Article 159

A GAS JET FOR D-C ARC SPECTROSCOPY

By A. W. HELZ, Washington, D.C.

Abstract.—A gas jet adaptable to enclosed arc-spark stands is described for use in d–c arc spectrochemical analysis. When used with a nitrogen-free gas, the jet is very effective for suppression of cyanogen bands.

The gas jets for spectrochemical analysis described by Annell and Helz (1961) proved to be very effective for arc stabilization and cyanogen-band depression. However, they were designed for open-type arc stands and are difficult to use in spectrographic assemblies with conventional enclosed arc-spark stands. For enclosed stands it was considered desirable to use prefabricated electrodes of standard 1.5-inch length. Figure 159.1 is a drawing of the jet described herein. To minimize the required electrode length, the ceramic cap forming the nozzle, *A* (fig. 159.1 section *XX′*) was shortened. To compensate for this loss of control of the gas flow and to try to insure lamellar flow, the internal construction was redesigned as described below. The control gas enters a lower chamber (fig. 159.1, *C*) surrounding the electrode, goes up through a ring of small holes (each 0.062 inch in diameter and 0.125 inch long) into an upper conically topped chamber (fig 159.1, *B*), and finally escapes through the annular space formed by the sample-bearing electrode and the ceramic cap.

The jet was made in the U.S. Geological Survey analytical laboratory shop by J. B. Beasley. The main body of the jet is a ¼-inch-thick brass plate supported on an electrically insulated post. Self alinement with the arc-stand jaws is augmented by freedom of the frame to swing on the post and by affixing the post to the arc-stand base loosely to permit some translational motion. The plate is effectively water cooled with a U-shaped channel. This jet is for use with standard electrodes 1½ inches long and 0.242 inch in diameter. Thus, if the bottom hole of the brass plate and the central hole in the brass section that separates chambers *B* and *C* are each 0.250 inch in diameter, the electrode clearance will be 0.004 inch. At least this much clearance is advisable for convenience in inserting electrodes from above.

The ceramic cap of the jet is a commercially available part used in tungsten-inert gas welding. The number 6 Linde Heliarc cup (Linde Co., division of Union Carbide Corp.) is suitable for use with the ¼-inch-diameter electrodes. The ceramic cup is shortened from 1.25 inches to 0.72 inch by cutting off the cylindrical tip at the outside circle where the cylindrical and conical parts of the cup meet. This leaves a short cylindrical section inside about 0.062 inch high and 0.375 inch in diameter.

The annular space for the escaping gas is 0.066 inch thick. The assembled height of the jet is 1 inch. In use the lower electrode height is frequently adjusted to keep the burning rim of the crater a constant distance above the rim of the ceramic cup. About 2-millimeters seems optimum for this distance.

This jet is much more compact than the earlier design of Annell and Helz (1961), but it is just as effective in producing a very steady arc and controlling cyanogen band interference. To show the effectiveness of the jet, 10 spectra of the cyanogen-band region are shown in figure 159.2. In addition to the spectrum of the arc in still air, spectra are also shown for the jet described herein, the Stallwood jet (Stallwood, 1954), and the enclosed Stallwood jet (see Spex Industries, Inc., 1962, for a summary status of Stallwood jets) at gas flows of 5, 10, and 15 cubic feet per hour. The control gas used was a mixture of 80 percent argon and 20 percent oxygen. For each spectrum shown in figure 159.2, 10 milligrams of a powdered rock was mixed with 20 mg of graphite and burned in a 15-ampere d-c arc. The spectra were recorded on an SA–1 plate using 38-percent transmission and 1-minute exposures. These first-order spectra have a reciprocal linear dispersion of approximately 5 A/mm.

The difference between the type of gas flow for the jet described in this article and the gas flow of the Stallwood jet is strikingly illustrated by the spectra

ART. 159 *IN* U.S. GEOL. SURVEY PROF. PAPER 475–D, PAGES D176–D178. 1964.

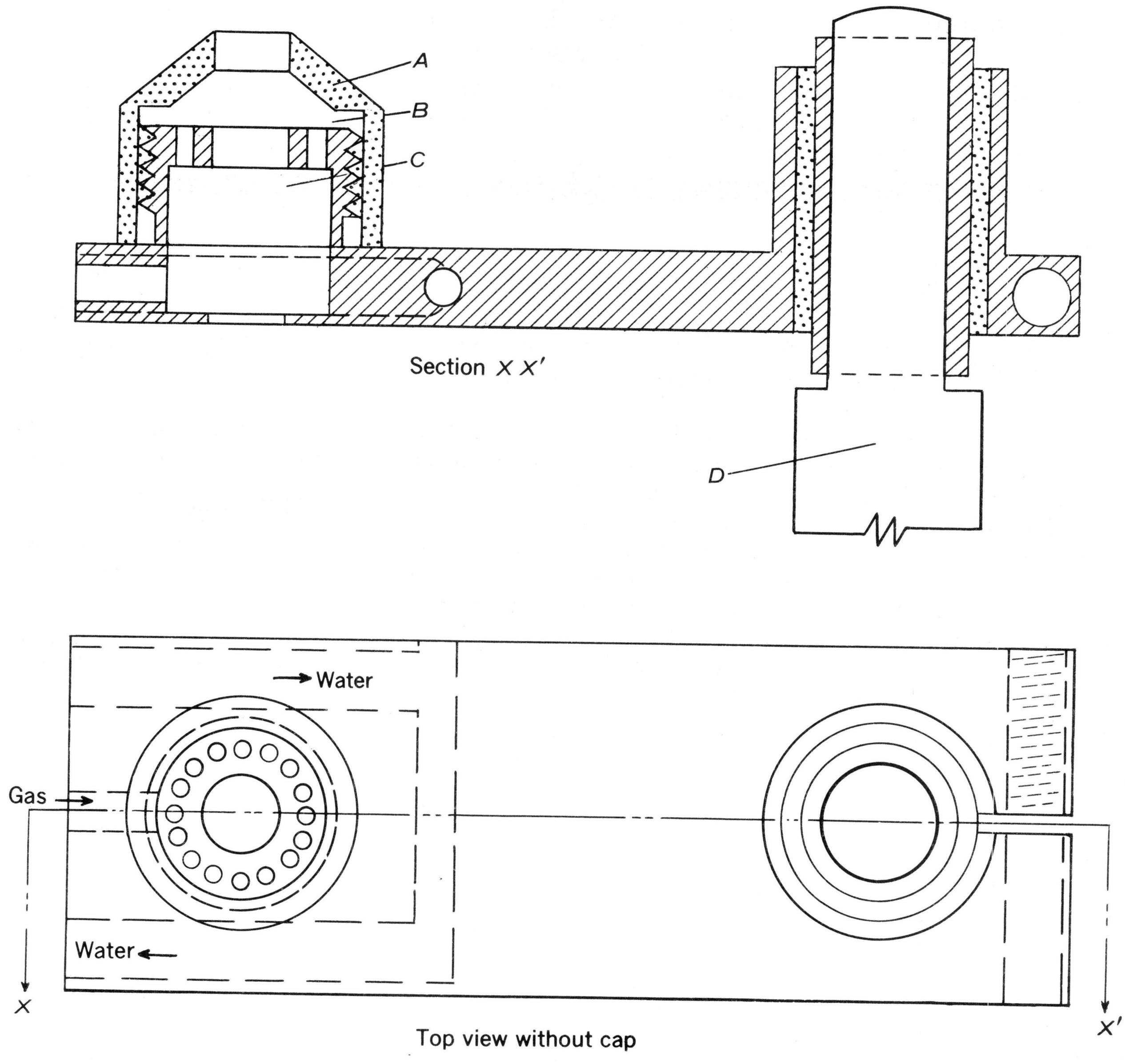

FIGURE 159.1.—Jet design. Overall dimensions of the brass base plate, 3¼ × 1⅛ × ¼ inch. In section XX' the control gas enters compartment C, passes through the ring of small holes to compartment B, and then out through the top of the ceramic cap A. D is the supporting post.

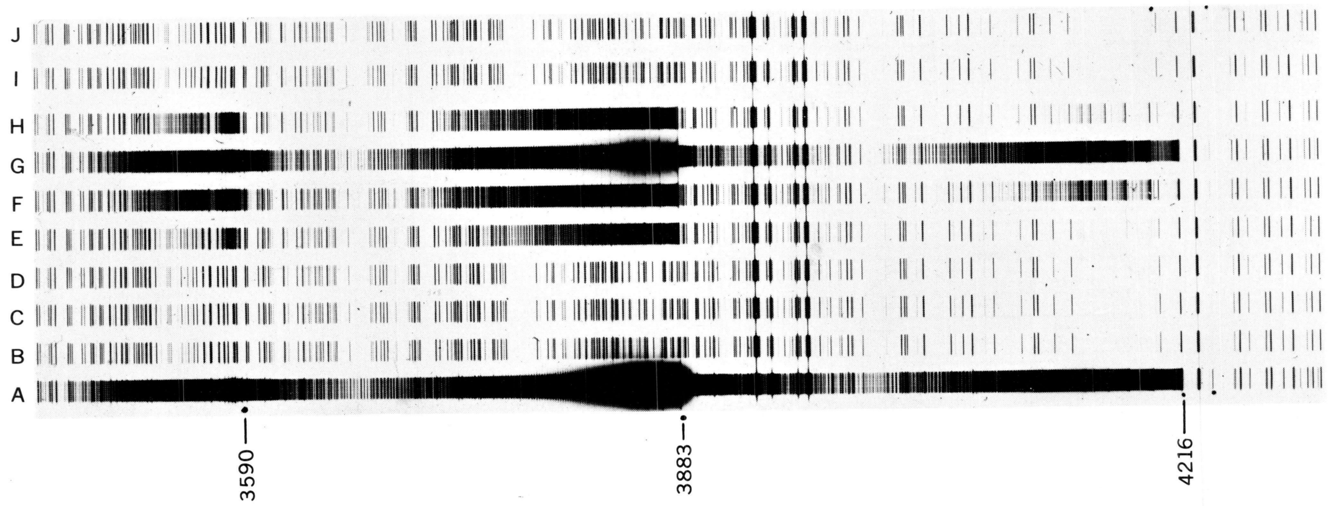

FIGURE 159.2.—Spectra of 15-ampere d-c carbon arcs, cyanogen-band region. *A*, arc in air. *B–D*, enclosed Stallwood jet, 5, 10, and 15 cubic feet per hour, respectively, of a mixture of 80 percent argon and 20 percent oxygen. *E–G*, open Stallwood jet, 5, 10, and 15 cubic feet per hour, respectively, of argon and oxygen mixture. *H–J*, jet described in the report; 5, 10, and 15 cubic feet per hour, respectively, of argon and oxygen mixture.

for different rates of flow. For the jet described herein the intensity of the cyanogen bands decreases with increasing gas flow (spectra *H*, *I*, *J*). For the Stallwood jet, intensity increases with the gas flow (spectra *E*, *F*, and *G*). For the enclosed Stallwood jet, though at a much lower level, intensity decreases as the gas flow is increased from 5 to 15 cfh (spectra *B*, *C*, and *D*). Cyanogen bands are absent in spectra *D* and *J*; that is the gas flow is 15 cfh with either the enclosed Stallwood jet or the jet described in this article. Thus the effective exclusion of cyanogen-band spectra in carbon arcs is obtainable without cumbersome enclosures of the arc.

REFERENCES

Annell, C. S., and Helz, A. W., 1961, A constant-feed direct-current arc: U.S. Geol. Survey Bull. 1084–J, p. 231–251.

Spex Industries, Inc., 1962, Spex Speaker VII, no. 3: Scotch Plains, N.J.

Stallwood, B. J., 1954, Air-cooled electrodes for the spectrochemical analysis of powders: Optical Soc. America Jour., v. 44, 171 p.