The purpose of our report was to call attention to the greatly improved performance of semiconductor detectors, particularly in energy resolution, which makes them extremely attractive devices in a simplified x-ray emission spectrograph consisting of a radioactive source of primary radiation and a detector to measure the secondary x-rays. Proportional counters and scintillation counters have been used for this purpose for years and we regret not citing Hall's articles in our report, as well as those of Cameron and Rhodes (*1*), Cook, Mellish, and Payne (*2*), Karttunen and co-workers (*3*), and many others.

Proportional counters have energy-resolving and efficiency characteristics comparable to semiconductor detectors in the range 4 to 15 kev and may have an advantage in sensitivity owing to greater solid angle. But even here recent developments in our laboratory have led to a resolution value of 0.6 kev at 14 kev for silicon diodes, which we believe is better, by a factor of two, than is possible in a proportional counter.

In the 15- to 100-kev range, the line width achieved with proportional counters steadily increases up to 7 kev or higher. Efficiency also drops rapidly, although this can be compensated for somewhat by the use of xenon or high pressure or both. On the other hand, the resolution of the semiconductor detectors is roughly constant (in kev) over the same energy range. The resolution of our original silicon diode system rose 1.1 to 1.5 kev in the 4- to 40-kev range. The germanium semiconductor system gave 1.1-kev resolution at 80 kev. With more recent developments these figures are much lower. Counting efficiency remains $>$ 50 percent over the entire 4- to 100-kev range; the exact values depend on the thickness of the depletion layer.

It may also be worth pointing out that the semiconductor detectors do not have the escape peak effect which complicates the spectrum obtained in proportional counters in some cases. The small size of the semiconductor detectors is a disadvantage which can be compensated for somewhat by designing the apparatus for close placement of source and detector. Future developments may well lead to greatly increased detector dimensions.

The necessity to cool the detector is an inconvenience but has proved to be a minor one in laboratory use. Scintillation counters are convenient when limited energy resolution is sufficient but are not competitive when high resolution is required. Over the past 3 years there has been a substantial shift from scintillation counters to solid state detectors in the field of nuclear spectroscopy. Our laboratory has participated actively in these developments, and we are convinced that the tremendous gain in energy resolution more than offsets the inconvenience of the cooling system. The demands of nuclear spectroscopy have also stimulated great improvements in stability and performance of electronic amplifiers and pulse height analyzers. The availability of this equipment from many manufacturers should facilitate the rapid introduction of semiconductor systems in x-ray analysis.

This short statement cannot cover all the manifold complexities of x-ray analysis. Certainly proportional counters will remain useful in many applications for years to come. However, we retain our original enthusiasm that the combination of high resolution and efficiency over the entire range of x-ray energies plus convenience, compactness, reliability, and stability make the semiconductor detector extremely attractive for use in an x-ray emission spectrograph.

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23 May 1966

Divers' Communications Improved

Underwater communication by voice between divers and between diver and surface, whether transmitted by cable or through the water, has been inadequate because of the respiratory noises and distortions of speech associated with the use of air-conduction transducers in face masks. When a mouthpiece is used for breathing, speech is even less intelligible. The use of standard air-conduction techniques with earphones is unsatisfactory because covering the ears with earphones interferes with the equalization of pressures on opposite sides of the eardrum and with detection of sounds from the environment. Voice communication between diver and surface is made effective by the use of a system in which bone-conduction transducers are utilized.

In quiet environments one transducer attached at either the forehead, top of the head, or back of the head (these sites are in order of decreasing effectiveness) is adequate for both talking and listening. For environments in which there are high levels of noise (100 db or higher), two transducers, one located on the upper lip for talking and the other located on the mastoid for listening, provide adequate transmission and reception.

The transducers, used with a full-face mask and a cable system, work well at 12-m depths in water and in simulations of 90-m depths in a compression chamber. Since in the water other divers within about 30 cm of the diver wearing the transducer also can hear the transmission from the surface, it seems probable that hearing is accomplished through both bone- and ear-conduction.

While it achieves adequate speech intelligibility, use of the bone-conduction transducers also allows the diver to hear sounds from his surroundings. Moreover, voice communication is possible while one uses mouthpiece-breathing equipment; speech is relatively unintelligible but, with adequate training in speaking and the use of a a "restricted" vocabulary, low-fidelity communication can be effected; and with the diver "on transmit" his breathing is audible and can be monitored at the surface.

This development was based on data obtained during investigation in my laboratory of the bone-conduction of sound and on the results of tests carried out jointly with the Personnel Research Unit of the Royal Canadian Navy at the Institute of Aviation Medicine, Toronto. I understand that the Royal Navy uses an underwater communication system for divers that employs a similar technique. This is Defence Research Medical Laboratories technical note 633.

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18 May 1966