United States Patent [19]

Boekkooi et al.

[11] **3,782,258**

[45] **Jan. 1, 1974**

[54] **IGNITION ARRANGEMENT FOR A DISCHARGE TUBE**

[75] Inventors: **Anton Boekkooi; Meerten Luursema; Taeke Tol,** all of Emmasingel, Eindhoven, Netherlands

[73] Assignee: **U.S. Philips Corporation,** New York, N.Y.

[22] Filed: **Dec. 3, 1971**

[21] Appl. No.: **204,461**

[52] **U.S. Cl.** ..... **95/11.5 R**

[51] **Int. Cl.** **G03b 15/03**

[58] **Field of Search** ..... 95/11.5 R, 11 L; 315/55, 241 P

[56] **References Cited**

UNITED STATES PATENTS

2,538,577	1/1951	McCarty	95/11
3,581,637	6/1971	Harvey	95/11
2,856,564	10/1958	Derwin	315/241 UX
2,972,937	2/1961	Suits	95/11.5
3,211,069	10/1965	Rixton	95/11.5
3,528,354	9/1970	Nakagawa	95/11.5

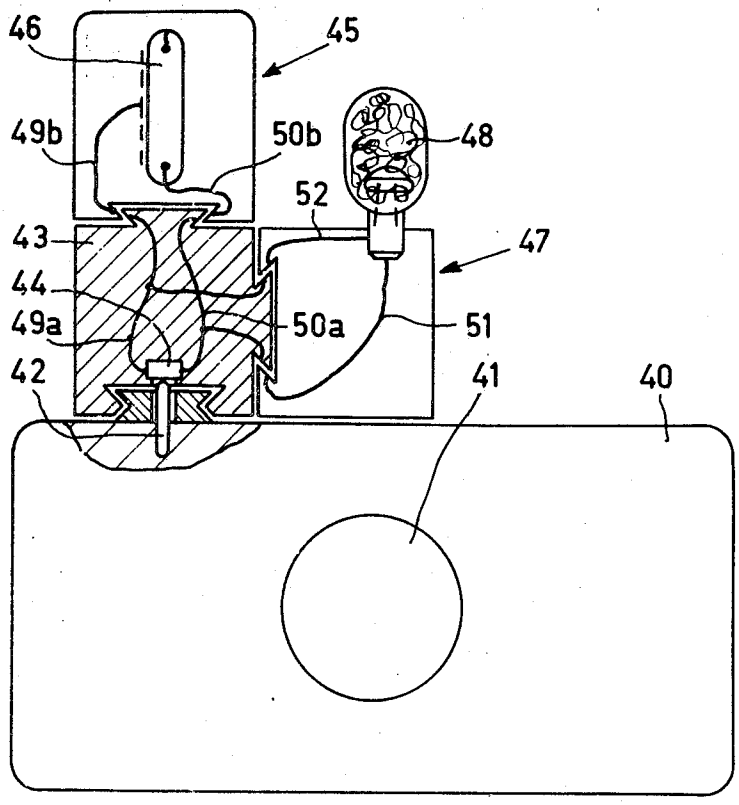
Primary Examiner—Samuel S. Matthews
Assistant Examiner—Michael L. Gellner
Attorney—Frank R. Trifari

[57] **ABSTRACT**

The invention relates to an arrangement for igniting a discharge tube provided with an external ignition electrode.

According to the invention this discharge tube is ignited with the aid of a mechanically operable piezo-electric element. The invention leads to a simple ignition circuit. In addition, the use of the invention in the field of flashing equipment in photocameras has the advantage that exchangeability is possible so that different kinds of flash lamps can be flashed on one and the same camera.

4 Claims, 6 Drawing Figures



PATENTED JAN 1 1974

3,782,258

SHEET 1 OF 4

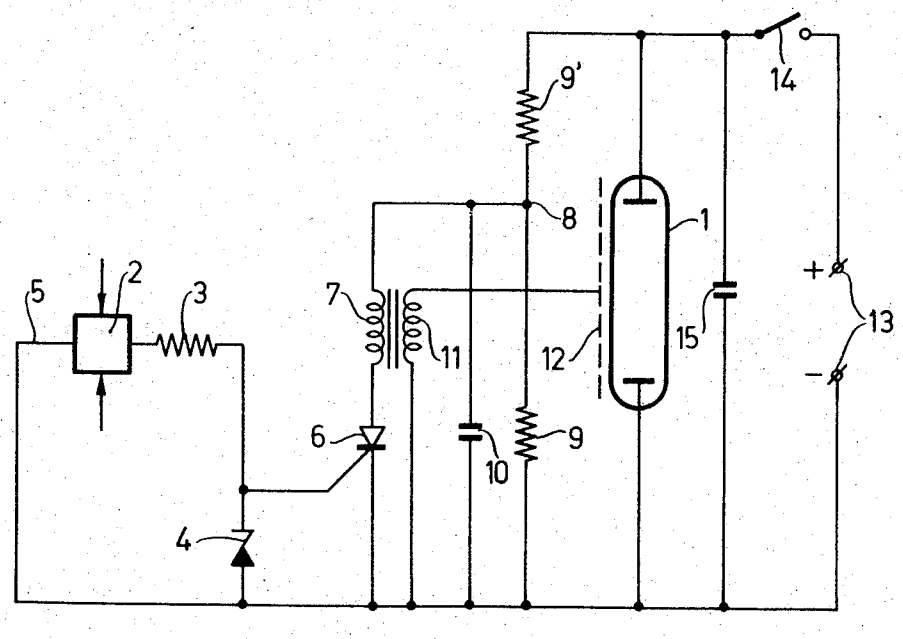


Fig.1

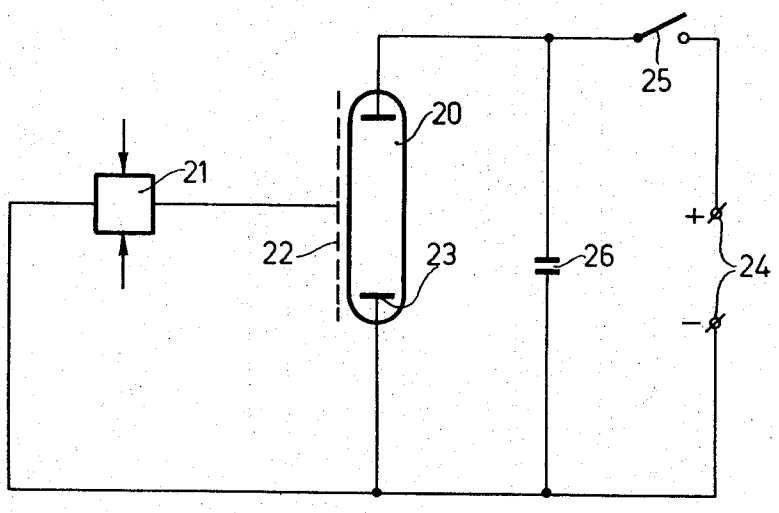


Fig.2

INVENTORS
ANTON BOEKKOOI
MEERTEN LUURSEMA
TAEKE TOL
BY
AGENT

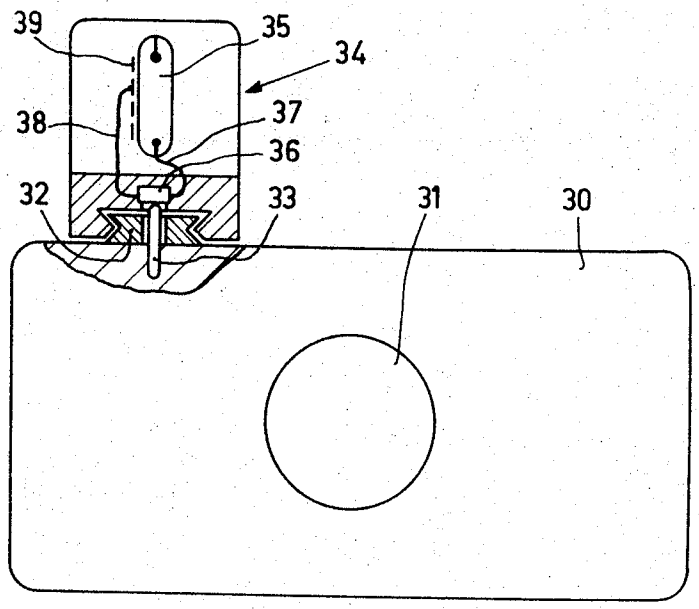


Fig.3

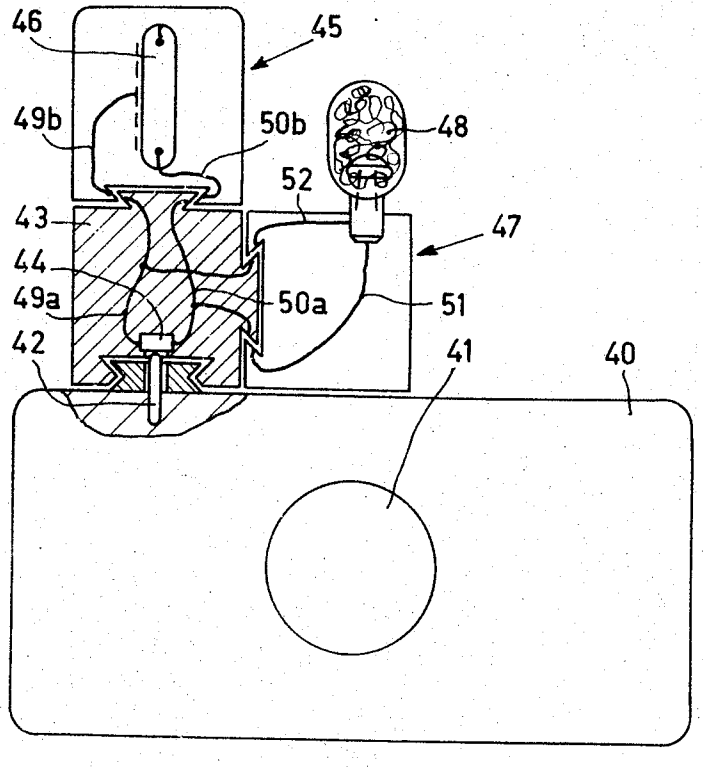


Fig.4

INVENTORS
ANTON BOEKKOOI
MEERTEN LUURSEMA
TAEKE TOL
BY
AGENT

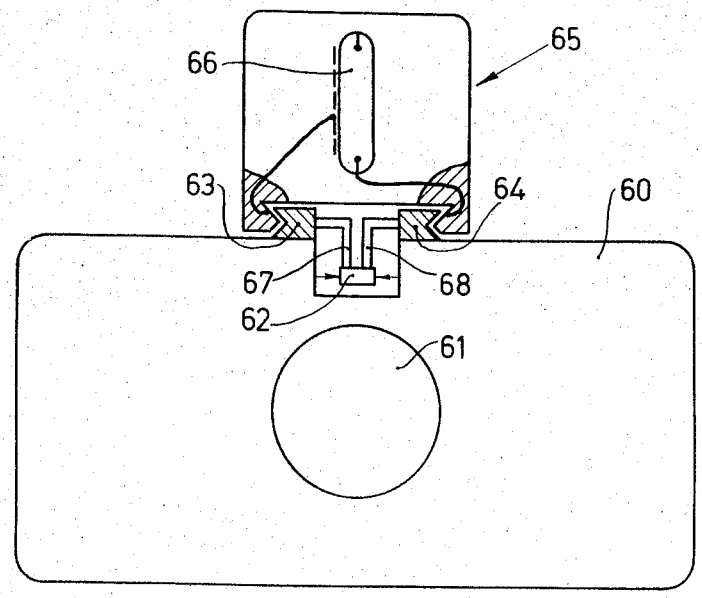


Fig. 5

INVENTORS
ANTON BOEKKOOI
MEERTEN LUURSEMA
TAEKE TOL
BY
AGENT

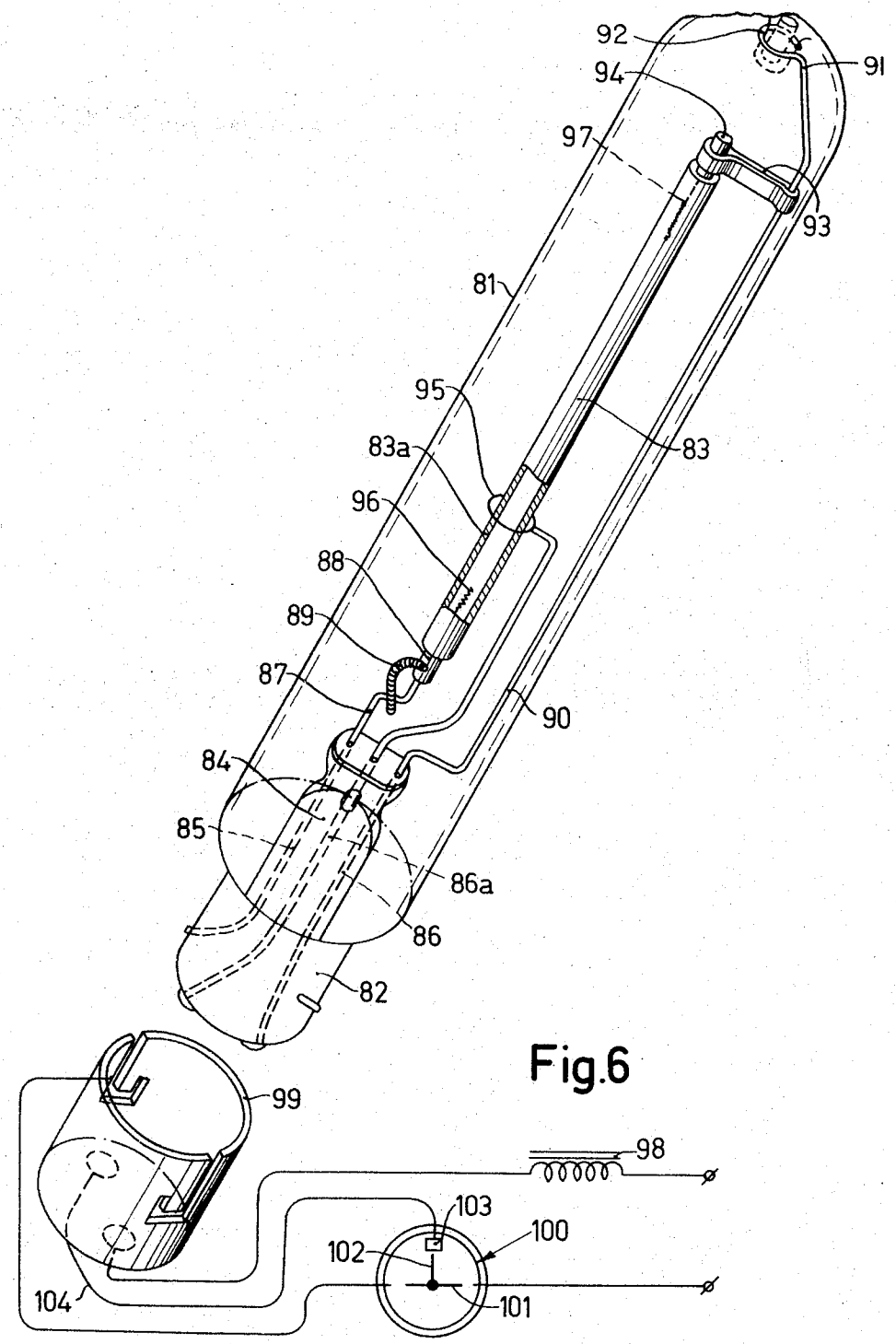


Fig.6

INVENTORS
ANTON BOEKKOOI
MEERTEN LUURSEMA
TAEKE TOL
BY
AGENT

IGNITION ARRANGEMENT FOR A DISCHARGE TUBE

The invention relates to an arrangement for initiating an electric discharge in a gas and/or vapour discharge tube which is provided with two main electrodes and an external auxiliary electrode.

An arrangement of the kind described above is shown, for example, in FIG. 2 of the magazine article "Recent developments in electronic flash lamps," Philips Technical Review, Volume 22, 1960/1961, no 12, pages 377–390. A drawback of this known arrangement is that it is not suitable to ignite the discharge tube starting from an impact pressure. A further drawback of this known arrangement is that its ignition circuit is fairly complicated, for a capacitor and a transformer are required. A further drawback of the known arrangement is that it cannot be used without further steps in a photocamera which is provided with an arrangement including a piezo-electric element and a mechanical operating member for this element.

An object of the present invention is to provide an arrangement of the kind described in the preamble which on the one hand leads to an ignition of a discharge tube by means of an impact pressure, and on the other hand makes it possible to use also a discharge lamp as a flash light source in combination with a photocamera and a piezo-electric element and an operating member therefor.

According to the invention, an arrangement for initiating an electric discharge in a gas and/or a vapour discharge tube which is provided with two main electrodes and an external ignition electrode, is characterized in that the arrangement includes a mechanically operable piezo-electric element which supplies an electric voltage to the ignition electrode for initiating the discharge in the tube.

An advantage of an arrangement as described above is that it can bring about an ignition of the discharge tube also by means of an impact pressure.

The signal which is generated by the piezo-electric element may be passed, for example, through a transformer to the ignition electrode of the discharge tube.

In an advantageous embodiment of an arrangement according to the invention in which the piezo-electric element is provided with two output terminals, one output terminal of the element is connected through a substantially impedance-free connection to the ignition electrode of the discharge tube, and the other output terminal is connected through a likewise substantially impedance-free electrical connection to a main electrode of the tube.

An advantage of this preferred embodiment is that the ignition circuit for the discharge tube may be very simple.

The discharge tube may be a discharge lamp, but this is not necessary. It may alternatively be a quench tube which in principle need not radiate light, but has a switching function only.

In a further special embodiment of an arrangement according to the invention suitable for use in combination with a photocamera which is provided with a member for the mechanical operation of the piezo-electric element, the discharge tube is a gas discharge flash tube.

An advantage thereof is that this leads to a very simple combination of a photocamera and an electronic (gas discharge) flash unit.

It is possible that the previously mentioned combination of photocamera and gas discharge flash tube constitutes a unit in which flash lamps of a different type cannot be used.

In a further advantageous embodiment of the arrangement, which in addition to initiating a discharge in a gas discharge flash tube is also suitable for the ignition of a high-voltage combustion flash lamp, there are at least two lamp holders both of which are electrically connected to the piezo-electric element and in which one lamp holder is suitable for a gas discharge flash lamp and the other lamp holder is suitable for a high-voltage combustion flash lamp.

An advantage of this arrangement is that flashing can take place both with a gas discharge flash lamp and with a high-voltage combustion flash lamp by means of the same camera and the same piezo-electric element. Consequently, this unit is fairly universal.

In a further special arrangement which is likewise suitable for flashing with the aid of a gas discharge flash lamp and a high-voltage combustion flash lamp, one holder for a lamp is provided which is electrically connected to the piezo-electric element and which holder is suitable for both a gas discharge flash lamp and for a high-voltage combustion flash lamp.

An advantage of the last-mentioned embodiment is that only one holder is sufficient.

It is possible to accommodate the electronic flash lamp and the piezo-electric element in different detachable parts of the arrangement.

In a further special arrangement according to the invention the electronic flash lamp and the piezo-electric element form part of one and the same structural unit.

An advantage of this preferred embodiment is that a compact unit is obtained.

In another special embodiment of an arrangement according to the invention, the piezo-electric element is accommodated in an adaptor which in the operating condition of the arrangement is present between the photocamera and a unit comprising the electronic flash lamp.

An advantage of this embodiment is that, when the camera is provided with an operating member for the piezo-electric element, three types of flash lamps can be flashed with the camera. The first possibility is to ignite the electronic flash lamp with the aid of the adaptor and the part comprising the electronic flash lamp, the second possibility is to place a high-voltage combustion flash lamp on the adaptor instead of the unit which comprises the electronic flash lamp, and the third possibility is to remove the adaptor from the camera and to use the operating member projecting from the camera to ignite a so-called percussion flash lamp. The embodiment mentioned above thus is quite universal.

As already described hereinbefore, the invention may be used in the field of generating light flashes for taking photographs. However, it is possible to extend the scope of the present invention to other fields, namely to fields using discharge lamps for general illumination purposes, which thus do not have a flashing character.

Thus, in a further special embodiment of an arrangement according to the invention, the discharge tube is

a discharge tube for general illumination purposes, in which the ignition voltage of the lamp is 300 Volts at a minimum and the voltage of the supply source for supplying the lamp current is lower than the ignition voltage of the lamp, and a piezo-electric element is present such that when it is mechanically operated a voltage is set up at the ignition electrode of the lamp, which voltage is sufficient to produce a breakdown between the main electrodes in case of a voltage between the main electrodes of the lamp which is equal to that of the supply source for supplying the lamp current.

An advantage of the last-mentioned arrangement is that discharge lamps fed by normal supply mains lines can also be ignited in a simple manner at a relatively high ignition voltage, namely without using auxiliary arrangements such as electronic starters, etc.

In the case of discharge lamps which are not provided with an outer envelope, for example, low-pressure mercury vapor discharge lamps, one of the output terminals of the piezo-electric element might be electrically connected to an ignition strip on the outer side of the lamp. In other cases there will be lamps which are provided with an outer envelope. Thus, for example, in a special arangement according to the invention the lamp is a high-pressure sodium vapour discharge lamp provided with an outer envelope and equipped with a third electric lead-through which is connected to an external auxiliary electrode of the discharge tube. In this case the piezo-electric element is provided outside the lamp and is connected between the third and one of the other electric lead-throughs of the lamp.

It is known that high-pressure sodium vapour discharge lamps have a relatively high lumen value, but on the other hand the ignition voltage is relatively high. According to the present invention such a lamp may be ignited in a very simple manner with the aid of a piezo-electric element.

In a further arrangement according to the invention the piezo-electric element is accommodated in an auxiliary circuit in which the operating member of this piezo-electric element can be operated manually, for example, by means of a push-button which hits the piezo-electric element. This auxiliary circuit may be provided, for example, close to a lamp to be ignited, for example, a high-pressure sodium vapour discharge lamp. This may be effected, for example, on the outer side of the fitting which accommodates this lamp.

A special embodiment of the last-mentioned preferred embodiment is formed in such a manner that the operating member of the piezo-electric element is coupled to a switch for switching on the lamp.

This special embodiment has the advantage that when the switch is switched an impact is produced on the piezo-electric element so that the lamp receives an ignition pulse.

In order that the invention may be readily carried into effect, some embodiments thereof will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 shows a circuit diagram of an arrangement according to the invention,

FIG. 2 shows a further circuit diagram of an arrangement according to the invention,

FIG. 3 shows an arrangement according to the invention provided with an electronic flash lamp,

FIG. 4 shows a further arrangement according to the invention which is provided with both an electronic flash lamp and a high-voltage combustion flash lamp;

FIG. 5 shows a further arrangement according to the invention in which a piezo-electric element is provided in a photocamera, and

FIG. 6 shows an arrangement according to the invention provided with a high-pressure sodium vapour discharge lamp.

In FIG. 1, the reference numeral 1 denotes an electronic (gas discharge) flash lamp. The reference numeral 2 denotes a piezo-electric element. An electric supply wire of element 2 is connected through a resistor 3 and a Zener diode 4 to a further output terminal 5 of the piezo-electric element 2. The connection between resistor 3 and Zener diode 4 is connected to the ignition electrode of a thyristor 6. The anode of the thyristor is connected to a primary winding 7 of a transformer. The cathode of thyristor 6 is connected to a point located between Zener diode 4 and connection terminal 5 of the piezo-electric element. The other side of the primary winding 7 of the transformer is connected to a point 8 located between two resistors 9 and 9'. Resistors 9 and 9' constitute a bridge across the discharge lamp 1. Resistor 9 is furthermore shunted by a capacitor 10. The secondary winding 11 of the transformer, whose primary winding is denoted by the reference numeral 7, is connected at one end to the cathode of thyristor 6 and at the other end to an external ignition electrode 12 of discharge lamp 1. The reference numeral 13 denotes a direct current source. The positive terminal of this source is connected through a switch 14 to a main capacitor 15. The other electrode of capacitor 15 is connected to the negative terminal of the voltage source 13. The lamp 1 is connected across capacitor 15.

The arrangement of FIG. 1 operates as follows. First the switch 14 is switched on so that capacitor 15 is charged by voltage source 13. In order to ignite the discharge lamp 1, a blow or impact may be exerted on the piezo-electric element 2. In fact, when this impact is produced, an electric voltage is generated in element 2. This voltage will produce a voltage across Zener diode 4 which voltage is higher than the ignition voltage of thyristor 6. When thyristor 6 conducts, a current will flow from capacitor 10 via primary winding 7 and thyristor 6. In fact, capacitor 10 has previously been charged via resistor 9' when the switch 14 was switched on. The current flowing through primary winding 7 of the transformer incudes a voltage in the secondary winding 11, which voltage is sufficiently high to ignite the discharge lamp 1 through the trigger electrode 12. When, for example, switch 14 is open before flashing, the flash lamp 1 will be extinguished after ignition, namely after a given discharge of capacitor 15.

In one embodiment the electronic flash lamp 1 was a lamp having an electrode distance of approximately 37 mms and a filler gas consisting of xenon at a pressure of approximately 340 Torr. The supply source 13 had a voltage of approximately 350 Volts. The capacitance of capacitor 15 was approximately 500 ,uFarad and the capacitance of capacitor 10 was approximately 0.1 ,uFarad. The resistor 9' had a value of approximately 750 k.Ohms and the resistor 9 had a value of approximately 1 M.Ohm. Upon closing switch 14, capacitor 10 was consequently charged to approximately 200 Volts. The resistor 3 had a value of approximately 82 k.Ohms. With mechanical operation, the piezo-electric element 1 could generate an electric voltage of approx-

imately 500 Volts for several microseconds in the circuit arrangement of FIG. 1. This was sufficient to drive thyristor 6 into conduction through its control electrode. Subsequently capacitor, 10 was discharged through the primary winding 7 of the transformer. The voltage induced thereby in the winding 11 produced a voltage pulse on the auxiliary electrode 12, which pulse caused the lamp 1 to ignite.

The circuit of FIG. 1 may be used, for example, if the distance between the piezo-electric element and the lamp 1 is relatively large.

FIG. 2 shows in principle the same circuit arrangement as that of FIG. 1. The circuit for igniting the lamp, which is denoted by the reference numeral 20 in FIG. 2 is, however, much simpler. This may be explained as follows. The reference numeral 21 denotes a piezo-electric element. This element is connected directly (through a substantially impedance-free connection) to an external ignition electrode 22 of an electronic flash lamp 20. The other end of the piezo-electric element is connected to a main electrode 23 of the lamp 20. The reference numeral 24 again denotes a direct voltage source, which is connected through a switch 25 to a main capacitor 26. The lamp 20 is switched across capacitor 26.

The operation of the circuit of FIG. 2 is as follows. First the switch 25 is closed so that main capacitor 26 is charged. However, the lamp does not ignite yet. When a mechanical impact is exerted on the piezo-electric element 21, a high electric voltage will be produced between trigger electrode 22 and main electrode 23 in such a manner that the lamp 20 is ignited. If switch 25 is opened prior to flashing, the lamp 20 is extinguished after an ignition and after a given discharge of capacitor 26. It is of course feasible that the lamp 20 may be extinguished in a different manner. The discharge tube 20 may be extinguished, for example, by means of a so-called quench tube (not shown) connected across the discharge tube and commanded, for example, through a photosensitive element. This photosensitive element may receive light reflected by an object to be photographed, whereby this object is radiated by the flash lamp 20.

In the arrangement of FIG. 2 the piezo-electric element 21 in one embodiment was of the same type as the element 2 of FIG. 1. This element 21 produced a voltage of approximately 3 k Volt upon mechanical operation (in its electrically unloaded state as is shown in FIG. 2). The lamp 20 was then ignited. In the circuit of FIG. 2, it is to be noted in connection with the ignition that the distance between the piezo-electric element and the lamp is not too large.

In FIG. 3, the reference numeral 30 denotes a photocamera. This photocamera has a lens which is denoted by the reference numeral 31. A connection block having two swallow-tail recesses is provided on top of the camera. This block is denoted by the reference numeral 32. A pin 33 partly protrudes from the block 32. The pin 33 is coupled in a manner not further shown to a shutter mechanism of the lens 31. The operation of the shutter mechanism results in the pin 33 being flipped upwards. The reference numeral 34 denotes as electronic structural flash unit which is provided with a gas discharge flash lamp 35. The base of the unit 34 includes a piezo-electric element 36. Electrical connection wires (37,38) are connected between this element and a main electrode and an auxiliary electrode 39 of the lamp 35. The other supply equipment of the lamp 35 such as, for example, a main capacitor which is denoted by the reference numeral 26 in FIG. 2, is not further shown in FIG. 3. However, the electrical circuit may be formed in a similar manner as in FIG. 2. When pin 33 is flipped upwards, the piezo-electric element 36 is struck and thereby generates a voltage which is set up at the auxiliary electrode of the lamp 35. This combination of camera and flash unit 34 is suitable for taking flash photographs.

In FIG. 4 the reference numeral 40 denotes a photocamera whose lens is denoted by the reference numeral 41. The reference numeral 42 denotes a pin which partly protrudes from the camera. This pin is coupled to the shutter mechanism of the lens 41. The reference numeral 43 denotes an adapter which is provided with a piezo-electric element 44. Furthermore two structural units are shown, namely unit 45 comprising a gas discharge flash lamp 46 and unit 46 comprising a high-voltage combustion flash lamp 48. Electrical connections (49^a, 49^b, and 50^a, 50^b) are passed from the piezo-electric element 44 to the lamp 46 in the structural unit 45, as well as connections (51, 52) which are passed to the lamp (48) in the structural unit 47. A change-over switch (not shown) is provided so that a current can flow either to lamp 46 or to lamp 48. When the lens of this camera is opened, the pin 42 strikes the crystal 44 and, dependent on the position of said switch, either the discharge lamp 46 or the high-voltage combustion flash lamp 48 is ignited. It is of course feasible that the structural unit 47 is not only provided with one combustion flash lamp 48, but with a magazine of combustion flash lamps which in an electrically parallel arrangement are juxtaposed on the upper side of the camera.

In FIG. 5, the reference numeral 60 denotes a photocamera having a lens which is denoted by the reference numeral 61. This camera includes an operating member for a piezo-electric element and the piezo-electric element itself. The latter is denoted by the reference numeral 62. A block having swallow-tail recesses is provided on top of the camera. These recesses are shown in a cross-section and are denoted by the reference numerals 63 and 64, respectively. A structural unit 65, which is provided with an electronic flash lamp 66, is slid around blocks 63 and 64. The reference numerals 67 and 68 denote electrical connections between the piezo-electric element 62 and the parts 63 and 64, respectively, and subsequently to the electronic flash lamp 66. Thus, this unit is suitable for taking flash photographs with the aid of a gas discharge flash lamp. The unit 65 may, optionally be replaced by the unit (47, 48) of FIG. 4.

FIG. 6 shows a high-pressure sodium vapour discharge lamp and a fitting therefor, and an electric supply circuit. In this Figure the reference numeral 81 denotes a glass outer envelope of the lamp. In this case a lamp is provided of approximately 400 Watts having a length of approximately 27½ cm. The reference numeral 82 denotes a lamp base of the bayonet type. The reference numeral 83 denotes a discharge tube in the outer envelope 81. A part of the discharge tube 83, namely part 83*a*, is shown in a longitudinal section. The reference numeral 84 denotes a stem through which three electric supply conductors 85, 86 and 86^a are passed. Conductor 85 is electrically connected to a conductor 87 which is inserted at the other end into a

tubular current supply member **88** provided at one end of the discharge tube **83.** A stranded wire **89** is secured to the conductor **87,** which wire is in electrical contact with the outer circumference of the current supply member **88.** The supply conductor **86** is connected to a terminal wire which consists of a straight part **90** and a part **91** provided with a convolution **92** passed around an indent in one end part of the outer envelope **81.** A rigid current supply strip **93** which is electrically connected to a tubular current supply member **94** of the discharge tube **83** is secured to one end of the straight piece of the terminal wire **90.** The reference numeral **95** denotess an external auxiliary electrode in the form of a convolution of tungsten wire having a thickness of approximately 0.24 mm. This auxiliary electrode is electrically connected to conductor **86^a**. The auxiliary electrode is provided around the discharge tube. The average distance between the auxiliary electrode and the discharge tube is a quarter of a millimetre. The reference numerals **96** and **97** denote the main electrodes of the discharge tube **83.**

In one embodiment the diameter of the outer envelope **81** was approximately **4.6** cms and the external diameter of the discharge tube **83** (**83^a**) was approximately 0.95 cm. The length of the discharge tube **83** was approximately 11.5 cms and the distance between the main electrodes **96** and **97** was approximately 8 cms. The distance between the auxiliary electrode **95** and the main electrode **96** was approximately 23 mms. The discharge tube **83** contained an ignition gas, namely xenon in addition to sodium and mercury.

The lamp described was connected in series with an inductance **98** of approximately 0.12 Henry and in series with a diagrammatically shown rotatable switch **100** to an alternating voltage supply of 220 Volts, 50 Hz. To this end, the lamp base **82** was first inserted in the fitting **99.**

Upon closing the series arrangement by rotating the switch **100,** the part **101** of switch **100** ensured closing of the main circuit. However, when the switch was rotated, the part **102** of switch **100** struck a piezo-electric element **103** incorporated in switch **100.** This impact was converted into an electric voltage pulse, which was applied to the ignition electrode **95** through the conductors **104** and **86^a**. The lamp was then ignited. If the lamp does not ignite for the first time, the switch **100** has to be rotated a number of times until one of these further starting attempts results in the ignition of the lamp.

We claim:

1. A light flashing device in combination with a photocamera comprising, a gas discharge flash lamp having two main electrodes and an external ignition electrode, a mechanically operable piezoelectric element having a pair of output terminals for supplying an electric ignition voltage to said ignition electrode, said photocamera comprising at least two lamp holders and a member for mechanically operating the piezoelectric element and coupled thereto, one lamp holder being adapted to hold a gas discharge lamp and the other lamp holder being adapted to hold a high-voltage combustion lamp, and means electrically connecting the terminals of each lamp holder to the output terminals of the piezoelectric element so that one output terminal of the piezoelectric element is connected to the ignition electrode of the discharge lamp through a substantially impedance-free connection and the other output terminal of the piezoelectric element is connected to a main electrode of the lamp through a second substantially impedance-free electric connection.

2. A light flashing device in combination with a photocamera comprising, a gas discharge flash lamp having two main electrodes and an external ignition electrode, a mechanically operable piezoelectric element having a pair of output terminals for supplying an electric ignition voltage to said ignition electrode, said photocamera comprising a member for mechanically operating the piezoelectric element and coupled thereto and a lamp holder adapted to hold both a gas discharge lamp and a high-voltage combustion lamp, means connecting one output terminal of the piezoelectric element to the ignition electrode of the discharge lamp through a substantially impedance-free connection that includes a terminal of the lamp holder, and means connecting the other output terminal of the piezoelectric element to a main electrode of the lamp through a second substantially impedance-free electric connection that includes a second terminal of the lamp holder.

3. A light flashing device in combination with a photocamera comprising, a gas discharge flash lamp having two main electrodes and an external ignition electrode, a mechanically operable piezoelectric element having a pair of output terminals for supplying anelectric ignition voltage to said ignition electrode, said photocamera comprising a member for mechanically operating the piezoelectric element and coupled thereto and an adapter for mounting and electrically coupling a gas discharge lamp and a high-voltage combustion lamp to the terminals of the piezoelectric element, said piezoelectric element being mounted in said adapter, means connecting one output terminal of the piezoelectric element to the ignition electrode of the discharge lamp through a substantially impedance-free connection, and means connecting the other output terminal of the piezoelectric element to a main electrode of the lamp through a second substantially impedance-free electric connection.

4. A light flashing device comprising, an electric discharge tube having two main electrodes and an external ignition electrode, a mechanically operable piezoelectric element having a pair of output terminals for supplying an electric ignition voltage to said ignition electrode, a pair of supply terminals connected to the main electrodes of the tube and adapted to be connected to a source of voltage that is lower than the tube ignition voltage, means connecting one output terminal of the piezoelectric element to the ignition electrode of the discharge tube through a substantially impedance-free connection, and means connecting the other output terminal of the piezoelectric element to a main electrode of the tube through a second substantially impedance-free electric connection, said piezoelectric element including an auxiliary circuit with which the operating member for the piezoelectric element can be operated manually, said auxiliary circuit further comprising a switch for switching current to the main electrodes of the tube, and means mechanically coupling the operating member for the piezoelectric element to the switch whereby mechanical operation of the piezoelectric element applys a voltage to the ignition electrode sufficient to produce a breakdown between the main electrodes of the tube with the supply voltage applied to said supply terminals.

* * * * *