

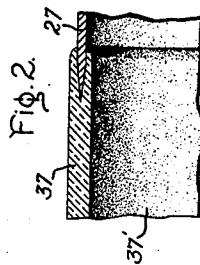
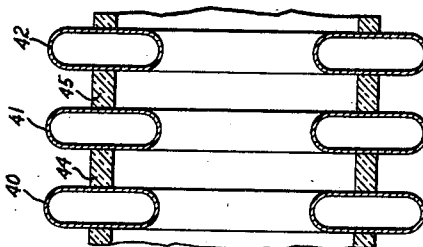
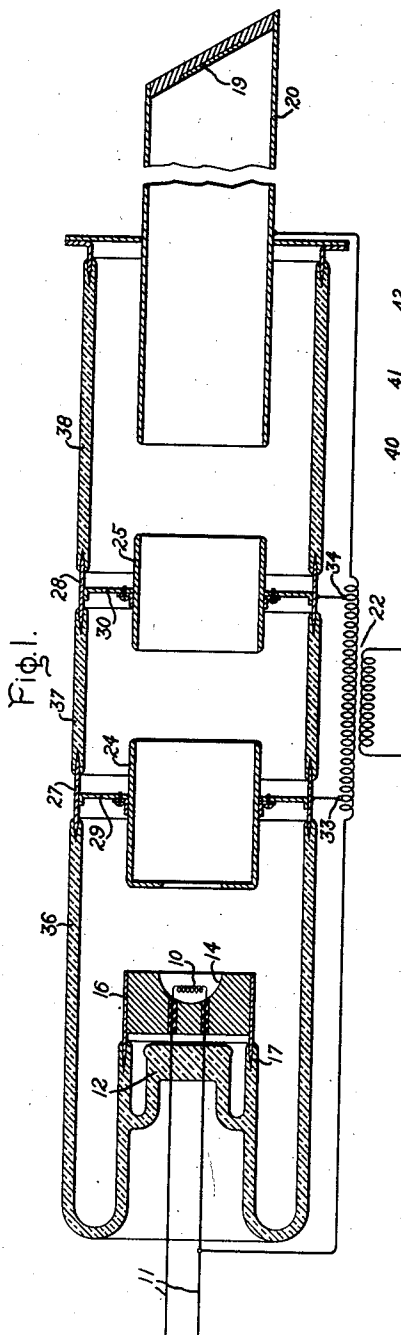
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2,284,341

DISCHARGE DEVICE

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2,284,341

DISCHARGE DEVICE

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4 Claims. (Cl. 250—27.5)

This is a continuation in part of my prior application Serial No. 332,528, filed April 30, 1940.

The present invention relates to improvements in evacuated electric discharge devices and the like, and has for a particular object the provision of means for increasing the breakdown strength of such devices.

In the operation of evacuated high voltage discharge devices such as X-ray tubes, a limit is imposed on the safe operating voltage by the danger of breakdown along the insulating wall surfaces which separate the various electrode parts. In accordance with my present invention, it is found that this limit may be substantially raised if the wall surfaces referred to are roughened by sand-blasting or some equivalent operation.

The features which I desire to claim herein are pointed out with particularity in the appended claims. The invention itself, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the drawing, in which Fig. 1 is a longitudinal section of a device which represents one embodiment of the invention; Fig. 2 is a fragmentary detail of the device of Fig. 1, and Fig. 3 illustrates a modified application of the invention.

Referring particularly to Fig. 1 there is shown an elongated X-ray tube which is designated as a whole by the numeral 9 and which is to be understood as being evacuated to a degree such that ionization plays no significant part in the operation of the tube. In this connection, the tube is exhausted to a pressure of less than 1 micron of mercury and preferably on the order of .05 micron, for example, by the procedure described in Coolidge Patent 1,203,495, granted May 9, 1913.

The X-ray tube 9 has at one end thereof a filamentary cathode 10 which connects with lead-in wires 11 extending through a press 12, and which is surrounded by a recessed focusing cup 14. The cup 14 is insulated from at least one end of the cathode filament and is supported within a metal cylinder 16 mounted on a reentrant tubular part of the envelope, as indicated at 17. A separate lead-in conductor (not shown) may be provided for maintaining the cup at a desired focusing or control potential.

Electrons projected from the cathode 10 are caused to impinge upon an anode or target 19 of X-ray generating character, which is provided at the other extremity of the envelope. This target, consisting, for example, of tungsten, is

positioned at one end of a tubular metallic part 20 which projects beyond the main body of the envelope so as to facilitate the generation of X-rays in a region external to the casing (not shown) within which the main body of the tube is enclosed when in use. By immersing the tube in oil or other insulating dielectric, the cathode 10 and the anode structure may be maintained at a potential difference considerably in excess of that required to produce breakdown in air. The operating potential, which is on the order of one hundred thousand volts or higher, may be supplied by means of a high voltage transformer 22, or, alternatively, by a D. C. high voltage generator (not shown). In order to equalize the potential stress in the region between the cathode and anode this region may be subdivided by the use of a plurality of intermediate conductive bodies or electrodes as indicated at 24 and 25.

In the arrangement shown the intermediate electrodes 24 and 25 are of tubular character and are supported by annular sleeve-like portions 27 and 28 set into the body of the envelope. Radially extending conductive parts 29 and 30 provide a rigid connection between the electrodes and the parts 27 and 28. If desired, the potential of the intermediate electrodes 24 and 25 may be fixed by connecting them to appropriate points of the secondary winding of the transformer 22 as shown at 33 and 34. Under these conditions, a high difference of potential exists between the various electrodes, and it is, of course, necessary that they be maintained in insulatingly spaced relation. In the arrangement shown, such spacing of the electrode parts is accomplished in the arrangement shown by the insulating envelope wall parts 36, 37 and 38 which are constituted of a vitreous material such as glass or quartz.

In the operation of a device such as that shown there is a tendency for break-down between the various electrodes to occur over the interior or exterior wall surfaces of the envelope parts 36, 37 and 38. In accordance with my present invention, it is found that this tendency may be materially reduced by roughening at least portions of the surfaces in question by sand-blasting or some equivalent operation. If sand-blasting is used, it is preferably carried to a point at which the surface of the glass presents a definitely etched or frosted appearance, such as is indicated generally by the stippled surface 37' of the fragmentary wall section 37 shown in Fig. 2. The area treated may include either the inside or outside wall surfaces or both. Treatment

of the inside surface is, of course, most important.

No completely satisfactory explanation of the improvement obtained in this manner is available at the present time. It is suggested that the effect of the sand-blasting may be to improve the degree of cleanness of the wall surfaces beyond that attainable with previously used methods; and to alter the secondary electron emission from the surface so treated. Although it is not certain which of these changes produced by the treatment is the most important and although the possibility of a more important effect is not excluded, it is definitely established that the treatment specified affords a material improvement in breakdown strength, such improvement being in some cases as high as 50% or more.

It will be understood, of course, that the application of the invention is not limited to the particular construction shown in Fig. 1, and in Fig. 3 there is illustrated an alternative arrangement in which the invention may be employed. In this case, only the intermediate portion of the tube structure is shown, and this is represented as comprising a plurality of generally toroidal electrodes, numbered 40 to 42 inclusive, which serve to subdivide voltage stress in the manner specified for the electrodes 24 and 25 of Fig. 1. The electrodes 40 to 42 are insulatingly separated by vitreous wall parts 44 and 45 which are sealed thereto in direct abutment therewith. In order to permit this possibility, the glass and the metal parts should be well matched as to expansion characteristics, and it may be desirable to form the latter of an alloy of nickel, iron and cobalt. In accordance with my present invention, the glass wall parts 44 and 45 are sand-blasted to produce a superficial roughening thereof as previously described in connection with Fig. 1.

While best results have been obtained in the practice of my invention by a mechanical method of roughening which involves abrasion with sand or carborundum directed at high velocity against the surface to be treated, it is probable that an equivalent roughening may be obtained by other means. I aim in the appended claims to cover

all variations of the invention which fall within the true spirit and scope of the foregoing disclosure.

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

1. A highly evacuated discharge device including a pair of conductive bodies which are maintained at a high difference of potential during the use of the device and a vitreous part extending between the said bodies for supporting them in insulatingly spaced relationship, the surfaces of the said part which extend between the bodies being roughened in the manner characteristic of sand-blasting.

2. A highly evacuated electric discharge device including spaced electrodes and a vitreous envelope of which the walls serve to support the electrodes in insulatingly spaced relationship, wherein at least the interior surfaces of the envelope walls are roughened in the manner characteristic of sand-blasting.

3. An electric discharge device including a vitreous envelope which is evacuated to such a degree that ionization plays no significant part in the operation of the device and which contains a cathode and an anode, conductive bodies positioned between the said cathode and anode for subdividing the voltage stress therebetween, and means including parts of the envelope wall for maintaining the said bodies in insulatingly spaced relationship, the said envelope wall parts being internally roughened in the manner characteristic of sand-blasting in order to increase the insulating strength thereof.

4. An electric discharge device including an anode and cathode, and an elongated cylindrical envelope enclosing the anode and cathode, the envelope being evacuated to such a degree that ionization plays no significant part in the operation of the device comprising a succession of alternately disposed glass and metallic parts, and the said glass parts being roughened internally in the manner characteristic of sand-blasting in order to increase their insulating strength.

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