3.1. INTRODUCTION

Mechanical transport devices have in common the feature that the reduction in solvent volume and concurrent concentration of solute is performed in a region physically removed from the ion source of the mass spectrometer. Solutes are subsequently sequentially transported by some physical means into the ion volume for ionization and analysis. Devices of this type may be conveniently divided into two distinct categories: on the one hand, those which purport to offer a continuous representation of solute composition at the exit of the chromatograph, termed continuous monitors, and, on the other hand, those which, by design, segment eluent into fractions which, following concentration, are presented to the spectrometric ion source. The latter, termed storage devices, may broadly be classified as mechanized fraction collection systems and are therefore not, in the strictest sense, direct liquid chromatographic–mass spectrometric unions. In either case, within tolerable limits, systems have been demonstrated to exercise the requisite pressure reduction between chromatograph and spectrometer. The requirements for pressure reduction are variable, being a function of the rate of liquid flow, the speed of transportation, the nature of the enrichment device used, and the pumping efficiency of individual systems. In any event, both of these approaches offer the significant theoretical advantage that the ionization of solutes can be made independent of any influence of the mobile phase. This virtue should not be underestimated. By way of emphasis, it is worth making the point that transport devices offer the possibility of measurement of true electron impact, chemical ionization (with free selection of reagent gas), fast atom bombardment, and other spectra. That is, the spectra are not modulated by the mobile phase, the advantage being that the measured spectra are comparable with those acquired by direct means. These devices therefore offer the analyst spectra with which he or she is likely to be familiar and, in particular, which are comparable with library spectra, where they exist.

Of the two approaches, that which yields a continuous report on the elution
of material from the column is ideally the more attractive. Nevertheless, both warrant discussion.

3.2. CONTINUOUS TRANSPORT SYSTEMS

3.2.1. Moving-Wire Interfaces

Scott and his colleagues [74SC95] modified a moving-wire gas chromatography detector, as manufactured at the time by Philips Chromatography, such that it entered the source region of their mass spectrometer. In doing so, they engineered a system which satisfied the minimal requirements of a combined liquid chromatography/mass spectrometry system. That is to say, the device permitted the introduction of sample from solution at atmospheric pressure into a mass spectrometric ion source at high vacuum. They successfully demonstrated the principle, by the enrichment, transportation, and ionization of several materials including diazepam, phenobarbital, and vitamin A. For a time, these researchers continued to develop the system and report on its potential [77SC13, 79SC95]. They were, however, certainly aware of its limitations in two major respects: firstly, its lack of sensitivity, and, secondly, its limited ability to successfully vaporize sample, albeit relatively efficiently introduced into the ion source. In suggesting the use of heater coils, infrared radiation, and lasers as possible solutions to the latter problem, and consequently possibly the former, they managed to presage much of the subsequent development of continuous transport systems.

3.2.2. Moving-Belt Interfaces

3.2.2.1. Introduction

Current manifestations of this type of interface owe their existence to Scott’s pioneering work, in the midseventies, on the moving-wire interface. In a remarkably short period, through the work of McFadden and co-workers, the Finnigan Corporation, which had supported Scott and his collaborators, developed [76MC29, 77DA54], patented [77MC87'], promoted [77MC7', 77MC56], and commercialized a transport interface. The interface, schematically represented in Figure 3.1, introduced, in place of the moving wire, a moving belt in the form of a band, which was made to continuously cycle within an enclosed housing. Chromatographic eluent is deposited on the belt, which is supported on a pulley driven by means of a variable-speed motor. The band passes below an infrared heater, whose output is adjusted to evaporate most of the mobile phase before the belt reaches the entrance slit to the first vacuum lock. The pressure drop between atmosphere and high ion source vacuum is maintained through stepwise reduction by means of two differentially pumped vacuum locks. The