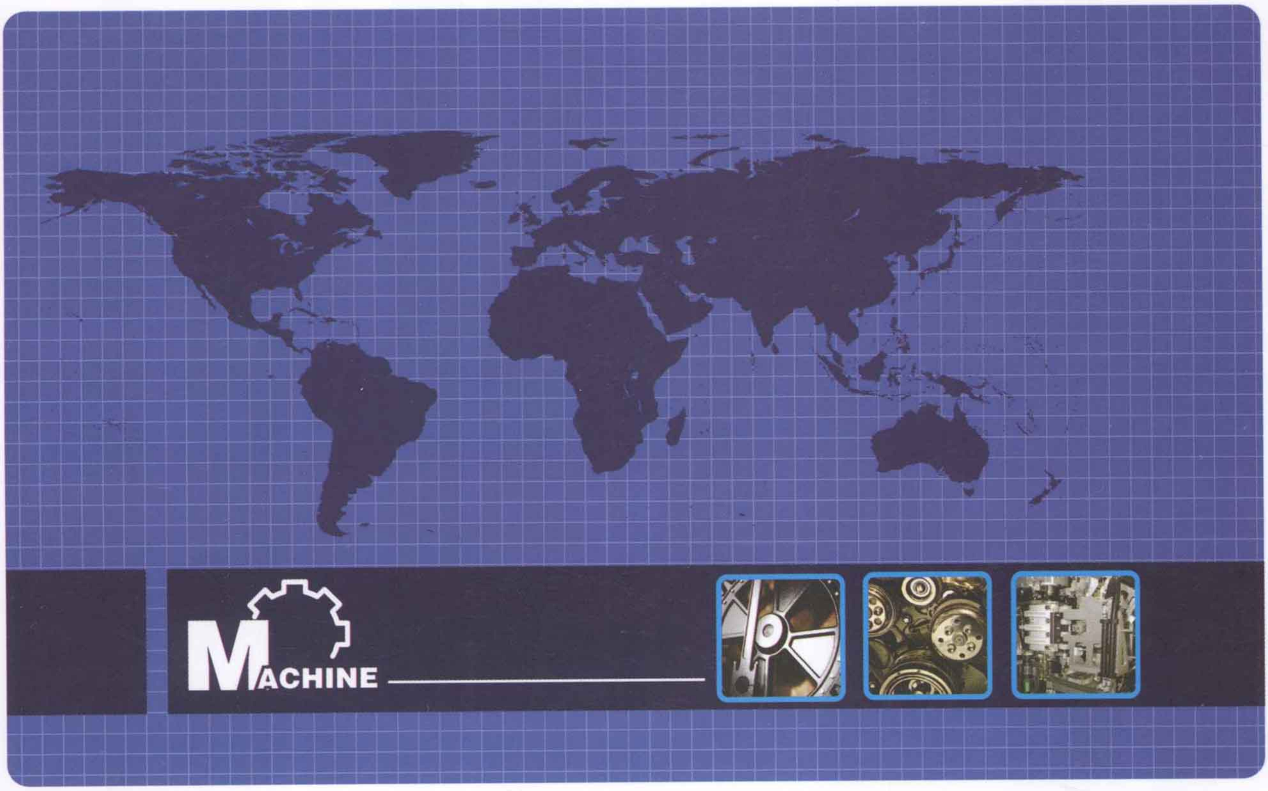
普通高等教育“十二五”机电类规划教材



机械工程专业英语

赵　武　黄　丹　主　编
赵明利　张　波　副主编

- 所有精选文章附有参考译文
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内 容 简 介

本书较系统地介绍了机械工程专业英语教学的基本知识点，内容涵盖了机械工程专业基础知识必涉及的机械设计、精度设计、材料选用和制造加工 4 个方面的专业英语用法和标准表达方式。

全书分为 4 部分，主要内容包括机械设计（第一部分：机械设计概述，齿轮，键、联轴器与密封，轴承，带传动，离合器等课文）；互换性与测量（第二部分：工程制图，产品可靠性，测量系统，传感器技术，产品质量控制与质量保证，设计与制造公差，公差、极限与配合，表面粗糙度，测量等课文）；材料科学基础与热处理（第三部分：工程材料基础介绍、材料机械特性铸造、锻压、焊接等课文）；制造技术与机床（第四部分：机床框架设计，车床的结构与功能、车削、铣削、钻削、磨削、镗削和插削及加工中的振动等课文），以及所有课文正文的译文、词组释文等，课后配有与本节专业内容相关的英语扩展阅读。

本书适合作为机械工程大类和近机类专业的本科教材或参考书，也可作为机械工程的研究生进一步学习的辅助教材。

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前言

PREFACE

当今高等教育非常重视培养学生的科技创新和实践能力。学生通过对“机械工程专业英语”必修课的学习，可获得机械工程的专业英语知识和英语使用能力，了解机械方面中外用语间的相互联系，获取科研信息，掌握学科发展动态，为今后从事机械工程领域的技术工作打下基础。本书遵循“重视基础、精简学时、拓宽口径”的改革思路，结合自身教学工作实践和各高等学校的教学探索与实践经验编写而成。我们在精简内容的同时扩大了知识涵盖面，在内容安排和知识阐述方面，注重循序渐进，力求深广适度，坚持内容少而精；主要内容涵盖了机械工程所能涉及的主要领域，包括机械设计基础、互换性与测量技术、工程材料与热处理、制造技术与机床和机械振动等。

本书所载文章均选自欧美原著及专业网站，并附所有课文的参考译文和常用专业词汇的注释，以供参考，课后还附有相关阅读材料。本书内容可根据读者特点分层次安排教学，可作为机械工程大类本科生和研究生的专业课教材。

本书由赵武组织编写，编写大纲由赵武、黄丹、赵明利共同制定。编写人员及负责的编写工作如下：河南科技大学张波负责编写第一部分，河南理工大学赵明利负责编写第二部分，河南理工大学黄丹负责第三部分及全书的结构和大纲的编写，河南理工大学赵武负责编写第四部分及全书的组织、审核和专业词汇注释。全书由赵武、黄丹任主编，赵明利、张波任副主编。全书由赵武负责统稿。

由于编者水平有限，书中难免会有疏漏之处，恳请读者给予批评指正。

编者

2013 年 7 月

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Part I

Mechanical Design

Lesson 1　Introduction of Mechanical Design

Mechanical design is the process of designing and/or selecting mechanical components and putting them together to accomplish a desired function. Of course, machine elements must be compatible, must fit well together, and must perform safely and efficiently. The designer must consider not only the performance of the element being designed at a given time but also the elements with which it must interface.

To illustrate how the design of machine elements must be integrated with a larger mechanical design, let us consider the design of a speed reducer for the small tractor. Suppose that, to accomplish the speed reduction, you decide to design a double-reduction, spur gear speed reducer. You specify four gears, three shafts, six bearings, and a housing to hold the individual elements in proper relation to each other. The primary elements of the speed reducer are:

- The input shaft is to be connected to the power source, a gasoline engine whose output shaft rotates at 2000 rpm. A flexible coupling is to be employed to minimize difficulties with alignment.
- The first pair of gears, A and B, causes a reduction in the speed of the intermediate shaft proportional to the ratio of the numbers of teeth in the gears. Gear B and C are both mounted to intermediate shaft and rotate at the same speed.
- A key is used at the interface between the hub of each gear and the shaft on which is mounted to transmit torque between the gear and the shaft.
- The second pair of gears, C and D, further reduces the speed of gear D and the output shaft to the range of 290 rpm to 295 rpm.
- The output shaft is to carry a chain sprocket. The chain drive ultimately is to be connected to the drive wheel of the tractor.
- Each of the three shafts is supported by two ball bearings, making them statically determinate and allowing analysis of forces and stresses using standard principles of mechanics.
- The bearings are held in a housing that is to be attached to the frame of the tractor. Note the manner of holding each bearing so that the inner race rotates with the shaft while the outer race is held stationary.
- Seals are on the input and output shafts to prohibit contaminants from entering the housing.

Details of how the active elements are to be installed, lubricated, and aligned are only suggested at this stage of the design process to demonstrate feasibility. One possible assembly process could be as follows:

Start by placing the gears, keys, spacers, and bearings on their respective shafts. Then insert input shaft into its bearing seat on the left side of the housing. Insert the left end of intermediate shaft into its bearing seat while engaging the teeth of gears A and B. Install the center bearing support to provide support for the bearing at the right side of input shaft. Install output shaft by placing its left bearing into the seat on the center bearing support while engaging gears C and D. Install the right side cover for the housing while placing the final two bearings in their seats. Ensure careful alignment of the shafts. Place gear lubricant in the lower part of the housing.

The arrangement of the gears, the placement of the bearings so that they straddle the gears and the general configuration of the housing are also design decisions. The design process cannot rationally proceed until these kinds of decisions are made. When the overall design is conceptualized, the design of the individual machine elements in the speed reducer can proceed. You should recognize that you have already made many design decisions by rendering such a sketch. First you choose spur gears rather than helical gears a worm and worm gear or bevel gears. In fact, other types of speed reduction devices—belt drives, chain drives, or many others could be appreciate.

1. Gears

For gear pairs, you must specify the number of teeth in each gear, pitch (size) of the teeth, the pitch diameters, the face width, and the material and its heat treatment. These specifications depend on considerations of strength and wear of the gear teeth and the motion requirements (kinematics). You must also recognize that the gears must be mounted on shafts in a manner that ensures proper location of the gears, adequate torque transmitting capability from the gears to the shafts (as through keys) and safe shaft design.

2. Shafts

Having designed the gear pairs, next you will consider the shaft design. The shaft is loaded in bending and torsion because of the forces acting at the gear teeth. Thus, its design must consider strength and rigidity, and it must permit the mounting of the gears and bearings. Shafts of varying diameters may be used to provide shoulders against which to seat the gears and bearings. There may be keyseats cut into the shaft. The input and output shafts will extend beyond the housing to permit coupling with the engine and the drive axle. The type of coupling must be considered, as it can have a dramatic effect on the shaft stress analysis. Seals on the input and output shafts protect internal components.

3. Bearings

Design of the bearings is next. If rolling contact bearings are to be used, you will probably select commercially available bearings from a manufacturer's catalog, rather than design a unique one. You must first determine the magnitude of the loads on each bearing from the shaft analysis and the gear designs. The rotational speed and reasonable design life of the bearings and their compatibility with the shaft on which they are to be mounted must also be considered. For example, on the basis of the shaft analysis, you could specify the minimum allowable diameter at each bearing seat location to ensure safe stress levels. The bearing selected to support a particular part of the shaft, then, must have a bore (inside diameter) no smaller than the safe diameter of the shaft. Of course, the bearing should not be grossly larger than necessary. When a specific bearing is selected, the diameter of the shaft at the bearing seat location and allowable tolerances must be specified, according to the bearing manufacturer's recommendations, to achieve proper operation and life expectancy of the bearing.

Words and Expressions

mechanical [mi'kænikəl] *adj.* 机械的；力学的

compatible [kəm'pætəbl] *adj.* 兼容的；能共处的

seal [si:l] *n.* 密封

prohibit [prə'hibit] *vt.* 阻止，禁止

efficiently [i'fiʃəntli] *adv.* 有效地；效率高地
interface ['intəfeis] *n.* 接合；连接
integrated with 使与…结合
speed reducer 减速器
tractor ['træktə] *n.* 拖拉机；牵引机
spur gear 直齿圆柱齿轮
gasoline engine 汽油发动机
flexible coupling 弹性联轴器
alignment [ə'lainmənt] *n.* 成直线；校准
intermediate [ˌintə'mi:djət] *adj.* 中间的
chain sprocket 链轮
contaminant [kən'tæmənənt] *n.* 污染物；致污物
feasibility [ˌfi:zə'biləti] *n.* 可行性；可能性
respective [ris'pektiv] *adj.* 分别的，各自的
straddle ['strædl] *v.* 跨坐
conceptualize [kən'septjuəlaiz] *vt.* 使概念化
pitch diameter 节圆直径
shaft [ʃɑ:ft] *n.* 轴
rigidity [ri'dʒiditi:] *n.* 刚性
mount [maunt] *vi.* 安装；装配
keyseat 键槽
dramatic [drə'mætik] *adj.* 戏剧的；引人注目的

Reading Material 1

Couplings, Clutches, Shafts and Springs

A coupling is a device for connecting the ends of adjacent shafts. In machine construction, couplings are used to effect a semipermanent connection between adjacent rotating shafts. The connection is permanent in the sense that it is not meant to be broken during the useful life of the machine, but it can be broken and restored in an emergency or when worn parts are replaced. There are several types of shaft couplings, their characteristics depend on the purpose for which they are used. If an exceptionally long shaft is required for a line shaft in a manufacturing plant or a propeller shaft on a ship, it is made in sections that are coupled together with rigid couplings. In connecting shafts belonging to separate devices (such as an electric motor and a gearbox), precise aligning of the shafts is difficult and a flexible coupling is used. This coupling connects the shafts in such a way as to minimize the harmful effects of shaft misalignment. Flexible couplings also permit the shafts to deflect under their separate systems of loads and to move freely (float) in the axial direction without interfering with one another. Flexible couplings can also serve to reduce the intensity of shock loads and vibrations transmitted from one shaft to another.

A clutch is a device for quickly and easily connecting or disconnecting a rotatable shaft and a rotating coaxial shaft. Clutches are usually placed between the input shaft to a machine and the output shaft from the driving motor, and provide a convenient means for starting and stopping the machine and permitting the driver motor or engine to be started in an unloaded state.

The rotor (rotating member) in an electric motor has rotational inertia, and a torque is required to bring it up to speed when the motor is started. If the motor shaft is rigidly connected to a load with a large rotational inertia, and the motor is started suddenly by closing a switch the motor may not have sufficient torque capacity to bring the motor shaft up to speed before the windings in the motor are burned out by the excessive current demands. A clutch between the motor and the load shafts will restrict the starting torque on the motor to that required to accelerate the rotor and parts of the clutch only. On some machine tools it is convenient to let the driving motor run continuously and to start and stop the machine by operating a clutch. Other machine tools receive their power from belts driven by pulleys on intermediate shafts that are themselves driven by belts from long lineshafts that serve a group of machines.

A shaft is a rotating or stationary member, usually of circular cross section, having mounted upon it such elements as gears, pulleys, flywheels, cranks, and other power-transmission elements. Shafts may be subjected to bending, tension, compression, or torsional loads, acting singly or in combination with one another. When they are combined, one may expect to find both static and fatigue strength to be important design considerations, since a single shaft may be subjected to static stresses, completely reversed stresses, and repeated stresses, all acting at the same time. The word "shaft" covers numerous variations, such as axles and spindles. An axle is a shaft, either stationary or rotating, not subjected to a torsion load. A short rotating shaft is often called a spindle.

A spring is a load-sensitive, energy-storing device the chief characteristics of which are an ability to tolerate large deflections without failure and to recover its initial size and shape when loads are removed. Although most springs are mechanical and derive their effectiveness from the flexibility inherent in metallic elements, hydraulic springs and air springs are also obtainable. Springs are used for a variety of purposes such as supplying the motive power in clocks and watches, cushioning transport vehicles, measuring weights, restraining machine elements, mitigating the transmission of periodic disturbing forces from unbalanced rotating machines to the supporting structure, and providing shock protection for delicate instruments during shipment.

Lesson 2 Gears

Gears are toothed, cylindrical wheels used for transmitting motion and power from one rotating shaft to another. The teeth of a driving gear mesh accurately in the spaces between teeth on the driven gear. The driving teeth push on the driven teeth exerting a force perpendicular to the radius of the gear. Thus, a torque is transmitted, and because the gear is rotating, power is also transmitted.

1. Spur Gear Geometry Involute Tooth Form

The most widely used spur gear tooth form is the full-depth involute form. Its characteristic shape is shown in Figure 2.1.

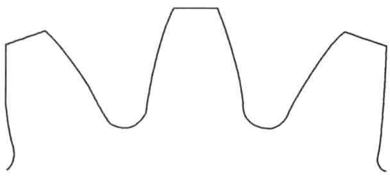


Figure 2.1 Involut-tooth form

The involute is one of a class of geometric curves called conjugate curves. When two such gear teeth are in mesh and rotating, there is a constant angular velocity ratio between them. From the moment of initial contact to the moment of disengagement, the speed of the driving gear is in a constant proportion to the speed of the driven gear. The resulting action of the two gears is very smooth. Otherwise there would be speeding up or slowing down during the engagement, with the resulting accelerations causing vibration, noise, and dangerous torsional oscillations in the system.

An involute curve by taking a cylinder and wrapping a string around its circumference can be seen. Tie a pencil to the end of the string. Then start with the pencil tight against the cylinder, and hold the string taut. Move the pencil away from the cylinder while keeping the string taut. The curve drawed is an involute.

The circle represented by the cylinder is called the base circle. Notice that at any position on the curve, the string represents a line tangent to the base circle and, at the same time, perpendicular to the involute. Drawing another base circle along the same centerline in such a position that the resulting involute is tangent to the first one, it demonstrates that at the point of contact, the two lines tangent to the base circles are coincident and will stay in the same position as the base circles rotate. This is what happens when two gear teeth are in mesh.

It is a fundamental principle of kinematics, the study of motion, that if the line drawn perpendicular to the surfaces of two rotating bodies at the point of contact always crosses the centerline between the two bodies at the same place, the angular velocity ratio of the two bodies will be constant. This is a statement of gearing. As demonstrated here, the gear teeth made in the involute-tooth form obey the law.

2. Helical Gear Geometry

Helical and spur gears are distinguished by the orientation of their teeth. On spur gears, the teeth are straight and are aligned with the axis of gear. On helical gears, the teeth are inclined at an angle with the axis, that angle being called the helix angle. If the gear was very wide, it would appear that the teeth wind around the gear blank in a continuous, helical path. However, practical considerations limit the width of the gears so that the teeth normally appear to be merely inclined with respect to the axis. Figure 2.2 shows an example of commercially available helical gear. The forms of helical gear teeth are very similar to those discussed for spur gears. The basic task is to account for the effect of the helix angle.

3. Helix Angle

The helix for a given gear can be either left-hand or right-hand. The teeth of a right-hand helical gear would appear to lean to the right when the gear is lying on a flat surface. Conversely, the teeth of a left-hand helical gear would lean to the left. In normal installation, helical gears would be mounted on parallel shafts. To achieve this arrangement, it is required that one gear should be of the right-hand design and that the other be left-hand with an equal helix angle. If both gears in mesh are of the same hand, the shafts will be at 90 degrees to each other. Such gears are called crossed helical gears.

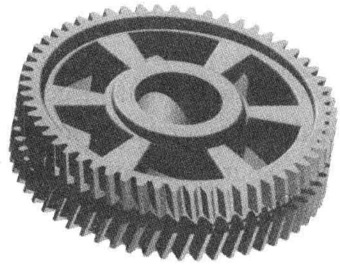


Figure 2.2 Helical gears

The parallel shaft arrangement for helical gears is preferred because it results in a much higher power-transmitting capacity for a given size of gear than the crossed helical arrangement.

The main advantage of helical gears over spur gears is smoother engagement because a given tooth assumes its load gradually instead of suddenly. Contact starts at one end of a tooth near the tip and progresses across the face in a path downward across the pitch line to the lower flank of the tooth, where it leaves engagement. Simultaneously, other teeth are coming into engagement before a given tooth leaves engagement, with the result that a larger average number of teeth are engaged and are sharing the applied loads compared with a spur gear. The lower average load per tooth allows a greater power transmission capacity for a given size of gear, or a smaller gear can be designed to carry the same power.

The main disadvantage of helical gears is that an axial thrust load is produced as a natural result of the inclined arrangement of the teeth. The bearings that hold the shaft carrying the helical gear must be capable of reacting against the thrust load.

Words and Expressions

cylindrical [sə'lindrikəl] *adj.* 圆柱的；圆柱体的
perpendicular [ˌpɜ:pən'dikjələ] *adj.* 垂直的
involute ['invəlu:t] *n.* 渐开线
geometric [ˌdʒi:ə'metrik] *adj.* 几何学的
conjugate ['kəndʒəˌgeit] *adj.* 共轭的
disengagement [ˌdisin'geidʒmənt] *n.* 脱离；
acceleration [ækˌselə'reiʃən] *n.* 加速度
vibration [vai'breiʃən] *n.* 振动
oscillation [ˌəsə'leiʃən] *n.* 振荡；振动；摆动
wrap [ræp] *vt.* 包；缠绕
circumference [sə'kʌmfərəns] *n.* 圆周；周长
taut [tɔ:t] *adj.* 拉紧的；紧张的
orientation [ˌɔ:rien'teiʃən] *n.* 方向；定向
be aligned with 与…对准
helical ['helikəl] *adj.* 螺旋的
helix angle 螺旋角
inclined [in'klaind] *adj.* 倾斜的
commercially [kə'mɜ:ʃəli] *adv.* 商业上
spur gear 直齿圆柱齿轮
parallel ['pærəlel] *adj.* 平行的
shaft [ʃɑ:ft] *n.* 轴
assume [ə'sju:m] *vt.* 承担；假定
gradually ['grædjʊəli] *adv.* 逐渐地；逐步地
tip [tip] *n.* 顶端

tangent ['tændʒənt] *adj.* 切线的；相切的
demonstrate ['demənstreit] *vt.* 证明；展示；论证
kinematics [kini'mætiks] *n.* 运动学；动力学
flank [flæŋk] *n.* 侧面
simultaneously [saiməl'teiniəsli] *adv.* 同时地
thrust load 轴向载荷

Reading Material 2

Types of Gears

Several kinds of gears having different tooth geometries are in common use. To acquaint you with the general appearance of some, their basic descriptions are given here.

Spur gears have teeth that are straight and arranged parallel to the axis of the shaft that carries the gear. The curved shape of the faces of the spur gear teeth has a special geometry called an involute curve. This shape makes it possible for two gears to operate together with smooth, positive transmission of power.

The teeth of helical gears are arranged so that they lie at an angle with respect to the axis of the shaft. The angle, called the helix angle, can be virtually any angle. Typical helix angle range from approximately 10° to 30°, but angles up to 45° are practical. The helical teeth operate more smoothly than equivalent spur gear teeth, and stresses are lower. Therefore, a smaller helical gear can be designed for a given power-transmitting capacity than a spur gear. One of the disadvantages of helical gears is that an axial force, called a thrust force, is generated in addition to the driving force that acts tangent to the basic cylinder on which the teeth are arranged. The designer must consider the thrust force when selecting bearing that will hold the shaft during operation. Shafts carrying helical gears are typically arranged parallel to each other. However, a special design, called crossed helical gears, has 45° helix angles, and the shafts operate 90° to each other.

Bevel gears have teeth that are arranged as elements on the surface of a cone. The teeth of straight bevel gears appear to be similar to spur gear teeth, but they are tapered, being wider at the outside and narrower at the top of the cone. Bevel gears typically operate on shafts that are 90° to each other. Indeed, this is often the reason for specifying bevel gears in a drive system. Specially designed bevel gears can operate on shafts that are at some angel other than 90°. When bevel gears are made with teeth that form a helix angle similar to that in helical gears, they are called spiral bevel gears. They operate more smoothly than straight bevel gears and can be made smaller for a given power transmission capacity. When both bevel gears in a pair have the same number of teeth, they are called miter gears and are used only to change the axes of the shaft to 90 degrees. No speed change occurs.

A rack is a straight gear that moves linearly instead of rotating. When a circular gear is mated with a rack, the combination is called a rack and pinion drive. You may have heard that term applied to the steering mechanism of a car or to a part of other machinery.

A worm and its mating worm gear operate on shafts that are at 90 degrees to each other. They typically accomplish a rather large speed reduction ratio compared with other types of gears. The worm is the driver, and the worm gear is the driven gear. The teeth on the worm appear similar to screw threads, and, indeed, they are often called threads rather than teeth. The teeth of the worm gear can be straight like spur gear teeth, or they can be helical. Often the shape of the tip of the worm gear teeth is enlarged to partially wrap around the threads of the worm to improve the power transmission capacity of the set. One disadvantage of the worm/worm gear drive is that it has a somewhat lower mechanical efficiency than most other kinds of gears because there is extensive rubbing contact between the surfaces of the worm threads and the sides of the worm gear teeth.

Think of examples of gears in actual equipment. Describe the operation of the equipment, particularly the power transmission system. Sometimes, of course, the gears and the shafts are enclosed in housing, making it difficult for you to observe the actual gears. Perhaps you can find a manual for the equipment that shows the drive system. Try to answer the following questions:

(1) What was the source of the power, an electric motor, a gasoline engine, a steam turbine, or a hydraulic motor? Were the gears operated by hand?

(2) How were the gears arranged together, and how were they attached to the driving source and the driven machine?

(3) Was there a speed change? Can you determine how much of a change?

(4) Were there more than two gears in the drive system?

(5) What types of gears were used?

(6) What materials were gears made from?

(7) How were the gears attached to the shafts that supported them?

(8) Were the shafts for mating gears aligned parallel to each other, or were they perpendicular to one another?

(9) How were the shafts themselves supported?

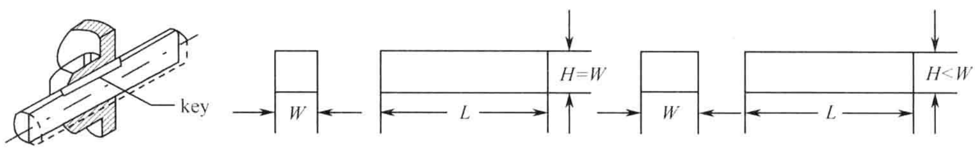
(10) Was the gear transmission system enclosed in housing?

Lesson 3 Keys, Couplings and Seals

A key is the machinery component placed at the interface between a shaft and the hub of a power-transmitting element for the purpose of transmitting torque [see Figure 3.1 (a)]. The key is demountable to facilitate assembly and disassembly of the shaft system. It is installed in an axial groove machined into the shaft, called a keyseat. A similar groove in the hub of the power-transmitting element is usually called a key way, but it is more properly also a keyseat. The key is typically installed into the shaft keyseat first; then the hub keyseat is aligned with the key, and the hub is slid into position.

1. Square and Rectangular Parallel Keys

The most common type of key for shafts up to 6.5 inches in diameter is the square key, as illustrated in Figure 3.1 (b). The rectangular key [illustrated in Figure 3.1 (c)] is recommended for larger shafts and is used for smaller shafts where the shorter height can be tolerated. Both the square and the rectangular keys are referred to as parallel keys because the top, bottom and the sides of the key are parallel.



(a)key and keyseat (b)square key (c)rectangular key

Figure 3.1 Parallel keys applied to a gear and shaft

The keyseats in the shaft and the hub are designed so that exactly one-half of the height of the key is bearing on the side of the shaft keyseat and the other half on the side of the hub keyseat.

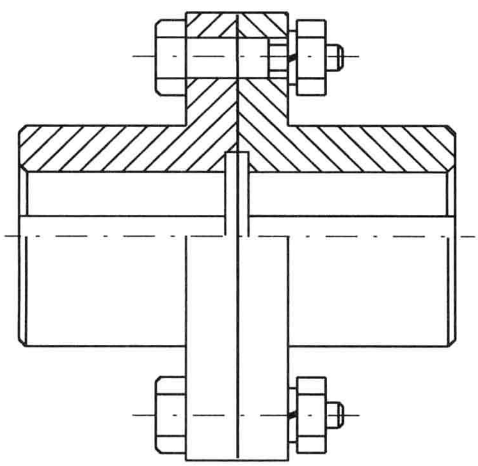


Figure 3.2 Rigid coupling

2. Couplings

The term coupling refers to a device used to connect two shafts together at their ends for the purpose of transmitting power. There are two general types of couplings: rigid and flexible.

1) Rigid Couplings

Rigid couplings are designed to draw two shafts together tightly so that no relative motion can occur between them. This design is desirable for certain kinds of equipment in which precise alignment of two shafts is required and can be provided. In such cases, the coupling must be designed to be capable of transmitting the torque in the shafts.

A typical rigid coupling is shown in Figure 3.2, which flanges are mounted on the ends of each shaft and are drawn together by a series of bolts. The load path is then from the driving shaft to its flange, through the bolts, into the mating flange, and out to the driven shaft. The torque places the bolts in shear. The total shear force on the bolts depends on radius of the bolt circle and torque.

Rigid couplings should be used only when the alignment of the two shafts can be maintained very accurately, not only at the time of installation but also during operation of the machines. If significant angular, radial, or axial misalignment occurs, stresses that are difficult to predict and that may lead to early failure due to fatigue will be induced in the shafts. These difficulties can be overcome by the use of flexible couplings.

2) Flexible Couplings

Flexible couplings are designed to transmit torque smoothly while permitting some axial, radial, and angular misalignment. The flexibility is such that when misalignment does occur, parts of the coupling move with little or no resistance. Thus, no significant axial or bending stresses are developed in the shaft.

Many types of flexible couplings are available commercially. Each of them is designed to transmit a given limiting torque. The manufacturer's catalog lists the design data from which you can choose a suitable coupling. Remember that torque equals power divided by rotational speed. So for a given size of coupling, as the speed of rotation increases, the amount of power that the coupling can transmit also increases, although not always in direct proportion. Of course, centrifugal effects determine the upper limit of speed.

3. Seals

Seals are an important part of machine design in situations where the following conditions apply: contaminants must be excluded from critical areas of a machine; Lubricants must be contained within a space; pressurized fluids must be contained within a component such as a valve or a hydraulic cylinder; some of the parameters affecting the choice of the type of sealing system, the material selection, and the details of its design are as follows:

- The nature of the fluids to be contained or excluded.
- Pressures on both sides of the seal.
- The nature of any relative motion between the seal and the mating components.
- Temperatures on all parts of the sealing system.
- The degree of sealing required is some small amount of leakage permissible?
- The life expectancy of the system.
- The nature of the solid materials against which the seal must act: corrosion potential, smoothness, hardness, wear resistance.
- Ease of service for replacement of worn sealing elements.

Words and Expressions

component [kəm'pəunənt] *n.* 成分；组件；元件

interface ['intəfeis] *n.* 接口；接触面

demountable [di:'mauntəbl] *adj.* 可拆的；可分的

disassembly [ˌdisə'sembli] *n.* 拆卸；分解

axial ['æksi:əl] *adj.* 轴的；轴向的

radial ['reidi:əl] *adj.* 径向的

misalignment ['misəlainmənt] *n.* 不重合；未对准

fatigue [fə'ti:g] *n.* 疲劳

direct proportion 正比

centrifugal [sen'trifjəgəl, -'trifə-] *adj.* 离心的