THE NEW COOLIDGE X-RAY TUBE

The new Coolidge X-ray tube is a direct outcome of Dr. W. D. Coolidge's previous invention of ductile tungsten, the physical properties of which enable its substitution for platinum as the target or anti-cathode in X-ray tubes.

The Coolidge tube is shown in detail in Fig. 1, while Fig. 2 gives details of the cathode and front end of the target.

The construction of the cathode can be seen from Figs. 1 and 2, in which (1) is a tungsten filament forming a flat, closely wound spiral. This tungsten filament (which consists of a number of convolutions) is electrically welded to heavy molybdenum wires (2 and 3), to the other extremity of which are welded the two copper wires (4 and 5), these being in turn welded to the platinum wire (6). To insure rigid support for the hot filament the molybdenum wires are sealed directly into a piece of special glass (7) which has the same coefficient of expansion as molybdenum. The outer end (8) of the supporting tube is of soda glass like the bulb itself, and it is therefore necessary to interpose at (9) a graduated series of different kinds of glass to allow for the difference of expansion of (7 and 8). A small glass tube (10) surrounding one of the copper leads prevents short-circuiting of the copper wires (4 and 5). The tungsten filament which forms the cathode is heated by a current from a small storage battery, which should be carefully insulated from the ground. An ammeter and an adjustable rheostat in the circuit enable the heating current to be regulated with great nicety between 3 to 5 amperes. This range of current gives a potential drop through the filament of from 1.8 to 4.6 volts, variations of the corresponding filament temperature being from 1,890 to 2,340 degrees absolute.

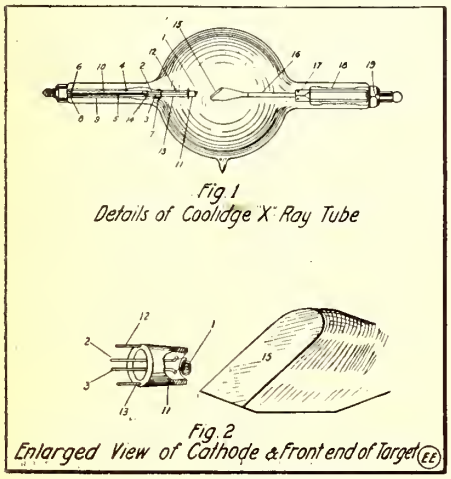


Fig. 1
Details of Coolidge X Ray Tube

Fig. 2
Enlarged View of Cathode & Front end of Target

The Famous "Coolidge" X-Ray Tube.

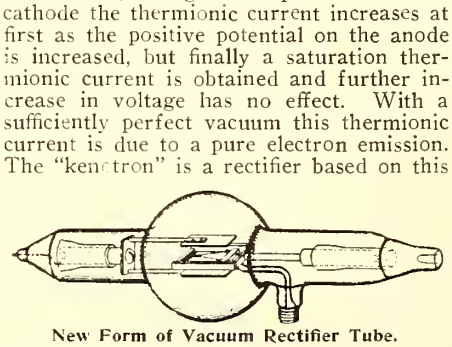
The focusing device consists of a cylindrical sleeve of molybdenum (11). It is mounted so as to be concentric with the tungsten filament, with its end projecting about 0.5 mm. beyond the plane of the latter. It is supported by two stout molybdenum wires (12 and 13) which are sealed into the end of the glass tube (7) (see Fig. 1). The sleeve is electrically connected to one of the filament leads (14). This, besides acting as a focusing device, also prevents any electron discharge from the back of the heated portion of the cathode. The anti-cathode or target (15), Figs. 1 and 2, also serves as an anode. It consists of a single piece of wrought tungsten welded to a molybdenum rod (16) of cylindrical section and supported by a molybdenum split tube (17). This split tube fits snugly in the glass anode arm (18) and serves the double purpose of supporting the anode and of conducting heat away from the cylindrical rod and so protect the seal of the inlet lead (19). The bulb is made of soda glass and is about 18 centimeters in diameter. The method of exhaustion is very long and complicated, and in the later stages of the exhaustion a very heavy current is maintained continuously on the tube for perhaps an hour, the temperature of the bulb being kept from rising too high by the use of a fan. The pressure in the finished tube is very low.

The main advantages of the Coolidge tube are the following: The quantity and the pentrating ability of the rays produced can be varied independently at the will of the operator with both ease and rapidity. When the tube is once adjusted to the requirements of the operator it needs no further attention. Both the intensity and the penetration of the X-rays are under the complete control of the operator. A higher penetration than can be obtained from any other tube is claimed, as well as a longer life. The tube can be worked off either alternating or direct current. Hence it is possible for an operator in actual practise to do all classes of work, ranging from that calling for the lowest to that calling for the highest penetration, with a single tube. Further, he can reproduce exactly what he or some other operator has done before. The adjustments are rapid and require the minimum of technical skill. It has been found that once the proper penetration and exposure had been determined radiographs of any object can be duplicated time after time with absolute precision.—*The Electrician*, London.

THE "KENOTRON" HIGH POTENTIAL RECTIFIER.

A new form of vacuum rectifier is described in a recent number of the *General Electric Review*.

When the electrically heated electrode in the bulb shown is cathode only a thermionic current passes. For a given voltage drop this thermionic current increases with the temperature, but above a certain temperature the current becomes constant. On the other hand, for a given temperature of the cathode the thermionic current increases at first as the positive potential on the anode is increased, but finally a saturation thermionic current is obtained and further increase in voltage has no effect. With a sufficiently perfect vacuum this thermionic current is due to a pure electron emission. The "kenotron" is a rectifier based on this phenomenon, and the article discusses how the design depends on the amount of current to be rectified, the maximum permissible voltage loss and the proper form of electrodes to prevent electrostatic strains on the filament. Three different forms of kenotrons are covered. The first type contains a molybdenum cylinder and a coaxial filament and is suitable for alternating-current voltages up to 15,000 and a current of 400 milliamperes and voltages up to 100,000 and a current of 100 milliamperes. The efficiency of this rectifier is between 98 and 98.75 per cent. A second type of "kenotron," which is suitable for voltages not over 10,000 and currents ranging up to 100 milliamperes, contains a small filament such as is used in automobile head lamps inserted in a molybdenum cap about ⅝ inch in diameter. A third style is shown in our illustration. It contains a V-shaped filament between two tungsten plates.

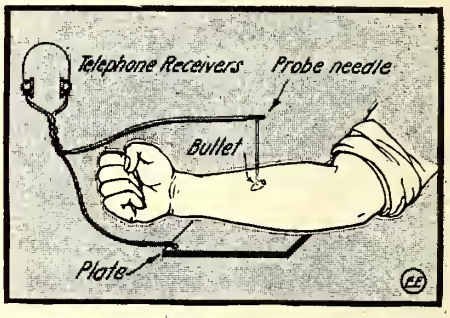


New Form of Vacuum Rectifier Tube.

Hence this new form of rectifier promises to fill a number of engineering wants.

ELECTRICAL BULLET PROBING.

A new electrical method of probing for bullets is being employed in the military hospitals of Europe, says the *Lancet*, London. It consists of a head telephone receiver such as a sensitive wireless phone, together with a flat metal plate and a probing needle of the same metal. The patient's arm, for instance, is placed on the metal plate, which is connected to the telephone receiver, as is also the probing needle. When the surgeon touches the bullet with the needle there is formed a galvanic battery. This gives rise to an electric current which is heard in the receiver. Sir James MacKenzie Davidson says this method is undoubtedly more certain and easier to apply than the "induction balance," also in use for the purpose.



Locating Bullets with Telephone Receivers Only.

TESTS OF PERMANENT MAGNET STEELS.

J. A. Mathews has contributed to the proceedigs of the American Society for Testing Materials a paper based upon an extensive series of magnetic tests on steel alloys. The amount of permanent magnetism which hard steel will retain, and the tenacity with which it retains it, are profoundly affected by the heat treatment of the steel, as well as by its chemical composition. But different steels are affected differently by heat treatment. Some have their best permanent-magnet quality in the oil-hardened condition, while others —sixty hundredths per cent. carbon steel and five per cent. tungsten steel—are best when water-hardened. Thus, the "magnetic hardness" does not vary in the same way as physical hardness. Drawing the temper, however, reduces both hardness and magnetic permanence. In some steels, pieces of small section have greater permanence than larger pieces, while other steels have the opposite characteristic. The chief result of the tests made up to the present is that no uniformity of behavior is found among different steels, and that no laws or theories covering the phenomena can be deduced before a great amount of further experimenting has been done. The author found the best index of permanent-magnet quality to be the ratio between residual magnetism and coercive force. He proposes this ratio as a new magnetic unit.