(No Model.)

E. THOMSON.

ROENTGEN RAY TUBE.

No. 575,772. Patented Jan. 26, 1897.

FIG. 4.

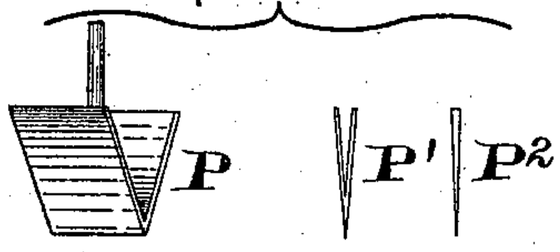

FIG. 1.

FIG. 3.

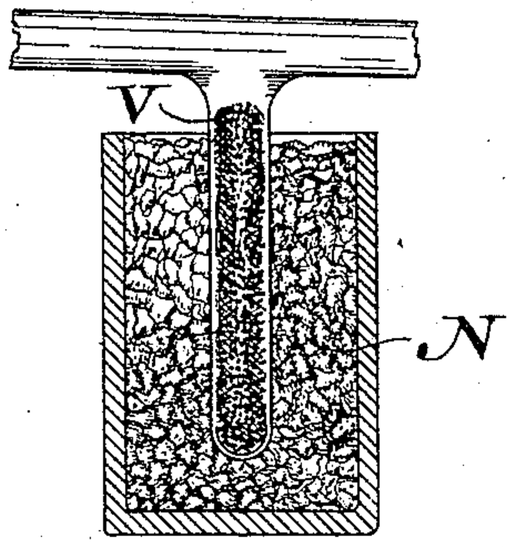

FIG. 2.

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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

ROENTGEN-RAY TUBE.

SPECIFICATION forming part of Letters Patent No. 575,772, dated January 26, 1897.

Application filed August 21, 1896. Serial No. 603,447. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Roentgen-Ray Tubes, (Case No. 428,) of which the following is a specification.

My present invention relates to improvements in the construction and arrangement of a Crookes tube especially adapted to the production of what are called "Roentgen" or "X" rays. In the working of such tubes the Roentgen rays are emitted from bombarded surfaces in the path of the cathode-rays. They are also produced in quantity if the material bombarded is of a dense close character, like platinum. It is necessary also to maintain for the proper working of such apparatus a certain degree of exhaustion, neither too high nor too low. During the working with tubes having the incomplete or Crookes vacuum there is a tendency for the exhaustion to rise to such an extent as to put the apparatus out of use by making the vacuum too non-conducting.

It is one of the objects of my present improvements to secure an apparatus which can be worked either by discharges in one direction, as from static machines or Ruhmkorff coils, or by alternating discharges, such as are obtained from a high-frequency coil of high potential.

It is also the object of my invention to control during the use of such tubes the degree of vacuum, and in case the vacuum rises to too high a degree to lower it while the tube is in service and without interrupting the operations dependent thereon.

Figure 1 shows a Roentgen-ray tube constructed in accordance with my present invention, and which I have found very successful in practice. Fig. 2 is a modified form somewhat more difficult of construction. Fig. 3 is an alternative way of working, and Fig. 4 shows details.

In Fig. 1 the glass envelop or bulb B is preferably constructed of a glass not containing lead or heavy bases, and in it are mounted two concave cathode-disks C C′ with their concavities presented to each other. They are preferably set a little farther apart than twice the radius of the center of curvature of each, so that the cone of rays which each produces would meet nearly at a common center. These cathodes are made of aluminium or of some such metal not subject to conversion of particles under the influence of an electric discharge. They are mounted upon glass stems extending into the bulb, as shown, and connected to the terminals T in the usual way, said terminals being made of platinum wire and sealed into the glass. At the middle point between the two concave cathodes and intersecting the line joining them is a bent piece P, of platinum foil, securely mounted on a wire carried outward through a glass stem and to a third terminal A, also of platinum. The piece P should be made of platinum foil or other metal of fairly dense character. The angle between the two leaves may be varied considerably, as shown in Fig. 4 at P P′ P^2. The Roentgen or X rays are emitted from those parts of its surface which are bombarded by the two cathodes. In the direction R such rays are obtained from both sides of the platinum wedge, and are there found of greatest intensity, so that the direction toward R is the most useful one in ordinary cases. The tube may be excited by attaching the terminals T T to the terminals of a high-frequency coil of sufficient potential, whereby a rapid succession of alternating discharges is passed through the tube, each concave disk C C′ becoming an anode or cathode in extremely rapid alternation, while the platinum piece P is bombarded from both sides and emits the Roentgen rays abundantly. Should the vacuum, however, be too high or become too high during use, which is apt to be the case, I provide for overcoming this difficulty a supply of material within the bulb-space or a space connected thereto, as in a side tube V, Figs. 1 and 2, which when heated gives out gas, with the effect of reducing the vacuum in accordance with the amount of gas so given up. For this purpose I may employ potassic, sodic, or calcic hy-

drates or hydrated calcic sulfate, or I may employ volatile materials, which, however, are only volatile in vacuum on increase of temperature. For this purpose some of the ammonia compounds, such as sulfate of ammonia, may be employed. I may likewise employ materials which undergo somewhat destructive distillation on heating, or I may use substances containing occluded gases, such as spongy platinum, or fine powder, such as dry calcium oxid or animal charcoal. I find, however, that the hydrates of the alkalies are adaptable to the purpose of maintaining during the use of the tube a proper degree of exhaustion. In such cases the heat of a lamp L, Fig. 2, may be employed to constantly keep the substance inclosed in the part V warmed.

The form of tube shown in Fig. 2, while more difficult to construct, has the same general features as that shown in Fig. 1. The axes of the cathodes instead of being in the same line are inclined at an angle one with the other and intersect or meet at the surface of a platinum plate P. In this case the direction of the rays is downward from the face of the platinum plate. In fact, they are sent out in every direction from the face of the platinum plate, but are most available in the direction R on account of the lack of interference by interposed objects.

While the adjustment of the vacuum may be obtained by warming the vacuum-varying chamber V with its contained material, it is to be understood that the adjustment may be secured by producing at the start too low a vacuum by having present some material the vapor-tension of which is too great to permit as high a vacuum as is needed being obtained, and that by cooling one portion of the bulb, either one of its sides or an extension therefrom, the condensation of such material and raising of the vacuum will be secured to the degree required for proper work. Such an arrangement is indicated in Fig. 3. Thus, assuming mercury-vapor to be present in some quantity in the tube as originally constructed, placing the part V in the freezing mixture N, Fig. 3, and so lowering the vapor-tension of the mercury would take it out of the tube and increase the vacuum, whereas by reducing the surface exposed to the freezing mixture, or at least allowing a slight increase of temperature in the part V to take place, such condensed vapor would be given out in case the vacuum became too high. The application of heat is of course the most convenient and in most instances would be preferred.

The tube of my invention is universal in regard to its application to different sources of discharges. I have already described how it may be employed with high-frequency discharges by connecting the terminals T T to the terminals of such apparatus. For use with an induction-coil as an exciter the terminal A or middle terminal is connected, so that the platinum plate P becomes an anode, while the concave disks C C′ may be either coupled singly to the other terminal as cathodes or may be connected together by a wire and attached as a double cathode. The same procedure may be employed with a static machine as with a Ruhmkorff induction-coil, while in all these cases the vacuum may be kept at the most efficient working point by the use of the adjusting devices described, and the connection of the different terminals may be variously made.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An apparatus for the generation of Roentgen rays, comprising a chamber having a Crookes vacuum and provided with a pair of concave electrodes both of which face upon a bombarded metal piece situated in substantially the focus of their concavities.

2. In an apparatus for the generation of Roentgen rays, a closed chamber having a Crookes vacuum, provided with terminals carrying concave disk cathodes focused to nearly a common point, and a bombarded metal piece, such as a piece of platinum, situated at the common focus of the cathodes and connected to a third terminal.

3. In an apparatus for the generation of Roentgen rays, a chamber within which a Crookes vacuum is maintained, having terminals carrying concave disk cathodes focused to nearly a common point, and a bombarded metal piece composed of a wedge-shaped piece of platinum mounted in the common focus of the cathodes and connected to a third terminal.

4. In an apparatus for the generation of Roentgen rays, an exhausted chamber having a pair of concave cathodes facing upon a bombarded metal piece in their common focus; in combination with means for adjusting the vacuum, consisting of a substance inclosed within or in an extension of the chamber adapted to alter its vapor tension by a change in temperature, and means for suitably adjusting the temperature of the apparatus.

5. In an apparatus for the generation of Roentgen rays, a closed chamber inclosing a Crookes vacuum, having terminals carrying concave cathodes focused to approximately a common point, and a bombarded metal piece located at the common focus of the cathodes and connected to a third terminal; in combination with a vacuum-adjuster comprising a tube extending out from the chamber and containing vaporizable or volatile material adapted to change the vapor tension in the tube by change of temperature.

6. In an apparatus for the generation of Roentgen rays, a closed chamber inclosing a Crookes vacuum, having terminals carrying concave cathodes focused to approximately a common point, and a bombarded metal piece located at the common focus of the cathodes

and connected to a third terminal; in combination with a vacuum-adjuster comprising a tube extending out from the chamber and containing vaporizable or volatile material adapted to change the vapor tension in the tube by change of temperature, and means for changing the temperature of the apparatus.

In witness whereof I have hereunto set my hand this 18th day of August, 1896.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
AUGUSTINE R. EVEREST.