

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN LIGHTERS

(71) We, ROWENTA-WERKE GmbH, a limited liability company organized under German Law, of 232-256 Waldstrasse, 605 Offenbach a.m., Germany, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to an electrically-ignited gas lighter for example for lighting cigarettes or the like.

In hitherto known lighters of the kind having a gas tank the supply of gas wherefrom is controlled by a valve operatively connected with a switch in the electrical gas-ignition circuit, gas ignition was obtained in various ways. For example, lighters are known which have galvanic cells connected to a capacitor which discharges via the primary winding of an ignition voltage transformer, to the secondary winding of which are connected the ignition electrodes. Disadvantageous in that case is the fact that the galvanic cells, mainly due to their varying qualities, do not have a sufficiently long storage life and have to be replaced frequently. In addition their capacity is low. In order for them to be adequate for a large number of gas ignitions, the lighter would have to contain galvanic cells of ridiculously large dimensions.

Lighters are also known which employ accumulators (i.e. rechargeable batteries) as the ignition energy source. The accumulators must be frequently recharged which requires the provision of an additional charging device either incorporated into the lighter or separate therefrom. In any case, the recharging is a nuisance for the user.

Other known lighters operate with electro-magnetic energy transformers. These magnetic ignition systems, although in-

dependent of galvanic cells or accumulators and their charging devices, require high actuating forces and consequently require a not inconsiderable expenditure for apparatus to bring these forces into action within the limited space of a lighter.

Recently also piezoelectric elements have been used to produce the ignition energy. This indeed obviates the galvanic cells or accumulators with charging devices, but the user has to develop considerable forces. In addition the operation of this lighter is noisy.

The object of this invention is therefore to provide a gas lighter with electrical gas ignition which, on the one hand, is independent of both galvanic cells which must be constantly replaced as well as accumulators which have to be periodically charged by special separate charging devices, and on the other hand, only requires slight actuating forces which can easily be developed in a lighter.

According to this invention, there is provided an electrically ignited gas lighter comprising a casing, one or more photoelectric cells mounted in or on said casing for the reception of light, a mounting for one or more accumulator cells for connection to said photoelectric cells to be charged thereby during illumination thereof, and an ignition circuit including a switch coupled to a gas-releasing valve and a voltage^o-increasing circuit adapted on operation of said switch to generate from said accumulator cell(s) a discharge spark for igniting gas released by the valve.

Our experiments have shown that the energy requirement for the ignition of a gas lighter, particularly a high voltage ignition, is only a few millijoules and that it is possible particularly with table lighters which are relatively large, to provide this by means of photoelectric cells.

For increased efficiency it is preferred to

[Price 33p]

provide a matching resistance connected between the photoelectric cell(s) and the accumulator cell connections which latter may be arranged to receive one or more miniature rechargeable batteries.

In the simplest case, the matching resistance, which is required to match the internal resistance of the photoelectric cells to the resistance of the accumulator cell circuit to maximise the efficiency of the charging process, is constituted by an ohmic resistance and this is adequate in many cases. However, optimum matching of the energy store and the photoelectric cells is not obtained if such a constant resistance is employed since the lighter will generally be subject to various levels of illumination ranging between total darkness and full sunlight and the characteristics of the photoelectric cells will change accordingly. It is therefore preferred to use a variable matching resistance such as, for example, a photoconductive cell the resistance of which varies automatically with the level of incident illumination between a small value with powerful illumination and a larger value with less illumination. Table lighters are generally kept in the open and therefore, even in winter with poor illumination, are exposed to the light for several hours so that sufficient energy can be produced and stored for a sufficient period to permit ignition of the table lighter even in darkness. To prevent the energy stored in the storage device from discharging through the photoelectric cells should their output fall below the stored voltage, e.g. during darkness or sufficient illumination, the matching resistance desirably is coupled with a diode poled to block such a discharge or alternatively and advantageously a photoelectric diode is used as the matching resistance.

The voltage increasing circuit preferably includes a capacitor in a discharge path of which are connected said ignition circuit switch and the primary winding of an ignition transformer adapted to produce sufficient energy in its secondary to cause arcing across an ignition spark gap.

It can be advantageous to provide a combination of one or more accumulators and capacitors, the accumulator(s) serving as an energy collector and being connected, generally via a resistor, to the capacitor(s) which serve as an energy distributor. The resistor limits the current which can be taken from the accumulator and can advantageously be so dimensioned that the capacitor can be recharged less than one second after an ignition. The provision of the capacitor enables the ignition energy to be supplied to the ignition transformer in accurately metered quantities which cannot be varied at will be the user, e.g. by un-

necessarily prolonging the ignition period, which ensures economic energy consumption.

With constant ignition power, the capacitance of the capacitor is inversely proportional to the square of the selected voltage. When working with a low battery voltage, the currents to be switched during the capacitor discharge are therefore large. There is then a danger that the switch contacts may fuse, or alternatively the switch must be made large and provided with high contact pressure. It is therefore advantageous, to avoid the above-mentioned effects and also relative to advantageous dimensioning of the capacitor output voltage transformer, to operate the lighter with a higher voltage than that produced by the photoelectric cells. This could be achieved by series connection of numerous, and at present still relatively costly, photoelectric cells in conjunction with a corresponding series connection of accumulators, but in order to avoid the high costs for the photoelectric cells but still enable a small capacitor to be used, according to preferred embodiments of the invention, several accumulators may be used which in a non-operative condition of the lighter are connected electrically in parallel with the photoelectric cells by means of mechanical switches and are connectable prior to ignition via the switches in series in the charging circuit to the capacitor of the high voltage ignition circuit. It is advantageous to use miniature Ni-Cd accumulators in the form of so-called button cells which are small and have a long life.

Another embodiment with voltage multiplication is characterised by several accumulators which in the non-operative condition are connected in parallel with the photoelectric cells via diodes and are separated from one another by multiple switches by means of which prior to ignition they are connectable in series in the charging circuit to the capacitor of the high voltage ignition circuit.

Voltage multiplication without multiple switching is obtainable by using a plurality of series connected accumulators individually connected in parallel with the photoelectric cells by means of diodes and separated from one another by series resistors, the arrangement furthermore being such that for operation of the lighter the several series connected accumulators can be switched across the capacitor in the ignition circuit for charging the capacitor with their added voltages.

It will be appreciated that as well as the arrangements described herein, other voltage multiplication circuits not illustrated can be built up. Tests have shown that successful operation can most conveniently

be obtained with voltages of the order of three to four volts. Thus at least three Ni-Cd accumulators must be used as energy accumulators when voltage multiplication is obtained by connecting the accumulators in parallel for charging and in series for discharging.

An alternative and particularly favourable means for voltage multiplication is obtained if the photoelectric cells are connected to the energy store via a D.C. voltage conductor. In this way it is possible to use a relatively small number of presently costly photoelectric cells for converting the light into electrical energy, and also the low output voltage of the photoelectric cells can be converted with simple means, which can easily be fitted into a lighter, to the higher direct voltage necessary for charging the energy (store). The provision of a voltage converter obviates the need to connect the accumulators in parallel for charging and in series for discharging.

Advantageously the components of the D.C. converter are combined to form a unit which is e.g. encapsulated and combined with the energy store (in the form of accumulators) to form a plug-in unit. Miniature Ni-Cd accumulators (known as button cells) are light, robust, completely enclosed, positionally independent and readily obtainable. The voltage of an Ni-Cd accumulator is about 1.2 volts. It is advantageous to combine four Ni-Cd accumulators into a pile by means of which a voltage of about 4.8 volts is obtained on the primary side of the ignition circuit.

D.C. voltage converters are known per se, and as such do not form the subject of the present invention. However, a particularly convenient construction is obtained if the components of the voltage converter are combined to form a unit which is placed inside a casing which then is inserted into an outer casing for the Ni-Cd accumulators. This results in a very simple prefabricated plug-in module which, like a battery, can be accommodated in the lighter housing. Tests have shown that the components of the D.C. converter only require a space of three to four cm³. Such a construction permits rapid replacement of the D.C. converter e.g. in the event of faults, and equally easy replacement of the Ni-Cd accumulators. It is particularly advantageous for the transformer of the D.C. converter to have a cup core which has a smaller diameter than the Ni-Cd accumulators and to combine these parts to form a pile which may be housed in a cylindrical metal or plastics casing. The Ni-Cd accumulators can be placed between a spring contact in the base of the casing and a contact on the transformer core of

the D.C. converter. The photoelectric cells can also be combined in a common casing with the D.C. converter and, if desired, with the energy storage accumulators. Such an arrangement is particularly advantageous for servicing.

According to a further preferred embodiment of the invention, a D.C. converter is arranged both between the photoelectric cells and the accumulator(s) and between the latter and the ignition spark gap. In this case the provision of a rectifier diode in the high voltage circuit to prevent discharge of the energy store via the photoelectric cells becomes superfluous.

The invention proposes several ways in which the photoelectric cells can be exposed to the light in the optimum way. According to one embodiment, the lighter has a casing upon which the photoelectric cells are mounted. In another embodiment the photoelectric cells are mounted on the lighter body behind corresponding apertures in the casing. The photoconductive cell or photoelectric diode is then located beside the photoelectric cells and is also exposed to the light. It is advantageous to arrange for the photoelectric cells to receive light via optical members such as a lens system and/or light guide. By such means it is possible to position the photoelectric cells at any desired, constructionally-favourable, protected position within the lighter casing. In a preferred embodiment the optical system comprising photoelectric cells, photoconductive cell and/or photoelectric diode, and the lens system together with an insulating mounting plate is assembled as an independent complete unit.

The photoelectric cells and/or optical members may be technically so designed that at the same time they appear as decorative elements on the lighter.

Henceafter, the construction and operation of various embodiments will be explained with the aid of the accompanying drawings wherein:—

Fig. 1 shows the circuit diagram of a first embodiment having high voltage arc ignition;

Fig. 2 shows in cross section a constructional detail illustrating a particularly convenient arrangement of the photoelectric cells;

Fig. 3 shows the circuit diagram according to Fig. 1 incorporating a voltage doubler;

Fig. 4 shows a partial circuit diagram of a high voltage arc ignition system with a voltage trebler;

Fig. 5 shows a partial circuit diagram of a further embodiment of a high voltage arc ignition system with a voltage trebler;

Fig. 6 shows a schematic longitudinal

section through a table lighter having an electrical circuit as shown in Fig. 3 and provided with automatic change-over switching for voltage doubling;

5 Fig. 7 shows a schematic front view of a table lighter with photoelectric cells located on the sides of the lighter casing;

Fig. 8 shows schematically a partial cross-section of a table lighter having a different arrangement of the photoelectric cells;

Fig. 9 shows a constructional detail of an optical system;

Fig. 10 shows a front view of a table lighter incorporating an optical system as shown in Fig. 9;

Fig. 11 shows a longitudinal section through a table lighter with the casing partially removed;

Fig. 12 shows the circuit diagram of a further embodiment of the invention;

Fig. 13 shows a circuit diagram of a further embodiment of the invention;

Fig. 14 shows a constructional detail illustrating a power pack unit;

Figs. 15, 15a, and 15b show construction details;

Fig. 1 shows the circuit diagram of a table lighter with high voltage arc ignition.

30 An accumulator 1, serving as the energy storage device of the lighter, is connected in parallel with four series-connected photoelectric cells 2 which serve as an energy generator for the lighter. The number of photoelectric cells provided depends on the nature of the cells and the intensity of illumination expected under charging conditions. Fundamentally, only one photoelectric cell need be provided.

40 Between the accumulator 1 and the photoelectric cells 2 is connected a matching resistance 3 as hereinbefore explained. Optimum matching between accumulator 1 and photoelectric cells 2 is not obtainable with a constant resistance 3. Since between darkness and full sunshine every level of illumination of the photoelectric cells must be expected, it is preferred that the resistance 3 is variable. With strong illumination the matching resistance must be small, whilst with less illumination it must be high. It can therefore be advantageous to connect in series or parallel with, or instead of, the resistance 3 a photoconductive cell 4 the resistance of which reduces with increasing illumination and vice versa.

In darkness or with insufficient illumination, the photoelectric voltage can fall to below the voltage of the accumulator 1. So that this does not then cause discharge of the accumulator via the photoelectric cells 2, a diode 5 is connected to block such a discharge. It is also possible to replace the matching resistance 3, photoconductive cell

4 and diode 5 by a photoelectric diode 6 (shown in addition in Fig. 1) or to combine a photoelectric diode with the resistance 3, whereby a good matching and the desired blocking action can be achieved.

For ease of illustration in the remaining Figs., members 3, 4, 5 and 6 are indicated together only by the resistance 3.

In Fig. 1, the accumulator 1 is connected via a resistance 11 and an automatically acting switch 10 to a capacitor 12 which forms a component of a per se known high voltage arc ignition circuit for lighters. On raising the table lighter from its base 7, a switch pin 8 protrudes from the base of the lighter under the action of a spring 9 and closes the switch 10 whereupon capacitor 12 is charged via a resistance 11. Resistance 11 limits the current taken from the accumulator 1 and may be selected so that the capacitor 12 is fully charged for example in less than one second.

Switch 10 is not absolutely necessary; however, owing to their high capacitance with small size, electrolytic capacitors are preponderantly used as capacitors, and these often have high leakage currents which, without switch 10, could under certain circumstances discharge the accumulator 1.

The recharging circuit between accumulator 1 and capacitor 12 takes in the resting contact path of a change-over switch 13, the operating contact path of which controls the high voltage ignition circuit. The change-over switch 13 can be operated as desired e.g. by means of a lever 45 in order to ignite the lighter.

After change-over switching of switch 13 out of its resting state as shown and into its operating state the capacitor 12 discharges in a very short time via the primary winding 14 of an ignition transformer in whose secondary winding 15 there is thus induced a high voltage which causes an arc across a spark gap 16 located above gas outlet 17 which is connected with a gas tank 18. A valve 19 serving to start and stop the gas flow is in per se known manner coupled by means of a linkage 20 or the like with the change-over switch 13 in such a way that on changing the change-over switch 13 the valve is opened or closed. For operating the table lighter only one member namely the change-over switch 13, therefore has to be moved. For this purpose considerably less force is necessary than when operating an electromagnetic ignition voltage generator or a piezoelectric ignition device.

By virtue of the provision of the capacitor 12, the ignition energy is supplied to the ignition transformer 14, 15 in an accurately metered manner. It cannot be varied at will by the user of the table lighter

so that an economic energy consumption is ensured.

In table lighters of the type described with reference to Fig. 1, with constant ignition power the size of the capacitor 12 is inversely proportional to the square of the voltage provided by the photoelectric cells 2. It is therefore advantageous to operate with a doubled or much higher voltage. Since, however, the price of a photoelectric cell 2 is much higher than that of an accumulator 1, it is inappropriate to correspondingly increase the number of series connected photoelectric cells 2. It is more convenient, when a higher voltage is required, to employ several accumulators, 1, 1.1, 1.2, etc., which on charging, i.e. in the non-operative position of the table lighter, are in parallel with the photoelectric cells 2 and, when the table lighter is in use, are discharged in series with capacitor 12.

According to the invention such a circuit can function purely mechanically with change-over switches, switches and diodes and, without movable parts, only with diodes and resistances.

Fig. 3 shows a voltage doubling arrangement in which two accumulators 1 and 1.1 are so connected with a two-pole mechanical change-over switch 23 that, for charging, the accumulators 1 and 1.1 are in parallel with the photoelectric cells 2, and, for use of the table lighter, the change-over switch 23 must be brought into the other switching position (e.g. by pressing down a button 24) to place accumulators 1 and 1.1 in series to charge capacitor 12 with their summed voltages. As described hereinafter and shown in Fig. 6, the two-pole change-over switch 23 can, in a simple manner, be arranged to be brought into the correct switching position automatically.

In the following embodiments to be described the components of the high voltage ignition circuit to the right of actuating switch 13, i.e. the primary and secondary windings 14, 15, spark gap 16, gas outlet 17, gas tank 18, valve 19 and lever 20 although included in these embodiments are not shown as they are not important for understanding the invention and have already been explained in detail in conjunction with Fig. 1.

Fig. 4 shows a circuit in which the energy-generating photoelectric cells 2 are in operative connection with the accumulators 1, 1.1, 1.2 etc. via diodes 25 and switches 26 in order to bring about a trebling of the voltage. The switches 26 can be coupled via linkages 27 with the switch pin 8 of switch 10 so that switches 10 and 26, under the action of spring 9, automatically close on lifting the table lighter from the base 7. With switches 10 and 26 closed, accumulators 1, 1.1 and 1.2 are series con-

nected so as to charge capacitor 12 with treble the voltage developed across the photoelectric cells. The parallel connection of accumulators 1, 1.1 and 1.2 for their re-charging takes place automatically when the table lighter is put down onto base 7 which operates switch pin 8 to open the switches 10 and 26.

Fig. 5 shows a circuit for trebling the operating voltage wherein only diodes 25 and resistances 28 are used, i.e. there are no movable members. As can be seen from the drawing, with switch 10 open the accumulators 1, 1.1 and 1.2 are all connected in parallel with the photoelectric cells 2, whilst with the switch 10 closed they are series connected to charge capacitor 12 with the sum of their individual voltages.

In the circuit according to Fig. 3 there is no need for the switch 10 because capacitor 12, in the non-operative position of the table lighter, is isolated by change-over switch 23 and no leakage current can flow. However, in the circuits according to Figs. 4 and 5, it is advantageous to provide the switch 10 because, without this switch, part of the energy supplied by the photoelectric cells 2 would be consumed by the leakage current of capacitor 12. With weak illumination, i.e. when the charging voltage of the photoelectric cell 2 is smaller than the accumulator voltage, accumulators 1, 1.1 and 1.2 would, with no switch 10, discharge via capacitor 12.

Figs. 3, 4 and 5 only show examples of voltage multiplication systems. With the means shown and described any other voltage multiplication circuit can be produced. When using presently available photoelectric cells, one to three accumulators 1, 1.1 and 1.2 will be sufficient.

Fig. 6 shows schematically in longitudinal section a table lighter employing the circuit of Fig. 3 and arranged for automatic voltage doubling.

The table lighter of Fig. 6, is enclosed by a housing 29 and closure member 30. To a side wall of the housing 29 there is attached an insulating plate 31 whereon are located the photoelectric cells 2. In the top of the housing 29, openings 32 and 33 are provided respectively for the actuating lever 34, which operates the change-over switch 13 and the valve 19, and for a flame outlet. The actuating lever 34 is returned by a spring 35 which always brings the lever 34, once released, into the "off" position as shown in Fig. 6. When the table lighter is not in use, the primary winding 14 is separated from capacitor 12 and the valve 19 is closed.

The two-pole change-over switch 23 is provided with a switch pin 8 which projects through an opening 36 in the closure 30 and is movable against the ac-

tion of a spring 37. If the table lighter is located on a base, then the switch pin 8 is forced upwardly by the weight of the table lighter against the action of spring 37 whereupon it switches change-over switch 23 to accumulator charge, i.e. switching accumulators 1 and 1.1 in parallel with the photoelectric cells.

As is already known with other electrically ignited table lighters, the gas valve can be locked in the open position so that the table lighter can be handed round without it being necessary to hold the operating lever 34 or 45. Release of the gas valve can be arranged to take place by means of switch pin 8 or similar means in an automatic manner when returning the table lighter to its place.

The photoelectric cells 2, photoconductive cell 4 and/or the photoelectric diode 6 must be exposed to the light and must therefore be located on the outside of housing 29 or behind apertures 44 therein. Fig. 7 shows the front view of such a table lighter, on the front of which to the left beside the operating lever 45 and on the left hand side thereof are located photoelectric cells 2 mounted on an insulating plate 31.

In another embodiment according to Fig. 8, the photoelectric cells 2 are arranged behind an aperture 44 in a wall of housing 29. For protection against contact damage, they are covered by a transparent disc 38 or by a layer of protective lacquer. The rear covering is again an insulating plate 31.

It is particularly advantageous to arrange the transparent disc 38, which serves for covering purposes, in the form of a convergent lens system. In this way it is possible in a simple and cheap manner to raise the illumination intensity at the surfaces of the photoelectric cells. Such a lens system need not be made from expensive ground glass, but instead cheap transparent thermoplastics or moulded glass can be used. Fig. 9 shows a partial cross section through a table lighter of such a construction. Behind the aperture 44 in the wall of the housing 19 is arranged the lens system 39. The photoelectric cells 2 are located in cavities. An insulating plate 31 serves for sealing purposes.

Fig. 10 shows a front view of the table lighter according to Fig. 9 and as above described.

It is of course also possible to use only a single convergent lens. The cheap manufacture of such a member is however only possible by means of moulding or injection moulding. However due to the necessary short focal length, such a lens is rather thick in the centre leading to incident points and dissymmetries. Since however in

addition the lenses can also have effects which will influence the appearance of the table lighter the multi-lens system according to Figs. 9 and 10 is preferable.

The optical system comprising photoelectric cells 2, photoconductive cell and/or photoelectric diode 6, lens system 39 and insulating plate 31 can be combined into a complete independent unit.

As already mentioned, photoelectric cells are expensive and should therefore be protected from risk of damage. One way of doing this is to locate the photoelectric cells well within the housing 29 so as to be protected thereby, and to supply the light to them via per se known but not shown light guides.

To open a table lighter according to the invention for servicing for example it must be possible to remove the housing 29 from the actual lighter body 40. If photoelectric cells are fixed in the housing 29, the connections between them and the accumulators 1, 1.1, etc., must be either in the form of flexible leads or more conveniently via automatically separating contacts.

Fig. 11 shows such an arrangement. The housing 29, which is shown in broken open form and therefore shows part of the insulating plate 31 which serves as the rear covering for the photoelectric cells, is partially removed from the lighter body 40. To the top of this body 40 are attached spring contacts 41 which, when housing 29 is pushed completely onto body 40, come into contact with the fixed contacts 42 located under the covering of housing 29 and thereby restore the electrical connection between the photoelectric cells 2 and the accumulators 1, 1.1, etc. Fixed and spring contacts can also be interchanged. An easily detachable connection can also be brought about by sliding contacts or other equivalent means.

In place of manual operation of the lever 34, it is also possible to use a small electromagnet (not shown) to operate the change over switch 13 and open valve 19. With such an arrangement the user of the table lighter would only have to operate a small contact e.g. via a push button or a handle 45. If the valve 19 was arranged to be automatically locked in the "open" position, the push button could be released immediately after ignition without the table lighter being extinguished.

Fig. 13 shows the circuit diagram of yet a further embodiment of the invention wherein the photoelectric cells 2 are connected via a d.c. voltage converter 100 to the energy accumulators 1, 1.1, 1.2, 1.3. The d.c. converter 100 converts the low output voltage of the photoelectric cells into the higher d.c. voltage necessary for

charging the accumulators 1, 1.1, 1.2, 1.3.

D. C. Voltage converters are known per se in numerous designs and circuits. They all function according to a similar principle; the d.c. voltage supplied is chopped and transformed through a transformer to a desired higher or lower voltage and subsequently rectified. According to Fig. 13 the photoelectric cells 2 are connected via input terminals 101, 102 to the d.c. converter 100 comprising two capacitors 105, 106, a resistance 107, a transistor 108, and a transformer 109, having primary winding 110, secondary winding 111 and feed-back winding 112. For rectification purposes, a diode 113 is provided. The d.c. converter 100 is connected via output terminals 103 and 104 to an ignition circuit such as is known from the previous embodiments.

The d.c. converter 100 starts functioning with low illumination and initiates a charging process of the energy store. Charging can take place throughout the day even during the evening hours and under artificial lighting. As the maximum spectral sensitivity of silicon photoelectric cells is approximately between 0.8 and 0.9 μm , i.e. displaced approximately in the direction of red, illumination by the bulbs generally used in living rooms, is well suited as the energy emitter for silicon photoelectric cells.

The d.c. converter 100 is constructed from commercially available components and takes up a space of about 3 to 4 cm³. For the protection of sensitive components, particularly the thin wire coils, the components of the d.c. converter can be combined into a unit and possibly encapsulated. This unit preferably forms with the energy accumulators 1, 1.1, 1.2, 1.3, advantageously comprising button cells, a plug-in unit. The electrical connections can be via flexible leads using solder or plug connections or via spring contacts. In the latter case the d.c. converter can be replaced by simply inserting or removing it from the space allocated for accommodating it in the lighter. This is important, both from the assembly standpoint and for after sales service, because it is not necessary to remove screws or break soldered joints.

Fig. 14 shows in detail an arrangement wherein four Ni-Cd accumulators are provided in the form of a pile and are constructed as a unit with the d.c. converter. In an outer casing 115, a leaf spring 117 with a contact 118 is fixed to the base 116. Above it the Ni-Cd cells 1, 1.1, 1.2, 1.3 are arranged. From the open end, an inner casing 114 is inserted in the outer casing 115, which casing 114 contains all parts of the d.c. converter 100 such as capacitors 105, 106, resistance 107, transistor 108, transformer 109 with windings 110, 111 and 112

and diode 113. The transformer 109 is appropriately fixed to an insulating plate 121 provided with solder pins (connection pins) 120, on the other side of which plate are arranged the remaining d.c. converter elements. As far as necessary the ends of the leads are passed through the base 122 of inner casing 114. As shown in Fig. 14 they can terminate in contact points. The outer and inner casings 115 and 114 can be held together by friction, screw threads, adhesive or any other suitable means. For the internal connection of energy store 1 and diode 113, a contact 123 is provided on the core of transformer 109.

The compact plug-in unit 98 according to Fig. 14 can also be easily replaced by untrained personnel. It can take no more space than a conventional battery in battery lighters.

Figs. 15, 15a and 15b show a further development of the invention. The photoelectric cells 2 and d.c. converter 100 are arranged in the common housing 128. Fig. 15 shows the common housing 128 from below, Fig. 15a is a side view and Fig. 15b a plan view. Fig. 15a shows that the d.c. converter 100, in the same arrangement as in Fig. 14, can be accommodated in housing 128. Figs. 15, 15a show further that in the housing 128 a cavity 129 can be provided which, between the contact 123 (cf. Fig. 14) and contact spring 117, accommodates accumulators 1, 1.1, 1.2, 1.3.

Without changing the fundamental features of the invention the housing 128 shown in Figs. 15 can also be arranged in the lighter casing to serve as an operating lever.

Housing 128 can be provided with a cavity which is open at the bottom or the side for the button cells. The cavity 129 permits easy replacement of the cells after removing the lighter casing.

Fig. 12 shows the circuit diagram of a further embodiment of the invention wherein d.c. converters 100 and 100.1 are provided both between the photoelectric cells 2 and the accumulators 1, 1.1, 1.2, 1.3 and between the latter and the ignition spark gap 16. The ignition transformer, 14 located behind the ignition capacitor 12 in the previous embodiment of Fig. 13 is replaced by a d.c. converter 100.1 in which the rectifier diode 113 provided in d.c. converter 100 is eliminated because it does not matter so far as spark ignition is concerned whether direct or alternating current is used. The same references are used to denote the components of d.c. converter 100.1 as are used for corresponding parts of d.c. converter 100 except that a "1" is added.

Fig. 2 shows a particularly advantageous connection of the housing 29 with one or

more photoelectric cells in the form of very thin silicon discs which are fragile and easily breakable. According to Fig. 2, the silicon discs are placed between, or at least on one side of, a very elastic material e.g. rubber or rubber foam. On casing 29, an elastic disc 124 is arranged whereon is located the photoelectric cell 2 the edge of which is in turn covered by a cut-out elastic disc 125. This arrangement is held together by a frame 126 which can for example be fixed in place by screws 127 on housing 29. The same applies for other photoelectric materials.

When using a d.c. converter between the photoelectric cells 2 and the energy store, matching means, e.g. the ohmic resistance 3, photoconductive resistance 4 or diode 5 or the photoelectric diode 6, in the charging circuit becomes superfluous. An energy flow, i.e. a discharge of the energy store via the photoelectric cells in the case of weak illumination or darkness, is not possible due to the galvanic separation in the d.c. converter. In addition, the circuit of the d.c. converter 100 can be designed so that there is an almost automatic optimum matching of the charging capacity to the radiant light energy converted by the photoelectric cells.

WHAT WE CLAIM IS:—

1. An electrically ignited gas lighter comprising a casing, one or more photoelectric cells mounted on or in said casing for the reception of light, a mounting for one or more accumulator cells for connection to said photoelectric cells to be charged thereby during illumination thereof, and an ignition circuit including a switch coupled to a gas-releasing valve and a voltage-increasing circuit adapted on operation of said switch to generate from said accumulator cell(s) a discharge spark for igniting gas released by the valve.

2. An electrically ignited gas lighter as claimed in claim 1 including a matching ohmic resistance connected between the photoelectric cell(s) and the accumulator cell connection(s).

3. An electrically ignited gas lighter as claimed in claim 1 including a matching resistance connected between the photoelectric cell(s) and the accumulator cell connection(s), the resistance of said matching resistance being variable as a function of the level of ambient illumination.

4. An electrically ignited gas lighter as claimed in claim 1, 2 or 3 including a diode connected between the photoelectric cell(s) and the accumulator cell connection(s) to prevent discharge of the accumulator cell(s) through the photoelectric cell(s).

5. An electrically ignited gas lighter as claimed in claims 3 and 4 wherein the matching resistance is constituted by a

photodiode which serves also to prevent discharge of the accumulator cell(s) through the photoelectric cell(s).

6. An electrically ignited gas lighter as claimed in any of the preceding claims wherein the photoelectric cell(s) are mounted within the lighter casing so as to receive light through aperture(s) formed in the casing.

7. An electrically ignited gas lighter as claimed in any of the preceding claims wherein the photoelectric cell(s) are mounted in a housing which is removable from the lighter casing, and for making electrical connection to the photoelectric cell(s) spring contacts are provided in the lighter casing.

8. An electrically ignited gas lighter as claimed in claim 5 and claim 6 or 7 wherein the photodiode is mounted together with the photoelectric cell(s).

9. An electrically ignited gas lighter as claimed in claim 6, 7 or 8 including an optical system comprising one or more lenses and/or light guides arranged for directing light onto the photoelectric cell(s).

10. An electrically ignited gas lighter as claimed in any of the preceding claims wherein optical and light-sensitive components are mounted together to form a modular unit.

11. An electrically ignited gas lighter as claimed in any of the preceding claims wherein photosensitive components of the lighter are disposed behind a transparent protective layer.

12. An electrically ignited gas lighter as claimed in any of the preceding claims wherein photosensitive components of the lighter are insulated from impact damage by being mounted on yieldable material.

13. An electrically ignited gas lighter as claimed in any of the preceding claims wherein a plurality of accumulator cells are provided and the arrangement is such that, for charging, the accumulator cells are connected to the photoelectric cell(s) in parallel with one another, and for discharge, the accumulator cells are connected in series with one another.

14. An electrically ignited gas lighter as claimed in claim 13 wherein each accumulator cell has a switch individually associated therewith for enabling the connection of the accumulator cell with the other accumulator cells to be changed from parallel to series, and the several switches associated with the plurality of accumulator cells are ganged together for simultaneous operation.

15. An electrically ignited gas lighter as claimed in claim 13 wherein the accumulator cells are connected in series with one another via series resistances, and each accumulator cell is connected via respective

more photoelectric cells in the form of very thin silicon discs which are fragile and easily breakable. According to Fig. 2, the silicon discs are placed between, or at least on one side of, a very elastic material e.g. rubber or rubber foam. On casing 29, an elastic disc 124 is arranged whereon is located the photoelectric cell 2 the edge of which is in turn covered by a cut-out elastic disc 125. This arrangement is held together by a frame 126 which can for example be fixed in place by screws 127 on housing 29. The same applies for other photoelectric materials.

15 When using a d.c. converter between the photoelectric cells 2 and the energy store, matching means, e.g. the ohmic resistance 3, photoconductive resistance 4 or diode 5 or the photoelectric diode 6, in the charging circuit becomes superfluous. An energy flow, i.e. a discharge of the energy store via the photoelectric cells in the case of weak illumination or darkness, is not possible due to the galvanic separation in the d.c. converter. In addition, the circuit of the d.c. converter 100 can be designed so that there is an almost automatic optimum matching of the charging capacity to the radiant light energy converted by the photoelectric cells.

WHAT WE CLAIM IS:—

1. An electrically ignited gas lighter comprising a casing, one or more photoelectric cells mounted on or in said casing for the reception of light, a mounting for one or more accumulator cells for connection to said photoelectric cells to be charged thereby during illumination thereof, and an ignition circuit including a switch coupled to a gas-releasing valve and a voltage-increasing circuit adapted on operation of said switch to generate from said accumulator cell(s) a discharge spark for igniting gas released by the valve.
2. An electrically ignited gas lighter as claimed in claim 1 including a matching ohmic resistance connected between the photoelectric cell(s) and the accumulator cell connection(s).
3. An electrically ignited gas lighter as claimed in claim 1 including a matching resistance connected between the photoelectric cell(s) and the accumulator cell connection(s), the resistance of said matching resistance being variable as a function of the level of ambient illumination.
4. An electrically ignited gas lighter as claimed in claim 1, 2 or 3 including a diode connected between the photoelectric cell(s) and the accumulator cell connection(s) to prevent discharge of the accumulator cell(s) through the photoelectric cell(s).
5. An electrically ignited gas lighter as claimed in claims 3 and 4 wherein the matching resistance is constituted by a

photodiode which serves also to prevent discharge of the accumulator cell(s) through the photoelectric cell(s).

6. An electrically ignited gas lighter as claimed in any of the preceding claims wherein the photoelectric cell(s) are mounted within the lighter casing so as to receive light through aperture(s) formed in the casing.

7. An electrically ignited gas lighter as claimed in any of the preceding claims wherein the photoelectric cell(s) are mounted in a housing which is removable from the lighter casing, and for making electrical connection to the photoelectric cell(s) spring contacts are provided in the lighter casing.

8. An electrically ignited gas lighter as claimed in claim 5 and claim 6 or 7 wherein the photodiode is mounted together with the photoelectric cell(s).

9. An electrically ignited gas lighter as claimed in claim 6, 7 or 8 including an optical system comprising one or more lenses and/or light guides arranged for directing light onto the photoelectric cell(s).

10. An electrically ignited gas lighter as claimed in any of the preceding claims wherein optical and light-sensitive components are mounted together to form a modular unit.

11. An electrically ignited gas lighter as claimed in any of the preceding claims wherein photosensitive components of the lighter are disposed behind a transparent protective layer.

12. An electrically ignited gas lighter as claimed in any of the preceding claims wherein photosensitive components of the lighter are insulated from impact damage by being mounted on yieldable material.

13. An electrically ignited gas lighter as claimed in any of the preceding claims wherein a plurality of accumulator cells are provided and the arrangement is such that, for charging, the accumulator cells are connected to the photoelectric cell(s) in parallel with one another, and for discharge, the accumulator cells are connected in series with one another.

14. An electrically ignited gas lighter as claimed in claim 13 wherein each accumulator cell has a switch individually associated therewith for enabling the connection of the accumulator cell with the other accumulator cells to be changed from parallel to series, and the several switches associated with the plurality of accumulator cells are ganged together for simultaneous operation.

15. An electrically ignited gas lighter as claimed in claim 13 wherein the accumulator cells are connected in series with one another via series resistances, and each accumulator cell is connected via respective



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diodes for charging in parallel with the photoelectric cell(s) and for discharge in series with the other accumulator cells, a single switch being provided in the discharge path from the accumulator cells.

16. An electrically ignited gas lighter as claimed in claim 13 or 14 or 15 adapted for use as a table lighter wherein the series connection of the accumulator cells for discharge is automatic in response to lifting the lighter.

17. An electrically ignited gas lighter as claimed in any of claims 1 to 12 wherein a d.c. converter is connected between the photoelectric cell(s) and the accumulator cell connection(s) whereby accumulator cell(s) charge to a potential higher than that developed by the photoelectric cell(s).

18. An electrically ignited gas lighter as claimed in claim 17 wherein the components of the d.c. converter are combined with the accumulator cell(s) in a modular unit.

19. An electrically ignited gas lighter as claimed in claim 18 wherein the said modular unit comprises sub-assemblies housing the accumulator cell(s) and d.c. converter respectively and making electrical connection with one another by means of pressure contacts, the said modular unit thereby being disassemblable into its separate sub-assemblies without need for desoldering or the like.

20. An electrically ignited gas lighter as claimed in claim 18 or 19 wherein the said modular unit further incorporates the photoelectric cell(s).

21. An electrically ignited gas lighter as claimed in claim 17 wherein the components of the d.c. converter are combined with the photoelectric cell(s) into a modular unit.

22. An electrically ignited gas lighter as claimed in any of the preceding claims wherein said ignition circuit includes a spark gap, and a capacitor is connected to

be selectively charged from accumulator cell(s) and discharged across said spark gap.

23. An electrically ignited gas lighter as claimed in claim 22 adapted for use as a table lighter wherein the charging of the capacitor from accumulator cells is arranged to be initiated automatically in response to lifting the lighter.

24. An electrically ignited gas lighter as claimed in claim 22 or 23 wherein said voltage increasing circuit includes a step-up transformer connected between the capacitor and the spark gap, the capacitor being arranged to discharge through the primary of the transformer and the spark gap being connected across the secondary of the transformer.

25. An electrically ignited gas lighter as claimed in claim 22, 23 or 24 wherein a d.c. converter is connected between the capacitor and the spark gap.

26. An electrically ignited gas lighter as claimed in any of the preceding claims wherein releasable locking means are provided for holding open the gas valve after resetting of the switch previously operated to light gas.

27. An electrically ignited gas lighter substantially as herein described with reference to any of Figs. 1 to 6 of the accompanying drawings.

28. An electrically ignited gas lighter substantially as herein described with reference to Fig. 12 of the accompanying drawings.

29. An electrically ignited gas lighter substantially as herein described with reference to Fig. 13 of the accompanying drawings.

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