KINEMATICS OF MACHINERY: A BRIEF TREATISE ON CONSTRAINED MOTIONS OF MACHINE ELEMENTS

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A BRIEF TREATISE ON CONSTRAINED MOTIONS OF MACHINE ELEMENTS.

BY

JOHN H. BARR, M.S., M.M.E.,

Professor of Machine Design, Sibley College, Cornell University
Member of the American Society of Mechanical Engineers.

With over Two Hundred Figures.

FIRST EDITION.

FIRST THOUSAND.

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PREFACE.

THIS book is the outgrowth of a somewhat smaller treatise which was prepared and printed by the writer in 1894 for the use of the classes in mechanical and electrical engineering at Sibley College, Cornell University.

After having used the original for several years, it was decided to issue the work in revised form, making such corrections and changes as experience suggested.

The present volume was prepared especially to bring together, and to present to the students in a condensed text-book, those principles and methods which are deemed most important in a general course on Kinematics. This is the only excuse offered for another book on a subject about which so much has been written. No pretension is made to originality except in the arrangement and manner of presenting a few subjects. Neither is the present work offered as in any sense a complete treatise on the Kinematics of Machinery. The treatment of many topics has been much abridged; particularly the portion relating to toothed gearing, a subject which is exhaustively treated in numerous available works. On the other hand, the discussions of the applications of such important conceptions as instantaneous centres, velocity diagrams, etc., are rather fuller than are found in many of the shorter works on Mechanism.

The treatment of these subjects follows closely that given by Professor Kennedy in his admirable work on the Mechanics of Machinery.

It is believed that the presentation of principles and methods, with illustrations of their applications, is the proper line to adopt

in a text-book intended for a short general course on such a subject as Kinematics. The detailed description of usual forms, and the discussion of the innumerable considerations with which the expert in any line must be familiar are to be sought in special treatises.

Messrs. A. T. Bruegel, D. S. Kimball, and W. N. Barnard, all of whom have given instruction in the course to which it applies, have rendered valuable assistance in the preparation of the present book. Mr. Bruegel contributed most of the problems, which were developed during his six years as instructor in Kinematics at Cornell University. Professor Kimball kindly wrote the articles on "Acceleration Diagrams" and "Epicyclic Trains," and he and Mr. Barnard have cooperated in other ways in the revision.

Many earlier works have been consulted and drawn on in the preparation of the present book. The following, especially, should be mentioned: Principles of Mechanism, by Professor Willis; Machinery and Millwork, by Professor Rankine; Kinematics of Machinery, by Professor Reuleaux; Mechanics of Machinery, by Professor Kennedy; Kinematics, by Professor MacCord; Machine Design, by Professor Unwin; Elementary Mechanism, by Professors Stahl and Woods; Teeth of Gears, by Mr. George B. Grant; A Practical Treatise on Gearing (Beale), published by the Brown and Sharpe Manufacturing Company.

The writer desires to acknowledge his obligations to all who have in any way aided in the preparation of this little book.

JOHN H. BARR.

ITHACA, NEW YORK,
October 1899.

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KINEMATICS OF MACHINERY.

CHAPTER I.

FUNDAMENTAL CONCEPTIONS OF MOTION. THE NATURE OF A MACHINE.

1. **Motion** is a change of position; and it is measured by the space traversed. Time is not involved in this conception. A train, in running between two stations fifty miles apart, has the same motion, whether the time occupied be one, two, or three hours. The motion of a crank-pin in making a revolution is independent of the time required.

2. **Linear Velocity,** or simply velocity, is the rate of motion of a point along its path in space. It is a function of both space and time, and is measured in compound units of these fundamental quantities; as feet per second, feet per minute, miles per hour, etc. In mathematical terms, velocity $= v = \frac{ds}{dt}$, in which s = the space passed over in the time t.

If, in the illustration of the preceding article, the time of the run between the stations is one hour, the train has an average, or mean, linear velocity of fifty miles per hour; if the time be two and a half hours, the mean velocity, or speed, as it is often called, is twenty miles per hour, etc., or 1760 ft. per min., or 29′ 4″ per sec.

3. **Acceleration**, or linear acceleration, is the *rate* of change of *velocity*. Acceleration is expressed in the same system of space- and time-units as the velocity itself (as feet and seconds, feet and min-