W. ROBINSON.

X-RAY TUBE.

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1,226,383.

Patented May 15, 1917.

Fig. 1.

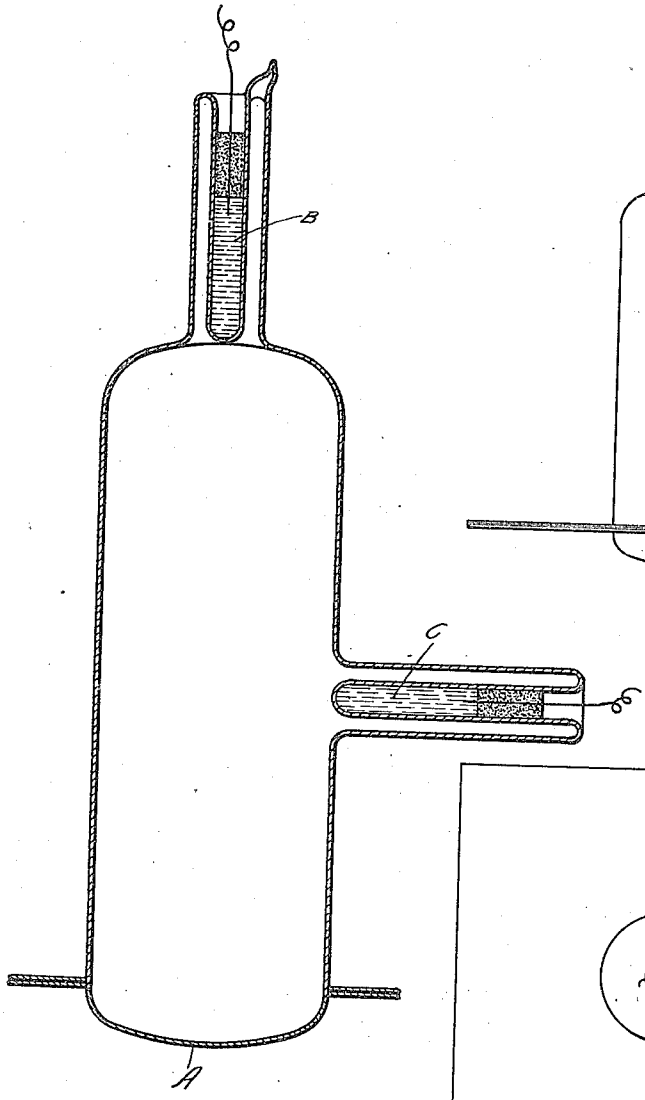


Fig. 2.

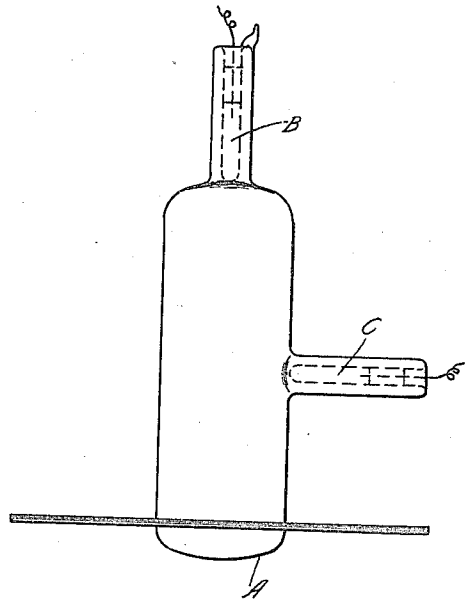
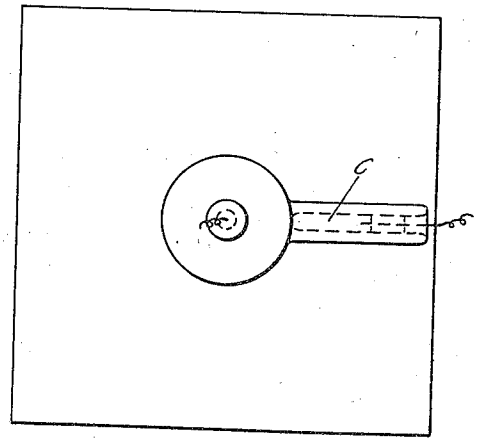


Fig. 3.



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UNITED STATES PATENT OFFICE.

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X-RAY TUBE.

1,226,383. Specification of Letters Patent. Patented May 15, 1917.

Application filed July 18, 1916. Serial No. 109,885.

To all whom it may concern:

Be it known that I, WILLIAM ROBINSON, a subject of the King of Great Britain, residing at West Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in X-Ray Tubes, of which the following is a specification.

The object of the present invention is to provide a tube of the character described applicable for use in such applications as those in which X ray tubes are ordinarily employed, viz. for making radiographs by X-ray emanations or for treatment work, such as for diseases of the skin, for superficial cancer, etc., and further to provide a tube of such construction that it will be cheap to manufacture, easy of shipment and effective in penetrating power for the purposes to which it is to be applied. Such tubes are ordinarily provided with a small piece of platinum or tungsten mounted on the end of one of the electrodes, and this is known as the target or anticathode. In my improved form of tube I dispense with this target, and find that I am enabled to get satisfactory focusing or directing of the rays in the tube by making the walls thereof of a certain shape. Furthermore, I construct my tube in such a manner that a stable vacuum is maintained. Heretofore, it has been necessary to provide means for regulating the vacuum which is charged by the influence of metal parts within the vacuum chamber. More specifically speaking, I make said walls straight-sided and of a material which is opaque to the effect of the rays which emanate therefrom, with the exception, of course, of a suitable window provided therein in order that the effective rays may pass through the window. The material of which the tube is composed may be of lead glass, having sealed or suitably fused therein a lime glass window at the "free" or working end of the tube. This material need not necessarily be lead glass, but lime glass or any glass ordinarily employed in the construction of X ray tubes may be used instead throughout the tube. In the latter case, however, suitable care should be taken to provide a satisfactory screen for the protection of the operator and patient from the injurious effects of the rays. My particular improved construction of tube permits of such a screen being readily applied, as by cutting a suitable hole in said screen a little larger than the "free" or working end of the tube and slipping the screen over said tube end. In handling the tube the latter can be held with the working end downward toward the affected part of the patient being treated.

The tube of my improved construction may be run on either alternating or direct current, and, of course, the tube is excited by the usual exciting arrangements, such as by a Thomson or Tesla high frequency coil, etc., together with a suitable condenser for furnishing the necessary electrical energy to the coil, these arrangements and appurtenances being so well known in the art that they do not require to be mentioned specifically for the purposes of this application.

In the conventional form of spherical tube heretofore manufactured it is necessary that the electrodes be relatively far apart in order to give satisfactory results, and in order to obviate any possibility of puncturing the tube. In some cases the distance between the electrodes is as much as 8″ or 9″. This necessitates a relatively high potential to secure tube discharge and involves increased penetration of X ray effect and renders it necessary to maintain the tube farther away from the patient in case said tube is used for medical treatment work. In the tube of my invention the electrodes need only be a short distance apart, such as a distance of 3″ or 4″, and a comparatively low potential only is needed to discharge the tube and yet give results comparable with the more expensively constructed and higher potential tubes. This result is due to the straight sided walls of the tube which function as a target and furnish an X ray effect from all parts of the tube. It may be that the straight sided tube of my invention dissipates less energy than a tube of the spherical type, and, therefore, requires less energy for its excitation for a given result. However, applicant does not feel that it is incumbent upon him to theorize as to the phenomena involved in his tube, but merely to point out the practical results accomplished incident to its operation or use. These results, however, enable him to construct a tube which can be sold for a very small proportion of the price for which it is necessary to sell tubes of other types now on sale. Also, the tube is so small and compact for the work done that a physician or other operator can place one in his pocket and carry the same without any

inconvenience or dread of loss or breakage involved as in the case of the more expensive tubes, thus adding greatly to safety and convenience. Another advantage incident to my improved tube is that for treatment work, on account of the ability to concentrate the rays closer to the affected part of the patient being treated, it is effective only upon the desired location, without the usual deleterious effects upon surrounding tissues and muscles, the consequence of which is sometimes paralysis of the latter, also dermatitis, necrosis, etc. Thus, my improved form of tube may be used for treatment work at more frequent intervals upon the same patient, such as on succeeding days, whereas heretofore it has been found advisable for similar work to allow several days to elapse before repeating treatments. In the case of tubes heretofore employed these latter objectionable effects are caused because the rays cannot be controlled readily within the desired limits for the actual work to be done, for the reasons previously enumerated; that is, with the spherical form of tube the greater distance between the electrodes necessarily involves more powerful and more penetrating rays initially upon beginning the operation of the tube. In order to "soften" these rays after operation of the tube has begun resort has to be had to introducing gas into the vacuum space in order to decrease the initial resistance of the tube. This is objectionable for its complexity and the operation is not easily controlled within desired limits. With my improved form of tube, however, the straight sided walls give an X ray effect all over the tube which is cumulative, and the effective rays are found to automatically focus themselves toward the free end of the tube without the provision of a target or other metallic masses therein which would give off gases and vary the resistance of the tube. This last result particularly, I accomplish in a very simple manner by inclosing the electrodes in chambers especially provided for the purpose outside of the vacuum space. In this manner the electrodes do not enter the vacuum space at all, and, therefore, there is no chance of emission of gases therefrom into the vacuum space. This enables the resistance of the tube and the original condition of vacuum therein to be maintained substantially constant at all times, and the physician or operator finds no necessity for bothering about tube adjustment due to the introduction of gases into the tube.

In the conventional form of spherical X ray tube one side only of the latter is active, whereas in the case of my improved tube all sides are active, or there is an X ray effect all over the tube, and there is no distortion of the rays as in the previous case.

The details of construction and operation of my invention, however, will be more clearly understood by reference to the accompanying specification and drawing in which Figure 1 represents a cross sectional elevation of a tube embodying my invention, the said tube being formed of an easily worked composition of glass, such as ordinary lead glass and made of cylindrical or straight walled contour; Fig. 2 represents a front elevation of my improved tube on the end of which is inserted a suitable screen for the protection of the operator, and Fig. 3 is a top plan view of Fig. 2.

In the end of the tube, as best shown in Fig. 1, is fused a window A of lime glass, which is much more permeable to the rays generated than lead glass, and is, therefore, more efficient in delivering the therapeutic rays generated. The entire tube might be made of lime glass, but when a window only is employed there is less precaution necessary to guard against injury to the operator, and moreover there is greater efficiency in delivery of therapeutic rays to the designed work, and a better localization and concentration on a patient or in other work. The electrodes are both on the outside of the tube; as here shown, they are formed of a body of mercury B and C contained in pockets, one in the end of the tube and the other in the side of the tube intermediate its ends. They are spaced much closer together than in the ordinary X ray tube and with admirable results may be placed 3 or 4 inches apart. The pockets are formed by the glass blower with reëntrant walls projecting into the tube molecularly integral with the glass forming the body of the tube. I prefer to use mercury as the electrodes, which is placed in the pockets and prevented from spilling out by vulcanized rubber or other form of seal. Mercury has the virtue of affording a close or intimate electrical contact on account of the ease with which it conforms itself to the shape of the electrode end of the tube. The circuit leads pass through the seal just mentioned to convey the electric impulses or charge to the mercury. The tube is excited by the usual source of high potential high frequency electric source. My tube thus differs from those ordinarily used in having no inside electrodes, in fact in having no metal parts whatever within the vacuum chamber. In the ordinary X ray tube both anode and cathode are inside the tube, and in addition, commonly, is a metal or other conducting body to create gas to maintain the vacuum in a proper state of tenuity to generate X rays. I have discovered that when no such metallic conductive masses are within the vacuum chamber it is stable and requires no regulator, and this is a very important feature of my improvements. The high frequency or inter-

mittent charges delivered to the conductor of considerable surface area in the pockets acts inductively on the inner wall of the glass which becomes thus a generatrix of rays of very short wave length like or similar to X rays. They have the same photographically actinic property, they act therapeutically in a similar way, and like the X-ray they penetrate organic materials. So far as I have thus ascertained they have the properties of the X ray, but whether they are of identical wave length with such rays as Röntgen discovered in the electric bombardment of a cathode inside a Crookes tube I am unable at present to state. In contradistinction, they do not destroy the efficiency of the vacuum by rendering it so perfect as to prevent production of the ray effect, as the ordinary X ray tube does in the absence of means for stabilizing the vacuum to a fairly constant value. I therefore desire my claims to be construed as covering a ray of any wave length, which has a combined therapeutic and photographic value of similar character to the Röntgen or X ray, within the scope of my annexed claims.

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

1. An X ray tube having two metallic electrodes both on the outside of the vacuum chamber in contact with its walls, one being at the end of the tube and the other at an intermediate point of its body.

2. An X ray tube of cylindrical form having two metallic electrodes both on the outside of the vacuum chamber in contact with its walls, one being at one end and the other at an intermediate part of the tube.

3. An X ray tube of cylindrical form having electrodes external to the vacuum chamber and in contact with its walls, one being at the end and the other at the side thereof.

4. An X ray tube of cylindrical form having both metallic electrodes external to the vacuum chamber, one being at the end, the other at the side of the tube, and a window permeable to the rays generated sealed vacuum-tight in the free end.

5. An X ray tube having no metallic parts within the vacuum, metallic electrodes on the outside wall, one at the end and the other at the side of the tube, and a window permeable to the rays at the free end.

6. An X ray tube having reëntrant pockets containing mercurial material forming electrodes in at least one of the pockets.

7. An X ray tube having reëntrant pockets containing mercury on the outside of the tube, and terminals for a charging circuit leading to the mercury through a liquid-tight seal.

8. An X ray tube having reëntrant glass pockets formed in the walls of the tube, mercury electrodes sealed in the pockets, one in the end and the other in the side of the tube, and a window at the other end permeable to X rays.

9. A tube generating a ray having the photographic and therapeutic properties of the X ray inclosing a tenuous vacuum and provided with electrodes on its outer wall as terminals of high potential, high frequency electric charge and a window sealed in the glass tube in the cathode end permeable to X-rays, whereby the inside wall becomes a generatrix of rays of short wave length.

In testimony whereof I have affixed my signature.

WILLIAM ROBINSON.