NOTES AND PROBLEMS ON THE ELEMENTS OF MECHANISM AND THE TRANSMISSION OF POWER

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NOTES AND PROBLEMS

ON THE

ELEMENTS OF MECHANISM

AND THE

TRANSMISSION OF POWER

COMPILED AND PREPARED

FOR THE USE OF

STUDENTS IN STEAM AND MECHANISM.

UNITED STATES ARTILLERY SCHOOL,

FORT MONROE, VA.

BY

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PREFACE.

These notes have been compiled from the works of Rankine, Schwamb, and Goodeve, with additions from various sources, for the convenience of students at the Artillery School in order to avoid a multiplicity of text books, and to present in a concise form, principles and facts concerning the transmission of power, that may be of interest and benefit tothe artillerist. The works quoted are

Rankine's "The Steam Engine."
Rankine's "Machinery and Mill work."
Schwamb's notes on the Elements of Mechanism, and notes on Toothed Wheels and Gearing.
Goodeve's "Principles of Mechanics."
Goodeve's "Elements of Mechanism."
The catalogues of the Page Link Belting Co., and of Brown and Sharp.

W. B. H.

CONTENTS.

NOTES ON MECHANISM.

INTRODUCTORY.

The science of Mechanism treats of the designing and construction of machinery.

1. A MACHINE is a combination of resistant bodies so arranged that by their means the mechanical forces of nature can be compelled to produce some effect or work accompanied with certain determinate motions. In general, it may be properly said that a machine is an assemblage of moving parts interposed between the source of power and the work, for the purpose of adapting the one to the other.

No machine can move itself, nor can it create any motive power, this must be derived from external sources, such as the force of gravitation, the uncoiling of a spring, or the expansion of steam. As an example of a machine commonly met with, a sewing machine might be cited. It is capable of doing work of a definite kind, provided some external source of energy shall act upon it and set the working parts in motion. On examining its construction, we should find a fixed framework supporting combinations of movable parts; some of which are employed in actuating a needle and shuttle, while others carry forward the material to be stitched. The moving parts are so arranged that they must make certain definite motions relatively to each other, when some natural force, as the power of the hand or foot or of a rotating shaft, is applied to the proper recipient; then the work is done as a necessary consequence of the action of the motive power.

The operation of any machine depends upon two things: first the transmission of certain forces, and second, the production of determinate motions. In designing, due consideration must be given both of these, so that each part may be adapted to bear the strains imposed on it, as well as have the proper relative motion in regard to the other parts of the machine.

But the nature of the movements does not depend upon the strength or absolute dimensions of the moving parts, as can be shown by models whose dimensions may vary from those requisite for strength, and yet the motions of the parts will be the same as those of the machine. Therefore, the *force* and the *motion* may be considered separately, thus dividing the science of Mechanism into two parts, viz.:—

1. PURE MECHANISM, which treats of the motions and forms of the parts of a machine, and the manner of supporting and guiding them, independent of their strength.

2. CONSTRUCTIVE MECHANISM, which involves the calculation of the forces acting on the different parts of the machine; the selection of materials as to strength and durability in order to withstand the forces, taking into account the convenience for repairs, and facilities for manufacture.

In what follows, we will, in general, confine ourselves to the first part, *pure mechanism*, or what is sometimes called "the geometry of machinery", but will in some cases consider the forces in action.

Then our definition of a machine might be modified to accord with the above, as follows:—

2. A MACHINE is an assemblage of moving parts so connected that when the first, or recipient, has a certain motion, the parts where the work is done, or effect produced, will have certain other definite motions. *A Mechanism* is a term applied to a portion of a machine where two or more pieces are combined, so that the motion of the first compels the motion of the others, according to a law depending on the nature of the combination. For example, the combination of a crank and connecting rod, with guides and frame, in a steam engine, serving to convert reciprocating into circular motion, would thus be called a *mechanism*.

The term *Elementary Combination* is sometimes used synonymously with *a Mechanism*.

A machine is made up of a series or train of mechanisms; as in the sewing machine, one mechanism serves to actuate the needle, another to move the shuttle, while still another gives motion to the cloth being stitched. All of these mechanisms

are actuated by the same source of power, and are so arranged that the motions occur at the proper times.

3. MOTION AND REST are necessarily relative terms within the limits of our knowledge. We may conceive a body as fixed in space, but we cannot know that there is one so fixed. If two bodies, both moving in space, remain in the same relative position in regard to each other, they are said to be at rest, one relatively to the other; if they do not, either may be said to be in motion relatively to the other.

Motion may thus be either relative or absolute, provided we assume some point as fixed. In what follows, the earth will be assumed to be at rest, and all motions referred to it will be considered as absolute.

4. PATH.—A point moving in space describes a line called its path, which may be rectilinear, or curvilinear. The motion of a body may be determined by the paths of one or more of its points selected at pleasure.

5. DIRECTION.—In a given path, a point can move in either of two directions only, which may be designated in various ways: as up, +, or down, —; to the right, +, or left, —; with the clock, +, or the reverse, —; direction, as well as motion, being relative.

6. CONTINUOUS MOTION. When a point goes on moving indefinitely in the same direction, its motion is said to be continuous. In this case, the path must return on itself, as a circle or other closed curve. A wheel turning on its bearings affords an example of this motion.

7. RECIPROCATING MOTION.—When a point travels the same path alternately in opposite directions, its motion is said to be reciprocating; it being understood that no part of the path is successively pased over more than once in the same direction.

8. VIBRATION, a term applied to reciprocating circular motion, as that of a pendulum.

9. INTERMITTENT MOTION.—When a piece having motion in alternate directions has definite periods at rest, it is said to have intermittent motion.

10. VELOCITY.—The motion of a point may be referred to a