **3.** The "step" is used to accommodate two electric cells **13** which are held in a plastics material tray (not shown) including means for making connection to the cells. The cells are connected in series and the positive pole of the series connected cells is connected to the casing **1.**

The arrangement of parts within the potted circui-try **10** is shown in FIGS. **4***a*, *b* and *c*. FIG. **4**a shows the component layout with a direction of view corresponding to that of FIG. **2.** FIG. **4***b* and **4***c* shows views at right angles to the direction of view of FIG. **4***a*, FIG. **4***b* being a side view and FIG. **4***c* an end view. The component reference numbers are the same as those used in the circuit diagram FIG. **18.** The layout shown in FIGS. **4***a*, *b* and *c* is thus considered to be self-explanatory.

LID CATCH

FIG. **5** shows a diagrammatic view of the lid catch. A compression spring **14** shown in broken outline is provided to urge the lid **2** open, the lid being provided with a hinge (not shown) at **15.** As may best be seen in FIG. **6,** the magnet **8** is generally 'U' shaped with a north pole piece **16** and a south pole piece **17** and has a base portion **18** which is received in a rectangular yoke **19.** Screws **20** and **21** are provided to bear upon and so retain the magnet **8** in the yoke **19.** The slide switch **4** is attached to the yoke **19** by means of a push-fit location lug **22** received in a hole **23** in the yoke **19.**

FIG. **7** shows the mechanical arrangements for biassing the slide switch **4** in its UP position (it should be noted that the magnet **8** is omitted from FIG. **7**). A helical compression spring **24** disposed coaxially about a tube **39** forming part of the burner assembly **6** acts at its lower end against a washer **25** positioned directly beneath the yoke **19.** The yoke **19** is shaped at **26** so as to conform to the shape of the tube **39** against which it lies so that the yoke can slide vertically. It will be seen that the casing **1** is recessed at **27** to provide a sliding surface for the slide switch **4.** When the slide switch **4** is in its UP position and the lid **2** is closed the poles of the magnet **8** are in contact with the under surface of the lid. The lid **2** which (as previously explained) is at least in part of ferromagnetic material is retained closed against the action of the spring **14** by the force of magnetic attraction. When the slide switch **4** is depressed the poles of the magnet **8** are moved away from the lid and the force of the spring **14** becomes more powerful than the magnetic attraction and the lid springs open to assume a vertical position. The return of the lid **2** to its closed position is achieved manually.

FUEL TANK

Details of the fuel tank **9** are shown in FIGS. **10** to **14.** The fuel tank is moulded from a plastics material such as that known as 'DELRIN' (registered Trade Mark). The burner assembly **6** and filler valve **40** are moulded during manufacture of the tank into the positions shown. Burner tubes and filler valves are components quite familiar to those skilled in the art of making smoker's lighters and hence a detailed description is not necessary here. The burner assembly **6** is preferably of the type described in British Patent No. 822,374 or No. 828,813 and the filler valve can, for example, be of the type described in British Patent Specification No. 784,357 or No. 966,967.

The fuel tank **9** includes a hole **41** for reception of switch components as will be further described later. Typically the wall thickness of the tank will be 0.04 inches.

BASE-PLATE

Details of the base-plate **3** and the means by which it is retained in position are shown in FIGS. **8** and **9.** Referring to FIG. **8,** the lower end of the casing **1** is provided with recessed portions **28** and **29.** The base-plate **3** is provided with a projection **30** for entry into the recessed portion **30** and a retractible projection **31** for entry into the recessed portion **29.** The base plate **3** has a groove **32** formed therein which acts as a mounting for the retractible projection **31.** The retractible projection **31** consists of a short length of springy wire of slightly smaller diameter than the width of the groove **32.** The shape of the wire could generally be described as a flattened "Ω." One end, **33,** of the wire is secured in the groove **32** by stamping the upper wall of the groove at that point to bend the upper wall towards the lower wall to trap the wire in position. A threaded screw hole **34** is provided in the base-plate **3** to receive a retaining screw **35** (shown in broken outline). When the screw **35** is removed from its hole the natural springiness of the wire causes its end **36** (shown in broken outline) to move into a position a little to the right (as shown) of the position normally occupied by the central axis of the screw **35** so that the projection **31** is retracted to allow the base-plate **3** to be removed from

the casing 1 for cell replacement and refuelling. When (with the base-plate 3 in position) the screw 36 is inserted the point of the screw (which is suitably shaped) displaces the end 36 of the wire so that the projection 31 is thrust outwards into the recessed portion 29 so retaining the base-plate 3 in the casing 1.

It will be understood that other types of base-plate can be used. For example, a base-plate which requires to be slid sideways against spring pressure to disengage a projection from a recess can be used. Alternatively a "snap-in" type base-plate can be used. If desired a hole and dust cap, corresponding in position to the filler valve, can be provided in the base-plate so that the lighter can be refuelled without removing the base-plate.

GAS CONTROL MECHANISM

Gas control mechanisms for smokers' lighters are well known to those skilled in the art and therefore a lengthy description is not necessary here. As previously stated, the burner assembly 6 is preferably of the type described in British Patent No. 822,374 or No. 828,813. FIG. 10 shows a view of the fuel tank 9, flame adjustment wheel 5 and burner assembly 6 with other components omitted. The burner assembly 6 comprises a central spring mounted rod 42 fitted coaxially within the tube 39. The rod 42 is able to move longitudinally against the action of the spring (not shown) which urges the rod 42 upwards (as seen in the drawing). The rod 42 is connected to a valve (not shown) which allows gas from the fuel tank to exit through the tube 39 when the rod is in its "UP" position. The top end of the rod is arranged to act against the lid 2 of the lighter. When the lid 2 is closed the rod 42 is depressed against the action of the spring and the valve (not shown) is closed. When the lid is open the rod 42 moves upwards, the valve opens and gas flows out of the fuel tank 9. Closure of the lid once more depresses the rod against its spring and shuts off the gas. By this means, opening and closure of the lid 2 of the lighter is made to provide a simple but effective on/off control over the flow of gas.

The component parts of the lighter used for flame regulation are shown in FIGS. 15 and 16 (FIG. 16 being to a larger scale than FIG. 15) with other parts omitted. Flame regulation in smokers' lighters is within the knowledge of those skilled in the art so that a simple description here will suffice.

The flame adjustment wheel 5 is of a resilient plastics material and has a knurled front 43 for operation by the user and a hole 44 with projections 45 arranged to push onto and mate with a splined shaft 46 on an screw member 47. Gas from the fuel tank 9 exists to the tube 39 by way of a slot 48 in a housing 49, thence through a wick 50 and a central passage 51 in a compression member 52, and thence by way of the gas on/off valve (not shown) to the tube 39. The wick 50 lies between the compression member 52 and a seating comprising a rubber pad 53 and a lower compression member 54. The screw member 47 has an external thread 55 arranged to mate with a corresponding thread in the part (not shown) in which it is fitted. Thus operation of the flame adjustment wheel 5 causes axial movement of the screw member 47 so that the wick 50 is compressed to a greater or lesser degree according to the sense of movement of the flame adjustment wheel 5. As will readily be understood, the wick 50 in a highly compressed condition will resist the passage of gas therethrough to a greater extent than when the wick is less compressed and control over the rate of flow of gas is thus achieved.

ELECTRONIC CIRCUITRY

Referring to FIG. 18, a battery E is connected to supply the ignition system of the lighter which comprises an ignition switch SW1; an inverter constituted by transistors VT1 and VT2, and a transformer T_1; an inverter control circuit constituted by transistors VT3 and VT4; resistors R_1, R_2, R_3 and capacitors C_2 and C_3; a full-wave bridge rectifier constituted by diodes D_1, D_2, D_3 and D_4; a triggering circuit constituted by triggering diode D_6 and resistors R_4 and R_6;and a discharge circuit constituted by a capacitor C_1, a step-up transformer T_2, a thyristor D_5, and ignition electrodes IE. As will be explained in more detail later, operation of the switch SW1 causes the production of an electric spark at the ignition electrodes IE to ignite the fuel of the lighter. Examples of suitable types and values of components for the circuit are set out in the table below.

Component	Type or Value
E	Two mercury cells each type MP625H
VT1, VT2, VT3	each 2N3794
VT4	2N4291
R_1	180 Ω ± 5% 0.1W
R_2	10k Ω ± 5% 0.1W
R_3	68k Ω ± 5% 0.1W
R_4, R_5	each 1kΩ±5% 0.1W
C_1	33μF 40V electrolytic
C_2, C_3	each 0.01μF 30V
D_1, D_2, D_3, D_4	each IN4148
D_5	TIC45
D_6	D32
T_1	first primary P_1 16 turns centre-tapped second primary P_2 16 turns centre-tapped secondary S_2 200 turns on an 8 mm diameter toroidal ferritecove
T_2	primary 12 turns secondary 2500 turns
SW1	normally open single pole switch

Transformer T_2 is preferably of the type described in British Patent Application No. 5981/72 entitled "Formers for Inductive Devices and Devices and Apparatus Employing Same."

The inverter is designed to have a high efficiency so that the time taken to charge the capacitor C_1 can be kept low. In this respect, silicon transistors selected for low collector-emitter saturation voltage at the operating currents involved are employed in conjunction with a toroidal ferrite transformer. The bridge rectifier diodes are high frequency types also chosen to maintain high efficiency. In this respect a full-wave rectifier arrangement is preferred to a half wave arrangement.

The collectors of transistors VT1 and VT2 are connected to respective ends of the primary winding P_1 of transformer T_1 and their emitters are connected in common to the negative pole of battery E. The bases of transistors VT1 and VT2 are connected to respective ends of the primary winding P_2 of transformer T_1. As will be explained in more detail later, transistors VT3 and VT4 are connected to control the base current to transistors VT1 and VT2 and so control operation of the inverter. The inverter functions in a known manner as a multivibrator square-wave oscillator with transformer coupling to provide the necessary feedback.

The secondary winding of transformer T_1 has one end connected to the cathode of diode D_1 and the anode of diode D_4 and its other end connected to the cathode of diode D_2 and the anode of diode D_3. The anodes of diodes D_1 and D_2 are connected in common to the negative pole of the battery E. The cathode of diodes D_3 and D_4 are connected in common to one end of trigger diode D_6 whose other end is connected to one end of resistor R_4 whose other end is connected through resistor R_5 to the negative pole of the battery E. Thyristor D_5 has its anode connected to the cathodes of diodes D_3 and D_4 and its cathode connected to the negative pole of the battery E. The trigger electrode of thyristor D_5 is connected to the junction of resistors R_4 and R_5. The full-wave rectified output of transformer T_1 thus appears across thyristor D_5.

Components VT3, VT4, R_1, R_2, R_3, C_2 and C_3 constitute the inverter control circuit. The emitter of transistor VT3 is connected to the centre-tap of primary-winding P_2 of transformer T_1 and its collector is connected to the base of transistor VT4. The collector of transistor VT4 is connected in common to the base of transistor VT3, one end of capacitor C_2, one end of capacitor C_3 and one end of resistor R_3. The emitter of transistor VT4 is connected to one end of resistor R_1 the other end of which is connected to the end of capacitor C_2 remote from the base of transistor VT3. The end of resistor R_3 remote from the base of transistor VT3 is connected to the negative pole of the battery E. Resistor R_2 is connected from the junction of resistor R_1 and capacitor C_2 to the negative pole of battery E. The common ends of resistors R_1 and R_2 and capacitor C_2 are connected to the centre-tap of primary winding P_1 of transformer T_1 and to the pole of switch SW1 remote from the battery E. The end of capacitor C_3 remote from transistor VT3 is connected to the positive output (cathodes D_3 and D_4) of the bridge circuit constituted by diodes D_1, D_2, D_3, D_4.

The positive pole of electrolytic capacitor C_1 is connected to the cathodes of diodes D_3 and D_4 and its negative pole is connected to one end of the primary winding of transformer T_2. The other end of the primary winding is connected to the negative pole of the battery E. One end of the secondary winding of transformer T_2 is connected to the negative pole of the battery E. The other end of the secondary winding of transformer T_2 is connected to the ignition electrode 7. The other ignition electrode is constituted by the rod 42 which is connected to the positive pole of the battery E. The positive pole of battery E is connected to the casing 1.

On closure of the switch SW1 the positive pole of the battery E is connected to the top end (as shown) of capacitor C_2 and a positive going waveform consequently appears at the base of transistor VT3. The emitter of transistor VT3 is connected to the negative pole of the battery E by way of the centre-tap of the primary winding P_2 so that the said positive going waveform tends to turn transistor VT3 ON. As a result collector current for transistor VT3 is drawn from the base of transistor VT4 which tends to turn VT4 ON. Collector current from transistor VT4 feeds the base of transistor VT3 which in turn draws more current from the base of transistor VT4. Thus, transistors VT3 and VT4 form a complementary pair switch and closure of switch SW1 results in both of transistors VT3 and VT4 turning ON.

Transistor VT3 feeds base current to transistors VT1 and VT2 of the inverter which oscillates and continues oscillating so long as the switch SW1 is closed to supply collector current and so long as transistor VT3 supplies base current to the transistors of the inverter.

When the inverter is functioning a square-wave output appears at the secondary winding S_1 of transformer T_1 of approximately 70V peak to peak amplitude at a frequency of approximately 40kHz. The output of the circuit will, of course, be somewhat less if the battery has deteriorated through age or use. The inverter and rectifier change the battery voltage from a level of a few volts to a level considerably greater.

The full-wave rectified output of the secondary winding S_1 charged capacitor C_1 through the primary winding of transformer T_2. Trigger diode D_6 remains non-conducting until its breakdown voltage is reached and so long as the voltage across trigger diode D_6 is less than the breakdown voltage the voltage drop across resistors R_4 and R_5 is effectively zero. A point is soon reached as capacitor C_1 charges when the voltage across trigger diode D_6 is equal to its breakdown voltage, whereupon the diode D_6 conducts and a signal appears at the junction of resistors R_4 and R_5 which triggers the thyristor D_5 into a state of conduction. Capacitor C_1 now rapidly discharges through the primary winding of transformer T_2 and thyristor D_5 (which, of course, remains conducting until the current through it becomes equal to zero) and as a result a very high voltage (about 7kV) is induced in the secondary winding of transformer T_2. The high secondary voltage causes a fuel-igniting spark to occur between the ignition electrodes IE.

The energy required to ignite the butane gas of the lighter is approximately $2mJ$ and in the present circuit at least $15mJ$ would be stored in capacitor C_1. While the energy available in the spark depends upon the efficiency of the transformer T_2 this value of stored energy in capacitor C_1 more than compensates for expected losses in transformer T_2.

The use of trigger diode D_6 and thyristor D_5 allows a high charging rate of capacitor C_1 to be employed since the open circuit output voltage of the inverter and rectifier can be made significantly greater than the maximum working voltage of the capacitor C_1. This fact is advantageous because the size of capacitors of a given value increases with their rated working voltage.

The discharge of capacitor C_1 also results in a negative going spike being applied through capacitor C_3 to the base of transistor VT3. This negative going spike causes both transistors VT3 and VT4 of the inverter control circuit to turn OFF. As a result the flow of base current to the transistors of the inverter ceases and the inverter stops oscillating. The negative going spike will charge capacitor C_2 in such a manner as to maintain the transistors VT3 and VT4 OFF. This charge decays through the resistances associated with capacitor C_2 but the transistors VT3 and VT4 remain OFF until a positive going waveform is again applied at the base of transistor VT3 by a further actuation of the switch SW1.

It will be appreciated that to obtain the spark discharge the user must continue to operate the switch SW1 for the multivibrator to function sufficiently long for the voltage on capacitor C_1 to be built up. Once capacitor C_1 has discharged it will be observed that the inverter is turned off. Thus, for a single actuation of the switch the inverter runs for a sufficient time to produce

the spark, after which it remains off irrespective of whether or not the user keeps the switch depressed.

The switch action does not need to be mechanically timed — providing the contact is made the inverter will run only for the time necessary to charge the capacitor with sufficient energy to create one ignition spark. This means that no energy is wasted after the capacitor is fully charged (a fixed time charging system would have to allow sufficient time for a partially used battery to charge the capacitor, which would thus be more than necessary for a fresh battery). The time (normally scarcely perceptible to the user) required for the capacitor to charge and a spark to be produced will increase as the battery ages and can serve as a useful indication of the necessity to renew the battery. Nevertheless, the ignition system should continue to operate even with fairly extended charging times.

MECHANICAL ASPECTS OF THE ELECTRONIC CIRCUITRY

The mechanical details of the switch SW1 are illustrated in FIG. 2 and **14.** A helical compression spring (not shown) is located in the hole **41** (FIG. **14,**) so as to act against the switch contact wire **11** (FIG. **2**). A contact pin **56** is inserted in the end of the hole **41** remote from the contact wire **11** and is biased by the spring into contact with the internal face of the slide switch **4.** The slide switch **4** is made of an insulating material with a fluted front face and an area **58** of conducting material on its inside face. The conducting area **58** is connected to the positive pole of the battery through the casing **1** (the area **58** slides against the casing **1**). When the slide switch **4** is in its UP position the contact pin touches the insulated part of the slide switch **4,** but when the switch **4** is depressed the pin **56** comes into contact with the area **58** and connection is made through the spring in hole **41** to contact wire **11** which in turn is connected to the electronic components.

The high voltage parts of the circuit need careful insulation to ensure that unwanted discharges do not occur. The shaping of the insulation about the ignition electrode **7** can be seen in the Figures. A shield **57** (FIGS. **1** and **17**) of a ceramic or other heat resistant insulating material is placed about ignition electrode **7** to help avoid such unwanted discharges. The burner assembly **6** is connected to the positive pole of the battery E through the yoke **19** (which is of metal) and the casing **1.**

It will be appreciated that the described embodiment has many advantages over prior art lighters. The provision of the inverter and rectifier to change the level of voltage supplied by the battery to a higher level enables a smaller capacitor to be employed for the storage of a given amount of energy than if the capacitor has been charged by the battery alone. This provides an advantageous economy in the space required within the lighter for the electrical components (the height of the lighter shown in FIG. **1** can be as little as 7 cms). Further, low voltage cells are employed which are relatively cheap and easily obtainable. The use of the inverter also provides a rapid means for charging the capacitor which is desirable in respect of repeated operation of the lighter and further no load is imposed on the cells during a period of non-use. The use of the trigger diode is particularly advantageous in respect of the speed of charging the capacitor and the use of the thyristor ensures a rapid discharge of the capacitor without any problems of the 'contact bounce' type (a thyristor, once triggered, remains conducting until the voltage across it drops to zero).

Other forms and modifications are possible within the scope of the invention. For example, the invention can be embodied in a table lighter. In a table lighter a more squat arrangement of components would generally be desirable. The thyristor can if desired be replaced by a mechanical switch contact and the trigger diode can be omitted, but the use of the components shown to provide automatic ignition is preferred. Transistors of the opposite conductivity types to those shown can be employed and other inverter arrangements are possible. For example, an oscillator employing a single transistor could be used. The inverter could employ a piezo-electric solid-state transformer. It is also contemplated that a voltage multiplier of the diode voltage-doubler type could be used. At least some of the electrical components of the lighter could be made in integrated circuit form. One or more rechargeable cells could be used to power the lighter. It is not essential for the electronic components to be potted as described.

I claim:

1. A smoker's lighter comprising:
- a housing,
- a fuel tank mounted within the housing,
- a burner assembly mounted within the housing and connected to said fuel tank, and
- an electric ignition circuit mounted within the housing, said ignition circuit comprising:
- cell connection means for making connection to at least one electric cell,
- d.c. voltage step-up means having its input connected to said cell connection means,
- a capacitor to store energy for the production of a fuel igniting spark connected to the output of said voltage step-up means,
- said voltage step-up means being operative to change the level of d.c. voltage supplied, during use, by said at least one cell to a substantially higher level for charging the capacitor,
- a manually operable switch electrically connected in said ignition circuit to actuate said ignition circuit,
- capacitor discharge means having its input connected to said capacitor, and
- spark electrode means connected to the output of said capacitor discharge means and co-operating with said burner assembly to ignite fuel therefrom.

2. A lighter as claimed in claim **1,** wherein the voltage step-up means to change the level of voltage comprises inverter means connected to rectifier means.

3. A lighter as claimed in claim **2** wherein the inverter means comprises oscillator means connected to step-up transformer means.

4. A lighter as claimed in claim **3** wherein the oscillator means comprises a multivibrator oscillator.

5. A lighter as claimed in claim **3** wherein the output of the step-up transformer means is connected to full-wave rectifier means.

6. A lighter as claimed in claim **1,** wherein said capacitor discharge means comprises:
- a thyristor, and
- a pulse transformer, said thyristor being connected to the capacitor and the pulse transformer and being operative to discharge said capacitor into said

pulse transformer, the output of said pulse transformer being connected to said spark electrode means.

7. A lighter as claimed in claim 6, further including trigger means connected to the thyristor and operative to trigger the thyristor into conduction when a predetermined voltage is reached across the capacitor.

8. A smoker's lighter comprising:

a housing

a fuel tank mounted within the housing,

a burner assembly mounted within the housing and connected to said fuel tank, and

an electric ignition circuit mounted within the housing, said ignition circuit comprising:

cell connection means for making connection to at least one electric cell,

d.c. voltage step-up means to change the level of d.c. voltage supplied by the said at least one cell to a substantially higher level,

manually operable switch means to actuate said ignition circuit connected from the cell connection means to the voltage step-up means,

a capacitor connected to the output of the voltage step-up means to store energy for the production of a fuel igniting spark,

capacitor discharge means having its input connected to said capacitor,

pulse transformer means connected to the output of said capacitor discharge means, and discharge means connected from the capacitor to the pulse transformer means for discharging the capacitor through the pulse transformer means, and

spark electrode means connected to the output of said capacitor discharge means and co-operating with said burner assembly to ignite fuel therefrom.

9. A smoker's lighter comprising:

a housing,

a fuel tank mounted within the housing,

a burner assembly mounted within the housing and connected to said fuel tank, and

an electric ignition circuit mounted within the housing, said ignition circuit comprising:

cell connection means for making connection to at least one electric cell,

transistor oscillator means,

step-up transformer means, the output of said transistor oscillator means being connected to the input of said step-up transformer means,

manually operable switch means to actuate said ignition circuit connected from the cell connection means to the transistor oscillator means,

rectifier means connected to the output of the step-up transformer means,

capacitor means connected to the output of the rectifier means to store energy for the production of a fuel igniting spark,

thyristor means connected to said capacitor means,

pulse transformer means connected to said thyristor means for discharging the capacitor through the pulse transformer means, and

spark electrode means connected to the output of said pulse transformer means and co-operating with said burner assembly to ignite fuel therefrom.

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