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THE THEORY OF MACHINES AND MECHANISMS. ADVANCED APPROACH

The rapid progress in technology over the past few decades has lead to an increase acceptance of the theory of machines and mechanisms as an important constituent of mechanical engineering. Great advanced have been made in automatic control where mechanisms incorporate pneumatic, hydraulic, and electronic components. This requires contributions from the sciences of automatic control, aerodynamics, hydraulics, gas dynamics, electronics, and electrical engineering, but also from the theories of elasticity and vibrations. These advances in basic theories have promoted the design of ingenious new machines.

The operating speed of machines has increased considerably, which has lead to corresponding increases not only in the dynamic loads on mechanisms and machine components but also in the levels of vibration and noise. Since vibration and noise are ubiquitous whenever a machine is operated they have been investigated extensively, and measures to reduce them have been examined particularly thoroughly in recent years. Another line of studies has dealt with the dynamics of systems comprising humans, machines and their environment.

In general, modern industrial production is reduced in the end to the execution of a great number of diverse working processes. Most processes are associated with treatment and transformation of initial raw materials into half- or fully finished products; such working processes are referred to as technological. Technological processes involve transportation of materials to the place of utilization as well as energy processes, i.e. generation and transformation of energy in forms most convenient for the respective process. Also, information processes, i.e. transmission and transformation of information are of great importance in modern production, ensuring execution of operations associated with control and organization of production.

The accomplishment of many working processes requires realization of certain mechanical motions. For instance, material processing on a lathe requires shifting the blank and the instrument; transportation of raw materials and of finished products is reduced to mechanical shifting; transformation of heat energy into electric energy requires rotations steam turbines and generators, and so on. The execution of working processes is also associated with the application of forces to materials in process in order to balance the weight of transported objects. A person is able to realize directly mechanical motions which allow him to carry out certain working processes manually. In modern production, however, the overwhelming majority of working processes associated with the realization of mechanical motions is carried out by machines.

We call machine (or machine aggregate) a system designed to realize mechanical motions and force actions related to the execution of one or another working process. Machines are divided into technological, transport, energy converting and information machines depending on the kind of working process.

In industrial production, in addition to machines, various apparatuses are used which are not directly associated with mechanical motion but with chemical, thermal and other processes or with transmission and transformation of information. Sometimes some of them are called machines, as well (e.g., electronic computing devices); however, the term "machine" will be used only in the indicated sense.

As for engineering mechanisms, which are simple devices that make a huge difference in our day-to-day lives (often without us even realizing it), we can identify six really important ones:

1. Actuators: Actuators are devices that convert some type of stored energy into motion. The stored energy is usually in the form of compressed air (pneumatic pressure), electrical potential, or liquid (hydraulic) pressure.

2. Cams: Cams are mechanical devices that convert rotational motion into linear motion. Different designs result in different types of motion in the cam follower. Circular cams cause smooth linear motion, heart cams maintain a uniform velocity in the cam follower, and drop cams produce a rapid and discontinuous linear motion.

3. Gears: Gears are one of the most common and diverse types of mechanical devices. The primary function of gears is to transmit torque and to adjust rotational velocity.

4. Levers: A lever is a mechanical device used to transmit and amplify force by fixing the input and output about a fulcrum or pivot point. There's a great quote from the ancient Greek mathematician Archimedes that succinctly summarizes the foundational principle of levers: "Give me a place to stand, and I shall move the Earth with it [a lever]."

5. Ratchets: Ratchets are the handy-man and mechanic's best friend. Anyone who has ever rented a UHaul to move between cities has probably used a ratchet to tighten down stored goods or to keep the wheels of their car strapped to the trailer. The neat thing about ratchets is that they lock in one direction allowing the user to tighten without fear of literally "going backwards."

6. Springs: Springs are mechanical devices that store and dissipate energy.

Thus, mechanical engineering has become a complex science dealing with the problems of structure, kinematics, and dynamics of machines. The analysis and synthesis of machines are closely linked to the questions of control and optimum design, and are strongly supported by recent advances in the computer and other interrelated sciences.

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