

3,096,465

Filed March 29, 1961



BY *Frank R. Jaffari*
AGENT

1

3,096,465

CIRCUIT ARRANGEMENT FOR IGNITING GAS DISCHARGE DEVICES

Jozef Cornelis Moerkens, Emmasingel, Eindhoven, Netherlands, assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed Mar. 29, 1961, Ser. No. 99,154

Claims priority, application Netherlands Apr. 26, 1960
14 Claims. (Cl. 315-278)

This invention relates to circuit arrangements for igniting gas discharge devices and more particularly to circuit arrangements for igniting gas discharge devices having an ignition response time proportional to the temperature of the gas.

One of the applications for circuit arrangements utilized to ignite gas discharge devices is the ignition of gas tubes and the like. In one particular type of circuit arrangement of the prior art, the secondary winding of a supply transformer is coupled to the input electrodes of a gas tube. Generally, in such a type, the kind of transformer utilized is immaterial and is usually selected to be an autotransformer. The no-load signal voltage of the secondary winding is generally selected to be large enough to ignite the tube when the rated input voltage signal is applied to the primary winding. It has been found that a gas tube ignites more rapidly for certain temperatures of the gas than for others. For example, it has been found, that when the gas of a certain tube type is below a predetermined temperature, the tube ignites rapidly, i.e., the ignition response time period of the tube is quite small. However, at higher temperatures of the gas the ignition response time period is proportionally increased. The temperature of the gas may be dependent, inter alia, upon the prior operating conditions of the tube. Thus, the ignition response period will be relatively smaller when the gas of this tube type is in a cold state as, for example, where the tube has not been ignited for a long period, than when the gas is in a hot state as, for example, where the tube has been previously ignited and has attained its operational temperature and subsequently is extinguished, either intentionally or unintentionally, and thereafter reignition is established before the heat of the gas dissipates.

This variance in ignition response periods is often undesirable in systems utilizing gas discharge devices. For example, in certain computer and/or other systems utilizing gas tube circuits, this variance causes an increase in the response time of such systems and unless the system provides and/or can tolerate such variance, results in erroneous operation of the system. Still, in some other systems, this time variance cannot be tolerated as, for example, where the gas discharge devices are gas lamps utilized to illuminate certain vital areas such as hospital operating rooms, highways, and the like, wherein a prolonged or even temporary absence of light may be critical. In the aforementioned type of circuit arrangement of the prior art, standard supply transformers having predetermined ratings are generally utilized. Often, in such cases, it is necessary to utilize a larger size transformer in order to insure ignition of the gas tube over the entire contemplated temperature spectrum than would otherwise be required if the tube did not have this variable ignition response characteristic but instead had a constant one. Consequently, in such cases, the cost of providing and operating such a transformer is correspondingly increased.

It is an object of this invention to provide a circuit arrangement for rapidly igniting a gas discharge device having an ignition response time period proportional to the temperature of the gas.

Another object of this invention is to provide a simple

2

and economical circuit arrangement for the aforesaid rapid ignition of such gas discharge device.

Accordingly, this invention features a circuit arrangement adapted to be disposed with a source of predetermined signal and the input means of a gas discharge device for the ignition of the device. The gas discharge device has an ignition response characteristic for a given signal voltage applied to the input means thereof proportional to the temperature of the gas. The characteristic includes at least two time periods of response, one of which is a relatively longer time period than the other, that are related to first and second predetermined temperatures of the gas, respectively. The circuit arrangement comprises transformer means having a primary winding coupled to the source and a secondary winding coupled to the input means to provide a first output signal sufficient to ignite the device in the lesser one of the relatively different time periods whenever the gas of the device is at a temperature of the first predetermined temperatures. In addition, switching means are coupled to the transformer means to short circuit and open circuit sequentially a part of the transformer means to provide a second output signal voltage sufficient to ignite the device whenever the gas is at a temperature of the second predetermined temperatures in a time period less than the longer one of the relatively different time periods, and the switching means further being provided with a response time greater than the lesser time period.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a schematic diagram of the circuit arrangement of this invention.

FIG. 2 is a waveform diagram helpful in explaining the operation of the circuit arrangement of FIG. 1.

Referring to FIG. 1, there is illustrated the circuit arrangement of this invention which is adapted to be disposed with a source (not shown) of signal voltage for ignition of a gas discharge device which has an ignition response characteristic including at least two relatively different time periods of response proportional to the temperature of the gas. Transformer means which may, as illustrated in FIG. 1, be an autotransformer, comprises a core, a primary winding 2-3 coupled to the source (not shown) of signal voltage via input terminals 4, 5, and a secondary winding 6-7 coupled to the input means of a gas discharge device which are illustrated by way of example only as being electrodes 8 and 9 and gas tube 10, respectively. The gas discharge device has an ignition response time period characteristic proportional to the temperature of the gas.

As illustrated in FIG. 1, the secondary winding comprises two coils 6-11 and 12-7, respectively, each of which constitutes a winding and which are serially connected at the common junction 11-12. Coil 6-11 is in tight magnetic coupling relationship with the primary winding 2-3, the latter forming a coincidental portion of the secondary winding 6-7, and more particularly of the coil 6-11. Coil 12-7 is in loose magnetic coupling relationship with the primary. Tapping means, illustrated as taps 13 and 14, are disposed at predetermined spaced locations on the secondary winding and, preferably, the taps 13-14 are disposed on the coils 6-11 and 12-7, respectively. Switching means having a delayed response, illustrated as being a normally open voltage operated relay of, for example, the gas discharge type such as a glow discharge switch 15-17 or the like, is coupled to the taps 13-14. As is well known to those skilled in the art, glow discharge switch 15-17, comprises an envelope 17 filled with a rare gas and two electrodes 15 and 16, which also function as two normally open contacts of

the switch. Electrode 16 is composed of two thin layers of metal, which have different coefficients of expansion which causes the strip 16 to bend when heated. When a signal voltage equal to or greater than the firing potential is applied to the switch, the tube conducts through the gas and the potential decreases to a certain operational potential sufficient to maintain conduction. After a suitable time interval, the heat generated by the conduction through the gas, causes the bimetallic strip 16 to bend and thereby closes the contacts 15 and 16. At this time, conduction through the gas ceases because of the decrease and/or elimination of the operational potential across the electrodes 15 and 16 required to maintain the conduction. As the heat of the gas and of the strip 16 is dissipated, the metals contract and, after a suitable time interval, the strip 16 returns to its original shape causing the contacts 15 and 16 to once again become open.

Referring to FIG. 2, the operation of the circuit arrangement of FIG. 1 will herein be described. For the sake of clarity, the waveforms are illustrated in FIG. 2 in ideal form. The input signal, curve A, is applied to the terminals 4—5. By way of example only, it is assumed that the input signal, curve A, is sufficient to cause the tube 10 to ignite over the entire temperature spectrum that is contemplated the gas will achieve during its operation in a particular application. Thus, the signal, in the assumed situation, will ignite tube 10 under any circumstances but the exact time of ignition will be dependent on the particular temperature of the gas because of its inherent ignition response characteristic. It is to be understood, however, that in some instances the input signal may be sufficient to ignite the tube 10 only over part of the contemplated temperature spectrum but insufficient to ignite the tube 10 over the balance of the spectrum, or at least, within a specified time interval thereafter. Nevertheless, in these instances, the circuit arrangement of this invention may still be utilized as will become apparent hereinafter. With the tube 10 not ignited, at t_1 , an input signal, curve A, FIG. 2, with a magnitude 18 causes a no-load signal voltage having a magnitude 19, curve B, to appear at the input electrodes 8 and 9 of tube 10. The magnitude 19 is capable of igniting the tube 10, for example, in a first time period t_{P-1} , for first predetermined temperatures of the gas, as illustrated by the solid line 20, curve B, in addition to being capable of igniting the tube 10, in a second time period t_{P-2} for second predetermined temperatures of the gas, as illustrated by the extended and broken-dashed outline 21, which represents the signal input to electrodes 8 and 9 if the switch 15—17 and action of this invention were not present, whereupon the potential across the tube 10 decreases to its operational potential 22. It is also assumed, for the sake of explanation, that the response time t_D of the switch 15—17 is selected, for example, to be greater than the first time period t_{P-1} but smaller than the second time period t_{P-2} , and at t_1 the gas of tube 10 is at one of the first predetermined temperatures.

At the time t_1 , the signal from the aforementioned source, not shown, is applied to the terminals 4—5, causing tube 10 to ignite at the time $t_1 + t_{P-1}$. As will be explained in greater detail hereinafter, the switch 15—17 remains inoperative at the time $t_1 + t_D$. For the sake of explanation, it is assumed at the time t_2 the gas of tube 10 is at one of the second predetermined temperatures. Also, at the time t_2 the tube 10 suddenly becomes extinguished whereupon the no-load signal voltage, curve B, reappears at the input of electrodes 8 and 9 but because of the temperature of the gas is not able to ignite the tube 10 at the time $t_2 + t_{P-1}$, that is, in the first time period t_{P-1} . As a consequence, at the time $t_2 + t_D$, that is, at the end of the time response t_D of switching means 15—17, the contacts 15 and 16 are sequentially closed and opened. Due to the switching action and presence of the inductance of the transformer, a no-load voltage signal having a sufficient magnitude, as for example, magnitude 23, curve B,

appears at the electrodes 8 and 9 which causes the tube 10 to ignite at the time $t_2 + t_{P-3}$, i.e., in a time period t_{P-3} which is smaller than the time period t_{P-2} . It can readily be seen that in those instances where the magnitude 18 of the signal, curve A, and the no-load voltage signal magnitude 19 of the associated signal, curve B, is sufficient to ignite tube 10 for only a limited part of the contemplated temperature spectrum within a first time interval as, for example, for the aforementioned first predetermined temperatures and the associated time period t_{P-1} but, however, is insufficient to ignite tube 10 for other temperatures within a second time interval which may be indefinite or finite as, for example, for the aforementioned second predetermined temperatures within the finite time interval chosen to be equal, for purposes of explanation, to the time period t_{P-2} , that, nevertheless, the magnitude 23 will still be sufficient to ignite the tube 10 within a third time interval which is less than the second time interval as, for example, within a time interval t_{P-3} .

The magnitude 23, curve B, FIG. 2, is determined by the location of taps 13 and 14 which, as illustrated in FIG. 1, are disposed on portions of the secondary winding 6—7 that are common and uncommon to the primary winding 2—3, respectively. As illustrated thereon, tap 13 is disposed on the portion, coil 6—11, of the secondary winding 6—7 that is in tight magnetic coupling relationship with the primary winding 2—3; whereas, tap 14 is disposed on the portion, coil 12—7, which is in loose coupling relationship with the primary winding. By judiciously selecting the spacing and/or location of taps 13 and 14, the short circuit current and, consequently, the magnitude 23 of the signal, curve B, FIG. 2, may be controlled. An optimum value of short circuit current is selected which will not cause the transformer to become overloaded when the contacts 15 and 16 close, either for the intended short-circuit period or even longer periods as when the contacts become defective and remain in the closed position, and which will provide a magnitude 23 sufficient to ignite the tube 10 at the aforesaid second temperatures of the gas within the specified time period t_{P-3} . Thus, the no-load voltage signal appearing across the tap 13 and junction 11—12 is made proportional to the no-load signal voltage across the tap 14 and junction 11—12. For example, in a particular application, the no-load voltage between taps 13—14 is 220 volts. By dividing the distribution of this voltage equally between the taps and the junction 11—12, a short circuit current of 2.26 amperes, in one case, is realized; whereas, in another case, a smaller short circuit current is realized, if the distribution is such that the no-load voltage between the tap 13 and junction 11—12 is about 70% of the no-load voltage between tap 14 and the junction 11—12, as, for example, a distribution of 90 volts and 130 volts, respectively, realizes a short circuit current of only 1.6 amperes. It is to be understood that other known means may be utilized to supplement the control of the magnitude 23 of the signal, curve B, as, for example, by shunting the switching means 15—17 with a capacitor (not shown) having a large value will increase the magnitude 23 proportionally, without departing from the scope of this invention.

As illustrated in the embodiment of FIG. 1, the switching means is illustrated as a gas discharge relay switch 15—17, and is so intended to be an example of one of the types of switching means to be utilized in cases where the operation of the switching means is not desired after tube 10 has been ignited as, for example, when tube 10 is ignited before the expiration of the response time t_D . The firing potential of the gas discharge relay switch is selected to be substantially equal to the no-load signal voltage across the taps 13 and 14. If the tube 10 ignites before the expiration of the response time t_D , then the voltage across the secondary winding, and, correspondingly, the voltage between taps 13 and 14 is diminished

to a value selected to be insufficient to support ignition in the gas switch 15—17. In the aforementioned first case, this voltage between the taps 13 and 14 is 82 volts, while in the aforesaid another case this voltage is 102 volts, both of which are below the extinguishing potential, as well as the ignition potential, of the gas switch 15—17. For the same reasons, if the operation of the gas switch is initiated because, for example, the gas of the unignited tube 10 is at a temperature that prevents ignition of tube 10 within the response period t_D , then after the tube 10 ignites, the gas switch 15—17 will thereafter become inoperative as long as tube 10 remains ignited. However, it is to be understood that if the operation of switching means can be tolerated after tube 10 is ignited, other switching types, as well as, these types may also be utilized without departing from the scope of this invention.

The circuit arrangement of this invention is particularly suited for gas devices having an operational temperature of at least 100° C., as for example 270° C. For a typical application, utilizing the circuit arrangement of this invention, the following ratings are recommended.

Transformer windings and/or parts:

(a) Primary winding 2—3—volts (R.M.S.)—	220
(b) Secondary winding, no-load (tube 10 not ignited)—	
(i) Part 6—11—volts R.M.S.—	360
(ii) Part 12—7—do—	300
(iii) Combined 6—7 (i and ii)—do—	1 660
(iv) Part 13—11—do—	90
(v) Part 12—14—do—	130
(vi) Complete 13—14 (iv and v)—do—	220
Secondary winding, loaded (tube 10 ignited)—	
(vii) Part 6—7—volts R.M.S.—	240
(viii) Part 13—14—do—	102

Voltage operated relay 15—17:

Firing potential—do—	220
Extinguishing potential—do—	2 102+

Tube 10:

Operational voltage (tube 10 ignited)—do—	240
Operational current—amperes—	0.9
Operational temperature—° C—	270

¹ Total.

² Approx.

Thus, while I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A circuit arrangement adapted to be disposed with a source of predetermined signal voltage and the input means of a gas discharge device for the ignition of said device, said device having an ignition response time period characteristic for a given signal applied thereto proportional to the temperature of said gas including at least a first time period of response for first predetermined temperatures of said gas and a second time period of response for second predetermined temperatures of said gas, said first time period being relatively smaller than said second time period, said circuit arrangement comprising transformer means having a primary winding coupled to said source and a secondary winding coupled to said input means to provide a first output signal sufficient to ignite said device in said first time period at said first predetermined temperatures of said gas, and switching means coupled to said transformer means operative to short circuit and open circuit sequentially a part of said transformer means to provide a second output signal sufficient to ignite said device at said second predetermined temperatures of said gas in a time period less than said second time period, said switching means having a response time greater than said first time period and becoming operative

whenever said gas discharge device is extinguished for a time period greater than the response time of said switching means.

2. A circuit arrangement according to claim 1, wherein said switching means comprises a gas discharge relay switch.

3. A circuit arrangement adapted to be disposed with a source of predetermined signal voltage and the input means of a gas discharge device for the ignition of said device, said device having an ignition response time period characteristic for a given signal applied thereto proportional to the temperature of said gas including at least a first time period of response for first predetermined temperatures of said gas and a second time period of response for second predetermined temperatures of said gas, said first time period being relatively smaller than said second time period, said circuit arrangement comprising transformer means having a primary winding coupled to said source and serially connected first and second secondary windings coupled to said input means to provide a first output signal sufficient to ignite said device in said first time period at said first predetermined temperatures of said gas, said first and second secondary windings being in tight and loose coupling relationship, respectively, with said primary winding, and switching means coupled to said transformer means to short circuit and open circuit sequentially a part of said transformer means to provide a second output signal sufficient to ignite said device at said second predetermined temperatures of said gas in a time period less than said second time period, said switching means having a response time greater than said first time period.

4. A circuit arrangement according to claim 3 wherein said switching means comprises a gas discharge relay switch.

5. A circuit arrangement adapted to be disposed with a source of predetermined signal voltage and the input means of a gas discharge device for the ignition of said device, said device having an ignition response time period characteristic for a given signal applied thereto proportional to the temperature of said gas including at least a first time period of response for first predetermined temperatures of said gas and a second time period of response for second predetermined temperatures of said gas, said first time period being relatively smaller than said second time period, said circuit arrangement comprising autotransformer means having a primary winding coupled to said source and a secondary winding coupled to said input means to provide a first output signal sufficient to ignite said device in said first time period at said first predetermined temperatures of said gas, said primary winding forming a coincidental portion of said secondary winding, and switching means coupled to said secondary winding at predetermined first and second locations thereof to short circuit and open circuit sequentially said secondary winding between said locations and provide a second output signal sufficient to ignite said device at said second predetermined temperatures of said gas in a time period less than said second time period, said switching means having a response time greater than said first time period, said first and second locations being disposed on portions of said secondary winding common and uncommon to said primary winding, respectively.

6. A circuit arrangement according to claim 5 wherein said switching means comprises a gas discharge relay switch.

7. A circuit arrangement adapted to be disposed with a source of predetermined signal voltage and the input means of a gas discharge device for the ignition of said device comprising a supply transformer having a primary winding coupled to said source and a secondary winding coupled serially to said input means to provide a first no-load voltage output signal sufficient to ignite said device at predetermined temperatures of said gas within a first time interval and insufficient to ignite said device at

temperatures of said gas other than said predetermined temperatures within a second time interval, said second time interval being relatively longer than said first time interval, first and second tapping means disposed on said secondary winding at predetermined spaced locations thereof, and voltage operated relay switching means coupled to said first and second tapping means to short circuit and open circuit sequentially thereat the part of said secondary winding between said tapping means to provide a second no-load output signal sufficient to ignite said device at temperatures of said gas other than said predetermined temperatures within a given third time interval less than said second time interval, said switching means having a response time at least greater than said first time interval and at most equal to said third time interval.

8. A circuit arrangement according to claim 7 wherein said first predetermined temperatures are less than 100° C.

9. A circuit arrangement according to claim 7 wherein said secondary winding comprises first and second coils serially connected at a common junction thereof, said first and second coils being in tight and loose magnetic coupling relationship, respectively, with said primary winding, said first tapping means being disposed on said first coil to provide a first no-load voltage signal between said first tapping and said junction, and said second tapping means being disposed on said second coil to provide a second no-load voltage signal between said second tapping and said junction, said first no-load voltage signal having a predetermined proportional relationship with said second no-load voltage signal.

10. A circuit arrangement according to claim 7 wherein said secondary winding comprises first and second coils serially connected at a common junction thereof, said first and second coils being in tight and loose magnetic coupling relationship, respectively, with said primary winding, said first tapping means being disposed on said first coil to provide a first no-load voltage signal between said first tapping and said junction, and said second tapping means being disposed on said second coil to provide a second no-load voltage signal between said second tapping and said junction, said first no-load voltage signal being relatively smaller than said second no-load voltage signal.

11. A circuit arrangement according to claim 10 where-

in said first no-load voltage signal is approximately 70% of said second no-load voltage signal.

12. A circuit arrangement according to claim 11 wherein said voltage operated relay switching means is a glow discharge relay, said first and second no-load voltage signals having a combined value of substantially 220 volts, and said first no-load output signal being greater than said 220 volts.

13. A circuit arrangement adapted to be disposed with a source of predetermined signal voltage and the input means of a gas discharge device for the ignition of said device, said device having first and second operating conditions and having a first ignition voltage level at a first predetermined temperature of said gas and a second ignition voltage level at a second predetermined temperature of said gas, said device having a first time period of response for first predetermined temperatures of said gas, said circuit arrangement comprising transformer means having a primary winding coupled to said source and a secondary winding coupled to said input means to provide a first output signal of said first voltage level sufficient to ignite said device in said first time period at said first predetermined temperatures of said gas, and voltage responsive switch means coupled to said transformer means and having a voltage applied thereto having first and second levels corresponding to the first and second conditions, respectively, of said gas discharge device, said switch means being operative to short circuit and open circuit sequentially a part of said transformer means to provide a second output signal of said second ignition voltage level sufficient to ignite said device at said second predetermined temperatures of said gas, said switch means having a response time greater than said first time period and becoming operative whenever said first voltage level is applied thereto for a time period equal to the response time of said switch means.

14. Apparatus as described in claim 13 wherein said first operating condition corresponds to the non-ignited condition of said gas discharge device and said second operating condition corresponds to the ignited condition of said device, and wherein said second ignition voltage level is higher than said first ignition voltage level.

References Cited in the file of this patent

FOREIGN PATENTS

63,985	Denmark	Oct. 1, 1945
908,531	France	Sept. 24, 1945