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1900-1977

By Ascher H. Shapiro

Joseph Henry Keenan, Professor Emeritus of Mechanical Engineering at the Massachusetts Institute of Technology (MIT), former Head of the Department of Mechanical Engineering, and Member of the National Academy of Engineering, died on July 17, 1977, after a three-year illness, during which time he had steadfastly maintained an active personal and professional life.

Professor Keenan was born August 24, 1900, in Wilkes-Barre, Pennsylvania. In 1922 he received from MIT the degree of Bachelor of Science in naval architecture and marine engineering.

The course of his future professional career-centered on the deep structure of thermodynamics-was in a sense set by his first job, when, in 1922, he became a turbine design engineer with the General Electric Company in Schenectady, New York. Here he first became interested in the properties of steam, which necessitated thorough grounding in the fundamentals of thermodynamics.

In 1922, he entered the academic world, there to remain, as Assistant Professor of Mechanical Engineering at Stevens Institute of Technology in Hoboken, New Jersey. At the invitation of Karl Taylor Compton he came to MIT in 1934 as Associate Professor of Mechanical Engineering and was promoted to Professor in 1939.

During the more than forty years he was associated with MIT, Professor Keenan made a host of friends among his colleagues and students. He is remembered by all for his personal qualities and for

his dedication to the Department of Mechanical Engineering and to the Institute. He consciously strived throughout his career to ensure continued excellence of the Department, the preeminence of which was a constant source of pride for him. His concern for students was deep and genuine, not only for their professional development, but for their growth as educated persons in the broadest sense. Truly a master teacher with a highly individual style, he patiently led students, by means of leading questions, to individual discovery and insight. No less was he concerned with the discovery and nurturing of the promising young faculty members, by this means imprinting the Department with his lasting influence.

Professor Keenan's works on thermodynamics are world-renowned and have directly and indirectly changed the face of thermodynamics teaching in engineering. His contributions to thermodynamics derived from an uncompromising search for understanding and elimination of ambiguities overlooked or accepted by others. He developed a coherent and logical exposition of the fundamentals of thermodynamics so that the widest possible range of problems could be considered in a uniform and consistent manner. To the very end he strove to improve the exposition and to make it more useful for practicing engineers. His famous textbook, *Thermodynamics,* published in 1941, remains a classic. It represents the distilled essence of thinking up to that time, and it is characterized by simplicity of approach, rigor in logical development, and economy of effort. This book has had an authoritative and continuous influence on teachers of thermodynamics, in all branches of engineering, and throughout the world.

James B. Killian, Jr., then Chairman of the MIT Corporation, said of Professor Keenan in 1966:

> To my mind he is one of the finest examples I know of a scholar of the first order who is also unremittingly interested in and concerned with the art of teaching. Not only has he made important contributions to the body of knowledge and understanding in the field of thermodynamics, but he has been able with great success to transmit his understanding to his students and associates.

Through his writing and teaching, Professor Keenan brought to the engineering profession the fundamental work of J. Willard

Gibbs in thermodynamics, which, for the most part, had been overlooked by engineers and scientists for five decades. In the 1930's he adapted Gibbs' concept of thermodynamic availability to the steady-flow processes of engineering. The initial motivation for this development was the allocation of fuel costs in a process with many outputs. The concepts of availability soon became widely used in chemical engineering and power-plant engineering, particularly abroad. In the United States, it has in a sense been tardily rediscovered and has recently become an important tool in the shaping of a national energy policy.

In the late 1950's and 1960's, Professor Keenan contributed to a new interpretation of thermodynamics that is applicable to a much wider range of systems and physical phenomena than any other interpretation presented in the past. This new interpretation applies to quantum systems and classical systems, relativistic mechanics and Newtonian mechanics, nuclear reactions and chemical reactions, fluids and solids, and to single molecules. It is presented in a book he coauthored, *Principles of General Thermodynamics,* published in 1965. In this book, the conflict between the postulates of thermodynamics, including irreversibility, and those of quantum mechanics are resolved, and many aspects of these two sciences are unified into a single conceptual entity.

The development of accurate tables of the properties of steam, so vital to the electric power industry, was a continuing preoccupation during Professor Keenan's career, the initial milestone being his appointment in 1929 as the U.S. delegate to the First International Conference on the Properties of Steam; he served as delegate in all successive conferences on this subject until the eighth in 1974. His name is synonymous with the Steam Tables, familiar to generations of students and practicing engineers; he was author or coauthor of successively improved tables of steam properties published in 1930, 1936, 1939, and 1969, all of them authoritative. The Air Tables, and then the Gas Tables, which he also coauthored, provided for the emerging gas-turbine industry what the Steam Tables had done for the steam-power industry.

During his professional career, Professor Keenan conducted significant experimental research, most of which represented

pioneering efforts. Among his works were the determination of steam-turbine nozzle performance, experiments on friction coefficients of air at supersonic speeds, experiments on injectors and on heat transfer at high speeds, the development of the free-piston compressor for gas-turbine applications, the development of equipment for processing coffee and cocoa, and the development of dust-separation equipment.

Professor Keenan headed the Department of Mechanical Engineering at MIT from 1958 to 1961, leading the Department through the post-Sputnik years, one of the most difficult periods of its recent history. The introspective studies under his leadership were important factors in the changes that kept the Department in a preeminent position.

Among the many honors awarded to Professor Keenan are Honorary Membership in the American Society of Mechanical Engineers (1966), the Worcester Reed Warner Medal of the American Society of Mechanical Engineers (1954) for permanent contributions to the literature of engineering, a Fulbright Lectureship at Cambridge University and at the Imperial College of Science and Technology in London (1951), an Honorary Doctor of Laws degree from the University of Glasgow (1966), and Membership in the American Academy of Arts and Sciences (1937) and the National Academy of Engineering (1976).

Professor Keenan is survived by his wife, the former Isabel Morrison, and two children, Mrs. John W. Carr III of Bryn Mawr, Pennsylvania, a Research Associate at the Philadelphia Child Guidance Clinic, and Matthew A. Keenan of 4 Dana Road, Belmont, an investment counselor.

Professor and Mrs. Keenan were summer residents of Nantucket for forty-five years. For the last ten years they lived in the Shimmo section of the island.

An avid sailor and tennis player, Joseph Henry Keenan was a Member of the Siasconset Casino, the Belmont Hill Club, the Harvard Musical Association, and the Nantucket Yacht Club.