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PART II.—KINEMATICS OF MACHINES.

45. *Introductory Remarks.*—The object of a machine is to enable the forces of nature to do work of various kinds. In this operation some given resistance is overcome, which is accompanied by a given motion, while the driving force is accompanied by some other given motion, often at a distant place. Hence a machine may be regarded as an instrument for converting and transmitting motion. When considered under this aspect it is called a Mechanism, or sometimes a Movement, a Motion, or a Gear, the first being the scientific term, and the others occurring in practical applications.

Every mechanism consists of a set of pieces possessing one degree of freedom, that is to say they are so connected together that when one changes its position all the rest do so too in a way precisely defined by the nature of the mechanism. Thus, for example, when the piston of a steam engine moves through any fraction of a stroke, the connecting rod, crank shaft, and the parts of any machine which it may be driving all shift their position in such a way that the connection between the various changes is completely determinate, and can be studied without reference to the work which the engine is doing, or the speed at which it is running. This branch of study is called the Kinematics of Machines.

The changes of position may be of any magnitude we please, and if they are very small are proportional to the velocities of the moving parts, hence a part of the subject, and generally an important part, is the consideration of the comparative velocities, or, as they are usually called, the velocity-ratios, of the moving parts. Further, since the comparative velocities are fixed by the nature of the

machine, the same must be true of the rates of change of these velocities, that is to say the accelerations. Hence the general question is to study completely the comparative motions of the several parts of a machine, so that when the position, velocity, and acceleration of any piece are given, those quantities may be known for every other piece. It is the positions and velocities which are chiefly considered.

The converse problem is to discover the mechanisms by which any required motion may be obtained, and for this purpose the connection which exists between different mechanisms is considered. The subject therefore forms an introduction to the science of Descriptive Mechanism in which existing machines in all their vast variety are classified and studied systematically.

AUTHORITIES.

The principal treatises on the theory of mechanism are—

WILLIS. *Principles of Mechanism*. Longman.

RANKINE. *Millwork and Machinery*. Griffin.

REULEAUX. *Kinematics of Machinery*. Macmillan.

The modern form of the theory is due to Professor Reuleaux, whose nomenclature and methods are followed, with some modifications, in the present work. The treatise referred to is a translation from the German by Professor A. B. Kennedy.