Int. J. Heat Mass Transfer. Vol. 11, pp. 3–5. Pergamon Press 1968. Printed in Great Britain

LLEWELLYN M. K. BOELTER
1898–1966

R. A. SEBAN
Mechanical Engineering Department, College of Engineering,
University of California, Berkeley, California

(*Received* 16 *June* 1967)

THE CAREER of Professor L. M. K. Boelter reflected throughout his technical interests in heat transfer and thermodynamics, a devotion to teaching, wide sociological interests, and leadership in educational administration. While the record of his activities reveals a chronology in the formalization of these interests, the older of his students remember that while the theme of his instruction was technical, there was emphasis too on the impact of technology on society and on the nature of education. Later students, whose contact with him was more informal, are aware of his administrative efforts in maintaining synthesis in the diversely growing field of engineering and of his activity in relation to urban problems through a long membership on the City of Los Angeles Planning Commission. All of his students were permanently influenced by instruction which centered on an awareness of the learning process and the provision of stimuli which aroused the highest achievements of which they were capable. One does not easily or briefly take the measure of such a man and there are here cited only biographical details and a review of his contributions to the field of heat transfer, in which selected references have been chosen to indicate the scope and chronology of his interests and to recall some of his students and co-workers.

Dean Boelter was born in Winona, Minnesota; there and in the state of Washington he received his early education. He matriculated at the University of California at Berkeley in 1913, received his bachelor's degree in 1917, and the Master's degree in Electrical Engineering in 1919. Then with his appointment as Instructor in Electrical Engineering began the uninterrupted, distinguished and loyal association as a faculty member of the University of California. In 1923 he became Assistant Professor in the Department of Mechanical Engineering and his interests in cooling problems in internal combustion engines stimulated his initial work in heat transfer. He was advanced to Associate Professor in 1927 and to the Professorship in 1934. He was appointed Associate Dean of Engineering at Berkeley in 1941 and delegated to organize the College of Engineering at Los Angeles, which began formally in 1944 with Professor Boelter as Dean and so continued until his retirement in 1965.

The rationalization of the engine cooling situation stimulated investigations of a variety of associated heat-transfer problems and the initial contributions thereto provided pioneering insights into many areas, some of which are still viable today. With Dittus [1], Professor Boelter developed the correlation for the heat-transfer coefficient for turbulent flow in tubes, with Cherry [2], there was examined the heat transfer to viscous flow with variable viscosity, and with Martinelli [3], the effect of combined free and forced convection in a vertical tube. The analogy between heat transfer and friction in turbulent flow was examined with Martinelli and Jonassen [4], and the effect of vibration on free convection from a horizontal cylinder was defined with Martinelli [5].

From 1919 to 1944 Professor Boelter directed the testing agency of the California State Division of Motor Vehicles, a service primarily directed toward the testing of motor vehicle lights and signalling devices, and this activity produced an interest both in illumination and in the transmission of visible radiation. The scattering of light by fog was considered with Ryder [6]. This involvement with the radiation problem was expanded by investigations in the agricultural area, in which the heating of citrus orchards was an acute problem in the early thirties. He demonstrated that the "smudge" produced by the heating methods then in use actually decreased the diurnal energy input to the fruit. This work in the thermal radiation area led to improved methods of shape factor determination with Cherry [7], and the development of improved radiometers, with Gier [8], for the measurement of the radiation from fruit, foliage and sky, with Brooks [9].

This activity focussed also on the orchard heater itself and stimulated studies on both combustion in the heaters and on a piped fuel feed system for them and it was the latter that led to interest in the pressure drop associated with two phase flow in pipes. This investigation led to pioneering papers with Kempner [10] and with Martinelli [11], which with subsequent papers defined the regimes of flow and presented a rational basis for the evaluation of pressure drop for two-phase, gas–liquid flows.

The late thirties also involved a sharpening interest in mass transfer, particularly associated with cooling tower performance and its prediction. The use of the enthalpy potential was exploited, new data were developed with London [12], and the rate of water evaporation in free convection from horizontal surfaces was also examined with Gordon [13], as was that from drops and sprays with Nottage [14].

The war years of 1941–45 saw Professor Boelter in the direction of a substantial research effort on various phases of aircraft heat transfer. Internal flows were investigated further, particularly in respect to roughness, property variation, and entry length, with Iversen [15]. External flow problems were considered with respect to icing protection with Tribus [16] and these considerations led to early examinations of the effect of variable wall temperature on the heat transfer to boundary layer flows. Heat flow meters were developed, using the plated thermopile, with Dunkle [17].

From 1928 through 1940, Professor Boelter continuously conducted classes in heat transfer at Berkeley and the early part of this period was devoted to an organization of knowledge in the form of class notes. In 1933, Cherry and Johnson formalized this material, with their additions, into the *Heat Transfer Notes*; these were augmented in several re-issues, with a final one, in which Martinelli participated, in 1941. Readers experienced in the field from the thirties through the fifties will recall the tremendous impact of these Notes in teaching, research, and design. Though never prepared as a text, they became the "bible" of their time and their continued usefulness led to revision and final publication [18] in 1965 by Johnson and Dean Boelter.

As administrative responsibilities accrued and broader problems arose after 1955, Dean Boelter's direct involvement in heat-transfer research diminished but his interest sustained and made the Los Angeles campus a home and focus for research in boiling, boundary-layer heat transfer, thermal radiation and mass transfer. Without citing references specifically (for the names themselves define the efforts) he was the aegis for much of the work of Tribus, Bromberg, Poppendiek, Morrin, Gier, Edwards, and Knuth, who were attracted to the Los Angeles campus by the environment he fostered and the inspiration that he gave.

Beyond his direct personal contribution to the field of heat transfer and the innumerable indirect ones through his students, recognition is due also to his organizational contributions. He was one of the founders of the Heat Transfer Division of the American Society of Mechanical Engineers and was Chairman thereof in 1938.

He was in 1948 a founder of the Heat Transfer and Fluid Mechanics Institute and later sustained its spirit and insured its viability. He encouraged the foundation of this Journal and remained a member of its Honorary Editorial Advisory Board. He received the Max Jakob Memorial Award in 1962 for his manifold contributions to the field of heat transfer.

His distinction in the field of heat transfer has been but partially defined here, much more has been contributed by the students he taught and inspired and it is a characteristic of the man that he was, that they recall him not first for technical leadership but for humanity, sympathy, and a loyal, almost fatherly association that even decades neither clouded or attenuated.

REFERENCES

1. F. W. Dittus and L. M. K. Boelter, *Univ. Calif. Publs Engng* **2** (13), 444–461 (1930).
2. L. M. K. Boelter, H. Cherry, A. Lee and W. O. Nelson, *Proceedings of the Fifth International Congress on Applied Mechanics*, pp. 571–578. John Wiley, New York (1938).
3. R. C. Martinelli and L. M. K. Boelter, *Univ. Calif. Publs Engng* **5** (2), 23–58 (1942).
4. L. M. K. Boelter, R. C. Martinelli and F. Jonassen, *Trans. Am. Soc. Mech. Engrs* **63**, 447–445 (1941).
5. R. C. Martinelli and L. M. K. Boelter, *Int. Congr. Appl. Mech.* 578–585 (1938).
6. L. M. K. Boelter and F. A. Ryder, *Illum. Engng* **35** (3), 223–235 (1940).
7. L. M. K. Boelter, V. H. Cherry and D. D. Davis, *Illum. Engng* **34** (9), 1085 (1939).
8. J. T. Gier and L. M. K. Boelter, *Temperature—Its Measurement and Control in Science and Industry*, p. 128. Reinhold, New York (1941).
9. L. M. K. Boelter, F. A. Brooks and C. Lorenzen, *Bull. Am. Met. Soc.* **20**, 433–439 (1939).
10. L. M. K. Boelter and R. H. Kempner, *Ind. Engng Chem.* **31**, 426–434 (1939).
11. L. M. K. Boelter, R. C. Martinelli, T. H. Taylor, E. G. Thomsen and E. M. Morrin, *Trans. Am. Soc. Engrs* **66**, 139–151 (1944).
12. A. L. London, W. E. Mason and L. M. K. Boelter, *Trans. Am. Soc. Mech. Engrs* **63**, 41–50 (1940).
13. H. S. Gordon, J. R. Griffin and L. M. K. Boelter, *Ind. Engng Chem.* **38**, 596–600 (1946).
14. H. B. Nottage and L. M. K. Boelter, *Heat. Pip. Air Condit.* **12**, 326–333 (1940).
15. L. M. K. Boelter, G. Young and H. W. Iversen, National Advisory Committee for Aeronautics, T.N. 1451 (1948).
16. M. Tribus, G. Young and L. M. K. Boelter, *Trans. Am. Soc. Mech. Engrs* **70**, 977–982 (1948).
17. L. M. K. Boelter, H. F. Poppendiek, R. V. Dunkle and J. T. Gier, National Advisory Committee for Aeronautics, AAR 4107 (1944).
18. L. M. K. Boelter, V. H. Cherry, H. A. Johnson and R. C. Martinelli, *Heat Transfer Notes*. McGraw-Hill, New York (1965).