

HISTORY AND ROOT OF THE PRINCIPLE OF THE CONSERVATION OF ENERGY

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ERNST MACH & PHILIP E. B. JOURDAIN

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THE PRINCIPLE OF THE
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OF THE PRINCIPLE OF THE
CONSERVATION OF ENERGY

BY
ERNST MACH

TRANSLATED FROM THE GERMAN AND ANNOTATED BY
PHILIP E. B. JOURDAIN, M.A. (Cantab.)

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TRANSLATOR'S PREFACE

The pamphlet of fifty-eight pages entitled *Die Geschichte und die Wurzel des Satzes von der Erhaltung der Arbeit.*¹ Vortrag gehalten in der k. böhm. Gesellschaft der Wissenschaften am 15. Nov. 1871 von E. Mach, Professor der Physik an der Universität Prag was published at Prague in 1872, and a second—unaltered—edition at Leipzig (Barth) in 1909. To this second edition (pp. iv, 60) were added a short preface and a few notes by Mach himself. This preface is translated below.

Quite apart from the interest which must attach to the first sketch of a way of regarding science which has become of such great importance to students both of science and of the theory of knowledge, this pamphlet is quite essential to the thorough understanding of Mach's work. In the first place, it contains a reprint of Mach's article (1868) on the definition of mass, which is, perhaps, his most important contribution to mechanics; and, in the second place, the discussion of the logical root of the principle of the conservation of energy is fuller than that in any of his later publications.²

¹ In the title of this translation, *Arbeit* is translated by *Energy*, as this word conveys a better idea, at the present time, than the older and more literal equivalent of *Work*. In the text, on the other hand, the word *Work* will always be used, as it corresponds more closely to the terminology of science at the time of the first publication of this essay.

² Thus, the questions connected with the uniqueness of determination of events are discussed and illustrated very fully in this essay,

It is proper here to give some references to discussions of Mach's point of view in science.

A fairly good general account of Mach's various works was given in Harald Höffding's lectures on modern philosophers held at the University of Copenhagen in 1902;³ and another account, with a hostile criticism, was given by T. Case in his article "Metaphysics" in the new volumes which make up the tenth edition of the *Encyclopaedia Britannica*.⁴ Often valuable criticisms of Mach's position are to be found in the reviews of the first and second editions of the *Analyse der Empfindungen* written by C. Stumpf,⁵ Elsas,⁶ Lucien Arréat,⁷ and W. R. Boyce Gibson.⁸

The last-named writer speaks⁹ of the "generous and it was this essay that formed the starting-point of Petzoldt's development of the view involved.

The essay "On the Principle of the Conservation of Energy" in Mach's *Popular Scientific Lectures* (3d ed., Open Court Publishing Co., 1898, pp. 137-185), though in many respects like the pamphlet of 1872, is not nearly so complete as it is—a remark made by Hans Kleinpeter (*Die Erkenntnistheorie der Naturforschung der Gegenwart*, Leipzig, 1905, p. 150), who therefore pointed out the need for a reprint of this rare pamphlet.

³ In the German translation, by F. Bendixen, of these lectures under the title: *Moderne Philosophen* (Leipzig, 1905), the part relating to Mach is on pp. 104-110. The section devoted to Maxwell, Mach, Hertz, Ostwald, and Avenarius is on pp. 97-127.

⁴ Vol. XXX, pp. 665-667. Cf. also the references to Mach's work in Ludwig Boltzmann's article "Models" (*ibid.*, pp. 788-790.)

⁵ *Deutsche Literaturzeitung*, Nr. 27, 3. Juli, 1886.

⁶ *Philosophische Monatshefte*, Vol. XXIII, p. 207.

⁷ *Revue Philosophique*, 1887, p. 80.

⁸ *Mind*, N.S., Vol. X, pp. 246-264 (No. 38, April, 1901).

⁹ *Ibid.*, p. 253.

recognition he [Mach] is always ready to give to anyone who succeeds in improving upon his own attempts," and "his still more eager readiness to put fact before theory. With this eagerness to find out the truth is associated a corresponding ardour in developing and applying it when found."

But philosophers seem hardly to have done justice to Mach's work. Mach himself, indeed, has repeatedly disclaimed for himself the name of philosopher; yet, in a sense, any man who forms a general position from which to regard, say, science, is a philosopher.¹⁰ It must be acknowledged that the least satisfactory parts of Mach's writings are those in which he discusses mathematical conceptions, such as numbers and the continuum; and in which he implies that logic is to be founded on a psychological basis; but such things are unconnected with the greater part of his valuable work.

There are three sets of notes to this translation. The first set, referred to by numerals in the body of the text, consists of the notes added by the author to the

¹⁰ Through a reference in the *Jahrbuch über die Fortschritte der Mathematik* for 1904 (Bd. XXXV, p. 78) I learn that D. Wiktorov has published, in Russian, an exposition of Mach's philosophical views, in the periodical whose name, translated, is *Questions of Philosophy and Psychology*, No. 73 (1904, No. 3), pp. 228-313.

J. Baumann (*Archiv für systematische Philos.*, IV, 1897-1898, Heft 1, October, 1897) gave an account of "Mach's philosophy." Cf. also Hönigswald, *Zur Kritik der Mach'schen Philosophie*, Berlin, 1903; and Mach, *Erkenntnis und Irrtum*, 1906, pp. vii-ix. Adolfo Levi ("Il fenomenismo empiristico," *Riv. di Fil.*, T. I., 1909) analyzed the theories of knowledge of Mill, Avenarius, Mach, and Ostwald.

original edition; the second set consists of those added by the author to the reprint of 1909;¹¹ and the third set, which contains some account of later work by the author and others on subjects connected with the history and root of the principle of the conservation of work, has been added by the translator. Any other notes by the translator, added for the purpose of giving fuller references, are enclosed in square brackets.

Professor Mach has been most kind in carefully reading my manuscript; and so I trust that not all of the freshness, the force of conviction, and the humour of the original are lost in the present translation.¹²

PHILIP E. B. JOURDAIN

THE MANOR HOUSE
BROADWINDSOR
BEAMINSTER, DORSET
November, 1909

¹¹ These notes are translated, with the exception of one correcting a misprint in the original edition.