

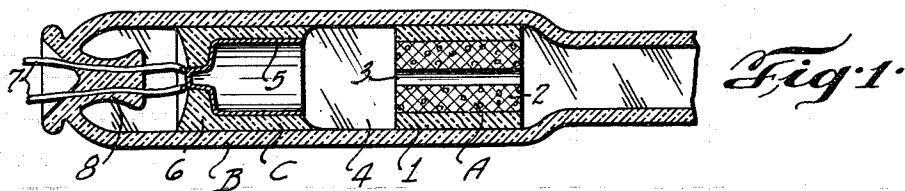
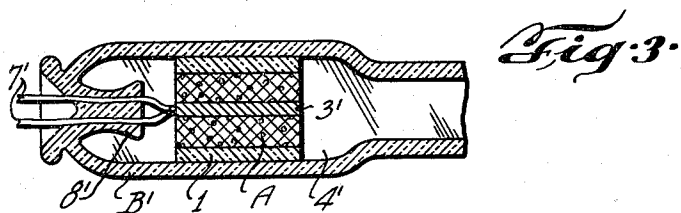
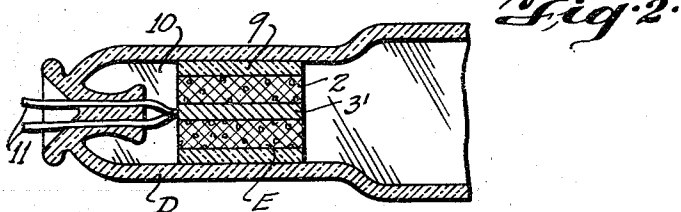
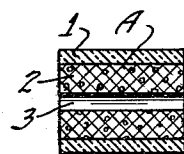
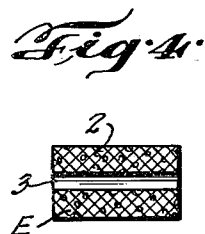
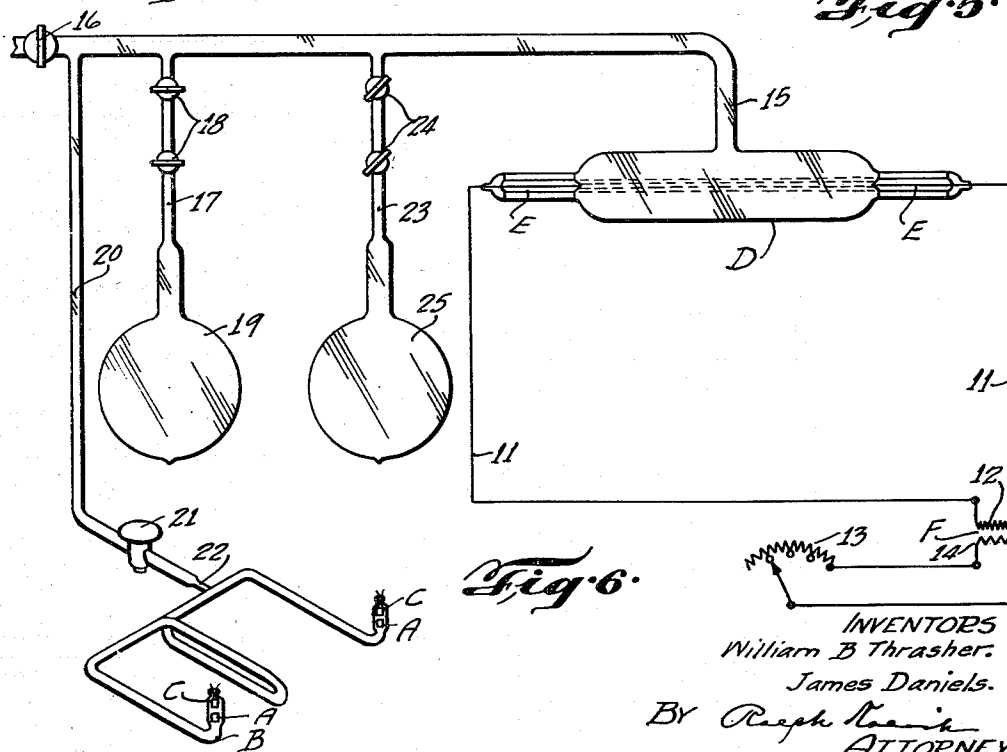
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W. B. THRASHER ET AL

2,065,252

LAMP OF THE LUMINOUS DISCHARGE TUBE TYPE

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LAMP OF THE LUMINOUS DISCHARGE
TUBE TYPEWilliam B. Thrasher and James Daniels,
San Antonio, Tex.

Application November 30, 1934, Serial No. 755,458

9 Claims. (Cl. 176—122)

This invention relates to a certain new and useful improvement in lamps of the luminous discharge or gaseous tube type.

Our invention has for its prime object the provision of a lamp of the type stated which emits a glow having a spectrum approaching that of a white light.

Our invention has for another object the provision in the conducting gas of a lamp of the type mentioned of a dispersion of carbon for modifying the characteristic light emitted from the tube.

Our invention has for still another object the provision, as a new article of manufacture, of a lamp of the type stated which, through the embodiment therein of unique means of our invention and discovery for initiating and maintaining a dispersion of molecular or particulate carbon in the conducting gas in the tube, will emit a white light of a commercially practicable brilliance and intensity for a period of usefulness comparable with that of the commercial forms of neon-tubes.

And with the above and other objects in view, our invention resides in the unique lamp and its novel features and its method of manufacture, all as presently described and set forth in the appended claims.

In the accompanying drawing,—

Figure 1 is a fragmentary sectional view of a luminous discharge tube of our invention, the lamp embodying a carbon-char plug or body as the source of particulate or molecular carbon, in conjunction with a conventional form of copper-electrode;

Figure 2 is a fragmentary sectional view of a modified form of a luminous discharge tube likewise of our invention, the lamp employing a carbon-char pencil as an electrode of the tube;

Figure 3 is a fragmentary sectional view of another modified form of a luminous discharge tube also of our invention, the lamp employing the carbon-char plug or body as an electrode of the tube;

Figure 4 is a sectional view of the carbon-char plug of Figures 1 and 2;

Figure 5 is a sectional view of the carbon-char pencil of Figure 3; and

Figure 6 is a diagrammatic view illustrating a method of, and apparatus for, the manufacture of a luminant gas having a dispersion therein of carbon particles and the manner of charging a tube with such gas for the production of a lamp of our invention.

Prior to detail reference to the drawing, which

illustrates practical embodiments of our invention, we would briefly outline that, in accordance with our invention, we provide a dispersion of particles of carbon, or, as it may be said, a molecular or particulate carbon dispersion, throughout the conducting gas of a luminous discharge tube, that is to say, a vacuum tube provided with electrodes across which may be impressed a suitable current and voltage. When such a tube is operated in substantially the usual manner, a light results which has a spectrum closely approaching or approximating that of a true white light,—a light very similar to daylight, and by which colors may easily be matched.

For a source of molecular carbon within the tube, certain gaseous mediums, as alcohol-vapor and illuminating-gas, as well as also certain liquid and solid mediums, such as glycerine and paraffine, respectively, and other similar low-vapor pressure carbon-bearing substances, may be successfully employed, for, when employed, as we have discovered, the tube glows with a white light for a considerable period of time.

For example, we may employ in the lamp a luminant gas which has its carbon content intrinsic in the gas, that is to say, a carbon-bearing conducting gas composed of carbon and other elements, such as alcohol-vapor or illuminating-gas, which, as we believe, is decomposed, when the tube is in use, under the influence of the electronic discharge of the tube, with resulting liberation of minute particles of carbon which become dispersed in the residual gas in the tube.

Again, we may provide a lamp employing an elementary gas, such as neon, helium, argon, hydrogen, or the like, and effect a carbon-dispersion therein by incorporating within the tube-space a carbon-bearing body which, while resident within the gas, is nevertheless extrinsic thereof.

Such an extrinsic source of carbon may be a liquid or solid carbon-bearing substance, preferably one having a low-vapor pressure, such as, for example, glycerine or paraffine, as well as other substances, such substances, as we believe, being decomposed when under the electronic discharge of the tube, with, likewise, resulting liberation of minute particles of carbon which become dispersed in the conducting gas of the tube.

Thus, for instance, we have found that a drop or two of paraffine or glycerine, deposited in a luminous tube filled with neon-gas and using copper electrodes, will successfully give a white light when the lamp is operated in the usual manner.

Finally, we may provide a lamp employing a conducting gas which initially contains a dispersion of carbon therein, that is to say, the carbon is dispersed in the gas prior to its introduction into the lamp-tube. In such case, the carbon may be obtained by employing a separate electronic discharge tube wherein is decomposed a carbon-bearing gas, or wherein a dispersion of carbon is effected in an elementary gas, as heretofore outlined, the resulting prepared luminant gas being employed for filling the tube of the lamp.

With respect to the available sources of carbon which may be successfully employed for our purpose, we may point out that, as we have discovered, paraffine, among the hydro-carbons, and glycerine, among the carbo-hydrates, and also many other similar carbon-bearing compounds, will produce a dispersion of carbon particles in a gas under reduced pressures, when subjected to the bombardment of electronic discharges, as occurs in a vacuum tube of the luminous discharge tube type.

Many of the alcohols, likewise, have a sufficiently low-vapor pressure to be suitable for our purpose, such as glycerine, already mentioned, and stearine from fats. Among the hydro-carbons, in addition to paraffine, we may mention methane and acetylene. Carbontetrachloride, iodoform, carbon-bisulphide, sulphurized hydro-carbons, benzene, naphthalene, and sundry other carbon-bearing compounds, have all been successfully used by us as a source, extrinsic to the gas, for effecting a carbon dispersion in the gas of the glow-tube for producing, according to our invention, white light.

Of the foregoing and other similar substances, it may be said that a tube employing those substances that have a relatively low vapor pressure will have a longer commercial life than the tube which employs those substances having a relatively high-vapor pressure, by reason of the fact, no doubt, that more of the low-vapor pressure substances may be satisfactorily employed in the tube without increasing the gas pressure in the tube to a degree which inhibits the successful operation of the tube for its intended purpose.

While we have enumerated several and sundry classes and groups of substances which we have found will successfully produce a white light in a glow-tube, as previously set forth, we do not wish to be limited to such specifically named substances, for our invention contemplates the use of any conducting gas in conjunction with other available sources of carbon for effecting a dispersion of carbon in the gas.

The theory of the operation of such a white light emitting lamp of our invention is, to some extent, obscure, and our present theory is that, under the influence of the electronic discharge in the tube, the carbon particles glow with a white light, which is of sufficient brilliance and intensity to overcome, as may be said, the characteristic glow of the conducting gas in the tube, causing the tube to glow with a white light.

The carbon particles are very small, approaching molecular dimensions, and will remain in suspension in the conducting gas for a very considerable period of time, for which reason it is possible, as we have stated, to employ either a gas having intrinsically a carbon-content, or a prepared conducting gas which initially contains a carbon-dispersion, without, in such case, any other source of carbon resident in the tube. Thus, for example, a glow-tube having copper

electrodes and employing as a luminant a conducting gas having, according to our invention, such a dispersion of particulate or molecular carbon therein, has emitted a white light over periods of a week or more without requiring any replenishing of the carbon dispersion. With neon-gas as the conducting medium or fluid, the carbon dispersion has shown no indication of settling or condensing out of the gas over a period of six weeks.

However, we have found that, unless some provision is made for automatically replenishing the carbon-content of the conducting gas in the tube, the settling out or removal of the carbon particles from the gas allows the gas pressure in the tube to rise or fall, as the case may be, which results from the decomposition of the gas in the tube until the tube ceases to glow or takes on the characteristic color of the residual or carbon-deprived gas under the influence of the glow discharge between the electrodes of the tube.

We prefer, accordingly, to employ the previously stated method of providing a suitable source of particulate or molecular carbon extrinsic or foreign to the conducting gas but contained within the lamp-tube in contact with the gas, for, in such case, the action of the electrical current impressed across the electrodes of the tube continuously, while the tube is in operation, effects a dispersion of molecular carbon from such source into and throughout the gas in the tube, whereby the white-light emitting characteristics of the tube may, under suitable conditions, be automatically maintained for an estimated period of at least three or four years.

For such source, in addition to those previously enumerated, we have discovered a unique material, which we employ in the preferred embodiment of our invention, as being highly efficient, convenient, and satisfactory for our intended purposes. The particular material referred to we designate as a carbon-char, that is to say, a char formed from organic compounds, such as sucrose, which are preferably low in ash, the char being prepared in such a manner that the product is highly porous and has a considerable electrical resistance. This char may be employed either as a target to be impinged by the electronic rays from the electrodes of a vacuum tube, or as an electrode, with equal effectiveness.

Referring now more in detail and by reference characters to the drawing, we will first describe such carbon-char and its ultimate characteristics and one method of producing the same.

A mixture is prepared, having as its chief ingredient sucrose, wood, or other suitable organic substance low in ash, which is ground with about eight to twelve percentum of its weight of a preferably gasifying and agglutinating substance, which may also comprise sucrose, or other like substances.

A suitable quantity of such mixture, preferably that which will produce a carbon-char of from three to five grams in weight, is packed into a short length of glass-tubing 1, which is then heated slowly for gradually bringing the tube and its contents to a low red heat. As a consequence, the mixture in the glass-tubing 1 is carbonized and forms a char, as 2, which is highly porous and of a cellular nature.

After the tube or shell 1 and its contents have cooled, the char 2 is drilled lengthwise and thereby formed with a small opening or bore 3 having a diameter which may vary from $\frac{1}{8}$ " to $\frac{1}{4}$ ". The resulting product we describe as 75

a carbon-char plug or body A, which is immediately available for use as a source of molecular carbon, as will presently appear, and as best seen in Figure 4.

5 In the one or preferred embodiment of our invention, a carbon plug or body A is disposed or mounted within the electrode chamber 4 of a lamp or luminous discharge tube B, the most effective location for the plug A, as we have
10 found, being in the immediate vicinity of an electrode C of the lamp B, preferably concentrically of the electrode chamber 4 of the lamp.

We prefer, when possible, to employ a commercial type of copper electrode C at each end of the tube B and to dispose a carbon-char A directly in front of each electrode C, that is to say, employing two carbon-plugs A to a tube. However, it may be said that a carbon-char A will satisfactorily perform its intended functions if employed in any other location in the lamp-tube B intermediate the electrodes C.

In our preferred embodiment, however, we provide a carbon-char body A which is mounted in the lamp-tube B preferably co-axially therewith, in such position as to be in front of, that is to say, inwardly the end of the tube from, the electrode C, which latter preferably, in the customary manner, comprises a tubular copper cup or tube 5 surrounded by a layer of mica 6, the whole being packed in the neck or terminal portion of the chamber 4 of the lamp-tube B and having the usual lead-in wires 7 sealed in the conventional wire-encasing capillary 8 of the lamp-tube B, as best seen in Figure 1.

35 The lamp-tube B is preferably similarly equipped and constructed at both ends, and, the plugs A and electrodes C having been sealed in the lamp-tube B, the lamp-tube B is then in condition to be charged with a carrier or
40 conducting gas, in the usual manner, which gas, as we have previously mentioned, may be any of the commercial forms of gases commonly used in red, blue, or other colored glow-tube lamps, such as the elementary gases neon, argon, hydrogen, oxygen, chlorine, or the like, or, if desired, gaseous carbon-monoxide or gaseous carbon-dioxide may be employed, although neon gas as the conducting gas in the tube is preferable.

50 If neon gas is employed, the gas is preferably charged into the tube at a pressure of approximately three millimeters of mercury or less, and an electrical alternating current of approximately fifteen to sixty milliamperes at a voltage of
55 from 4000 to 15000 volts is caused in the usual manner, to flow between the electrodes C of the tube B.

In a relatively short time, the usual red glow of the neon gas changes to white. This result, so far as we are able to determine, may be explained as follows,—

The char-plug A forms a permanent target for the bombardment of electrons discharged from the electrodes C of the tube B, which
65 effect a dislodgment of molecular or particulate carbon from the plug A, the dislodged carbon, under the propulsive effect of the electronic rays from the electrodes C, becoming dispersed or scattered and suspended in the gas of the tube B.

70 The dispersed carbon particles are very small, approaching molecular dimensions, and, under the influence of the electronic discharge in the tube B, glow with a white light of sufficient
75 brilliancy and intensity for overcoming the char-

acteristic glow of the neon gas, so that the lamp B emits a white light having the characteristics of daylight.

Apparently, no chemical reaction takes place between the gas and the carbon, the gas serving to conduct the electrical current between the electrodes C of the tube and as a carrier for the carbon dispersion.

Tubes that have been properly "burned in" and have been idle for several weeks or longer, glow with a white light immediately when they are turned on. However, if a tube should be idle long enough for the carbon particles to settle out, the white light will reappear shortly after the current is turned on.

15 As the lamp is used, it will be found that, for various reasons not as yet clearly understood, some of the carbon particles settle out or otherwise disappear. The carbon-plug A, however, provides a permanent source of carbon for dispersion in the gas to automatically, as it may be said, replace those lost from the gas.

We have found that, at the rate the carbon is consumed in the operation of the lamp, a consumption of not more than two or three
25 tenths of one gram of carbon will suffice to keep the lamp glowing with a white light for more than a year. It is preferable, therefore, to provide the carbon-plugs A of from three to five grams in weight.

30 The pressure of the gas in a successful tube to produce a white light is approximately three millimeters of mercury, or even less, which is lower than that for a neon tube, as heretofore manufactured, which is to be used for sign or other commercial purposes, a pressure of gas of from 6 to 15 mm. of mercury being commonly employed for such latter class of luminous discharge tubes.

In practice, however, we prefer to charge the tube B with a prepared luminant gas containing
40 initially a dispersion of carbon therein, which luminant gas is prepared from one of the suitable conducting or carrier gases before mentioned, in which has been effected a dispersion of particulate molecular carbon from a source extrinsic to the gas. We will accordingly now describe the preferred, though not necessarily the only, method for the manufacture of such prepared luminant gas, and the manner of charging the lamp-tube therewith.

50 A so-called generating-tube D is provided, which may comprise a glass-tubing wherein, as the electrodes of the tube, we prefer to employ what we may describe as carbon-char pencils E, the carbon-char pencil E being formed by simply forcing the charred core 2 out of the glass tube 1 of a carbon-char plug A, as best seen in Figure 5.

For use as an electrode, the core or pencil E is preferably surrounded with a layer of mica 9, and the whole packed into the suitably proportioned neck or terminal pocket 10 of the generating-tube D, as best seen in Figure 2.

The usual lead-in wires 11 are firmly connected to the char-pencil E by means of a copper rod 3' disposed in the aperture or bore 3, and the whole is then, in the conventional manner, sealed to and in the generating-tube D.

Both ends of the tube D are equipped in the same manner, and the respective leads 11 are connected in circuit with the secondary 12 of a suitable alternating current transformer F, which, in turn, is controlled by means of a suitable rheostat 13 disposed in the primary circuit 14 of the transformer. Preferably the transformer may vary in output voltage from 4000 to 15000 volts, and
75

the current output may vary from 15 to 60 milliamperes.

The interior of the generating-tube D is communicated with a suitable vacuum pump (not shown) by means of a pipe 15 having a stop-cock 16 between the tube and the pump, in the conventional manner. Leading into the pipe 15 between the stop-cock 16 and the tube D, is a branch pipe 17 provided with a pair of stop-cocks 18, which branch pipe 17 communicates with a flask 19 containing a supply of the selected carrier gas under a suitable pressure.

Another branch or feed-pipe 20 leads from the pipe 15 through a suitable stop-cock 21 and connector piece or capillary tube 22, to the tube of the particular glow-lamp, which is to be filled with the carbon-charged gas, as, for example, the lamp B heretofore described. Also, a third branch pipe 23, equipped with a pair of stop-cocks 24 and communicating the pipe 15 with a storage flask 25, may be provided, if desired.

Initially, the flask 19 is charged with the particular conducting or carrier gas which is to be employed in the glow-tube B, and, as we have stated, any of the commercial forms of gases commonly used in red, blue, or other colored glow-tube lamps has been found satisfactory for such use. In such regard, it may be said, in repetition, that we have successfully employed such elementary gases as neon, argon, hydrogen, oxygen, chlorine, and the like, although we prefer to employ neon gas, as the carrier or conducting gaseous medium.

In the usual manner, both the lamp-tube B and the generating-tube D are evacuated by opening the pump stop-cock 16 and the lamp stop-cock 21. This being effected, the cocks 16, 21, are closed and the cocks 18 are opened for charging the tube D with the gas from the flask 19.

Preferably the pressure of the gas in the flask 19 is such as to charge the generating-tube D with the gas at a pressure of from fifteen to twenty-five millimeters of mercury, that is, when neon is the gas employed.

The supply flask 19 being cut-off, a high voltage alternating current, obtained from the transformer F, is then caused to flow through the neon gas in the tube D between the pencil-electrodes E. In a short time, the usual red glow of the neon gas, if such is the gas used, changes to white. The cause of this phenomenon is obscure, but we believe to be due to molecular disintegration of the char-pencil E under influence of the electronic activity of the pencil E acting in its capacity as an electrode of the tube.

Such disintegration of the pencil E results in a dispersion of carbon particles in the gas, with the production and emission of a white light, substantially as heretofore described with relation to the tube B.

The current is kept on until the heat generated by the electronic discharge causes a paling of the light owing to an increase of the pressure of the gas within the chamber D.

The supply of current is continued, while the stop-cock 21 is opened for communicating the generating-tube D with the lamp-tube B, and the carbon-charged luminant gas from the generating-tube D is forced into the lamp-tube B.

The current supply from the transformer F is meanwhile increased for augmenting the heating of the gas in the tube D for maintaining the desired pressure therein, until the lamp-tube B is charged with the luminant gas at the desired

pressure, which, as has been said, is approximately three millimeters of mercury.

The charging of the lamp-tube B being completed, the stop-cock 21 is closed, and the capillary-tube 22 is sealed and broken, the glow-lamp B then becoming immediately available for use in the usual manner.

After the stop-cock 21 is closed, the residue of the luminant gas, if any, in the generating-tube D may be discharged into the storage flask 25 for future use, after which the supply of current from the transformer F is discontinued, and the apparatus is in condition for a repetition of the luminant gas making and lamp-charging cycles as described.

As an alternative to the use of the char-plug A as a target-source of molecular carbon in the lamp-tube, we may employ the carbon-plugs A, or the carbon-pencils E, as previously described, alone as the electrodes of the tube, the usual copper electrodes, in such case, being wholly omitted.

Figure 3 illustrates, for example, a construction employing the carbon-plug A as an electrode of a luminous tube B', the plug A, with its glass shell 1, being mounted in the end of the electrode chamber 4' of the tube B'. The conducting rod 3' is inserted in the bore of the plug A and is connected to the wires 7' leading in through the capillary 8', in the usual manner, as heretofore described for the tube B.

In the use of the tube B', a carbon dispersion in the gas of the tube is effected in the same manner and with the same consequences as heretofore set forth regarding the tube D.

It will be also readily seen that, if desired, the tube D itself comprises a luminous discharge tube-lamp, and hence any vacuum tube, when equipped with a carbon-plug A or pencil E, and charged with a suitable carrier gas, as neon gas or the like, may have a carbon dispersion effected directly in the lamp-tube for effecting a white light emission from the tube, the presence of the char, whether as a plug or pencil, automatically maintaining a dispersion of molecular or particulate carbon in the conducting gas, whereby the tube or lamp will emit a white light of a commercially practicable brilliance and intensity for a period of usefulness comparable, as we stated in the outset, with that of present day commercial forms of neon tubes.

The light obtained from the lamp is a white-light which has a spectrum approximately that of daylight and enables by its illumination facile comparison and matching of colors.

The tube is very brilliant and apparently gives more light per unit of length than a similar sized tube filled with carbon-dioxide but without the carbon-dispersion of our invention.

We have constructed tubes up to thirty-two feet between electrodes and eleven millimeters inside diameter. We have also constructed tubes having an inside diameter of thirty-five millimeters inside diameter, which also emit a white light, although it is lacking in brilliancy. The quantity of light per unit of length, however, is about the same as for the smaller diameter tubes.

While we have described one method of producing a carbon-char plug and a carbon-char electrode, we do not wish to be limited in the practical application of our invention to the use of sucrose as a material for producing the carbon-char, and it will be understood that other changes and modifications in the employment of carbon-bearing gases, in the manufacture and use of carbon-char, and in the form, construction,

arrangement, and combination of the several parts of our luminous discharge tube or lamp may be made and substituted for those herein shown and described without departing from the nature and principle of our invention.

Having thus described our invention, what we claim and desire to secure by Letters Patent is,—

1. A glow tube having a gas inherently incapable of producing a white light, in combination with a carbon body disposed within the tube directly in the path of the electronic discharge of an electrode of the tube.
2. A glow tube having a gas inherently incapable of producing a white light, in combination with an electrode embedded in a carbon body disposed within the tube for effecting the production of a white light from the tube.
3. A glow tube having a gas normally giving a colored light when under the influence of electronic discharge in the tube, in combination with a carbon body disposed between an electrode and the glow chamber of the tube.
4. In a glow tube, a glow chamber, a gas therein having normally a colored light responsive to electronic discharge, an electrode, and a carbon body disposed for substantially obstructing the path of electronic discharge from the electrode to the glow chamber of the tube.
5. A glow tube characterized in being devoid of any originally carbon-bearing gases, in combination with a carbon-bearing body disposed in the tube in the path of electronic discharge of an electrode of the tube.
6. In a glow tube characterized in being devoid

of any originally carbon-bearing gases and having a glow chamber and a cylindrical electrode chamber communicating therewith, in combination, an electrode in the electrode chamber, and a cylindrical carbon body snugly fitting in the electrode chamber between the electrode and the glow chamber.

7. In a glow tube characterized in being devoid of any originally carbon-bearing gases and having a glow chamber and a cylindrical electrode chamber communicating therewith, in combination, an electrode in the electrode chamber, and a cylindrical carbon body snugly fitting in the electrode chamber for surrounding the electrode therein.

8. In a glow tube characterized in being devoid of any originally carbon-bearing gases and having a glow chamber and a cylindrical electrode chamber communicating therewith, in combination, a cylindrical carbon body snugly fitting in the electrode chamber, said body having a cylindrical aperture, and a cylindrical electrode snugly fitting in said aperture.

9. In a glow tube characterized in being devoid of any originally carbon-bearing gases and having a glow chamber and a cylindrical electrode chamber communicating therewith, in combination, a cylindrical carbon body snugly fitting in the electrode chamber, said body having a cylindrical aperture, and a solid cylindrical electrode snugly fitting in said aperture.

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