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APPARATUS FOR COATING INDIRECTLY HEATED CATHODES

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This invention relates to electric discharge devices, more especially thermionic valves, having indirectly-heated cathodes and to the manufacture of the cathodes of such devices.

Indirectly heated cathodes usually comprise a metal cylinder coated with activating material. In their manufacture, the activating material, or more often material from which the true activating material is produced by heat, is usually deposited on the cylinder by spraying, dipping, or like means. In modern thermionic valves having indirectly heated cathodes, the clearance between the cathode and a neighbouring electrode may be so small that variations in the thickness of the coating that are difficult to avoid in such processes may lead to undesirable variations in the characteristics of the resulting valve. Thus the tolerance on the diameter of the coated cathode may be as small as .005 mm. The object of the invention is to provide a method of making activated indirectly heated cathodes in which the variation in the diameter of the cathode is less than is easily attained by merely spraying or dipping a cylinder of fixed dimensions.

According to the invention, the manufacture of an activated indirectly heated cathode comprises the steps (1) forming on the outer surface of a metal cylinder, whose diameter is less than that of the final cathode, a coating of activating material, or material from which activating material is subsequently produced, so thick that the diameter of the coated cylinder is greater than that of the final cathode, (2) passing the product of step (1) through a die in such a manner that the diameter of the coated cylinder is reduced by the removal of part but not all of the said material.

It is usually important that in step (2) the material is removed uniformly from the surface of the coating, so that the surface of the final coating is coaxial with the metal cylinder. We have found that it is easier to achieve this result than might appear.

Thus in one method of performing step (2), described by way of example, a modification of the known "pilfer" die is used. The die, having an upper cutting edge slightly smaller than the maximum permitted diameter of the final cathode, is mounted on a base plate. Two pillars, one on each side of the die, rise from the base plate; on each pillar slides a long sleeve, spring-biased away from the base plate. A cross bar, carried on the two sleeves, has on its lower side a pin, directed towards the centre of the die. This pin is adapted to fit closely inside the metal cylinder of a cathode.

In operation, the cylinder of a cathode, already subjected to step (1), is slipped over the pin. The cross bar is then depressed against the spring-bias. The cathode, centred by the pin, is thus forced into the die and step (2) is therefore performed.

In a modification, the instrument just described is inverted, so that the cathode approaches the die from below, instead of from above. Then the material removed by the die falls away from it, and does not tend to clag the die.

However this is not the preferred method. In the preferred method apparatus is used comprising a pair of coaxial pins, each fitting within the coated cylinder, each constrained so as to be translatable only along their common axis, one of the said pins being spring-biased so as to protrude through the die; and comprising also means for causing the other of the said pins to move towards the first-mentioned pin through a predetermined distance.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawing wherein:

Figure 1 is a plan view of the apparatus of the invention;
Figure 2 is an elevation partly in section along the line 2--2 of Figure 1;
Figures 3 and 4 are plan views in section of details showing the bases for the pins of the apparatus;
Figure 5 is a detail view in section of the die which may be used in the apparatus;
Figure 6 shows a sectionalized view of the friction device for controlling the speed of return motion of the apparatus.

In the drawing, rests 1 and 2 are mounted on the common base 3, providing guides for the slides 4, 5 respectively. Slides 4, 5 carry respectively at the ends turned towards each other a pin 6 and a coaxial pin 7. Both these pins project from flat bases; the base of pin 7 is shown...
clearly in Figure 3 at 7a, the base 6a of pin 6 shown in Figure 4 abuts against the back face of slide 4. Slide 4 is pressed towards slide 5 by the spring 8, but is stopped by the die 9 through the hole in which pin 8 projects. Slide 5 is moved to and fro by the crank 19 operated by the wheel 11 with handle 12. At the base of each pin is an annular depression 13 and 14 in the slider, in which the end of the cathode locates itself. The wheel 11 is provided with a friction device shown at figure 6 which prevents a too rapid return motion of the wheel, which might lead to scoring of the cathode. This device consists of a fibre plug 15 pressed against a face of the wheel by a spring 16 compressed by an adjustable screw 17.

In the embodiment shown the wheel makes a complete revolution during the treatment of a single cathode, so that the travel of the slide 5, and therefore the length of that part of the cathode which passes through the die, is controlled by the travel of the crank; the machine is therefore adapted to deal with cathodes of one particular size only. But in modifications adjustments are provided which enable cathodes of different length to be treated by the same machine. Thus a stop may be provided to prevent complete revolution of the wheel; or the crank pin 16 may be adjustable along a radius of the wheel so that the throw for a complete revolution can be varied.

In one mode of operating such apparatus described by way of example, one end of the coated cathode to be subjected to step (2) is slipped over the end of pin 6 that is protruding from the die. Pin 7 is then caused to approach pin 6 until its forward end enters the other end of the cathode. On continued approach of pin 7, this other end of the cathode abuts against a base from which pin 7 protrudes, so that the cathode is driven further over pin 6 until the first said end abuts against a base from which pin 6 protrudes. During this stage part of the cathode passes through the die. When both ends of the cathode abut against the said bases, the cathode is pushed further through the die against the spring biasing 6, until the required part of the cathode has been scraped. Pin 7 is then withdrawn; the spring causes the cathode to follow it so far that the cathode can easily be detached from the die.

It will be realized that many minor variants of this procedure are possible. Thus one end of the cathode might be first fitted over pin 7 and the other end fitted over pin 6 only as pin 7 moves forward.

If the cathode to be coated is 1.00 mm. in internal diameter with a wall 0.07 mm. thick, the pins 6, 7 may be conveniently 0.98 mm. in diameter and the diameter of the hole in the die 1.32 mm. The thickness of the coating left on the cathode after passage through the die will then be 0.09 mm. If the length of the cathode is 26 mm., the throw of the crank may be some 92.5 mm., the excess being allowed in order to permit of the cathode's being easily placed on the pins. The end of the cathode placed over the pins 6 will necessarily be scraped up to its extremity; the other end can be scraped very nearly to its extremity by adjusting the position of the rest 1 in relation to the throw of the crank so that the base of the pin 7 approaches very near to the die at one end of its travel. The part in the depression 14 cannot be scraped; but that will usually be of no consequence, because a cathode is not generally coated right up to both extremities.

In step (1) most of the usually practised methods of coating appear to be suitable. Thus the cathode may be coated with a known mixture such as 57.5% BaCO₃ + 43.5% SrCO₃ (by weight) .

Necoloidine (5% solution in butyl acetate) .

Anhydrous butyl acetate .

Methyl alcohol .

Ethyl oxalate .

the mixture having been balled-milled for 16 hours. The dried layer should be of such a thickness, in the example given above, that the external diameter of the cathode at the end of step (1) is some 1.35 mm.

What we claim is:

1. Apparatus for removing a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising a die having an opening therein of predetermined size, and means for causing said cathode to pass longitudinally through said opening in said die, said means including two coaxially disposed pins having a cross sectional area slightly less than a cross section of the interior of said cathode, whereby, said cathode is threadable on said pins, said pins being movable longitudinally with respect to said die, one of said pins extending through said die.

2. Apparatus for removing a portion of the coating from an indirectly heated cathode, wherein said cathode comprises a sleeve having an emitting coating on its outer surface, and comprising means for supporting said cathode, said means including two longitudinally disposed pins having a thickness enabling them to readily enter said sleeve, means for initially moving one of said pins longitudinally towards the other of said pins and for subsequently moving both of said pins axially in a common direction, means engaging said sleeve for preventing relative motion between said sleeve and at least one of said pins, a die having an aperture therein axially disposed with respect to said pins and said sleeve, and supported against movement in any direction, said die being positioned in the path of axial movement of said sleeve.

3. Apparatus for removing a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising means for supporting said sleeve, a die having an aperture of predetermined size, and a support for said die, said sleeve being disposed coaxially with respect to said aperture in said die, means for moving said first-named means to pass said sleeve through said aperture in one direction, and means for moving said first-named means to pass said sleeve through said aperture in the opposite direction, said first-named means including two coaxially disposed and longitudinally separable pins for receiving said sleeve.

4. Apparatus for removing a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising means for supporting said sleeve, a die having an aperture of predetermined size, and a support for said die, said sleeve being disposed coaxially with respect to said aperture in said die, means for moving said first-named means to thread said sleeve through said aperture in one direction, and means for moving said first-named means to thread
5 said sleeve through said aperture in the opposite direction, said first-named means including two coaxially disposed and longitudinally separable pins for receiving said sleeve, the remote ends of said pins being fixed to members having surfaces lying in parallel planes transverse to the axis of said pins and serving as stop means for said sleeve.

5 Apparatus for scraping a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising a fixed support and two movable supports, said fixed support including two coaxially disposed and longitudinally displaced passageways, said movable supports including two longitudinally movable members disposed within said passageways, means on each of said members movable therewith for engaging the inner walls of said sleeve to support said sleeve between said members, a die supported on said fixed support and having an aperture in registry with said sleeve, and means for moving said first-named means for causing said sleeve to enter said aperture, and additional means for moving said first-named means for causing said sleeve to be ejected from said aperture.

6 Apparatus for scraping a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising a fixed support and movable supports, said fixed support including two coaxially disposed and longitudinally displaced passageways, said movable support including two longitudinally movable members disposed within said passageways, means on each of said members movable therewith for engaging the inner walls of said sleeve to movably support said sleeve between said members, a die supported on said fixed support and having an aperture in registry with said members, means for actuating one of said movable members for causing said sleeve to enter said aperture, including a rotatable wheel linked to one of said longitudinally movable members, and additional means for actuating the other of said movable members for causing said sleeve to be ejected from said aperture, including a tensioned spring engaging said other of said movable members.

7. Apparatus for scraping a portion of the electron emitting coating from the sleeve of a cathode having open ends, comprising a die having an aperture therein, a fixed support for said die and movable supports for said cathode, said movable supports including two axially displaced pins having cross sections of such dimension as to permit them to enter said cathode and disposed in registry with said aperture, and being operable to axially displace said pins for threading said sleeve thereon, and means for moving said movable support to cause said pins and said sleeve to enter said aperture in said die, and to be ejected therefrom.

8. In an apparatus for scraping a portion of the electron emitting coating from the sleeve of an open ended cathode, including a die having an aperture and a fixed support therefor, movable support means for said cathode comprising a pair of coaxial pins aligned with said aperture and fitting within said cathode, and means for constraining said pins to render them translatable only along their common axis, spring biasing means in registry with said aperture and one of said pins for causing said one of said pins to protrude through said die, and means for causing the other of said pins to move towards said one of said pins through a predetermined distance.

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