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THERMODYNAMICS AND RELATIVITY¹

By Professor RICHARD C. TOLMAN

CALIFORNIA INSTITUTE OF TECHNOLOGY

(1) INTRODUCTION

WE have met to do honor to the memory of Josiah Willard Gibbs. By the labors of this master, the classical principles of thermodynamics were given their most complete and comprehensive expression. As the subject for the tenth memorial lecture, it seems appropriate to discuss the extensions to these classical principles which have since been made necessary by Einstein's discovery of the special and general theories of relativity.

The need for an extension of thermodynamics to relativity arises in two ways.

In the first place the classical thermodynamics was

¹ The tenth Josiah Willard Gibbs Lecture, delivered at Atlantic City, December 29, 1932, under the auspices of the American Mathematical Society, at a joint meeting of the society with the American Physical Society, and Section A of the American Association for the Advancement of Science.

—perhaps unintentionally but nevertheless actually—only developed for systems which were tacitly assumed to be at rest with respect to the observer, and further investigation is necessary for the treatment of thermodynamic systems which are moving relative to the spatial coordinates in use. This further investigation must be carried out with the help of those principles for the intercomparison of measurements—made by observers in uniform relative motion to each other—which form the subject-matter of the special theory of relativity.

In the second place, the older thermodynamics tacitly assumed that the behavior of thermodynamic systems could be described with the help of ideas as to the nature of space and time which we now know to be approximately valid only for a limited range of space-time and in the absence of strong gravitational fields. The considerations of the classical thermody-

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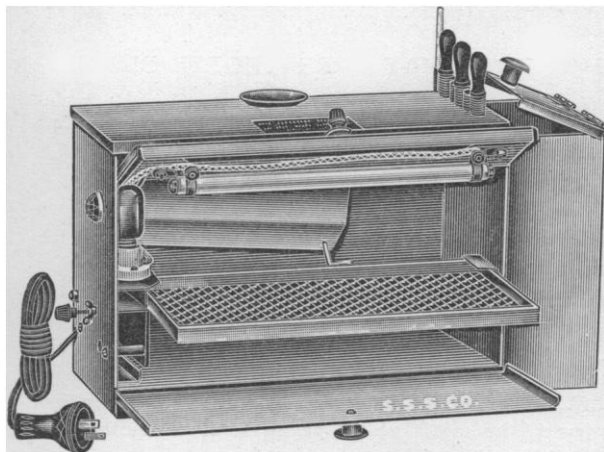
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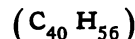
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