Aug. 6, 1935. W. D. COOLIDGE 2,010,712

CATHODE RAY TUBE

Filed Sept. 23, 1930

Fig.1.

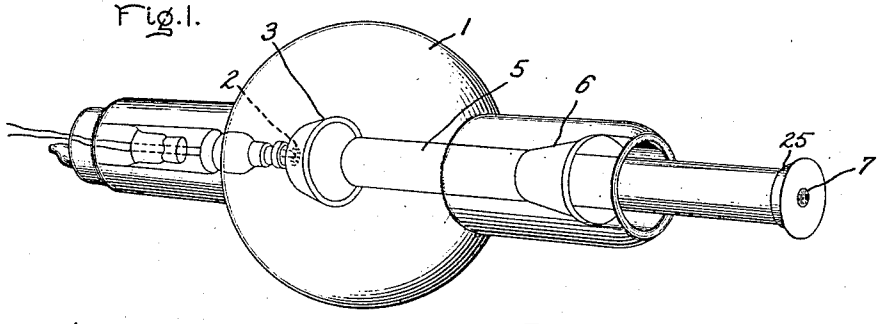


Fig.2.

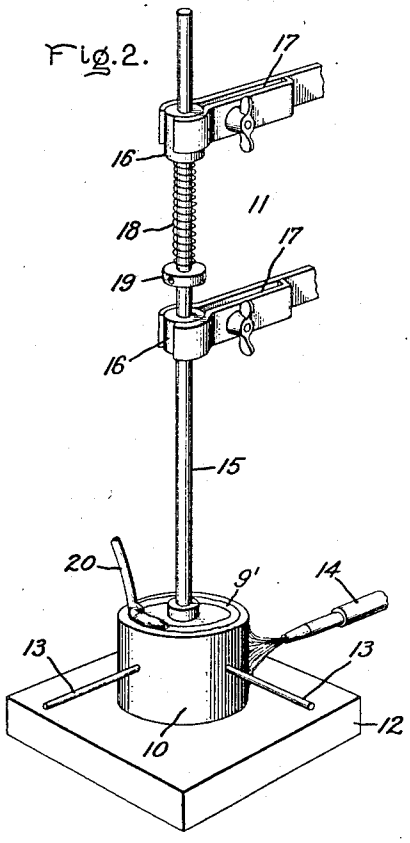


Fig.3.

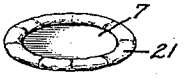


Fig.4.

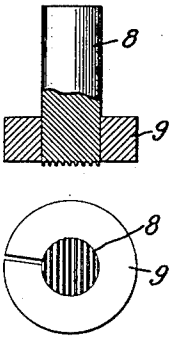


Fig.5.

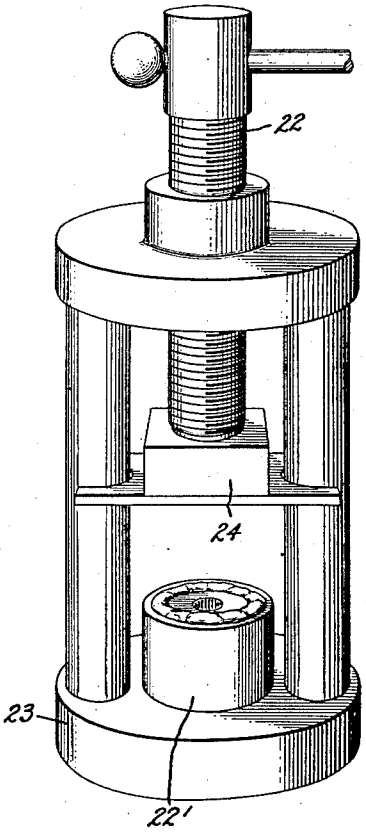


Fig.6.

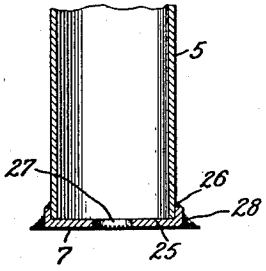
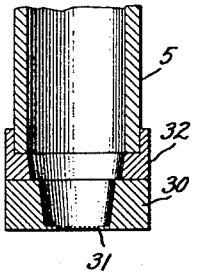


Fig.7.



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His Attorney.

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UNITED STATES PATENT OFFICE

2,010,712

CATHODE RAY TUBE

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Application September 23, 1930, Serial No. 483,900

6 Claims. (Cl. 250—27.5)

My invention relates to cathode ray tubes. A cathode ray tube comprises essentially an evacuated envelope containing a source of electrons, ordinarily a filament and an anode charged positive with respect to the filament. The electrons in moving from the cathode to the anode give rise to a bundle of rays termed for convenience "cathode rays". The latter are capable of penetrating materials to varying depths depending upon the specific gravities of the respective materials and the velocity of the electrons, and are useful in the arts for many purposes, such as examining the genuineness of gems, producing acceleration of chemical reactions, causing particular physiological effects, etc.

The anode of a cathode ray tube is usually made as a long hollow cylinder so that when the electrons are attracted thereto by the positive electrostatic field, the rays are constrained to pass through the interior of the anode from which they emerge into the exterior spaces. The outer end of the anode cylinder is closed and hermetically sealed by a window through which the rays must travel. The present invention is concerned with the nature and construction of the window, also with the manner of producing an effective seal between the window and the hollow cylinder. The seal, produced in accordance with the invention, described hereinafter, is so effective that the cathode ray tube may be permanently sealed from the pump and operated in this manner.

Various substances including metals have been proposed for the window material but it has been found that when this material is of sufficient thickness, considering its diametral size, to withstand a high vacuum on one side and atmospheric pressure on the other side, the energy lost by the electrons in traversing the material is considerable. Moreover, it is difficult to secure a thin window to the envelope of an electric discharge device and this difficulty is enhanced as the degree of thinness approaches that necessary to allow ready propagation of electrons through the window when accelerated by a relatively low voltage. The difficulty lies in the fact that heat normally is required to render the securing means effective and metal of extreme thinness readily fuses upon the application of heat. The solution to the problem would appear to reside in providing the windows with sufficient thickness to withstand the heat treatment but in this case the metal normally would seriously obstruct the passage of rays. It is known that the permeability of a given substance with respect to cathode ray penetration, i. e. the facility with which the rays traverse the material is an inverse function of its specific gravity so that many non-metallic materials allow greater facility of electron traverse than the metals. However, the latter are preferable for window material, particularly the lighter metals, such as aluminum, beryllium, on account of their greater ruggedness in sheet form. Notwithstanding the relatively low specific gravity of aluminum, beryllium, hence, the comparative ease offered to cathode ray movement therethrough, it has been found that when the metal is sufficiently thick to withstand exposure to heat and the pressure differential referred to above, most of the rays still fail to reach the exterior of the window.

An object of the present invention is to provide metallic windows for cathode and similar ray tubes which are of sufficient thickness to lend themselves readily to the application of heat so as to be secured to the envelope and sufficiently rugged to withstand high pressure differentials, yet not offer undue obstruction to the passage of electrons therethrough. This object is attained in brief, by utilizing metal of practical working thickness, having relatively low specific gravity, and providing the window with alternate lands and grooves which are cut to such a depth as to leave between the lands, a series of extremely thin portions through which the electrons may readily move. The thin portions are flanked along both edges with thicker portions which serve as strengthening ribs and facilitate the conduction of heat through the material of the window. Another object is to improve the technique of hermetically sealing thin metal windows to the envelope of cathode ray tubes.

Other objects and features will be apparent as the specification is perused in connection with the accompanying drawing in which Fig. 1 is a view in perspective of a cathode ray tube provided with the improved window; Fig. 2 shows a clamping device used in the preparation of the window prior to sealing; Fig. 3 illustrates the condition of the window after being removed from the device shown in Fig. 2 and a ring of solder applied thereto, as explained hereinafter; Fig. 4 shows a punch for pressing lands and grooves in the window; Fig. 5 depicts in perspective a hand-operated press which receives the punch shown in Fig. 4 and with a window blank in place; Fig. 6 illustrates a window sealed to the tubular anode while Fig. 7 shows a modified construction of the window and an alternative method of sealing the same to the cathode ray tube.

Referring to Fig. 1, numeral 1 designates a highly evacuated envelope containing a filament 2 and the usual focusing cup 3. The anode consists of a relatively long hollow copper tubing 5 sealed intermediate its length to the envelope by means of an ordinary sealing cone 6. The anode is terminated by a metal window 7 improved in accordance with my invention. The manner of operating a tube of this sort is well known. It is sufficient to state that when a relatively high voltage of proper polarity is impressed between the cathode and anode the electrons emitted by the filament are accelerated with high velocity toward the anode and travel through the tubular electrode as a beam which emerges from the window 7.

The window may consist of light metal stock such as aluminum, as pure as possible, of one-half mil or other suitable thickness and is characterized by a series of parallelly arranged lands and grooves. It is apparent that the desirable thickness of window depends not only on its diametral size and the pressure differential, but is also a function of the voltage applied to the tube, and in the case of extremely high voltages may be fairly large. The grooves are formed preferably by a stamping or pressing operation and for this purpose a press or punch member 8 (Fig. 4) may be provided which terminates in a corrugated surface corresponding to the impressions desired in the window. The corrugated surface advantageously may consist of alternate grooves of rectangular shape with adjacent projections also rectangular, although it will be understood that any configuration of groove or projection may be employed. There is a thick metal ring member 9 frictionally secured to the punch 8, the purpose of which will be explained presently.

The fabrication of the window and the preferred mode of sealing the same to the tube is as follows; the window blank is cut from aluminum sheet stock and a ring of solder 9' (Fig. 2) applied over that portion of the window surface which is to contact with the metal of the anode. Aluminum solder without a flux is used for this purpose and applied as a very thin layer, in fact, so thin that the operation may be considered purely as a tinning or plating process. The use of flux is deliberately avoided so as not to provide the slightest source of corrosion, with possible air leakage, when the window is affixed in place. Due to the thinness of the aluminum piece, it is not feasible to play a Bunsen flame directly on the material since the metal may melt but I have found it practical to employ an indirect method of heating the window. The improved method utilizes a block 10 of any suitable metal upon which the thin metal piece is placed and held in position by any convenient form of clamp 11 so that the flame may be directed on the block and the heat communicated to the window by conduction. For convenience, the block 10 of the clamp arrangement may be slidably supported on a metal base 12 and provided with rods 13 which serve as handles in rotating the block so as to present fresh surfaces to be heated by the burner 14. The clamp 11 comprises a vertical rod 15 free to move in a pair of bearings 16, the latter being held rigidly by screw clamp support 17. The rod is forced downwardly by a compression spring 18 which seats itself between the upper bearing member 16 and an adjustable collar 19. The window is placed in the block 10 by pushing the rod 15 upwardly against the force of the spring. After being positioned on the block and before the solder is applied it may be desirable to clean the metal, particularly in the case of aluminum by briskly rubbing steel wool or other abrading material over the surface. The Bunsen flame is then directed on the block which may be rotated by means of the handles 13 and solder from a stick 20 applied simultaneously to the upper surface of the window. The excess solder may be removed by rubbing the surface again with the steel wool while the solder is in a melted condition. The window may now be taken from the clamp and soft solder 21 melted over the ring of aluminum solder, as shown more clearly in Fig. 3. The solder 21 is applied with the minimum amount of flux and such flux as is necessary is of the non-corrosive kind. The window may be provided with grooves and projections and for this purpose is placed in a hand-operated press (Fig. 5) or similar apparatus which has an upper movable screw member 22 and a stationary base plate 23. The window blank may rest on a metal block 22' which preferably has a ground and polished upper surface. The punch 8 shown in Fig. 4 is then placed between the ram 24 and the blank, with the corrugated surface of the punch positioned next to the blank and the screw 22 rotated. The downward pressure on the punch leaves an impression on the window material corresponding to the corrugated surface of the punch which in the case of rectangular lands and grooves causes a substantial thinness of the metal at the bottom of the grooves and forces this metal into the adjacent projections. During the pressing process, the lower surface of ring 9 lies flat against the window and prevents buckling of the thin material. The initial vertical alignment of the punch during this operation is not critical because it has been found that when pressure is applied to the punch causing the metal of the window to "cold flow" outwardly, the punch tends automatically to align itself in such a manner that the corrugated surface lies substantially parallel to the plane of the window blank.

The effect of the grooving operation is to present alternate portions of thick and thin sections of metal to the cathode rays and it is obvious that the width of each groove or thin portion should be as great as is consistent with the mechanical strength provided by the adjacent projections or ribs. The latter serve not only to strengthen but also to facilitate the conduction of heat through the material of the window. In order to lend optimum strength and heat conduction to the window without offering severe obstruction to the cathode rays, the rectangular projections advantageously may be of oblong cross-section of which the shorter side lies along the main portion of the window and the longer side extends normal thereto. The ribs are integral with the window and present an "all-metal" high conductivity path to the heat generated in the window by the impinging electrons; the ribs also offer a large section thru which the heat may be conducted to the contiguous window frame. When aluminum is used for window material, it has been found practical to have the grooved portions in the aggregate extend over more than two-thirds of the entire active width of the window. The window is now ready for sealing to the anode.

As shown in Fig. 6 the latter is provided with a cap piece 25 of copper which is secured to the anode by hard silver solder 26 and has a central

aperture 27. The window is pressed with the soldered side against the cap piece and a small flame played about the periphery to melt the solder 21, thereby hermetically sealing the window to the cap. Solder may also be applied between the inner surface of the window and the outer periphery of the cap piece as indicated by reference character 28 which, in addition to the layer of solder 21 holds the window securely to the anode. The solder 28 is applied with the minimum amount of non-corrosive flux as in the case of solder 21.

The tube may then be finished and exhausted in the usual manner. The grooved portion has a diametral size corresponding to that of the aperture 27 so that the cathode rays which go through the opening are obstructed in a large degree only by the thin sections of metal. In the case of parallel grooves, the cathode stream emerges as sheets of rays in parallel planes and separated from each other by the thickness of each land or projection.

As a modified construction, I may employ the arrangement shown in Fig. 7 in which the window is obtained by counter-boring a solid aluminum or other light metal member 30 and leaving a thin section of metal 31 which is attached by butt-welding to a heavy flanged cap piece 32 made of copper and secured to the end of the tubular anode 5 by solder as in the previous construction. This modification offers some advantage over that shown in the other figures in that the window is an integral part of the cap member and the rings of solder 9' and 21 are not necessary. Moreover, the solder which secures members 5 and 32 together is far removed from the window position.

While I have described my invention more particularly with reference to aluminum, it will be understood that the process of grooving or otherwise producing thin localized sections of metal to offer facility of traverse to an electron stream is applicable to all metals, also to non-metallic materials. However, I prefer to employ metals, particularly those of low specific gravity on account of their ready transparency to cathode rays.

It is evident that my invention is not limited to any specific form or shape of groove but includes surface indentations and deformations of all kinds and shapes whereby certain portions of a window which ordinarily would be impenetrable to cathode or other rays are rendered penetrable in a substantial degree.

In will also be understood that the use of integral ribs and projections for strengthening the window, as described hereinbefore, does not preclude the employment of additional supporting structure where necessary in the case of large windows. Indeed, the ribs, particularly those of rectangular section, lend themselves readily to the use of ordinary supporting grids which may abut that surface of the ribs, the furthermost removed from the thin portion of the window. An extensive window may thus be supported in two lateral directions, if desired, in one direction, by the parallel ribs and in another direction, preferably normal thereto, by the grid on which the ribs rest. Furthermore, the invention is not limited to cathode ray propagation but is sufficiently broad to cover electrical rays of all wave lengths including X-rays, also alpha rays, which have to pass through a window of a tube in which such rays are generated.

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

1. An electric discharge device comprising an evacuated envelope, a cathode and an anode therein cooperating to produce cathode rays, a metal window secured to the envelope and electrically connected to the anode, said window being a single sheet of material provided with alternate and integral relatively thin and relatively thick portions, the thin portions allowing ready penetration of the material by the rays.

2. An electric discharge device comprising an evacuated envelope, a cathode and an anode therein cooperating to produce cathode rays, a corrugated metal window secured to the envelope and electrically connected to the anode, said window being a single sheet of material and the metal at the bottom of the corrugations being sufficiently thin to offer the minimum practical amount of obstruction to the passage of the rays.

3. An electric discharge device comprising an evacuated envelope, a cathode and a hollow anode therein cooperating to produce cathode rays, said anode terminating in a metal window, said window being a single sheet of material provided with parallel lands and grooves of rectangular section, the thickness of material at the bottom of the grooves being sufficiently small to allow ready passage of the electrons therethrough.

4. An electric discharge device comprising an evacuated envelope, a cathode and an anode therein cooperating to produce cathode rays, a metal window secured to the envelope and electrically connected to the anode, said window being a single sheet of material provided with parallel lands and grooves, and having a thickness at the bottom of the groove of less than one-half mil.

5. An electric discharge device comprising an envelope, a cathode and a hollow cylindrical anode therein cooperating to produce an electron stream, said anode being hermetically closed by a window consisting of metal of relatively low specific gravity and being a single sheet of material provided with integral strengthening ribs.

6. A window for an electric discharge device, said window being fabricated of aluminum and being a single sheet of material provided with a plurality of integral strengthening ribs.

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