

## Leak Detection in High Pressure Gas System\*

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(Received 9 September 1968)

**M**OST high pressure systems are plagued from time to time by small leaks. To find these leaks is often a cumbersome and frustrating process. Ultrasonic probes can be used in many cases to detect moderate leaks. Soap bubbles or similar techniques are messy and limited to easily accessible areas. We have successfully used radioactive <sup>85</sup>Kr to detect leaks at a rate too small to be found by these other means.

Our system uses argon as a pressure medium and is capable of generating 14 kilobars, where the net volume filled by the compressed gas is approximately 5 cc.<sup>1</sup> One percent of krypton is added to the argon.<sup>2</sup> The krypton contains sufficient <sup>85</sup>Kr so that its activity is 10 mCi/liter. <sup>85</sup>Kr has a half-life of 10.4 years and emits a soft  $\gamma$  ray of 0.52 MeV and  $\beta$  particles with a maximum energy of 0.67 MeV. The  $\beta$  particles are efficiently shielded by the steel tubing in the pressure system but can be readily detected upon escape into the atmosphere with a  $\beta$  probe.<sup>3</sup>

In a 5 cc volume, where the concentration of the added krypton is 1%, with a 10 mCi/liter level of radioactivity, and at a pressure of 1 kilobar, we calculate that a 1% volume loss in 10 000 sec corresponds to approximately 20 counts/sec. Much smaller leaks can be detected by increasing the proportion of <sup>85</sup>Kr or by the use of higher pressures. The background count in our laboratory is less than 1 counts/sec. Therefore, our detection threshold under the conditions described is about a 1% leak per day (86 400 sec).

The work was supported by NSF Grant No. GA 1003, for which we are most grateful.

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<sup>1</sup> The cost of the gas for one pressure run with leak detection is less than one dollar.

<sup>2</sup> The krypton used on the tracer was obtained from Union Carbide's Linde Division.

<sup>3</sup> The radiation detector was a Wm. Johnson and Assoc., Inc., model GSM-S with a GP-200 probe.

## Coaxion—A New Ion Source\*

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(Received 27 December 1967; and in final form, 19 September 1968)

**I**NCREASING interest in the generation and application of ion beams has produced ion sources of varied constructions and efficiencies. A significant portion of these ion generators are of the contact ionizer type, and these can be divided into the ribbon type and the rear-fed porous plug type.

The tungsten ribbon ionizer is useful in many applications primarily because of its simplicity and low cost.<sup>1,2</sup> However, this basic type suffers from some disadvantages. The method of supplying the atomic vapor to the face of the ionizer is inefficient with the vapor source located some distance from the ribbon. Without benefit of ducting, the probability of more than a small percentage (1 or 2% on a geometric basis) of the evaporated material reaching the ionizing surface is remote, and the remainder serves only to contaminate the vacuum system. With a ribbon type ionizer, the ion source shape creates severe problems in forming a cylindrical or focused ion beam. In addition, the contact ionizer material is generally resistance heated and must therefore possess reasonable resistivity properties, as well as a high work function and mechanical integrity at working temperatures.

The rear-fed porous plug ion source has been well developed and has overcome most of the problems of the ribbon type while retaining contact ionization. The device described by Kuskevics and Thompson<sup>3</sup> is of this type, with reported Cs ion currents up to 9 mA with low neutral content. Similar systems have been employed for the ionization of indium<sup>4</sup>; however, these devices utilize a tungsten element which requires oxygenation when used to contact ionize materials such as indium, if reasonable efficiencies are to be expected. Introduction of oxygen into the vacuum system is generally not advantageous, due to gas reactions between the oxygen and the ion beam and also due to the requirement of special pumping arrangements in order to obtain a low pressure in the region beyond the ion generator.

Difficulties of the above nature prompted the designing of an ion generator that would remove the deficiencies and still be inexpensive and simple to construct. The new ion generator consists of two main coaxial components, the contact ionizer and the vapor source, as shown in Fig. 1. The contact ionizer consists of a strip of platinum foil (50  $\mu$  thick) which is rolled up on a platinum wire core. This roll is inserted in the ionizer housing tube and allowed to unroll slightly, fitting the bore of the tube and

JUN 14 1971