Sept. 4, 1934. A. CLAUDE 1,972,183

ELECTRIC GASEOUS DISCHARGE TUBE

Filed Oct. 22, 1931

Fig.2

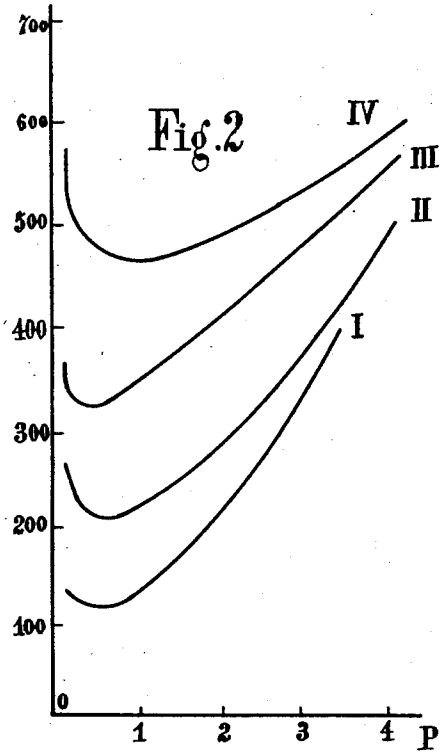
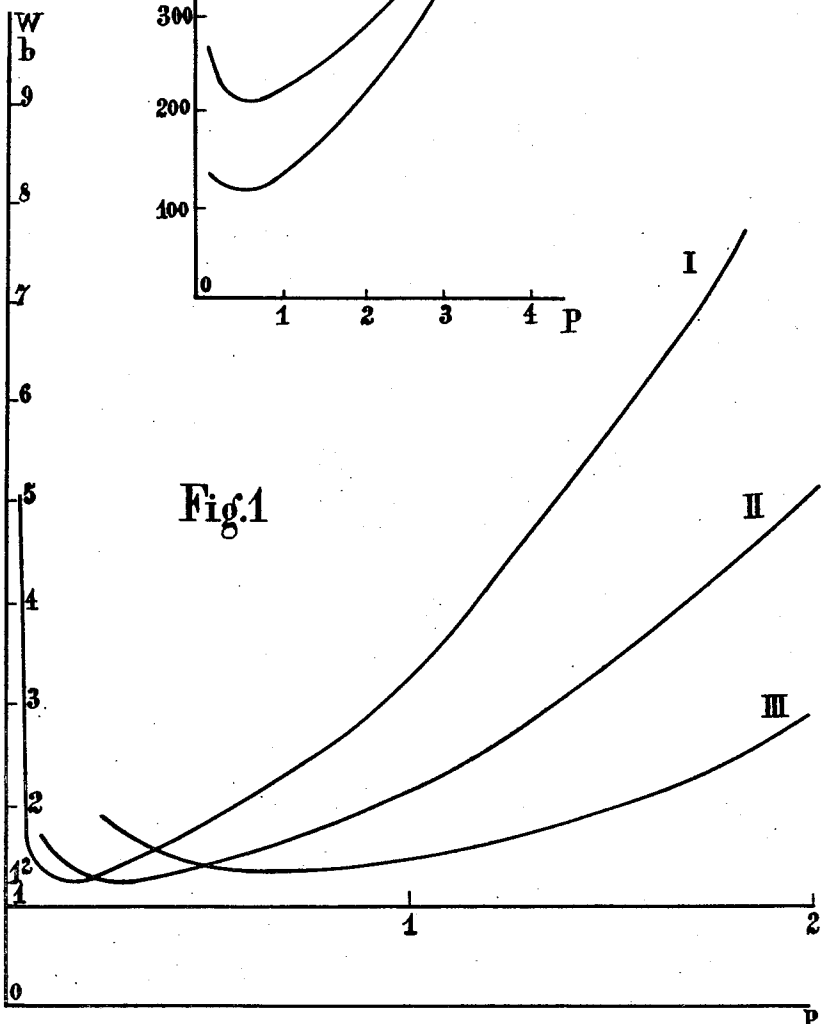


Fig.1



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ELECTRIC GASEOUS DISCHARGE TUBE

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Application October 22, 1931, Serial No. 570,452
In France November 5, 1930

4 Claims. (Cl. 176—124)

In a patent applied for in France on the 30th August 1928 and granted under No. 673,741 G. Claude has described a process for the improvement of illumination provided by luminescent tubes having a helium atmosphere, which consists in substituting for this atmosphere a mixture of helium and neon with a small proportion of neon and of using alkaline metal electrodes or electrodes of alkaline earth metal in combination with the said atmosphere. By this process is obtained a slightly rose tinted white light which by direct observation appears similar to that of daylight.

For convenience of description "white light" describes a light which gives the objects which it illuminates the tint which would be given to them by daylight, that is to say a light which contains radiations throughout all the regions of the visible spectrum, the said radiations having intensities which can be compared with those of the solar spectrum.

The object of the present invention is the use of a gaseous atmosphere of the above-mentioned type formed from helium and a small proportion of neon for forming illuminating devices having however a high energy efficiency

For this purpose, according to the present invention a discharge device operating on the arc principle is constructed by using an atmosphere formed by a mixture of helium and neon in which the neon is in proportion suitable for the production of white light under a pressure of gaseous mixture between 3 millimeters and 0,05 millimeters of mercury.

In addition in a device of this kind the cathode can be of one of the type mentioned in my copending patent application Serial No. 570,451, filed October 22, 1931 for "Improvements in electric gaseous discharge devices".

Further an anode (or anodes in the case of devices having more than one anode) can be constructed according to one of those described in the said patent application and the cathode and an anode (or anodes) can be of the type mentioned above. The anode (or anodes) the cathodes and the walls of the discharge device can be charged with occluded gas in any desired proportion, the occlusion being able to be extended up to the saturation of the said elements according to the said patent application.

By the combined utilization of these various means it is possible to provide an installation operating by arc with an electric discharge apparatus containing a mixture of helium and neon and at the same time presenting a series of technical advantages of capital importance which have not been obtained up to date. Among these advantages can be mentioned, firstly the high luminous power of the discharge apparatus, secondly the quality of the light obtained, thirdly the high energetic efficiency of the installation and fourthly the long life of the functioning of the discharge apparatus without any appreciable change in the preceding advantages.

It is to be noted that these results are absolutely new by reason on one hand of the extreme facility with which the rare gases are absorbed in the discharge devices at present used and on the other hand of the low pressure of the mixture of rare gases used here, which condition incidentally would normally exaggerate the said damaging effect, and they are new also by reason of the rather small proportion of neon existing in the above-mentioned mixture of rare gases. This proportion is such that the volume of neon contained in a discharge tube of usual dimension is several thousandths of a cubic centimeter and at atmosphere pressure.

The discharge apparatus according to the present invention also have various other properties which are as interesting from the point of view of their construction as from their operation; amongst these can be cited the following:

Firstly in opposition to arc operated tubes charged with pure neon the minimum specific consumption in the positive column exclusive of the loss of energy at the electrodes of a discharge apparatus according to the present invention is independent of the diameter of this column but like the pure neon tubes it is obtained with a pressure which is the lower, the greater the diameter of the tube and this pressure is approximately in the inverse ratio of the diameter for example it is 0,2 millimeters for a tube of 65 millimeters and it is 0,55 millimeters for a tube of 20 millimeters.

Secondly in opposition to arc operated neon tubes in the tubes made according to the present invention irrespective of diameter, the minimum voltage necessary for the feed for any given value of pressure coincides almost exactly with the minimum specific consumption in such a way that the tube, the luminous efficiency of which is the highest, is also that which for a given length functions under the lowest voltage or which can be the longest for a given feed voltage.

The invention is more particularly described with reference to the drawing in which:—

Figure 1 shows curves indicating for various diameters of the tube the variation of the specific

consumption under given pressure values, the current intensity being constant.

Figure 2 shows curves indicating for various diameters of tubes the feed voltage under given pressure values, the current intensity being constant.

These curves are taken out of a double system of curves obtained experimentally by the applicant, each curve corresponding to a predetermined diameter of the tube.

In Figure 1, the pressures have been marked on the line of the abscissa in millimeters of mercury for the mixture of helium and neon used and the specific consumptions of the luminous column have been marked on the ordinates, these consumptions being shown in watts per candle. Each curve of this figure gives the variation of the specific consumption for a tube of predetermined diameter under the effect of the variation of pressure prevalent in this tube. This curve shows that there is a minimum of specific consumption. The series of curves of this figure show in addition that this minimum has practically the same value for all diameters of tube.

The table below gives the diameters of various tubes which have been used for forming the curves of Fig. 1.

Curves	Diameter of the tube
	Millimeters
I	66
II	36
III	20

Applicant has determined from these curves a process for manufacturing discharge apparatus of the type described above. According to this process each discharge apparatus is charged with a predetermined mixture namely helium and neon at a pressure corresponding to the minimum of specific consumption of the said apparatus and the apparatus resulting from the working of this process also form new products which are included in the ambit of the present invention.

In Figure 2 the pressures of the mixture used namely helium and neon are marked off on the abscissa line in millimeters of mercury and the gradient of potential in the positive column is expressed along the ordinates in volts per meter of the positive column the intensities being of the order of several amperes.

The table given below shows the diameters of the various helium + neon tubes which have been used for forming these curves.

Curves	Diameter of the tube
	Millimeters
I	66
II	36
III	20, 5
IV	15

These curves show that for each diameter of the tube there is a pressure of the mixture of helium and neon for which the tube definitely functions with a minimum voltage.

In addition when comparing the corresponding curves of Figs. 1 and 2 it is shown that there is minimum voltage and minimum specific consumption for a predetermined diameter at substantially the same pressure so that a discharge apparatus established according to the present invention with a given mixture of helium and neon at a pressure corresponding to that of the minimum consumption will also function at minimum voltage.

The composition of the mixture of helium and neon is chosen in each case so as to obtain the same white light. It is dependent on a certain number of factors the chief of which are:—

(*a*) The total pressure of the gaseous mixture
(*b*) The intensity of the current
(*c*) The cross section of the positive column.

The experiments to which the various discharge tubes have been subjected by applicant has shown that the increase of pressure and increase of diameter of the tube act in the same sense as the increase of the amount of neon and inversely. The experimental results obtained are interpreted by a complete series of diagrams. The following examples will show the importance of the three factors indicated relatively to the proportion of the mixture.

Pressure	Diameter	Intensity	$\frac{Ne}{Ne+He}$
			Percent
0, 05	20 mm.	2 amp.	10
0, 5	20 mm.	2 amp.	4
3	20 mm.	2 amp.	0, 75

Intensity	Pressure	Diameter	$\frac{Ne}{Ne+He}$
			Percent
2 amp.	0, 5	36 mm.	5
4, 5 amp.	0, 5	36 mm.	3

Diameter	Intensity	Pressure	$\frac{Ne}{Ne+He}$
			Percent
20 mm.	2 amp.	0, 5	4
20 mm.	2 amp.	0, 5	3

The influence of the pressure used is particularly important. The above data was obtained from experiments in which white light was produced.

The values stated above are shown by way of example, it being understood that the ambit of the present invention is not exceeded by using different diameters and intensities in combination with pressures included in the above limits.

It is an important fact when the composition of the mixture of helium and neon varies between the limits stated above, the specific consumption and the feed voltage do not appreciably change.

In the present application, it is to be understood that the expression "electric gaseous discharge tube" means not only an electric gaseous discharge tube that is to say an apparatus with an elongated cylindrical chamber, but also any apparatus of the kind described provided with a chamber of any other shape.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electric gaseous discharge illuminating apparatus adapted to operate on the arc principle, comprising an envelope containing an atmosphere consisting of a mixture of helium and neon in which the neon is in such proportion as to obtain a white light under the action of an electric discharge in the said atmosphere, said atmosphere being at a pressure ranging between

3 millimeters and 0,05 millimeters of mercury, the anode of the discharge apparatus having an anodic zone, the surface of which has a minimum value determined by the pressure of the gaseous mass in the discharge apparatus, this value ranging between 1 square centimeter per ampere when this pressure is 3 millimeters of mercury and 8 square centimeters per ampere when the pressure is 0,05 millimeters.

2. An electric gaseous discharge illuminating apparatus adapted to operate on the arc principle, comprising an envelope containing an atmosphere consisting of a mixture of helium and neon in which the neon is in such proportion as to obtain a white light under the action of an electric discharge in the said atmosphere, said atmosphere being at a pressure ranging between 3 millimeters and 0,05 millimeters of mercury, the anode of the discharge apparatus having an anodic zone, the area of which at the minimum is one-seventh the total area of the anode.

3. An electric gaseous discharge illuminating apparatus adapted to operate on the arc principle, comprising an envelope containing an atmosphere consisting of a mixture of helium and neon in which the neon is in such proportion as to obtain a white light under the action of an electric discharge in the said atmosphere, said atmosphere being at a pressure ranging between 3 millimeters and 0,05 millimeters of mercury, the anode of the discharge apparatus being hollow, the depth of the hollow in the electric field being at least equal to the diameter of said anode.

4. An electric gaseous discharge illuminating apparatus adapted to operate on the arc principle, comprising an envelope containing an atmosphere consisting of a mixture of helium and neon in which the neon is in such proportion as to obtain a white light under the action of an electric discharge in the said atmosphere, said atmosphere being at a pressure ranging between 3 millimeters and 0,05 millimeters of mercury, the anode of the discharge apparatus being provided with a di-electric lining or covering on the parts of said anode which are apt to become disintegrated.

ANDRÉ CLAUDE.