

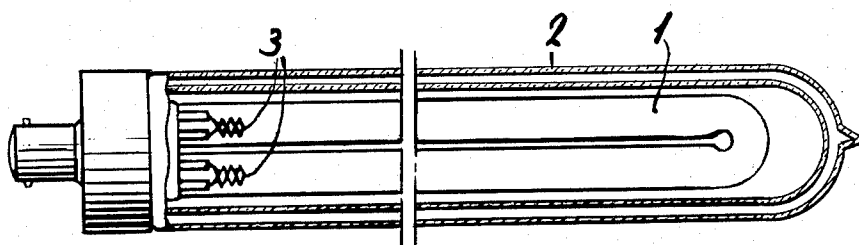
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SODIUM-VAPOUR DISCHARGE LAMP

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SODIUM-VAPOUR DISCHARGE LAMP

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This invention relates to sodium-vapour discharge lamps having a positive column and containing a filling of rare gas.

Conventional sodium-vapour discharge lamps have a rare-gas filling at a pressure of about 10 to 20 mms. of mercury at room temperature.

The decline in the light output of such sodium lamps is largely attributable to the displacement of the sodium along the wall of the tube during its life by the action of temperature differences along the wall of the tube. The sodium is ultimately distilled to the coldest area of the lamp, so that after a longer period of operation a shortage of liquid sodium and hence of sufficient sodium vapour occurs in large portions of the tube. The discharge in situ takes place substantially in the rare gas and produces substantially no light.

Attempts have been made to inhibit the distillation effect by creating along the wall of the tube special cold areas in the form of protuberances which may have several shapes, such as bulges, ribs, etc. Although such solutions yield marked improvements, the said problem of sodium distillation has never been solved efficaciously.

An object of the present invention is to solve the problem of the sodium distillation in a totally different manner and more efficaciously.

According to the invention, the pressure of the rare gas at room temperature lies between 1 and 8 mms. of mercury and at the same time the gradient in the positive column lies between 0.25 and 2.5 volts/cm. Due to the decreased pressure of the rare gas, the decline in light output resulting from sodium distillation is minimised, while the shorter lifelength of the lamp resulting from the decreased pressure of the rare gas, is compensated in part or completely and may even be overcompensated due to the simultaneous decrease of gradient in the positive column of the discharge.

The gradient in the discharge may be influenced by suitable proportioning and design of both the discharge tube and the heat-insulating envelope. Thus, widening of the discharge tube results in a decreased gradient and improvement in the heat-insulating properties of the envelope also results in a decreased gradient.

The invention is based upon recognition of the fact that the decline in light output resulting from the sodium distillation effect is in the majority of cases an unstable effect having a cumulative character.

The gradient in the rare gas is substantially always higher than the gradient in the sodium discharge.

For the same current of the lamp, the consumption of energy per centimetre length of tube is thus higher in the rare-gas discharge than in the sodium discharge. Consequently, the temperature of portions of the tube exhibiting predominantly the rare-gas discharge is higher than the temperature of portions of the tube in which a sufficient quantity of sodium vapour is present and in which hence a predominant sodium discharge takes place. This phenomenon gives rise to an avalanchelike extension of the tube portions poor in sodium, resulting in the light output of the lamp being affected very detrimentally.

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According to the invention, by suitable choice of the pressure of the rare gas, the rare-gas discharge may be given a character such that, although the gradient in the rare-gas discharge exceeds the gradient in the sodium discharge, the consumption of energy per cm. length of the tube is lower in the rare-gas discharge than in the sodium discharge for lamp currents otherwise unchanged. Consequently, the temperature in the tube portions poor in sodium becomes lower than in those containing a sufficient quantity of sodium, sodium distilling automatically to the tube portions poor in sodium.

The gradient in the rare-gas discharge is highly dependent upon pressure. Although the gradient for conventional mixtures of rare gases, such as neon-argon and neon-xenon is always higher than the gradient in the mixture of rare gas and sodium vapour, for a certain pressure a minimum in the gradient of the rare gas can be found which is not much higher than the gradient of the rare gas-sodium vapour mixture. Since in alternating-current operation the form factor in the arc voltage of, and hence the power factor in the rare-gas discharge is about 0.80 and may be about 0.95 in the rare gas-sodium vapour discharge, the wattage consumed per cm. length of tube in the rare gas discharge may be lower in a given range of pressures than in the rare gas-sodium vapour discharge. This optimum range lies between about 1 and 8 mms. of mercury.

The decrease in pressure relative to conventional pressures, which are from about 10 to 20 mms. of Hg, usually involves a shorter lifelength since the small amount of a give kind of rare gas, for example of the argon added to the neon, which is required for obtaining favourable ignition properties, is absorbed by the glass wall more rapidly. A lifelength which nevertheless remains approximately unchanged may be achieved by decreasing the gradient in the sodium discharge approximately in proportion to pressure. The lower pressures of the rare gas must therefore be combined with lower gradients and the higher gradients must be combined with higher pressures.

Optimum results are obtained if the ratio between pressure (in mms.) and gradient (in volts/cm.) lies approximately between 1 and 7 and preferably between 1.5 and 5. The lowest pressure-gradient ratios can be used only with such glasses at the inside of the discharge vessel as are comparatively impermeable to rare gas, since otherwise their lifelength becomes unduly short. Such glasses which, in addition, do not substantially discolor by the action of the sodium discharge may be for example of the following composition:

	Percent, by weight
B ₂ O ₃ -----	13 to 26
Al ₂ O ₃ -----	0 to 20
SiO ₂ -----	0 to 8
Alkaline-earth oxides -----	55 to 85
Alkaline oxides -----	0 to 3
on the condition that	
BaO -----	40 to 65
SiO ₂ +B ₂ O ₃ -----	15 to 30
SiO ₂ +Al ₂ O ₃ -----	5 to 25

The invention will now be described more fully with reference to the accompanying drawing in which the sole figure shows a sodium vapor discharge lamp according to the invention.

A U-shaped sodium-vapour discharge tube 1 is housed in a double-walled exhausted cylindrical envelope 2. The discharge tube, which is made of lime-glass has an internal diameter of 15 mms. and is internally provided with a

thin layer of sodium-resistant glass of the following composition:

	Percent, by weight
SiO ₂ -----	2.9
B ₂ O ₃ -----	19.1
Al ₂ O ₃ -----	4.4
BaO -----	59.0
CaO -----	10.4
MgO -----	4.2

The tube possesses activated thermionic electrodes 3 at its ends and has a length of about 80 cms. between the electrodes, as measured along the axis of the tube. The tube contains about 500 mgs. of sodium metal and a filling of neon gas at a pressure of about 6 mms. of mercury at room temperature to which about 1% by volume of argon has been added. The tube which, in normal operation, consumes about 130 watts for a tube current of about 0.9 amp has a tube voltage of about 155 volts, a voltage drop across the thermionic electrodes of about 15 volts and hence a gradient of about 1.75 volts per cm. in the positive column, it reaches a lifelength of about 6000 working hours.

If the lamp is manufactured with a gradient higher than 2.5 volts/cm., the pressure is required to be at least 9 mms. for the same composition of the glass and the same composition of the rare gas, in order to obtain the same lifelength. If, in this case, use is made of a filling pressure of 6 mms., the lifelength is about 2500 burning hours.

The lamp described in the example reaches a light output of about 103 lumen per watt at the beginning of its life and, after 4000 burning hours, the light output is still about 94 lumen per watt. The sodium remains divided along the whole wall of the tube during this period of life.

If the same tube is filled at a pressure of 9 mms. the said values are about 97 lumen per watt and about 81 lumen per watt respectively. During the lifetime of about 4000 burning hours, a distinct displacement of the sodium along the wall of the tube takes place.

Instead of using a mixture of neon and argon, use may alternatively be made of other mixtures, for example Ne-Xe or Ne-Ar-Xe, with similar results.

What is claimed is:

1. A sodium vapor discharge device adapted to operate with a positive column discharge comprising an envelope, a pair of electrodes within said envelope and a mixture of a rare gas and sodium within the envelope for maintaining a discharge between the electrodes, said rare gas having a pressure of about 1 to 8 mms. of Hg at room temperature and said envelope having dimensions and thermal characteristics whereby with a potential applied between said electrodes a positive column is produced having a voltage gradient of about 0.25 to 2.5 volts per cm.

2. A sodium vapor discharge lamp adapted to operate with a positive column discharge comprising an envelope, a pair of electrodes within said envelope, and a mixture of a rare gas and sodium within the envelope for maintaining a discharge between the electrodes, said rare gas having a pressure of about 1 to 8 mms. of Hg at room temperature and said envelope having dimensions and thermal characteristics whereby with a potential applied between the electrodes and a voltage gradient in the positive column is produced at which the ratio between the pressure of rare gas and the voltage gradient in the column is between 1 and 7 mms. of Hg per volts per cm.

3. A sodium vapor discharge lamp as defined in claim 2 in which the ratio of the pressure of the rare gas and the voltage gradient is between 1.5 and 5.

References Cited by the Examiner

UNITED STATES PATENTS

2,030,390	2/1936	Navias -----	313—221
2,238,777	4/1941	Lemmers -----	313—221

OTHER REFERENCES

H. Cotton: Electric Discharge Lamps, Chapman & Hall, London, 1946, pages 287—310, especially 295.

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