SHOP NOTES

These are ''how to do it'' papers. They should be written and illustrated so that the reader may easily follow whatever instruction or advice is being given.

Filament replacement for ''nude'' Bayard–Alpert ion gauges

Michael E. Cox and J. A. Panitz
Department of Physics and Astronomy, The University of New Mexico, Albuquerque, New Mexico 87131

(Received 6 December 1995; accepted 7 June 1996)

A simple method for producing inexpensive, replacement filaments for a ''nude'' Bayard–Alpert ion gauge is described. Replacement filaments in the form of a ten-turn coil fabricated from 6-mil tungsten wire are identical in performance to their commercial counterparts. © *1996 American Vacuum Society.*

I. INTRODUCTION

The Bayard–Alpert ion gauge is commonly used to measure pressures from 10^{-5} to 10^{-12} Torr.[1,2] For ultrahigh vacuum applications, a Bayard–Alpert ion gauge is typically mounted on a flange in a ''nude'' configuration which exposes its filament directly to ambient vacuum. The filament is operated at an elevated temperature. After some period of time the filament will burn out and must be replaced. Replacement filaments are commercially available, but the replacement package is expensive because the mounting supports for the filaments are also supplied. This Note describes a simple procedure for fabricating replacement filaments for nude Bayard–Alpert gauges and for reusing existing filament supports. The performance of the resulting filament assemblies are indistinguishable from their commercial counterparts.

II. FILAMENT FABRICATION

Bayard–Alpert gauge filaments are typically spotwelded to nickel or stainless steel supports that provide mechanical stability. The supports can be reused after the old filaments have been removed and cleaned.[3] A replacement filament in the form of a coil is fabricated from a 5.1 cm length of tungsten wire.[4] A simple procedure for winding the coil is to secure one end of a longer length of tungsten wire (7–8 cm) in the chuck of a hand drill that is tightened onto a mandril.[5] The hand drill is slowly turned, winding the wire into a ten-turn coil with a pitch of ≈1 coil/mm. After the coil is wound, it is removed from the mandril and the wire is cut to a length of 5.1 cm.[6] Each end of the wire is crimped into a small piece of 0.1-mm-thick nickel foil. The coil is stretched to fit in the space defined by the support ends, and spotwelded in place as shown in Fig. 1.

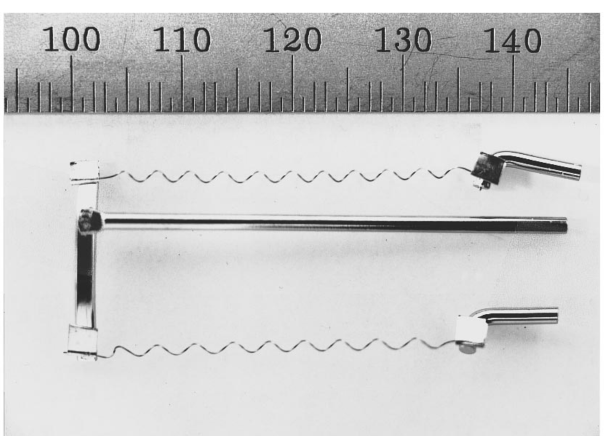

FIG. 1. Filament assembly. Replacement filaments are shown, spotwelded to original mounting supports. Ruler spacing=1 mm/div.

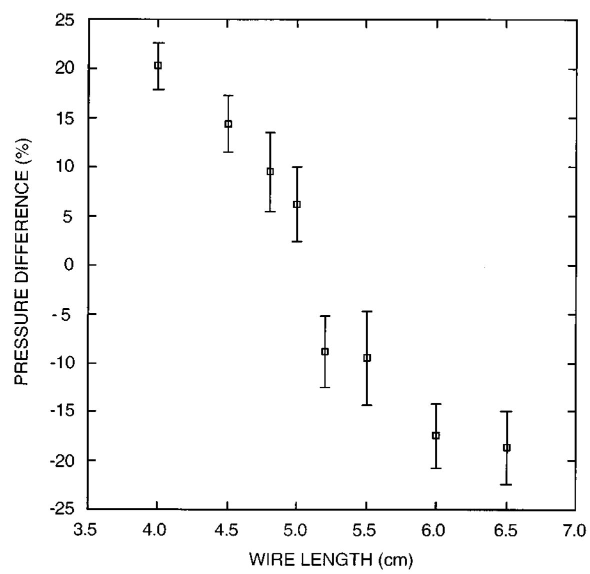

FIG. 2. Percent difference in pressure, $D_p = 100(P_{\text{commercial}} - P_{\text{replacement}})/P_{\text{commercial}}$ as a function of filament wire length. For each of eight different wire lengths, eight (8) filaments of that length were fabricated. An average value of D_p was determined for each wire length and plotted with an error bar (indicating the standard deviation in D_p).

III. FILAMENT PERFORMANCE

A replacement filament length of 5.1 cm was chosen after determining the performance of a filament relative to its commercial counterpart as a function of wire length. This was accomplished by mounting both filaments in a nude, dual filament, Bayard–Alpert gauge mounted on a turbomolecular pumping station.[7,8] The pressure indicated by the commercial filament, $P_{\mathrm{commercial}}$, and by the replacement filament, $P_{\mathrm{replacement}}$, were recorded at a filament current of 4 mA. Pressure readings were made when $P_{\mathrm{commercial}} < 10^{-7}$ Torr was measured.[9] A percent difference in pressure, $D_p = [100(P_{\mathrm{commercial}} - P_{\mathrm{replacement}})/P_{\mathrm{commercial}}]$, was calculated from the pressure readings. For each of eight different wire lengths, eight (8) filaments of that length were fabricated and an average value of D_p was determined for that wire length. Figure 2 shows the average value of D_p plotted as a function of wire length (with an error bar indicating the standard deviation in D_p). A filament wound from a 5.1 ± 0.1 cm length of tungsten wire resulted in $D_p = 5\%$, which is within the tolerance observed for commercial filaments.

[1] R. T. Bayard and D. Alpert, Rev. Sci. Instrum. **21**, 571 (1950).

[2] S. Dushman, *Scientific Foundations of Vacuum Technique* (Wiley, New York, 1962).

[3] Sonicate in acetone, or electropolish in phosphoric acid (85–87) at ≈10 V_{dc} for 1 min.

[4] Tungsten wire, annealed and cleaned, 0.15 mm (6 mil) in diameter. Available from Thermionic Products company, North Plainfield, NJ.

[5] The mandril should be ≈1 mm in diameter. The (unfluted) end of a #60 twist drill is suitable.

[6] It is good practice to clean the wire by ultrasonic agitation in NaOH (1–4 M) for 2–3 min.

[7] Varian Vacuum Products, Lexington, MA, Part No. 0580-L5150-304.

[8] Balzers Pfeiffer North America, Inc., Freemont, CA, Part No. TSU 180H.

[9] Ion gauge controller, model DGCIII, Perkin Elmer Vacuum Products, Eden Prairie, MN.