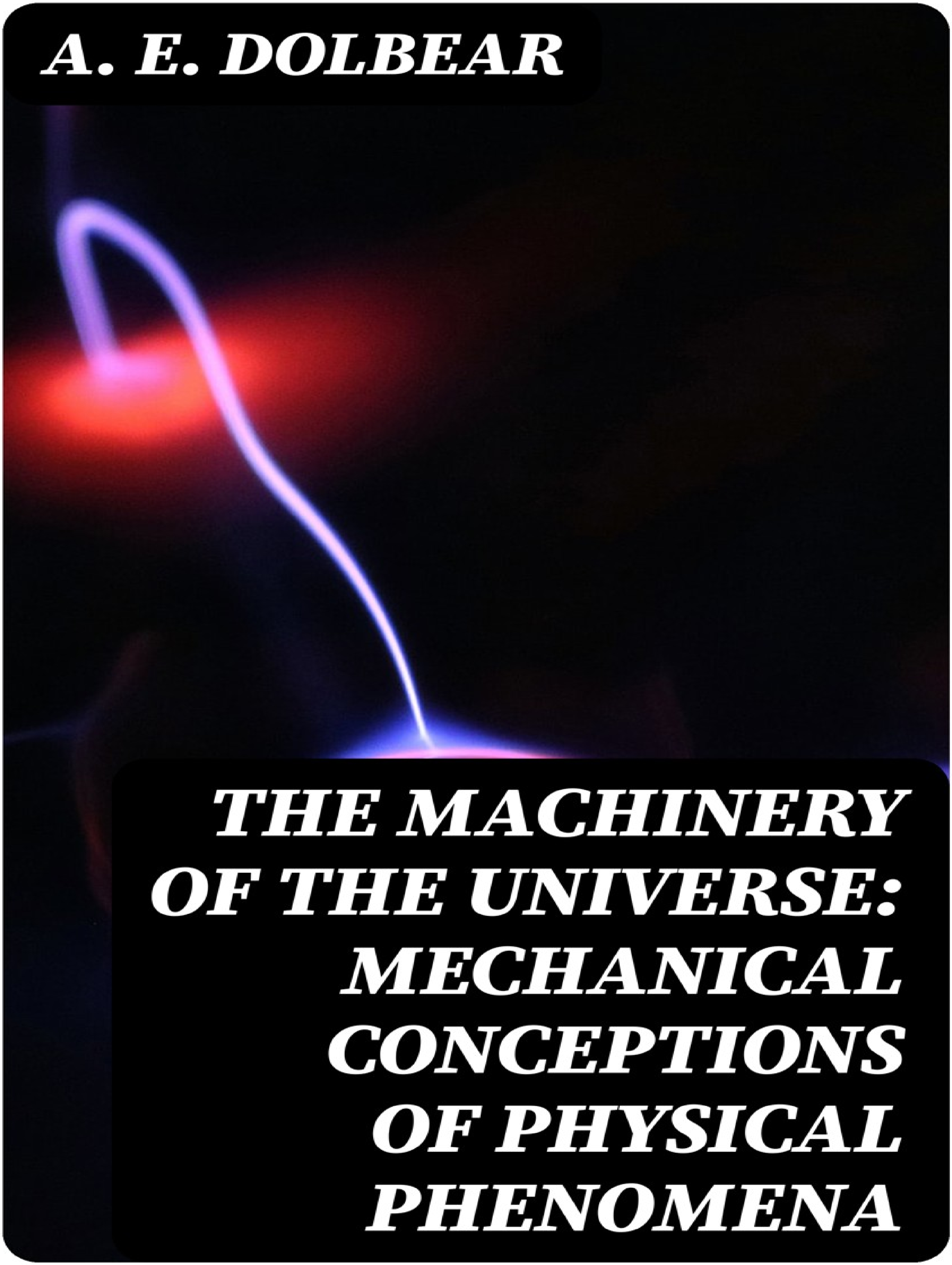
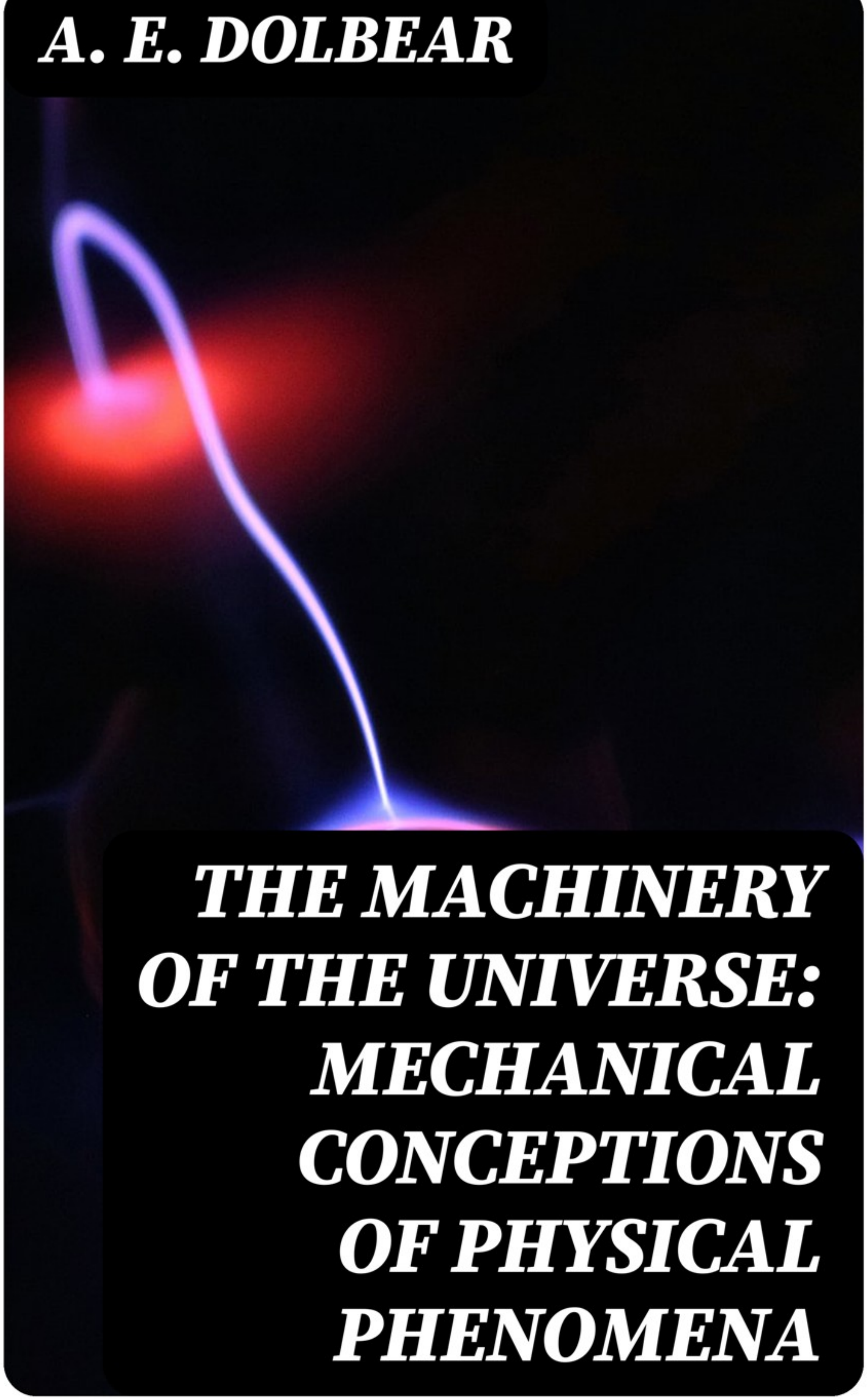
A. E. DOLBEAR



THE MACHINERY OF THE UNIVERSE: MECHANICAL CONCEPTIONS OF PHYSICAL PHENOMENA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The Machinery of the Universe: Mechanical Conceptions of Physical Phenomena

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PREFACE

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For thirty years or more the expressions “Correlation of the Physical Forces” and “The Conservation of Energy” have been common, yet few persons have taken the necessary pains to think out clearly what mechanical changes take place when one form of energy is transformed into another.

Since Tyndall gave us his book called *Heat as a Mode of Motion* neither lecturers nor text-books have attempted to explain how all phenomena are the necessary outcome of the various forms of motion. In general, phenomena have been attributed to *forces*—a metaphysical term, which explains nothing and is merely a stop-gap, and is really not at all needful in these days, seeing that transformable modes of motion, easily perceived and understood, may be substituted in all cases for forces.

In December 1895 the author gave a lecture before the Franklin Institute of Philadelphia, on “Mechanical Conceptions of Electrical Phenomena,” in which he undertook to make clear what happens when electrical phenomena appear. The publication of this lecture in *The Journal of the Franklin Institute* and in *Nature* brought an urgent request that it should be enlarged somewhat and published in a form more convenient for the public. The enlargement consists in the addition of a chapter on the “*Contrasted Properties of Matter and the Ether*,” a chapter containing something which the author believes to be of philosophical importance in these days when electricity is so generally described as a phenomenon of the ether.

A. E. Dolbear.

CHAPTER I

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Ideas of phenomena ancient and modern, metaphysical and mechanical—Imponderables—Forces, invented and discarded—Explanations—Energy, its factors, Kinetic and Potential—Motions, kinds and transformations of—Mechanical, molecular, and atomic—Invention of Ethers, Faraday's conceptions.

‘And now we might add something concerning a most subtle spirit which pervades and lies hid in all gross bodies, by the force and action of which spirit the particles of bodies attract each other at near distances, and cohere if contiguous, and electric bodies operate at greater distances, as well repelling as attracting neighbouring corpuscles, and light is emitted, reflected, inflected, and heats bodies, and all sensation is excited, and members of animal bodies move at the command of the will.’—Newton, *Principia*.

In Newton's day the whole field of nature was practically lying fallow. No fundamental principles were known until the law of gravitation was discovered. This law was behind all the work of Copernicus, Kepler, and Galileo, and what they had done needed interpretation. It was quite natural that the most obvious and mechanical phenomena should first be reduced, and so the *Principia* was concerned with mechanical principles applied to astronomical problems. To us, who have grown up familiar with the principles and conceptions underlying them, all varieties of mechanical phenomena seem so obvious, that it is difficult for us to understand how any one could be obtuse to them; but the records of Newton's time, and immediately after this, show that they were not so easy of apprehension. It may be remembered that they were not adopted in France till long after Newton's day. In spite of what is thought to be reasonable, it really requires something more than complete demonstration to convince most of us of the truth of an idea, should the truth happen to be of a kind not familiar, or should it chance to be opposed to our more or less well-defined notions of what it is or ought to be. If those who labour for and attain what they think to be the truth about any matter, were a little better informed concerning mental processes and the conditions under which ideas grow and displace others, they would be more patient with mankind; teachers of every rank might then discover that what is often called stupidity may be nothing else than mental inertia, which can no more be made active by simply willing than can the movement of a cannon ball by a like effort. We *grow* into our beliefs and opinions upon all matters, and scientific ideas are no exceptions.

Whewell, in his *History of the Inductive Sciences*, says that the Greeks made no headway in physical science because they lacked appropriate ideas. The evidence is overwhelming that they were as observing, as acute, as reasonable as any who live to-day. With this view, it would appear that the great discoverers must have been men who started out with appropriate ideas: were looking for what they found. If, then, one reflects upon the exceeding great difficulty there is in discovering one new truth, and the immense amount of work needed to disentangle it, it would appear as if even the most successful have but indistinct