comparison, simple pulse-counting systems that measure peaks containing less than 1 ion per spectrum which allow one to utilize the full sensitivity range of the instrument, and simple gating systems which allow conventional recording of mass spectra.

An experiment recently performed concerning the detection of metallic ions may suggest other applications for the instrument. It was desired to check the dependence of resolution on initial energies considerably higher than those usually encountered, and for this purpose a beam of metallic molecules, thermally emitted from a hot source, was allowed to pass through the ionizing region at right angles to the electron beam and parallel to the source electrodes. As was expected, the resolution was unaffected by this transverse velocity. In general the resolution and intensity obtained with metallic vapors have proved to be very similar to those that would be obtained with gases at the same molecular density. It was possible, however, to detect a shift in the direction of travel of the metallic ion beam as compared with the background ions, the metallic ions being displaced at the collector in the direction of their high initial velocities. This fact can be turned to advantage by aiming the metallic ions directly at the collector, causing the majority of the background ions to be lost to one side. With aluminum vapor, an improvement of a factor of 10 for the sensitivity of the metallic vapor as compared with the background gas was obtained in this way.

Another application in the experimental field is to measure the lifetime of different types of ions by varying the time between the shutoff of the ionizing electron beam and the beginning of the ion-acceleration pulse. With most source geometries it is possible to have a lag between ion formation and ejection from the source of about 5 to 10 microseconds.

Conclusions

Many of the applications of the Bendix Time-of-Flight Mass Spectrometer make use of the instrument's high resolution, speed of response, and simplicity. Among these are studies of fast reactions, the monitoring of chromatography columns, fast, moderately accurate chemical analyses, the optimizing of pilot-plant operations, the detection of metallic vapors, and studies of ion lifetimes.

Further experience is expected to uncover other applications to the problems of science and industry where the unique characteristics of this instrument can be of service.

References and Notes

1. U.S. patent 2,685,035.
2. W. C. Wiley and I. H. McLaren, *Rev. Sci. Instr.* 26, 1150 (1955).
3. L. P. Lessing, *Sci. Am.* 188, No. 5, 29 (May 1953).

News of Science

Phosphagen of Tunicates

It has been established that invertebrates and vertebrates differ with respect to their phosphagens. Thus, phosphoarginine is characteristic of invertebrates and phosphocreatine of vertebrates.

The invertebrates, however, exhibit some variability [Baldwin, *Dynamic Aspects of Biochemistry* (Cambridge Univ. Press, ed. 2, 1952)]. Although most of the five extant classes of Echinodermata possess nonprotein arginine and so follow the general invertebrate pattern, the Ophiuroidea contain creatine and the Echinoidea both arginine and creatine. A few invertebrates are devoid of both phosphoarginine and phosphocreatine but possess one or the other (gephyreans, some polychaete annelids) or both (some polychaetes) of two recently discovered phosphagens that contain neither arginine nor creatine. On the other hand, phosphocreatine is the only phosphagen present in vertebrates.

The protochordates (Hemichordata, Urochordata, Cephalochordata), although they are grouped together with the vertebrates to form a single phylum, the Chordata, are recognized as being morphologically intermediate between invertebrates and vertebrates. Their biochemical affinities, and hence their phosphagens, are therefore of considerable interest (see Baldwin, 1952). Only phosphocreatine is present in Cephalochordata (lancelets), which thus most closely resemble vertebrates, as they do in their morphology. On the other hand, the Hemichordata (sea acorns), which exhibit the greatest structural affinities with invertebrates, appropriately possess both the arginine and creatine compounds. Since 1932, the Urochordata (tunicates or sea squirts) have been regarded as quite anomalous among chordates in this respect, for the studies of both Flössner and Needham *et al.* have indicated the presence of phosphoarginine, but not of phosphocreatine, in these animals. Hence, in this respect, the tunicates have been thought to resemble the invertebrates.

Morrison, Griffiths, and Ennor have recently reported a study of two species of tunicates, *Pyura stolonifera* and *P.* sp. [*Nature*, **178**, 359 (18 Aug. 1956)] in which they found no traces of arginine, phosphoarginine, or arginine phosphokinase. However, the presence of creatine, phosphocreatine, and an enzyme possessing creatine phosphokinase activity was established. The authors note that, although it may not be permissible to conclude that tunicates as a class possess phosphocreatine, their findings on *Pyura* do relieve these animals of their anomalous position and provide biochemical support for their accepted classification among the chordates.

It would seem of interest to investigate the phosphagens of other species of tunicates, including those already studied by earlier workers. It may well be that Flössner, Needham *et al.*, and Morrison *et al.* are all correct; if so, the tunicates possess more than one type of phosphagen, which varies with the species, sometimes being phosphoarginine, as in invertebrates, sometimes phosphocreatine, as in vertebrates and lancelets, and sometimes, perhaps, both of these compounds, as in hemichordates. This would befit the accepted phylogenetic position of the Urochordata.—W. L. S., JR.

French Atomic Power

France became the first country on the West European continent to produce electricity by atomic means on 28 Sept. On that date the atomic center at Marcoule, on the Rhone River north of Avignon, began to produce sufficient heat to make vapor, which in turn started the operation of specially constructed turbines.

The pile, the first of three that will be built at Marcoule, began operating in