Nov. 18, 1924. 1,516,422

W. DÄLLENBACH

ELECTRICALLY INSULATING PIPE SECTION FOR HIGH VACUUM PIPE LINES

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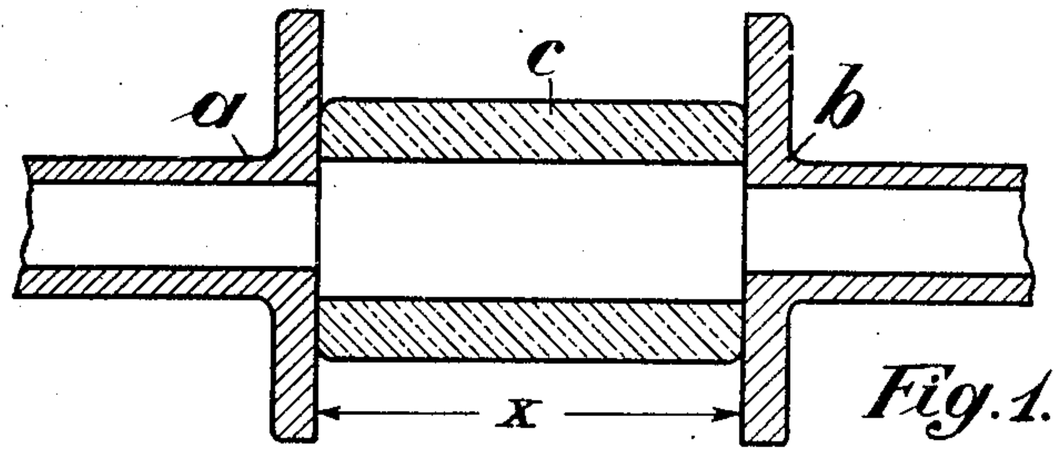

Fig. 1.

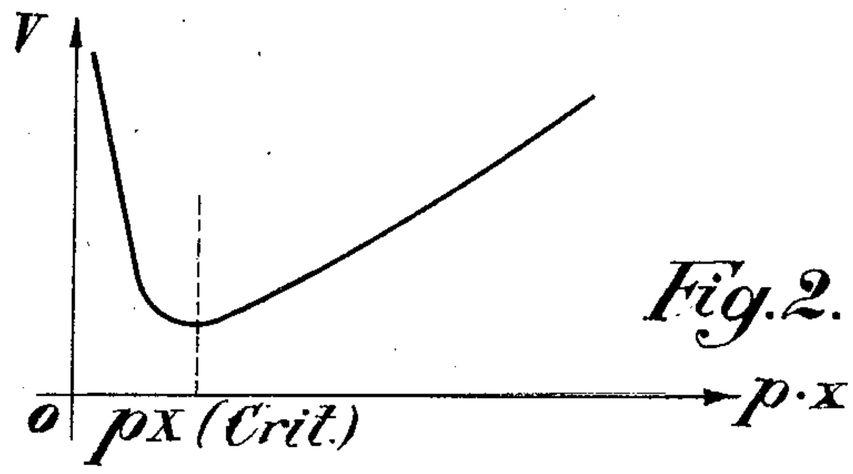

Fig. 2.

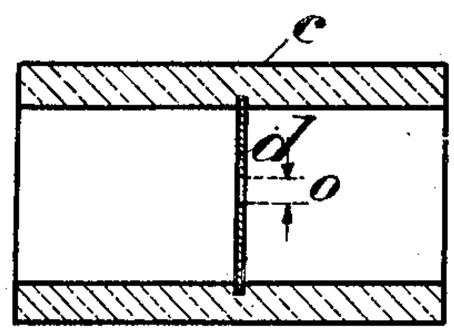

Fig. 3.

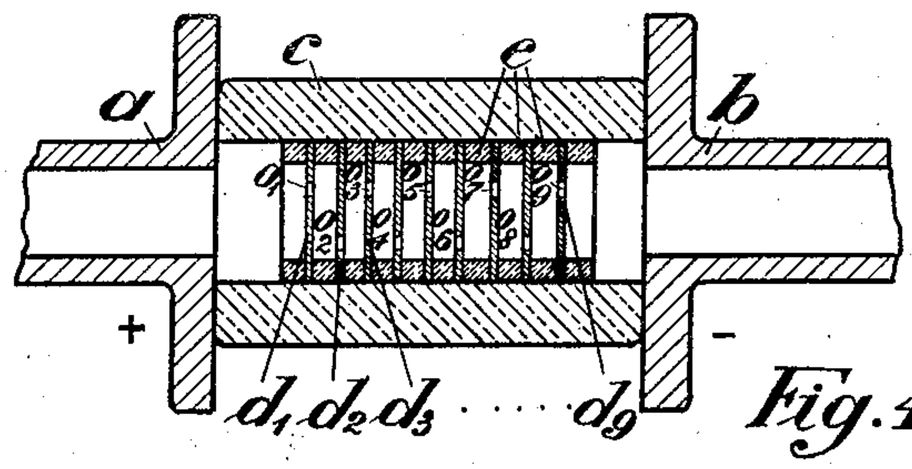

Fig. 4.

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UNITED STATES PATENT OFFICE.

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ELECTRICALLY INSULATING PIPE SECTION FOR HIGH-VACUUM PIPE LINES.

Application filed July 31, 1922. Serial No. 578,734.

To all whom it may concern:

Be it known that I, WALTER DÄLLENBACH, a citizen of the Swiss Republic, residing at No. 23 Dynamostr., Baden, Switzerland, have invented certain new and useful Improvements in Electrically Insulating Pipe Sections for High-Vacuum Pipe Lines, of which the following is a specification.

This invention has for its object to provide an improved electrically insulating pipe section for high-vacuum pipe lines, which is of great value for insulating pipe lines electrically from one another in high-vacuum installations, especially in those cases where a portion of the high-vacuum installation is under high electrical pressure, whilst the other portion is required to be continually accessible for inspection. This is, for instance, the case, in large rectifier installations where the large rectifier is connected to a high-vacuum pump by pipe lines which convey the high direct current potential of the rectifier to the high-vacuum pump, so that the latter must be so mounted as to be insulated from earth for the full direct current voltage. One way of carrying the invention into effect will now be described with reference to the accompanying drawings, in which:—

Figure 1 shows an ordinary insulating pipe section;

Figure 2 is a curve connecting breakdown voltage with the product of gas pressure and length of spark gap;

Figure 3 shows a portion of the insulation section of a vacuum pipe with a perforated metal screen inserted across the passage;

Figure 4 is a section of a vacuum pipe having an insulated portion according to the invention.

A simple expedient would consist, as shown in Fig. 1, in insulating the different parts a and b of the installation from each other by the interposition of a pipe section c composed of insulating material. This expedient is effective so long as a high-vacuum actually exists in the pipe line. But immediately the vacuum deteriorates, the so-called sparking voltage, that is, the voltage required for "striking across", will at first diminish, and may fall below the direct current voltage of the rectifier. If that case should occur, then the spark strikes across, inside the insulating section, in the form of a passing-through arc which raises the pumping plant to the potential of the rectifier, and thereby endangers the said pumping plant.

On a further rise of pressure the sparking voltage increases again, but the arc, when it has been once formed, continues even when the pressure continues to rise. The curve of the sparking voltage has the shape shown in Fig. 2. In this figure V is the sparking voltage. This latter is plotted as a function of the product $p.x$, where p is the gas pressure, and x is the distance between the electrodes (in the present case, the length of the insulating section).

As will be perceived from Fig. 2, there is a critical value of $p.x$ at which the sparking voltage is a minimum. In normal working, the installation works below the value $p.x$ (crit.), so that when the vacuum deteriorates, the sparking voltage at first tends to assume its minimum value.

In the improved electrically insulating pipe section constructed according to the present invention, the sparking voltage is never lower than the direct current voltage of the rectifier under practical conditions, even in the case of a deterioration of the vacuum. This effect is achieved by the arrangement of apertured screens fitted airtight in the interior of the insulating pipe section.

Fig. 3 shows a portion of the vacuum pipe line in the interior of which is situated a screen d with a screen aperture o.

If the screen is made for instance, of thin sheet metal, it offers practically no resistance to a gas flowing in the pipe section if the mean free length of the path of the gas molecules is great, or at least equal to the diameter of the pipe section. This is the case for vacua which exist in the rectifier in normal workings. The interposition of one or more screens therefore does not increase the resistance to the gas current, but nevertheless it has the result of preventing the electrons from passing freely through the pipe section. The effect of this however is that the interposition of the screens reduces considerably the sparking voltage.

The improved electrically insulating pipe section according to the present invention consists of an electrically insulating pipe section in high-vacuum pipe lines in the interior of which said pipe section thin screens are inserted, having their apertures

staggered relatively to one another. When in this improved construction, an electron moves in a direction parallel to the axis of the pipe section through an aperture in a screen, it does not pass directly into the aperture of the following screen, but impinges with great velocity against the wall of the next screen, whereby it loses a large part of its kinetic energy.

A practical embodiment of this invention is illustrated in Fig. 4 in which c is the electrically insulating pipe section; $d_1 \ldots d_9$ are screens. e are annular insets of insulating material, provided for the purpose of spacing the screens d_1, d_2, d_3 . . . apart.

The apertures o_1, o_2, o_3, o_4 in these screens are arranged eccentrically. The odd-numbered apertures o_1, o_3, o_5 and the even-numbered apertures o_2, o_4, o_6 are arranged respectively in straight lines parallel to the axis of the pipe section, but are arranged 180° apart. Any electron which attempts to travel from a to b, must take the zig-zag path through the apertures o_2, o_3 . . .

This means on one hand a lengthening of the path to be traversed by the electrons, whilst on the other hand the kinetic energy of the electron is used up by the repeated impacts against the screens, thereby greatly reducing the impact-ionization of the electrons striking the electrode.

The pipe section c may be made of porcelain, glass or other suitable insulating material, and it is made tight against high-vacuum by clamping between the two flanges a and b. The length x of this insulating pipe section is made such as to provide the necessary "creeping surface" for preventing an injurious glow discharge at atmospheric pressure. The screens d are preferably made of conducting material and set at very short distances apart from one another. They may likewise be insulated from one another, and they should be made to fit as far as possible gas-tight against the inside surface of the insulating pipe section.

What I claim is:—

1. In an electrically insulating pipe section for interposition in a high-vacuum pipe line, the combination with a tubular pipe section composed of electrically insulating material connecting in a gas-tight manner the two pipe line sections to be electrically insulated from each other, of a plurality of thin screens each with an aperture, located in the interior of said insulating pipe section, the aperture in each screen being located out of line with the apertures in the next screen on either side.

2. In an electrically insulating pipe section for interposition in a high-vacuum pipe line, the combination with a tubular pipe section composed of electrically insulating material connecting in a gas-tight manner the two pipe line sections to be electrically insulated from each other, of a plurality of thin screens each with an eccentrically located aperture, located in the interior of said insulating pipe section, said aperture in each screen being located 180° out of line with the aperture in the next screen on either side.

In testimony whereof I have signed my name to this specification.

WALTER DÄLLENBACH.