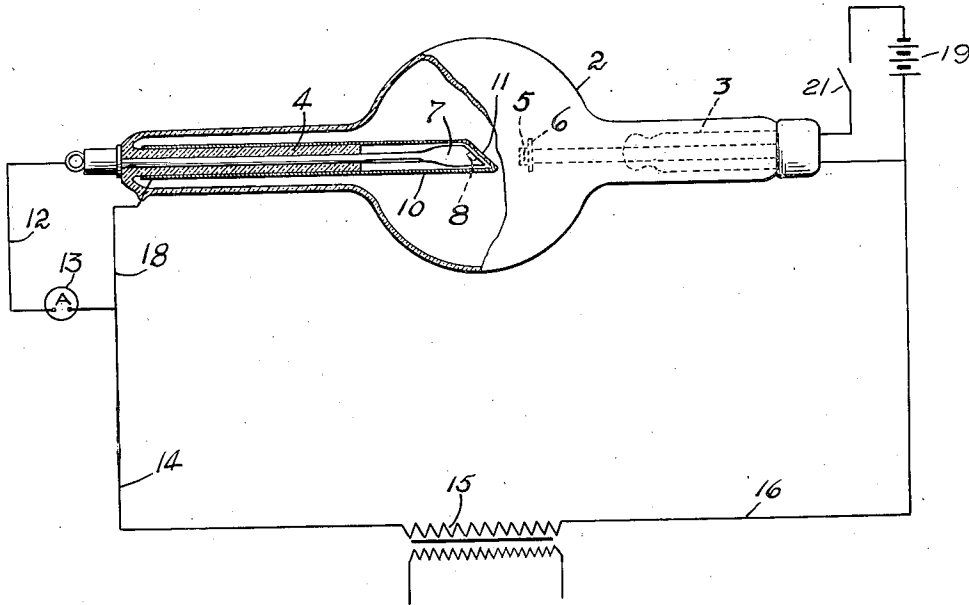


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M. MORRISON
X-RAY APPARATUS
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X-RAY APPARATUS.

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This invention relates to certain improvements in X-ray apparatus and particularly to means for more accurately measuring the useful discharge current in an X-ray tube.

5 An object of my present invention is the provision of means whereby the useful X-ray energy of a Roentgen ray device may be accurately measured in terms of the discharge current.

10 Other objects will be apparent from a reading of the following specification.

Roentgenology, and especially that branch of it which deals with X-ray therapeutics, demands an accurate measurement of the X-ray energy emitted by devices built for generating the same. Instead of measuring directly the X-ray energy as such, it is more convenient to measure the same in terms of the discharge current passing through an X-ray tube. This method, however, has not been very accurate because the discharge current consists of two components, namely, one which produces useful X-rays and a component which produces non-utilizable X-rays, both of which have heretofore been measured together as though they were a single current producing useful X-rays. The former component will hereinafter be called the useful current and the latter will be designated as the non-useful current. The term "useful current" may also hereinafter be used to apply to that portion of the discharge current which strikes the focal spot or useful target area of an X-ray target while the term "non-useful current" will apply to that portion of the discharge current which falls outside the focal spot or useful target area of the target. By focal spot, I mean that part of the target surface producing X-rays in the useful field of such rays from the device.

According to my invention, the total discharge current may be divided into its two components both of which are conducted, after division, along paths which permit the measurement of either or both components separately. By this method a more accurate measurement may be made of the useful X-ray energy developed in the tube.

50 As an embodiment of my invention the accompanying drawing shows an X-ray tube, partly in section, means for passing a discharge current therethrough, means for separating the useful from the non-useful

current and means for measuring the useful 55 current.

In particular, the drawing shows an evacuated glass envelope 2 in which are sealed, by means of stems 3 and 4 respectively, a filamentary cathode 5 of refractory conducting material adapted to be heated to an electron emitting temperature in the usual manner and a target or anode 7 which has a focal spot 8. Encircling the cathode 5 is a focusing device 6 intended as means for directing the electron stream from the cathode 5 to a restricted portion of the target 7 known as the focal spot and here designated by the digit 8. Partially enclosing the target 7, but separate therefrom, is a hood or shield 10 supported on the stem 4 and having an opening 11 through which cathode rays or electrons from the cathode 5 may pass and strike the target 7 within the focal spot 8 thereof. The material of which the hood 10 consists is a conductor the atomic weight of which is preferably low; the reason for this will appear hereinafter but in some cases necessarily high, such as molybdenum, for reasons well understood by those skilled in the art of pumping X-ray tubes.

Connected in series with the target 7 by means of a conductor 12 is a milliammeter 13, one terminal of which is connected by means of a conductor 14 to a terminal of the high potential secondary winding 15 which has its other terminal connected by means of a conductor 16 to the cathode 5 of the X-ray tube. The secondary winding 15 is thus a means for passing a discharge from the cathode 5 to the target 7 when the former is heated to an electron-emitting temperature. The hood 10 is electrically connected by a conductor 18 to the conductor 14 and thereby to the transformer winding 15. It will thus be seen that the hood 10 is in parallel with the target 7 and the meter 13.

During the operation of the X-ray tube, an electron stream proceeds from the cathode 5, which may be heated to an electron-emitting temperature by a current from battery 19, or other source of electricity, through switch 21, traverses the intervening space and comes into contact partly with the target 7 and partly with the hood 10. That part of the electron stream which comes into contact with the target 7 passes through the

aperture 11 which is made of such size that the electrons passing therethrough strike substantially only the focal spot 8 of the target 7. These electrons give rise to useful X-rays which escape through the aperture 11 and are directed towards their intended objective. These same electrons, according to the present day theory, pass through the target 7, continue through the conductor 12, the meter 13, the conductor 14 and finally reach the cathode 5 and then again traverse the space between the cathode 5 and the anode 7. It will thus be seen that the meter 13 is in position to measure the useful discharge current of the tube, or, in other words, the current which gives rise to useful X-rays.

As previously stated, a portion of the current through the tube is not utilized and may be regarded as a waste inasmuch as it does not generate useful X-rays. The non-utility of these rays arises from the fact that they do not originate within the focal spot of the target; the reason for this latter fact may be ascribed to the imperfection of the focusing device 6 in allowing part of the electron stream to fall outside of the focal spot. Another cause of the generation of non-utilizable X-rays may be the action of secondary electrons which are emitted to a certain extent when the target is bombarded by high velocity primary electrons. These secondary electrons may be drawn back into the target, striking the sides thereof, whereby non-useful X-rays are generated.

It will be appreciated by reference to the drawing that those electrons which do not strike the focal spot 8 come into contact with the hood 10. These electrons will also give rise to X-rays but if the material of the hood is of low atomic weight the X-rays will be very soft and therefore will have insufficient penetrating power to pass through the glass envelope 2; these rays will therefore not have to be absorbed by a special shield. In the case of a hood of high atomic weight the X-rays generated by such a hood may be reduced in the active X-ray field by the common method of diaphragming, which is well known in the art. Those electrons which strike the hood will then pass therethrough, enter the conductor 18 and thence continue to travel around the circuit shown. It is thus apparent that the discharge current which does not give rise to useful X-rays is shunted around the meter 13 which measures the useful current and thus does not interfere with the measurement of the latter. The shunted current may, obviously, be measured, if desired, by placing the meter in the conductor 18.

While I have herein described one embodiment of my invention, modifications thereof may be conceived but it should be

understood that the scope of the invention is to be limited only by the appended claims.

What is claimed is:

1. In an X-ray tube the combination of an evacuated envelope, a target and a cathode therein, an electrically conductive shield surrounding said target, said shield having an opening therein adjacent the X-ray emitting surface of said target, and means connected to said target for measuring the current flowing thereto and independent means for shunting the current flowing to said shield.

2. An X-ray tube comprising an evacuated envelope, a target having a focal spot and an electron-emitting cathode within said envelope, an electrically conductive shield surrounding said anode and having an opening in the end thereof in axial alignment with said cathode and focal spot, the end of said shield being so arranged with respect to the face of said target as to prevent electrons from said cathode from striking the surface of said target other than the focal spot and also serving to prevent inverse electron flow.

3. In X-ray apparatus, the combination of an X-ray target, a meter in series therewith and a hood partially enclosing said target, said hood being in parallel with said target and meter during the operation of said apparatus.

4. In X-ray apparatus, the combination of an X-ray target, a meter in series therewith and a hood for said target having an aperture for the entrance to the target of the useful cathode rays and the escape of X-rays therefrom, said hood being in parallel with said target and meter during the operation of said apparatus.

5. An X-ray device comprising an electron-emitting cathode, a cooperating target, an evacuated enclosing envelope, an electrically conductive shield so spaced from the face of said target as to separate the useful current from the nonuseful and means for measuring said useful current.

6. An X-ray device comprising an electron-emitting cathode, a cooperating target, an evacuated enclosing envelope, a meter in series with said target, means for passing a current from said cathode to said target, said current having useful and non-useful components, and an electrically conductive shield closely spaced from the face of said target to prevent inverse electron flow, whereby only the useful component of the current may be measured by said meter.

7. An X-ray device comprising an electron-emitting cathode, a cooperating target having a focal spot, an enclosing evacuated envelope, a meter in series with said target, means for passing an electron stream from said cathode to said target and means for shunting around said meter substantially all

that portion of said electron stream which does not strike said focal spot.

8. An X-ray device comprising an electron-emitting cathode, a cooperating target having a focal spot, an evacuated enclosing envelope, a meter in series with said target and a hood for said target having an aperture for the entrance of the useful cath-

ode rays and the escape of X-rays, said hood being in parallel with said target and meter 10 during the operation of said apparatus.

In testimony whereof, I have hereunto subscribed my name this twenty-second day of June, 1922.

MONTFORD MORRISON.