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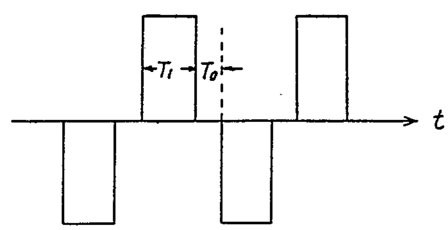
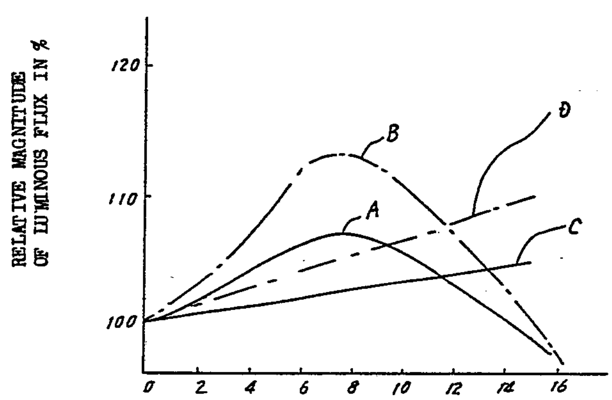
(54) **LOW PRESSURE MERCURY VAPOR DISCHARGE LAMP UNIT.**

(57) Low pressure mercury vapor discharge lamp unit which is constructed to employ a high frequency inverter, have a quiescent time T_0 in the range of 0.5×10^{-6} to 10×10^{-6}, generate a rectangular high frequency AC voltage having a frequency of more than 1kHz, and supply a high frequency voltage to a low pressure vapor discharge lamp sealed with mercury and a rare gas selected so that the ratio X/Y of the molar number Y of the mercury vapor to the molar number X of the rare gas is in the range of 0.5×10^2 to 1.0×10^4. The moving moire of the lamp is suppressed so as to be reduced or eliminated, thereby largely improving the resonant radiation energy efficiency of the mercury.





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"LOW PRESSURE MERCURY VAPOR DISCHARGE LAMP DEVICE"

This invention relates to a low pressure mercury vapor discharge lamp device including a low pressure mercury vapor discharge lamp, for example a fluorescent lamp, combined with a firing device for firing the discharge lamp at a high frequency.

It has long been known that, if fluorescent lamps are fired with high frequency oscillations, the lamp efficiency is improved. The demand for high efficiency due to the latest energy situation together with improvements in performance of power transistors have led to the spread of high frequency firing devices with a firing frequency of the order of from 15 to 50 KHz. Taking the case of 40 W lamps, an improvement in efficiency of the lamp alone of the order of 12 to 13% and an improvement in efficiency of the device as a whole of the order of 20 to 25% can be achieved.

On the other hand, according to the latest literature, it is reported, for example, in Polman et al J. Phys D; Appl. Phys <u>5</u> pages 274 - 276 (a part of the paper) (1972) that, when a pulse discharge is applied with a duty ratio of 50%, a Hg -Ne discharge lamp (Ne : 10 Torrs) has a mean radiant output <12537> standardized at 2537 Å of Hg which exhibits a maximum value at a minimum value of the standardized mean electron temperature $\langle Te \rangle$ and further increases by 10% near to 32 KHz and at current of 0.4 A (I_{DC}). Also it is reported in В.М.МИЛЕНИН et al: Sovetotep, 4 pages 6 - 8 ('81) that, with an Hg-Ar mixed gas subjected to a pulse moldulated discharge at a low voltage, luminous efficiency increases by 20 - 30% under the conditions that Ar is under a pressure of from 133 to 470 Pa, the pulse duration is 25 - 150 µS, and the pulse frequency is of 5 to 20 Khz, for a 20W daylight fluorescent lamp, compared with DC firing.

It is also reported in Japanese Utility Model No. 1,400,382 that, when a low pressure rare gas-mercury vapor discharge lamp including an Ne-Ar mixture as the rare gas is fired with rectangular-wave A.C., a pulse discharge with a duty cycle of 35 to 65% causes the lamp efficiency to increase by about 11% as compared with commercial firing.

The present invention arises from the previously unexpected phenomenon that the energy transition from 6^3P_1 to 6^4So of mercury atoms is attended with a sharp increase in energy efficiency of radiation at 235.7nm by providing a pause time period of not less than 0.5×10^{-6} second and not larger than 15×10^{-6} seconds in the voltage applied across the electrodes of a low pressure mercury vapor discharge lamp containing a rare gas composed of at least one of the elements Kr and Xe or at least one of rare gases low in ionization voltages such as Kr and Xe during the AC firing thereof at a frequency not less than 1 KHz, the inside diameter D in mm of the discharge lamp to being $23 \leq D \leq 35$ and the ratio X/Y of the total molar number X of the rare gas or gases to the molar number Y of mercury vapor within the discharge lamp 10 being kept in the range $0.5 \times 10^2 \leq X/Y \leq 1.0 \times 10^4$. This sharp increase in energy efficiency results from the collective effect that, due to the firing conditions as described above, the electrode loss attendent on the discharge decreases, the radial diffusion of energy within the positive column becomes optimum, the atomic density at the 6^3P_1 level increases and the molar ratio of the molar number X of the rare gas to the molar number Y of the mercury vapor becomes optimum by means of the thermal equilibrium due to the discharge. Thus the present invention aims at a sharp increase in radiation efficiency of ultraviolet compared with conventional Ar-Hg, Ar-Ne-Hg systems.

In the accompanying drawings:-

Figure 1 is a sectional view of a discharge lamp used with experiments resulting in the present invention; Figure 2 is a view illustrating an experimental device including the discharge lamp shown in Figure 1; Figure 3 is a waveform diagram of an applied voltage illustrating the principles of the present invention; Figure 4 is a characteristic diagram illustrating the relationship between the pause time period and the relative magnitude of the luminous flux in one embodiment of the present invention; Figure 5 is a characteristic diagram illustrating the relationship between firing frequency and the relative magnitude of the luminous flux in one embodiment of the present invention; Figure 6 is a diagram illustrating one example of a circuit configuration desirable for carrying out the present invention; Figure 7 is a diagram for explaining the pause time period of the applied voltage in the present invention; Figure 8 is a characteristic diagram illustrating the relationship between the pause time period and the relative magnitude of the luminous flux, in another embodiment of the present invention; and Figure 9 is a characteristic diagram illustrating the relationship between firing frequency and the relative magnitude of the luminous flux in another embodiment of the present invention.

Before an embodiment of the present invention is described, a fundamental experiment resulting in the discovery of said phenomenon will be described on the basis of Figures 1 to 3. In Figures 1 to 3 identical reference numerals designate identical or corresponding components.

Figure 1 is a sectional view illustrating an electric discharge lamp 4 used in this fundamental experiment wherein 1 is a bulb made of quartz glass which bulb is filled with a rare gas and mercury b in the liquid phase which is a mercury vapor generator. A preheated type electrode 2 is sealed through each end of the bulb and an electric discharge path a is formed between the electrodes. The inside tube diameter of the bulb 1 is 30 mm, and the tube length L is 1187 mm as defined by the outer ends of the bulb. The low pressure mercury vapor discharge lamps used were a 40 W rapid start type flurescent lamp and a discharge lamp identical in specification thereto and having the bulb made of quartz glass and not coated with phosphors.

Figure 2 is a view illustrating an experimental device comprising a commercial 100 V AC electric source 5, a filament transformer 6 energized by the electric source 5, an electric source 7 of rectangular waves for supplying a voltage having an application time period T and a pause time period T_0 as will be described later, a switch 8 provided in a preheating circuit for the electrodes 2, and a variable resistance ballast 9 for controlling the discharge current through the discharge lamp.

In the construction shown in Figures 1 and 2 experiments have been conducted with an electric source having the voltage application time period T_1 and the pause time period T_0 as shown in Figure 3, variable in frequency and duty cycle of the periods T_1 and T_0.

In a circuit such as described above a discharge lamp without phosphors has been first fired and the observation and measurements of electric discharges therein have been done in conjunction with the time period T_0 of zero or present and under various conditions. The switch 8 is closed only upon the start of the electric discharge lamp and is open during the measurements.

Fluorescent lamps 4 with a tube length L of 118 mm and an inside tube diameter D of 30 mm were used principally but for a small number thereof a different diameter was used in the range 22 to 36 mm. The rare gas filling was of various single elementary gases and mixtures thereof and their filling amounts have been changed to large extents. The mercury (b) was filled in a substantially constant amount of 25 mg.

These samples were put in running water of about 6ℓ/minute and fired by a high frequency inverter having a rectangular wave output voltage such as shown in Figure 2, with a resistance ballast.

By changing the discharge current and the firing frequency thereof and the temperature of the running water, the states of the electric discharges have been observed while the intensities of radiant spectral lines from the rare gas and mercury have been measured. As a result, it has been seen with a multitude of the samples that, upon the occurrence of moving striations in the positive column, the luminescence of the rare gas becomes noticeable in the positive column and on the other hand, the luminescence of the mercury, and particularly the intensity of resonance radiation at 253.7 mm, is much lowered. The occurrence and extinction of these moving striations is dependent upon the discharge current, the firing frequency, the temperature of the running water etc., but it has been found that, for firing frequencies of not less than 1 KHz, the moving striations occur less readily as the frequency is higher. However the result obtained is that the relative intensity of the resonance radiation for an input power to the discharge lamp (the product of the effective value of current and voltage) can not be said always to be improved attendant on a rise of the frequency.

Thus it has been considered whether the moving striations may be suppressed, as in the case of a rise of the frequency, and also whether the efficiency of resonance radiation energy may be more improved than by the mere increase of the frequency, by shortening the application time period T_1 through the provision of the pause time period T_0 in the voltage applied across the electrodes 2 during the firing of the discharge lamp as shown in Figure 3.

Furthermore, according to the literature (Carl Kenty: Journal of Applied Physics, 21 (Dec) page 1309 - 1318 (1950)), when the firing has been effected with the effective value of 0.42 A at a commercial frequency under the conditions that the inside tube diameter D is 36 mm and the filled argon is under a pressure of 3.5 Torrs, light quanta at 253.7 mm of mercury have the effective lifetime of 7.6 to 7.2 µs. Thus experiments similar to those described above have been conducted at a firing frequency of 20 KHz by setting the pause time period T_0 of the voltage to about 7 µs.

As a result of the experiments as described above, it has been found that the moving striations are suppressed by providing a short pause time T_0 and that upon the moving striations decreasing or disappearing, the intensity of the resonance radiation of the mercury at 253.7 mm is increased.

Accordingly, a 40 W rapid start type fluorescent lamp has then been used as the discharge lamp and the relative magnitude of its luminous flux has been measured, for changes of the time period T_0 at a constant frequency of 17 KHz with a constant current having the effective value of 0.42 A. Fig. 4 shows the result thereof. In Figure 4 the solid line A is data for the discharge lamp 4 filled with argon under about 2.6 Torrs and the chain line B with single dots is data for the discharge lamp 4 filled with a mixed gas or argon (35%), krypton (45%) and neon (20%) under about 2.2 Torrs. As seen in Figure 4 a maximum increase in luminous flux is observed with the pause time period T_0 of from 7 to 8 μs and the increase is about 7% with the lamp 4 filled with argon and about 13% with the lamp 4 filled with the mixed gas, as compared with a time period T_0 of zero.

Further experiments have been conducted for investigating how said increase in luminous flux will be changed with the firing frequency. In these experiments said mixed gas has been used in the discharge lamp and the magnitude of the luminous flux has been measured at an effective current value of 0.42 A, the pause time period T_0 being constant at about 7 μs at frequencies not higher than 36 KHz and the ratio of the time period T_1 to the time period T_0 being set to about 1:1 at frequencies in excess of 36 KHz. The result thereof is shown by a solid line in Figure 5, and a chain line with single dots illustrates the relative magnitude of luminous flux with the effective current value being similarly of 0.42 A but in the absence of the pause time period T_0. The magnitude of the luminous flux in Figure 5 is relative to the magnitude of luminous flux obtained when the firing is effected by a commercial AC electric source using a reference ballast prescribed by JIS, considered at 100%. As seen in Figure 5, the effect of providing the pause time period T_0 can always be observed at firing frequencies of not less than 1 KHz and it is found that its effect is maximum at a firing frequency lying in the vicinity of 20 KHz.

The maximum value of the relative magnitude of the luminous flux changes with the individual parameters such as the pause time period, composition of the rare gases filled in the lamp etc. but it has been confirmed in any event that, if the pause time period is 0.5 to 1.5 µs and the firing frequency is not less than 1 KHz, then a high magnitude of the luminous flux is obtained as compared with firing at a conventional frequency.

A circuit configuration desirable for carrying out the present invention is shown in Figure 6, which shows an AC 100 V electric source 5, a switch 10 for the electric source, a full-wave rectifier 11, a smoothing capacitor 12, a voltage dividing resistance 13, a constant voltage diode 14, an IC 15 for regulating the switching, a pair of output transistors 15a for the IC, and a pair of transistors 16 for amplifying the output which transistors form a push-pull circuit with the output transformers 17. 18 is a voltage dividing resistance which is resistance for supplying currents to bases of the respective transistors through the transistors 15a, 17S is the secondary winding of the transformer 17, 17F are a pair of filament windings, and 19 is a capacitor ballast.

In a construction such as described above, by setting the periods with which the transistors 15a and 15b in the IC 15 switch respectively and the time interval from the blocking of the one transistor 15a to the firing of the other transitor 15b to 8 μs, a voltage waveform such as substantially shown in Figure 3 has been obtained on the secondary winding 17S of the transformer 17, with a frequency of about 20 KHz, a pause time period T_0 of 8 μs and an ON time period T_1 of 17 μs. When the discharge lamp has been fired with such a voltage and the ballast 19 has been adjusted to make the effective value of the discharge current 0.42 A, the voltage waveform applied across the electrodes during the steady state firing has become substantially a triangular wave and its pause time period T_0 has been about 7.5 us. When the magnitude of the luminous flux of and the input power to the discharge lamp have been measured in such a state, high magnitudes not previously existing have been obtained so that, when the said discharge lamp 4 is filled with argon, the increase in efficiency of the lamp alone is about 16% and the increase in efficiency of the device as a whole is about 30% as compared with he case of commercial frequency a.c. firing, and when said discharge lamp 4 is filled with the mixed gas, the increase in efficiency of the lamp alone is about 20% and the increase in efficiency of the device as a whole is about 33%.

While there are known various circuits for providing the pause time period T_0 in the voltage applied across the electrodes other than what is shown in Figure 6, each of them is presumed to have the effect of improving the efficiency of the discharge lamp in view of the phenomenon that moving striations are suppressed. By setting the output voltage from the firing device to be slightly higher than the voltage aross the discharge lamp 4 and controlling the circuit with a voltage across the low resistance for detecting the current, it is possible to make the voltage across the discharge lamp 4 a rectangular wave. Thus a high efficiency can be expected. However the effect of improving the efficiency is low with the pause time period T_0 of less than 0.5 µs.

While the pause time period T_0 may be indefinite as shown in Figure 7, the present invention defines it as described below. When the relationship $5(t_1 + t_2) \geqq t_0$ holds between the sum $(t_1 + t_2)$ of the decay time (t_1) from a value of 10% of the peak value V_p of the voltage applied across the electrodes 2 and the rise time t_2 up to a value of 10% of V_p and the time interval t_0 of zero voltage, the pause time period T_0 is defined as $(t_0 + t_1 + t_2)$; the pause time period T_0 is taken to be equal to t_0 when the time interval t_0 for zero voltage is longer than $5(t_1 + t_2)$.

It has now been confirmed that, as the applied voltage, that is, the firing frequency increases, there is a tendency to decrease the consumed power, in other words, to increase the efficiency for a constant brightness, but the firing frequency is selected in consideration of the switching characteristics and other characteristics of the firing circuit. It is considered that in the existing high frequency firing technique from 10 to 60 KHz are desirable but if the high frequency firing technique advances in the future then it will be sufficiently possible in view of practical use to effect the firing with a pulse frequency of several hundred KHz.

When firing is effected with high frequency pulses there is a tendency to shift the mercury vapor towards the cathode electrode in the bulb, thus making the brightness of the discharge lamp non-uniform also shortening the lifetime of the discharge lamps. However when firing is effected with an alternating current, there is not quite such a risk.

Another embodiment of the present invention will now be described in conjunction with the result of experiments concerning a discharge lamp using, as a rare gas filling, a mixture with a molar ratio of Kr to Ar of 1.0 to 0.2 and with the molar ratio X/Y of the molar number X of the rare gas to the molar number Y of the mercury vapor equal to 3.3×10^2 at a temperature T_n of 40°C of the running water, which is the apparent atom temperature of the rare gas within the positive column.

The said molar ratio X/Y is a quantity approximately obtained from the ratio of the pressure of the rare gas filling at 40° to the vapor pressure of the mercury at 40°C.

Figure 8 shows the variation in relative intensity of resonance radiation of mercury at 253.7 mm for said discharge lamp fired with a peak current value of 0.42 A (of substantially a rectangular wave) at 20 KHz in a stream of water at 40°C, with the pause time period T_0 changed. While in this Figure the intensity is made 100% with a pause time period T_0 of zero, this value is about 17% higher than that in the firing with a commercial electric source. As seen in Figure 8, the intensity becomes maximum with the time period T_0 of 7 to 8 x 10^{-6} second and the increase in relative intensity reaches 35%. Also for time periods T_0 of more than 15 x 10^{-6} seconds the intensity is less than that in the absence of the pause time period T_0. Still considerably strong moving striations exist in the positive column with a time period T_0 of zero, but with the time limit period T_0 ranging from 0.5 to 15 x 10^{-6} seconds the peak current value is increased and the moving striations disappear or are sharply reduced owing to the zero-voltage time period T_0 assuming that the peak value of the source voltage is kept constant. Even if the peak current value is further lowered to a constant value of 0.42 A then the moving striations do not increase as much as when the time period T_0 is zero.

Figure 9 shows the variation in relative intensity of the radiation at 253.7 mm when the same discharge lamp as that used in the measurements of Figure 8 is used and the firing frequency is changed. The solid line in Figure 9 illustrates the case where the pause time period T_0 is a constant of about 7 x 10^{-6} at frequencies of not higher than 36 KHz and where the ratio of the time period T_1 to T_0 is set to about 1 at frequencies in excess of 36 KHz. The chain line with single dots is the case where the time period T_0 is zero. For both cases the temperature of running water was 40°C and the peak current value was 0.42A. Figure 9 shows the intensity of radiation with the firing effected by a commercial electric source as 100%. As seen in Figure 9, the effect of providing the pause time period T_0 is always observed at firing frequencies not less than 1 KHz and that effect is maximum when the firing frequency is near to 20 KHz.

It is considered that the temperature of 40°C of the running water corresponds to 25°C for windless air

The effect of providing the time period T_0 has been similarly observed in conjunction with various discharge lamps having each simple substance of Kr and Xe as the rare gas, the peak current value of from 0.2 to 2 A, the running water emperature of from 5 to 60°C and the molar ratio X/Y during the firing ranging from 0.5×10^2 to 1.0×10^4 as in said discharge lamp.

The limitation of the molar ratio X/Y according to the present invention results from the fact that, when the sort of rare gases, the firing frequency and the pause time period T_0 are determined, the generation and extinction of the moving striations is effected on a boundary made of a border line as determined by the molar ratio X/Y and the apparent atom temperature T_n of the rare gas. Also in this embodiment the lamp was fired by means of the circuit of the configuration shown in Figure 6 and brought into the steady state with said firing device A used, after which the measurements of the magnitude of the luminous flux and electric power were effected.

When said 40 W discharge lamp 4 filled with Ar and having the inside tube diameter D of 30 mm was fired with a peak current value of 0.42 A under said conditions, the molar ratio X/Y (which was obtained assuming that the atom temperature of the rare gas corresponds to the temperature on the central portion of the tube and the vapor pressure of mercury corresponds to the temperature on the coldest portion) has amounted to 0.64×10^8 and high values not previously existing were provided so that, as compared with the firing with the commercial frequency, the increase in efficiency of the lamp alone was about 16% and the increase in efficiency of the device as a whole was about 30%.

Subsequently when an electric dishcarge lamp similar in size of the bulb to said embodiment and having a molar mixture ratio of Kr to Ar of 1.0 to 0.2 was fired under conditions similar to those described above, the molar ratio X/Y of the mixed rare gas to the mercury vapor amounted to 0.4×10^3 while the increase in efficiency of the lamp alone was about 19% and the increase in efficiency of the device as a whole was about 32%.

When a discharge lamp having an inside tube diameter D of 23 mm and a tube length of 1187 mm and filled with elementary Kr alone has been fired under the conditions similar to those for said embodiment, the molar ratio X/Y amounted to 0.7×10^2 while the increase in efficiency of the lamp alone was about 20% and the increase in efficiency of the device as a whole was about 33%.

Also when this discharge lamp 4 filled with Kr was fired with the peak current value of 0.23 A, the molar ratio X/Y amounted to 0.17×10^3 while the increase in efficiency of the lamp alone was about 22% and the increase in efficiency of the device as a whole was about 34%.

When a bulb having an inside tube diameter D of 36 mm and a tube length L of 2354 mm was filled with a rare gas mixture having a molar mixture ratio of Ar to Kr to Ne of 7 to 9 to 4 and fired with a peak current value of 0.8 A, the molar ratio X/Y amounted to 0.25×10^3 while the increase in efficiency of a lamp alone was about 15% and the increase in efficiency of the device as a whole was about 34%.

Also a discharge lamp was fired with a peak current value of 2 A, with an In - Hg amalgam or amalgams disposed in the vicinity of the electrodes 2 in place of the liquid phase mercury b, with a bulb 36 mm in inside tube diameter and 2354 mm in tube length L filled with a rare gas mixture having a molar mixture ratio of Ne to Ar of 7 to 3. At that time the vapor pressure of the mercury was 4.5×10^{-3} Torrs and the molar ratio X/Y amounted to 0.56×10^{3}, while the increase in efficiency of the lamp alone was 14% and the increase in efficiency of the device as a whole was about 36%.

Said embodiments relate to discharge lamps comparatively high in practical use and illustrate only several examples of the effect of the present invention. However when said experiments are considered, the fact that the lamp efficiency is devised to increase by the provision of the proper pause time period T_0 can be said to be effective for a very wide variety of discharge lamps. The maximum value of the relative magnitude of the luminous flux is changed with the firing frequency, the pause time period, the composition of gases filled in the lamp etc., but it has been confirmed that, when the firing is effected at not less than 1 KHz and the pause time period is 0.5 to 15 μs, the relative magnitude of the luminous flux is increased as compared with the conventional firing at a commercial frequency without the provision of the pause time period.

CLAIMS

1. A low pressure mercury vapor discharge lamp device comprising a low pressure mercury vapor discharge lamp forming a discharge path between electrodes, and a firing device for AC firing said discharge lamp at a frequency of not less than 1 KHz, characterized in that said firing device is constructed so that, upon the firing of said discharge lamp, a voltage applied across said electrodes has a pause time period of not less than 0.5×10^{-6} second and not larger than 15×10^{-6} seconds.

2. A low pressure mercury vapor discharge lamp device according to claim 1 characterized in that the voltage applied across the electrodes of the discharge lamp is a rectangular wave.

3. A low pressure mercury vapor discharge lamp device according to claim 2 characterized in that the firing device fires the discharge lamp at a frequency of not less than 10 KHz and not higher than 100 KHz.

4. A low pressure mercury vapor discharge lamp device according to claim 3 characterized in that the firing device fires the discharge lamp at a frequency of 15 KHz and not higher than 50 KHz.

5. A low pressure mercury vapor discharge lamp device comprising a low pressure mercury discharge lamp filled with a rare gas and a mercury vapor generator to form a discharge path between electrodes, and a firing device for AC firing said discharge lamp at a frequency of not less than 1 KHz, characterized in that said firing device is constructed so that, upon the firing of said discharge lamp, a voltage applied across the electrodes has a pause time period of not less than 0.5×10^{-6} second and not larger than 15×10^{-6} seconds while said discharge lamp and said firing device are constructed so that, when said discharge lamp is brought into the steady state, a molar ratio X/Y of a molar number X of mercury vapor to molar number Y of said rare gas within said discharge lamp is of not less than 0.5×10^2 and not larger than 1.0×10^4.

6. A low pressure mercury vapor discharge lamp device according to claim 5 characterized in that the voltage applied across the electrodes is a rectangular wave.

7. A low pressure mercury vapor discharge lamp device according to claim 6, characterized in that the firing device fires the discharge lamp at a frequency of not less than 10 KHz and not higher than 100 KHz.

8. A low pressure mercury vapor discharge lamp device according to claim 7, characterized in that the firing device fires the discharge lamp at a frequency of not less than 15 KHz and not higher than 50 KHz.

9. A low pressure mercury vapor discharge lamp device according to any of claims 5 to 8, characterized in that the rare gas comprises any simple substance of Ne, Ar, Kr and Xe.

10. A low pressure mercury vapor discharge lamp device according to any of claims 5 to 8, characterized in that the rare gas comprises a mixture of not less than two sorts of rare gases.

11. A low pressure mercury vapor discharge lamp device according to claim 10, characterized in that the mercury vapor generator comprises an amalgam.

12. A low pressure mercury vapor discharge lamp device according to claim 10, characterized in that the peak value of a discharge current through the low pressure mercury vapor discharge lamp is of not less than 0.2 A and not higher than 2 A.

AMENDED
CLAIMS:

1. A low pressure mercury vapor discharge lamp device comprising a low pressure mercury vapor discharge lamp (1) filled with a rare gas and a mercury vapor generator (b) to form a discharge path between electrodes (2), and a firing device (5-9) for firing said discharge lamp at a frequency of not less than 1 KHz, characterised in that said rare gas is a mixed rare gas including at least any one of a simple substance Kr and a simple substance Xe or any one of Kr and Xe, the firing device is so constructed that, upon the firing of said discharge lamp, the voltage applied across said electrodes (2) has a pause time not less than 0.5×10^{-6} second and not larger than 15×10^{-6} seconds and the peak value of the discharge current is not less than 0.2 A and not higher than 2 A, the inside tube diameter D in mm of said discharge lamp is in the range $23 \leq D \leq 35$, and the ratio X/Y between the molar number Y of the mecury vapor and the molar number X of said rare gas during the steady state firing of said discharge lamp is set to a range of $0.5 \times 10^{2} \leq X/:Y \leq 1.0 \times 10^{4}$.

2. A low pressure mercury vapor discharge lamp device according to claim 1, characterised in that the mercury vapor generator comprises an amalgam.

FIG. 1

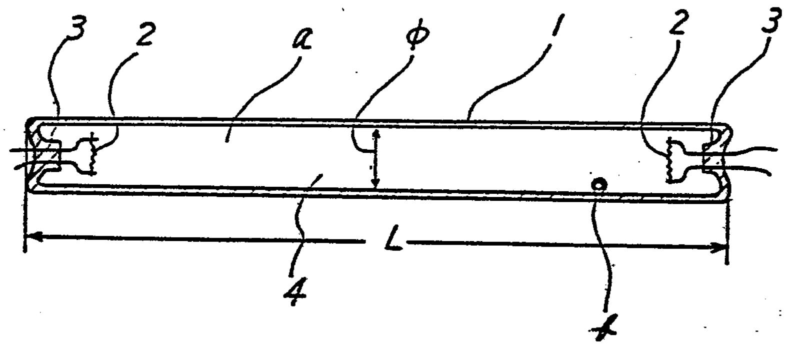


FIG. 2

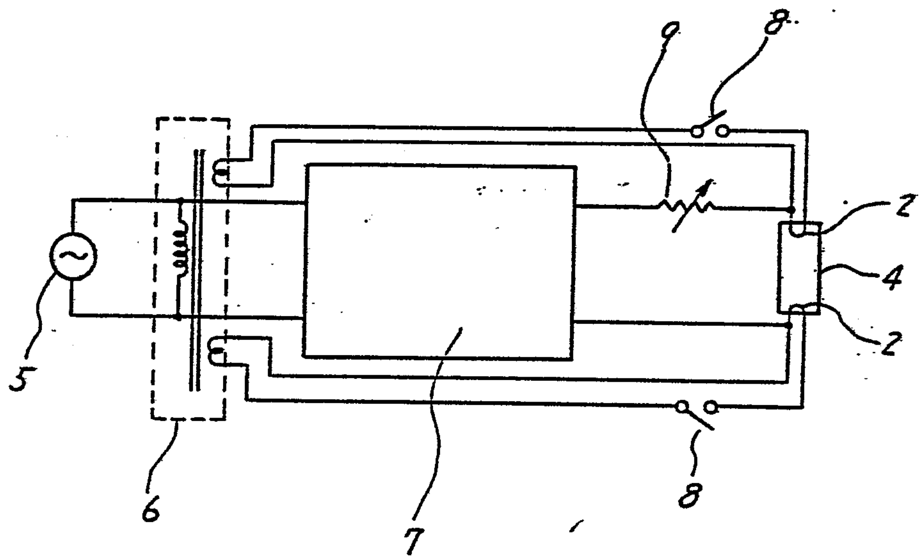


FIG. 3

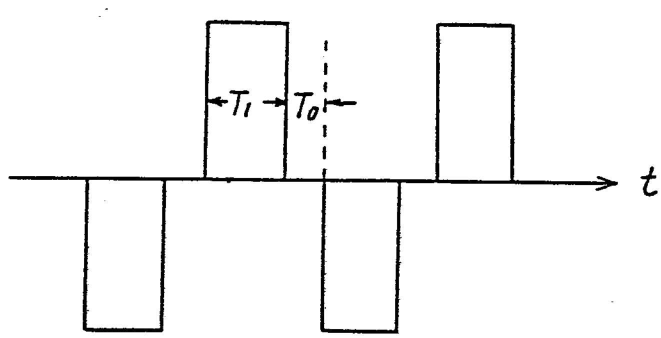


FIG. 4

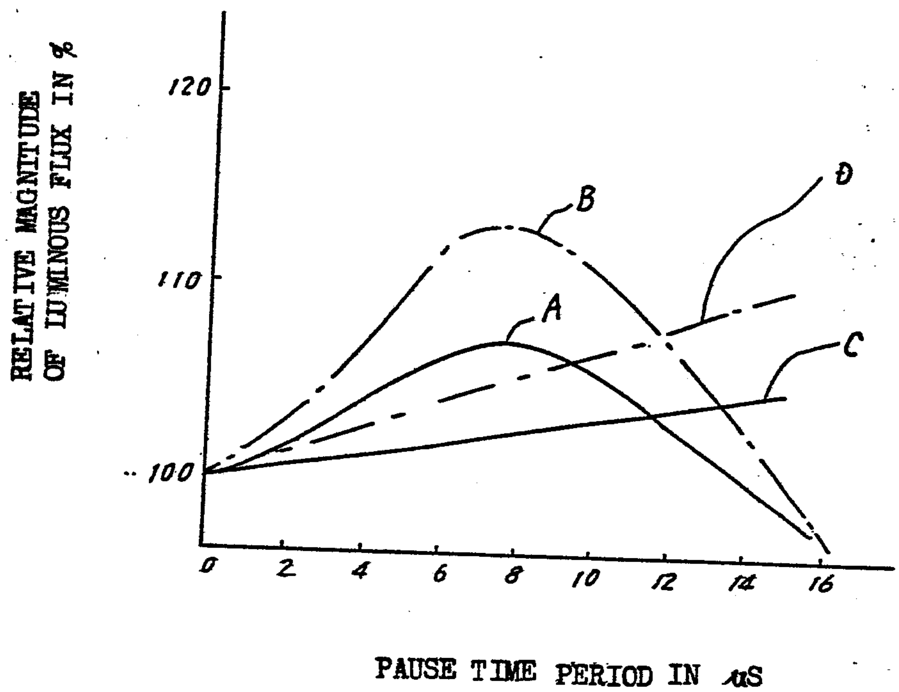
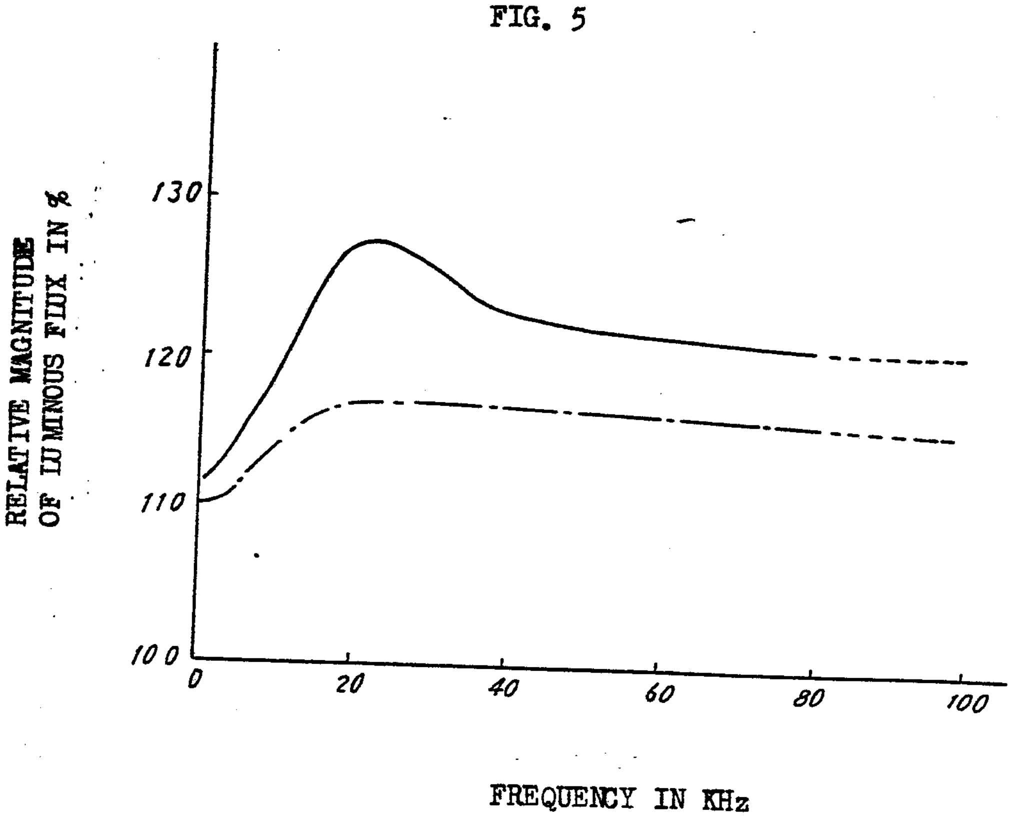

RELATIVE MAGNITUDE OF LUMINOUS FLUX IN %
120
110
100
0
2
4
6
8
10
12
14
16
A
B
C
D
PAUSE TIME PERIOD IN µS

FIG. 5


RELATIVE MAGNITUDE OF LUMINOUS FLUX IN %
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120
110
100
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20
40
60
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FREQUENCY IN KHz

0079969

FIG. 6

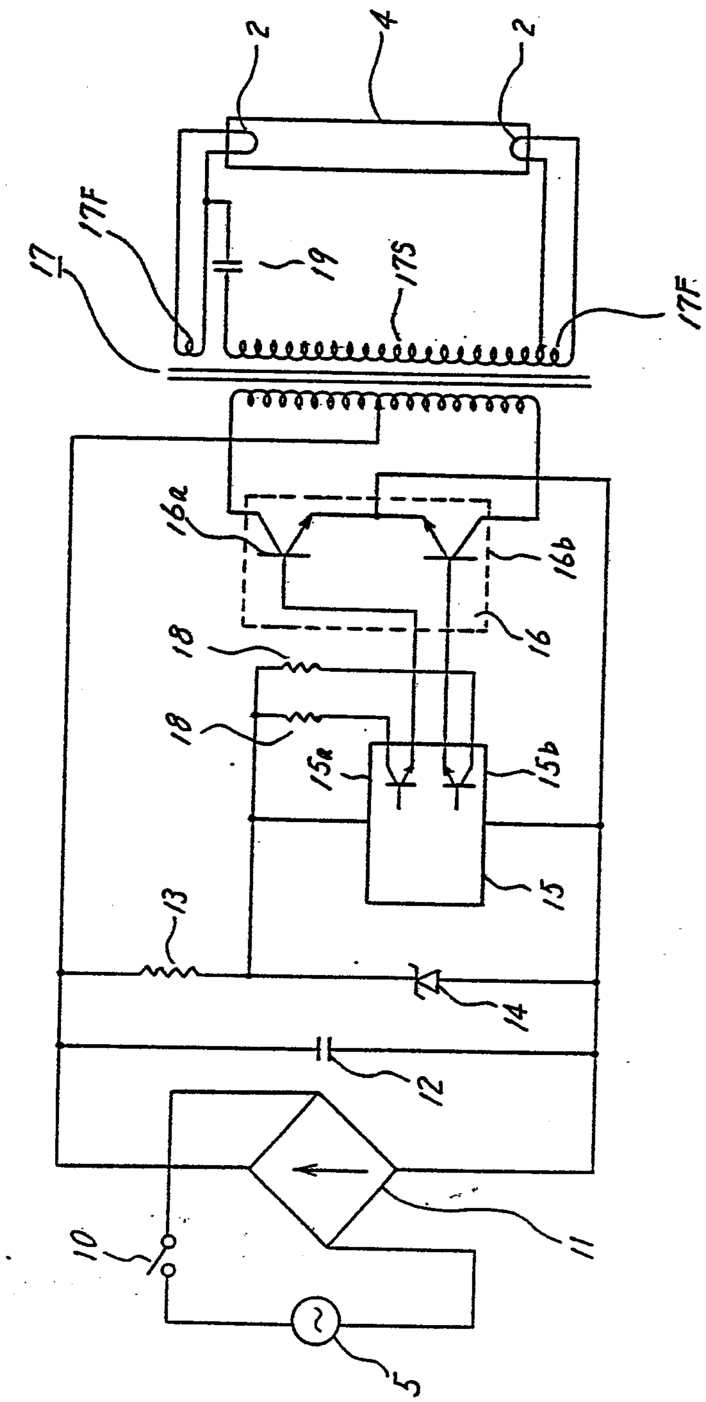


FIG. 7

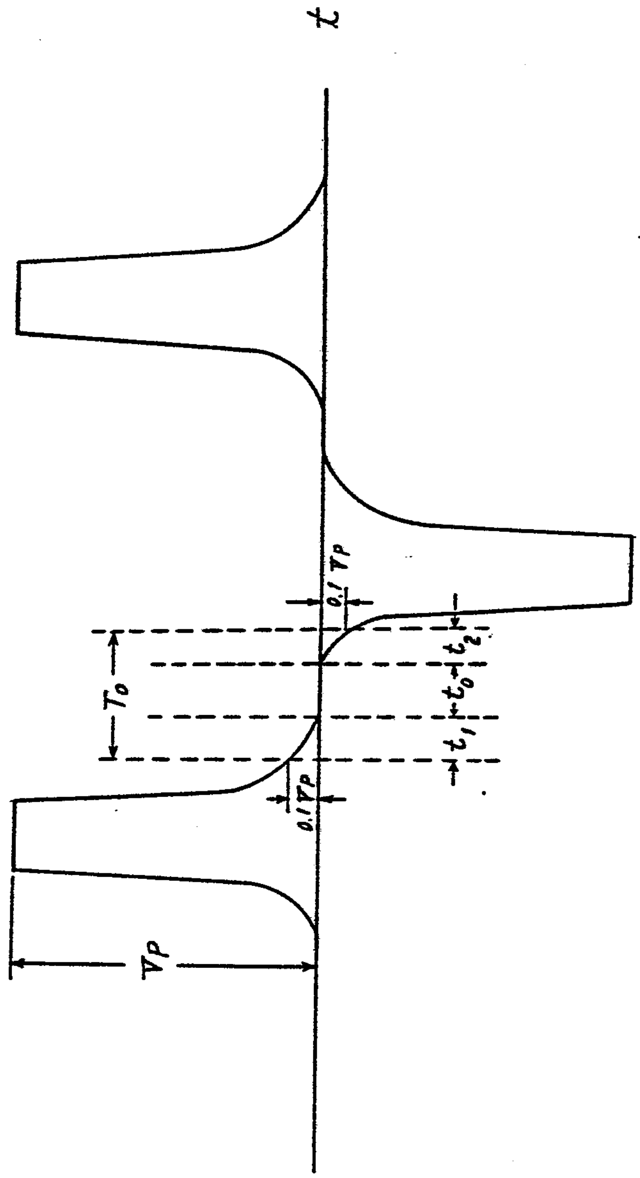


FIG. 8

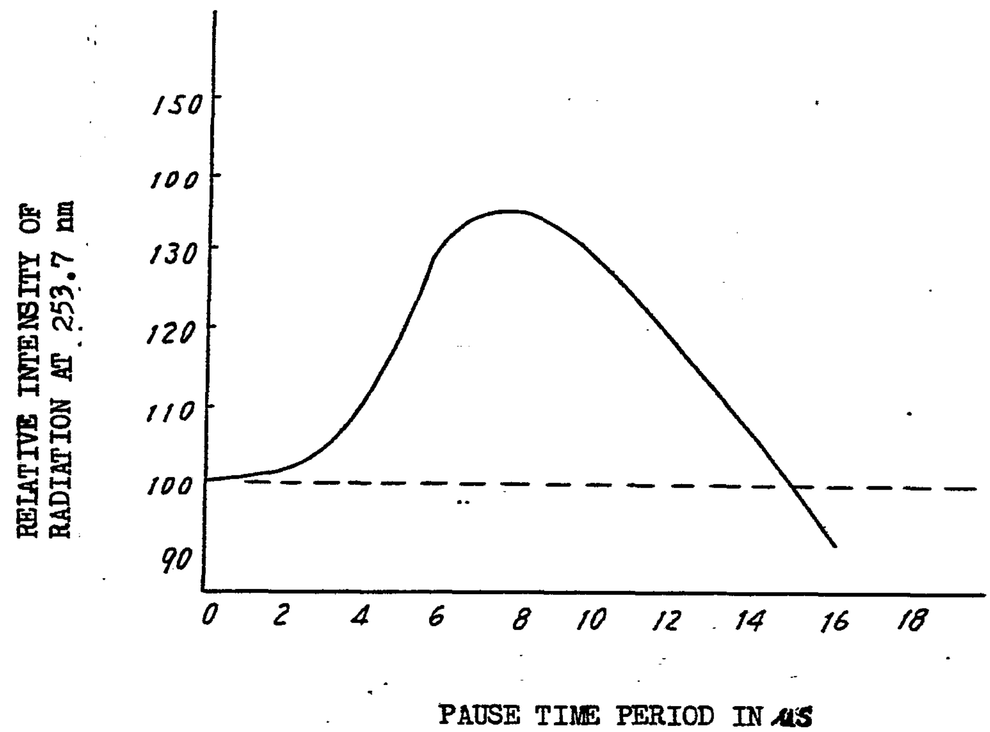
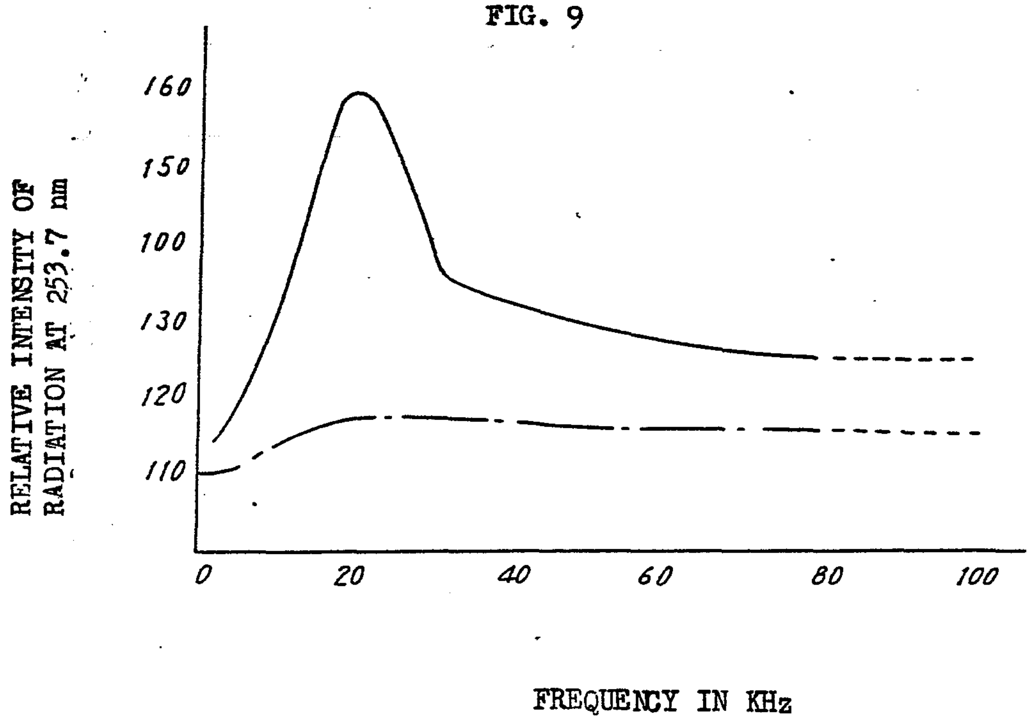

RELATIVE INTENSITY OF RADIATION AT 253.7 nm
150
100
130
120
110
100
90
0
2
4
6
8
10
12
14
16
18
PAUSE TIME PERIOD IN µs

FIG. 9


RELATIVE INTENSITY OF RADIATION AT 253.7 nm
160
150
100
130
120
110
0
20
40
60
80
100
FREQUENCY IN KHz

INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP82/00206

0079969

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] H05B 41/24

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
I P C	H05B 41/24

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho	1931 - 1982
Kokai Jitsuyo Shinan Koho	1973 - 1982

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	JP,A, 47-44978 (N.V. Philips' Gloeilampen-fabrieken) 23. December. 1972 (23.12.72) & JP,Y2, 56-8160 & CH,A, 543847 & US,A, 3789266 & CA,A, 960744 & AT,B, 322040 & SE,B, 385647 & FR,B1, 2137615	1-8, 10, 12
Y	JP,A, 47-44978 (N.V. Philips' Gloeilampen-fabrieken) 23. December. 1972 (23.12.72)	9, 11
Y	Shomei Gakkai-hen "Shomei Handbook" 20. May. 1978 (20.05.78) Ohm-sha, P.160, left column, line 28 to P.161, left column, line 8	9, 11
A	JP,U, 49-103278 (Matsushita Electric Works, Ltd.) 5. September. 1974 (05.09.74)	1 - 12
A	JP,U, 49-62372 (Matsushita Electric Works, Ltd.) 31. May. 1974 (31.05.74)	1 - 12

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
August 26, 1982 (26.08.82)	September 6, 1982 (06.09.82)
International Searching Authority [1]	Signature of Authorized Officer [20]
Japanese Patent Office	