(No Model.)

H. L. SAYEN.

ROENTGEN RAY TUBE.

No. 594,036. Patented Nov. 23, 1897.

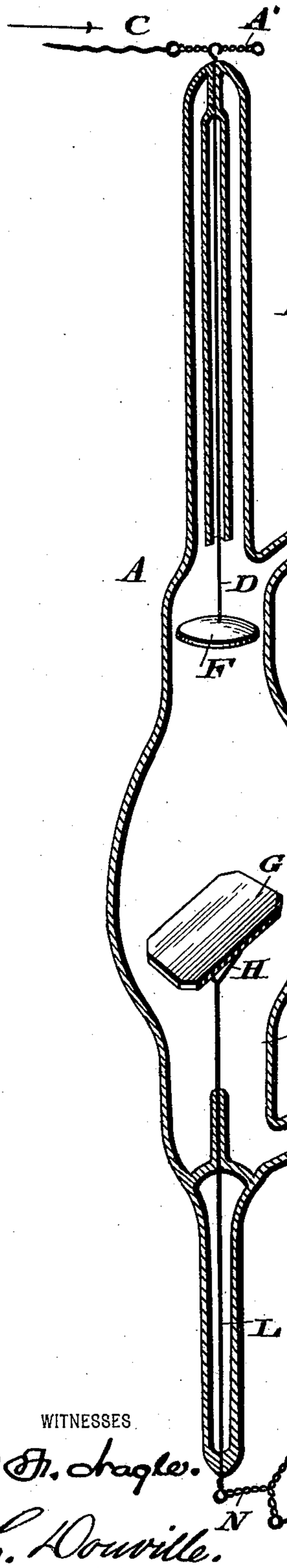

Fig. 1.

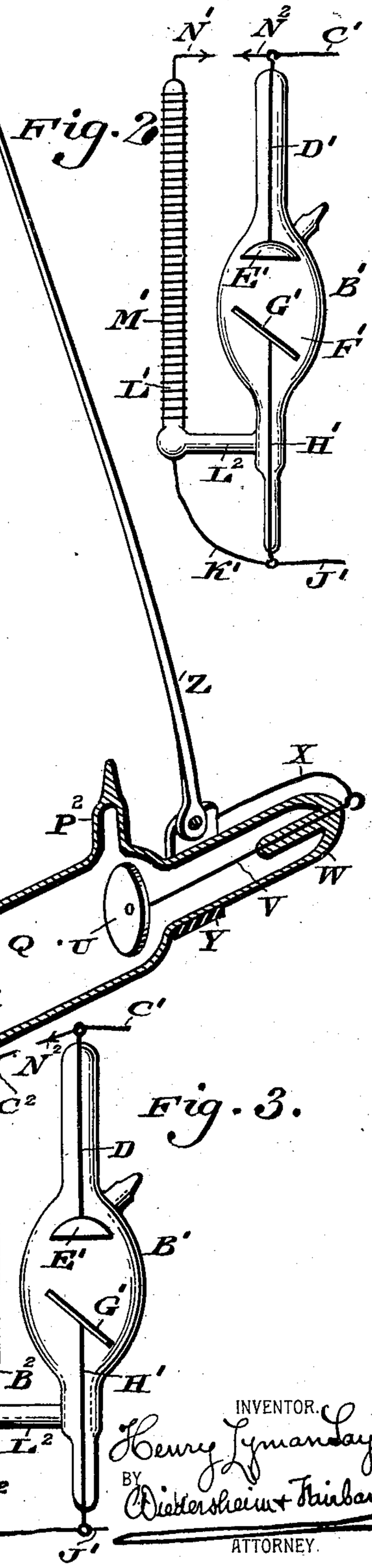

Fig. 2.

Fig. 3.

WITNESSES

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ROENTGEN-RAY TUBE.

SPECIFICATION forming part of Letters Patent No. 594,036, dated November 23, 1897.

Application filed April 29, 1897. Serial No. 634,319. (No model.)

To all whom it may concern:

Be it known that I, HENRY LYMAN SAŸEN, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented a new and useful Improvement in High-Vacuum or Roentgen-Ray Tubes, which improvement is fully set forth in the following specification and accompanying drawings.

My invention relates to high-vacuum tubes more especially used for the generation of X-rays, (Roentgen rays;) and it consists of a novel method of providing the same with an automatic and rapid adjustment for the pressure of the gas therein.

It further consists of novel details of construction, all as will be hereinafter fully set forth, and pointed out in the accompanying claims.

As is well known to those skilled in the art, the gas in a high-vacuum tube, being rarefied to such a high degree, is ordinarily in a very unstable condition as regards pressure. Continuous use of a tube seems to decrease the pressure of the gas therein, so that in time it is impossible to get any current through the tube at all, since the conductivity of gases at these low pressures decreases with the pressure. It is also known that the lower the pressure is in a tube the greater is the penetrability of the light generated, wherefrom it will be seen that it is essential to have a tube in which the pressure of the gas therein can be altered at will and stay where first put. For instance, in an X-ray picture of the hand contrast between bone and flesh is much better when the pressure of the gas is greater, while in locating foreign metallic bodies in the trunk it is desirable to have greater penetration and consequently less pressure. To overcome the difficulties hereinbefore stated, tubes have been constructed with a bulb connected with the main tube and containing potassic hydrate or other similar material which is capable of giving off gas on heating and the regulation effected by means of a spirit-lamp placed under the bulb. It has further been suggested to use a resistance-coil around the aforesaid bulb, obtaining the necessary heat by an auxiliary current passing through the coil. In these forms of tubes regulation not only lacks automatic action, but is exceedingly difficult, for the following reasons:

First. Experiment has shown that the material in the bulb must be used in a very small quantity in order that it will be possible to manipulate the auxiliary source of heat to effect the desired change in pressure. This small amount of material is incapable of absorbing the gas given off from the main tube in case of its getting hot from excessive current, and the conductivity of the main tube increases, allowing it to absorb more and more current until disastrous results are produced.

Second. It is almost impossible to keep the pressure of the gas constant, and, as a very small change in pressure makes considerable difference in the penetrability of the X-rays, consequently an exceedingly minute change in temperature is often more than necessary to produce the desired result.

Figure 1 represents a vertical sectional view of a Roentgen-ray or high-vacuum tube having attached thereto my improved device for automatically adjusting the pressure of the gas therein. Figs. 2 and 3 represent side elevations of modified embodiments of the principle of my invention.

Similar letters of reference indicate corresponding parts in the figures.

Referring to the drawings, A designates a high-vacuum X-ray or Roentgen-ray tube, which is, except as hereinafter specified, of the usual construction, said tube having the high-vacuum chamber B and the conductor C leading into a portion thereof and communicating with the conductor D, to which the electrode F, of aluminium or similar material, is attached.

G designates the other electrode, of platinum or similar material, which has the conductor H leading thereto, said conductor being attached to the conductor L, which extends to the exterior of the tube, said conductor L having the conductor N attached thereto exteriorly of the tube. The conductor N has a branch N′ leading into the extension P, which latter opens into the vacuum-chamber Q.

R designates a chamber, bulb, or pocket

which acts as a gas-producing means and extends into the chamber Q, though out of communication therewith, and is filled with potassic hydrate or other suitable material S, said bulb opening into the passage T, which latter communicates with the high-vacuum chamber B.

It will of course be evident that it is not always necessary to have material in the chamber R, as the mere heating of the said bulb will effect the vacuum and secure the desired result, it being further noted that the chamber R may open directly into the vacuum-chamber B without the use of the passage T.

U designates a plate or electrode, of aluminium or similar material, located in the chamber Q and having a conductor Y leading therefrom, said conductor having an extension X leading to the clip or support Y.

Z designates a conductor provided with the terminal Z′ and which is pivotally attached to the clip Y, which is suitably supported, so that the distance between said conductor Z and the terminal or branch A′ of the conductor C can be varied as desired.

The function of electrode U in vacuum-chamber Q is to heat the chamber R by molecular bombardment should the current take the circuit Z′ Z V Q N′ N.

The main tube A is exhausted through the nipple P′ to the highest vacuum obtainable with a mercury-pump, during which operation the chamber R is kept warm by the current from a small induction-coil, which is connected therewith, the current passing through the circuit X V Q N′ A^3, the chamber Q having been previously exhausted the desired amount through the nipple P^2. After sealing off from the pump the chamber R is allowed to cool.

The operation is as follows: C is connected to the negative pole of the induction-coil or other suitable source of current and A^3 to the positive pole. The resistance of the chamber B to the current is practically infinite, and the current jumps across the gap A′ Z′, taking the path of the circuit Z′ Z V Q N′ N. This heats R, causing it to emit gas through the passage T into the chamber B until the pressure of gas therein is sufficiently increased or the vacuum reduced, so as to allow the current to take the path through the main tube B in preference to jumping across the spark-gap A′ Z′. Immediately then R cools and reabsorbs the gas, and the current jumps again from A′ to Z′ because of the decreased conductivity of tube B. It will be seen, therefore, that there will be an intermittent current through chamber Q, due to minute fluctuations in the pressure in B, serving to keep R at the desired temperature. If the distance from A′ to Z′ be increased, the resultant pressure in B will be less because of the increased resistance of the circuit A′ Z′ Z, &c.

Neither of the objections hereinbefore mentioned is inherent to my form of tube, because owing to this immediate regulation it is possible to use more potash S in the bulb R, and when the current used with my tube is excessive the extra gas evolved is absorbed by S, which cools immediately on the lowering of the pressure in the tube. The limit then of a tube equipped in accordance with my invention is the melting-point of the platinum-plate, and if we provide means for getting rid of the heat by conduction or otherwise and immerse the tube in oil to prevent sparks from puncturing the tube we have practically no limit to the amount of current which can be used, and consequently no limit to the light produced.

It will thus be seen from the foregoing that by my invention positive means are provided so that when the conductivity of the tube decreases, due to an increase of vacuum, more current takes the path of the shunt-circuit and sends gas into the tube, or vice versa, and it will be evident that I need not necessarily be limited in every instance to the exact means which I have shown and described in the present instance, but reserve to myself the right to make such changes as will come within the spirit of my invention.

In Figs. 2 and 3 I show modifications of the principle of my invention, the tube B′ in Fig. 2 having a high-vacuum chamber F′ and the electrodes E′ G′ therein, the latter being connected by means of the conductors D′ H′, respectively, with the conductors C′ J′. L′ designates a tube located adjacent the tube B′ and filled with potash or similar material, said tube L′ being supported from the tube B′ by means of the neck L^2. M′ designates a resistance-coil wound around the tube L′ and having a branch K′ leading to the conductor J′, the upper portion of said resistance-coil having a branch N′ deflected toward, but disconnected from, the branch N^2, and the latter being connected with the conductor C′.

In the construction seen in Fig. 3 the high-vacuum tube and its adjuncts are substantially the same as in Fig. 2, the tube L′ containing potassic hydrate or other suitable material and being supported by the neck L^2 from the tube B′ and being provided with a conductor A^2, the latter having a branch deflected toward, but disconnected from, the conductor N^2, while the lower conductor B^2 is connected with the conductor A^2 and has a branch D^2, which leads to the conductor J′. There is an annular chamber Y′ around the tube L′, which is partially exhausted of gas, so that the current in taking the path of the circuit C^2 A^2 B^2 D^2 J′ heats the tube L′, due to the resistance of the gas to the current.

I do not desire to limit myself to the use of my method and apparatus in connection with X-ray or Roentgen-ray tubes, but may use the same with any vacuum tubes or bulbs.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. As a means for varying the pressure in a high-vacuum tube, a main circuit for operating the tube and a shunt-circuit for varying the pressure.

2. In combination with a high-vacuum tube, a shunt-circuit arranged in proximity thereto, means connected with the above and set into operation by the current in the shunt-circuit to cause gas to enter said tube, and means for varying the pressure in the shunt-circuit.

3. The combination with a high-vacuum tube of a shunt-circuit arranged in proximity thereto, and means connected with the above and set into operation by the current in the shunt-circuit to cause gas to enter said tube.

4. In combination with a high-vacuum tube, a vacuum-chamber, a bulb containing potassic hydrate or other suitable material located therein, but out of communication therewith, a passage leading from said bulb to said high-vacuum tube, and a shunt-circuit arranged in proximity to said bulb.

5. In combination with a high-vacuum tube, a passage T leading therefrom, a bulb R containing potassic hydrate or other suitable material S therein, in communication with said passage T, a vacuum-chamber Q, having an extension P, in which the conductor N′ is located, a conductor V, having an electrode U attached thereto, and disconnected from said conductor N′, and a conductor Z in proximity to but disconnected from the terminal A′.

6. A device for varying the pressure of a high-vacuum tube, consisting of the passage T, the bulb R in communication therewith, and containing potassic hydrate or other suitable material, a vacuum-chamber adjacent to and disconnected from said bulb, said chamber having an extension P in which the conductor N′ is located, a conductor V also located in said chamber and having a plate U attached thereto and a conductor Z in communication with said conductor V, and in proximity to but disconnected from the main circuit.

7. In combination with a high-vacuum tube, a passage T leading therefrom, a bulb R containing potassic hydrate or other suitable material S therein, in communication with said passage T, a vacuum-chamber Q, having an extension P, in which the conductor N′ is located, a conductor V having an electrode U attached thereto, and disconnected from said conductor N′, and a conductor Z suitably supported, so that the same may be moved toward or away from the terminal A′.

HENRY LYMAN SAYEN.

Witnesses:
JOHN A. WIEDERSHEIM,
WM. C. WIEDERSHEIM.

Disclaimer in Letters Patent No. 594,036

DISCLAIMER.

594,036.—*Henry Lyman Saÿen*, Philadelphia, Pa. ROENTGEN-RAY TUBES. Patent dated November 23, 1897. Disclaimer filed April 29, 1908, by the assignee, *Queen and Company.*

Enters this disclaimer—

"To that part of the claim in said specification which is in the following words, to wit:

"1. As a means for varying the pressure in a high-vacuum tube, a main circuit for operating the tube and a shunt-circuit for varying the pressure."—[*Official Gazette, May 5, 1908.*]