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前　言

从20世纪90年代初开始，我国的高职高专教育英语课程教学改革与研究已经历时20年，硕果累累，成绩斐然。在此期间，教育部先后颁布了《普通高等专科教育英语课程教学基本要求》（1993年）和《高职高专教育英语课程教学基本要求（试行）》（2000年）。这两部教学指导性文件确立了英语课程“以实用为主、应用为目的”的教学指导方针，把培养应用能力，特别是实用能力作为教学目标，大力推进了我国高职高专英语课程的基本建设和改革，使高职高专英语教学改革不断向纵深发展，教学质量明显提高，学生实际应用英语从事涉外活动和业务交际的能力，尤其是听说能力，得到大幅度提高。十多年来，教育部批准实施的“高等学校英语应用能力考试”合格率的逐年攀升，“高教杯”全国高职高专实用英语口语大赛上选手们的精彩表现，都从不同侧面反映出我国高职高专教育英语课程教学改革与研究取得的显著成效。

进入21世纪，在教育部提出的高等职业教育“以服务为宗旨，以就业为导向”的办学指导方针和“工学结合”培养模式的指导下，根据新世纪我国高等职业教育的特点和改革发展的需要，在传承和创新20世纪90年代研究成果的基础上，教育部高等学校高职高专英语类专业教学指导委员会《高等职业教育英语课程教学要求》项目组积极汲取国内外先进的外语教学理念，经过大量的社会调查和教学状态调查与分析，对我国高等职业教育英语课程的改革与建设提出了更深一层的思路，并在全国教学一线教师中达成共识：高等职业教育英语课程要以培养学生实际应用英语的能力为目标，侧重职场环境下交际能力的培养；应以岗位需求为主线，开发和构建教学内容体系；要按照行业涉及的典型职业岗位和主要工作内容进行教学情景设计，做到职业岗位群、典型工作任务与英语交际技能的有效结合，通过开设行业英语教学提高学生的就业竞争力。

“职业教育行业英语”系列教材的开发就是以上述研究成果为基础，针对行业英语教学阶段设计的。其宗旨是培养学生在职场环境下使用英语从事职场交际的能力，提升学生的工作适应性，并为未来的职业发展创造有利的条件。

教学理念与特色

1. 根据“工学结合，能力为本”的职业教育理念，《机械英语》教材针对具体行业岗位群对“行业人”所需要的英语实用能力设计教材的框架、教学内容和语言交际技能，突出教学内容的针对性和实用性。

2. 选材反映了机械行业在技术应用领域的最新成果及重大发展趋势，注重本行业涉外交际必须掌握的基本知识和技能，其内容涵括：工程制图、工程材料、机械零件、液压传动、成形、数控、计算机辅助设计与制造，大数据和3D打印等。

3. 考虑到学生的实际英语水平，为了增加直观性，我们在书中尽可能多配插图，以帮助学习者更好地理解和掌握。每个单元练习的设计，都是以多种形式帮助学习者熟悉和掌握本单元的内容，以期增强其行业英语的综合应用能力。

4. 充分利用先进的现代网络技术以及每个行业英语的资源库，为教师和学生提供丰富便捷的教与学的资源和全新的学习途径。

教材结构

本书共有10个单元，每单元包含3大模块。

Part I

第一个模块为阅读与翻译（Reading and Translating），这一模块所涉及的是机械专业核心课程中的内容，由Section A与Section B两部分构成。

Section A部分专业性较强，包括阅读、生词和技术术语及注释和练习。练习围绕课文内容设计，包括问题正误甄别、词汇派对、补词填空及汉译英四项。

Section B由副课文、词汇和练习组成。副课文内容与主课文相互补充，形成完整的核心课程体系。

Part II

第二个模块为听与说（Listening and Speaking）部分。通过对第一模块的学习，排除了语言障碍，学生对课程相关的行业语境已不再陌生，能够比较轻松地完成两项听力练习。Speaking是语言学习的重要环节，Exercise III培养学生的朗读能力，Exercise IV旨在提升学生的表达能力，可以通过分组讨论方式完成。

Part III

第三模块为应用文写作（Practical Writing）。为满足机械行业对人才的不同需求，安排了一些说明文写作（Expository Writing）练习，由学生课后完成，教师应在课堂上对写作要点进行指导。

编写队伍

《机械英语》由上海工商职业技术学院邹晶明、上海政法学院欧阳美和主编，参编人员有上海工商职业技术学院阎庆华、柏青、蔡璇和潘晓峰。

本书在编写过程中得到了高等教育出版社的大力支持，在此表示诚挚谢意。由于编写时间有限，错误或疏漏之处在所难免，敬请各位专家、读者提出宝贵意见。

编　者

2016年11月

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Unit 1

Engineering Drawing

Part I Reading and Translating

Section A: Types of Views

1.1 Basic Views

1.2 Sectional Views

1.3 Broken Views

Exercises

Section B: Mechanical Drawings and Dimensioning

1.4 Detail Drawings

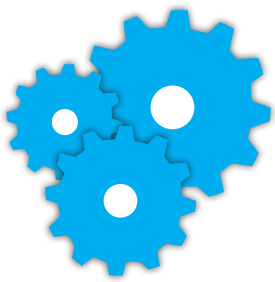
1.5 Assembly Drawings

1.6 Dimensioning

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Types of Views

Engineering drawing is a graphic language shared by people in different nations. It deals with the means of representation of a designer's idea by line styles or specific symbols on the plane. In engineering environment, drawings or views are chosen to describe physical objects like machine parts. Therefore, only the minimum number of views or drawings is used to portray the size and shape of an object completely.

1.1 Basic Views

The First-angle Projection

The first-angle projection is widely used and makes a standard in China. In the first-angle projection, an object is supposed to be positioned in a square box, and the image of the object from six viewing directions creates six projected orthographic views on the principle planes, that is, each view of the object is

drawn on the opposite side of the box (Fig. 1-1). Frequently, in industry, three views are chosen to represent the shape of an object. They are top, front and left side views. Imaginatively, the top view is seen directly from above, the front view is drawn by looking straight at the front, and the sight of left view is on the right side of the object (Fig. 1-2).

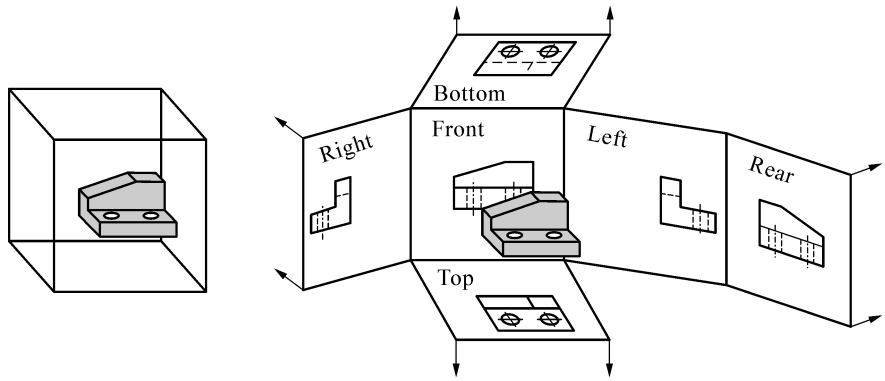


Fig. 1-1 Six Principle Views

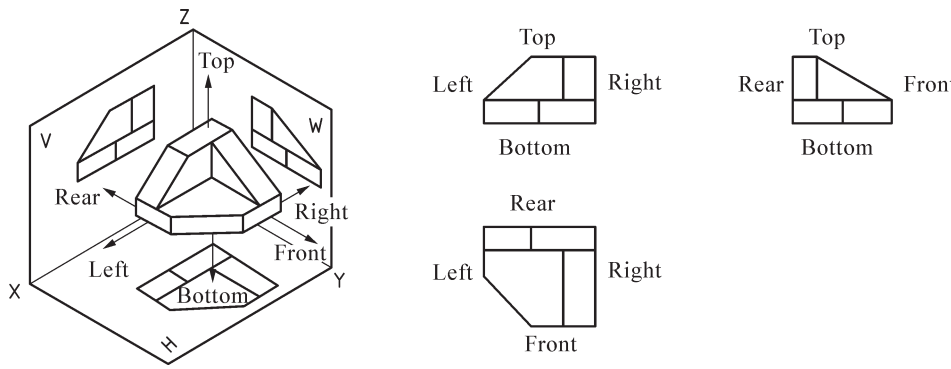


Fig. 1-2 Three Views

Auxiliary Views

An auxiliary view is another orthographic projection on a plane (not one of the six primary planes). It is used to show a slanted surface in true size and shape of an object. When necessary, the auxiliary view will be combined with a partial view. One of its features is that the projection on a plane is perpendicular to one of the principle planes (Fig. 1-3).

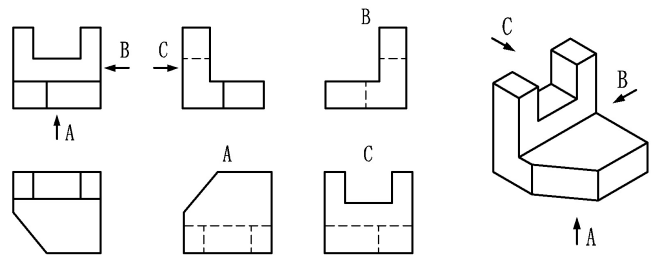


Fig. 1-3 Auxiliary Views of an Object

Partial Views

Principle views are generally used to represent an object. If some part of an object isn't shown clearly and it is not necessary to draw the whole principle view, but to project the local part of the object to the principle plane, we can get a projection view of this part, called partial view as shown in Fig.1-4.

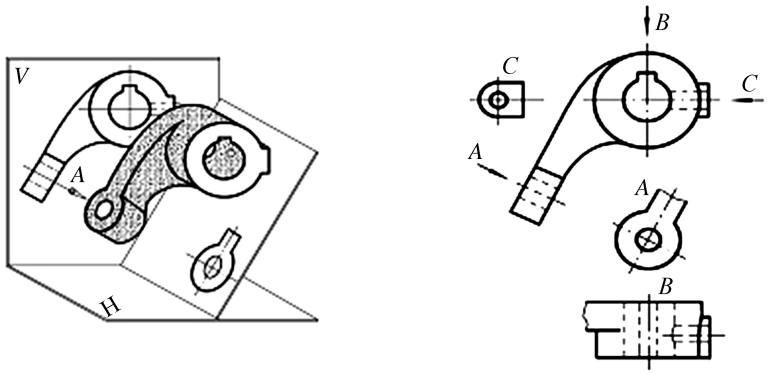


Fig. 1-4 Partial View

1.2 Sectional Views

A simple object may have an invisible and complicated internal design, while a view "in section" can clearly display the detailed structure. A sectional view is supposed to have a cutting plane. Its front part is removed to make the internal features visible. Representations of this kind are specified mainly by full and half views.

Full View

A full view is derived from a cutting plane passing entirely through an object. The resulting section will show the whole model on the datum plane (Fig. 1-5).

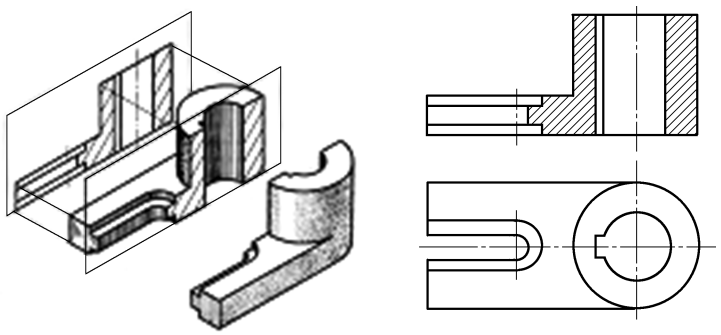


Fig. 1-5 Full-sectional Views of an Object

Half View

If the cutting plane cuts only half-way across an object, usually symmetrical, a half view of the section

appears. A sectional view of this type deals with the representation of both the interior and exterior construction of a symmetrical object, as shown in (Fig. 1-6).

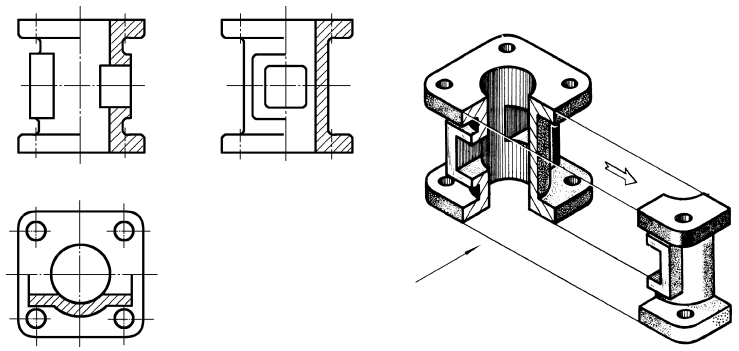


Fig. 1-6 Half-section View of an Object

1.3 Broken Views

From a geometric point of view, a broken view is an orthographic projection of an object from the position of a plane. View of this type is used to display only a cross-section of a body for a particular view (Fig. 1-7). More plainly, it is supposed to cut through an object along a cutting plane, where the parallel cross section can be drawn.

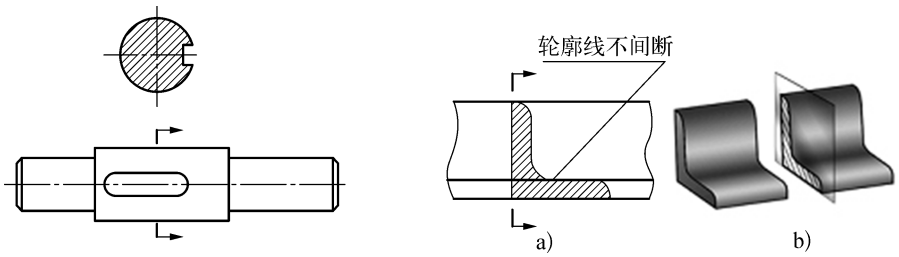


Fig. 1-7 A Broken View

New Words

1. **auxiliary** /ɔːgˈzɪlɪərɪ/ *a.* 辅助的，补助的
2. **combination** /ˌkɒmbɪˈneɪʃən/ *n.* 结合，联合
3. **complicated** /ˈkɒmplɪkeɪtɪd/ *a.* 复杂的；难解的
4. **datum** /ˈdeɪtəm/ *n.* 数据，资料；基准面
5. **detail** /ˈdiːteɪl/ *v.* 详述，细说； *n.* 细节，详情
6. **exterior** /eksˈtɪərɪə/ *a.* 外部的，表面的；*n.* 外部，表面
7. **feature** /ˈfiːtʃə/ *n.* 特征；特色；*v.* 是…的特色
8. **geometric** /ˌdʒɪəˈmetrɪk/ *a.* 几何（学）的
9. **graphic** /ˈgræfɪk/ *a.* 图形的，图表的
10. **interior** /ɪnˈtɪərɪə/ *a.*内部的； *n.* 内部
11. **internal** /ɪnˈtɜːnəl/ *a.* 内在的；国内的
12. **minimum** /ˈmɪnɪməm/ *a.* 最小的； *n.* 最小值
13. **orthographic** /ˌɔːθəˈgræfɪk/ *a.* 正交的；直线的
14. **partial** /ˈpɑːʃəl/ *a.* 部分的，局部的
15. **perpendicular** /ˌpɜːpənˈdɪkjʊlə/ *a.* 垂直的；正交的； *n.* 垂线

16. **plane** /pleɪn/ *n.* 平面； *v.* 刨，刨平
17. **portray** /pɔ:'treɪ/ *v.* 描绘，描画
18. **project** /prə'dʒekt/ *v.* 投影
    /'prɔdʒekt/ *n.* 方案
19. **represent** /ˌreprɪ'zent/ *v.* 表现；描绘
    representation /ˌreprɪzen'teɪʃən/ *n.* 表现，表述
20. **section** /'sekʃən/ *n.* 截面；断面
    specification /ˌspesɪfɪ'keɪʃən/ *n.* 规格；说明书
21. **specify** /'spesɪfaɪ/ *v.* 指定；详细说明
22. **symmetrical** /sɪ'metrɪkəl/ *a.* 对称的；均匀的

Technical Expressions

1. **auxiliary view** 辅助视图
2. **broken view** 断面图
3. **cross-section** 剖切面；横截面
4. **engineering drawing** 工程制图
5. **full view** 全剖视图
6. **half view** 半剖视图
7. **partial view** 局部视图
8. **projection view** 投影图
9. **projection-plane** 投影面
10. **section view/drawing** 剖面图
11. **section-lining** 剖面线
12. **sectional view** 剖视图
13. **the first-angle projection** 第一视角投影

Notes

1. Engineering drawing is a graphic language *shared by people in different nations.*
   工程制图是世界各国人们都使用的一种绘图语言。
   句中"*shared by people in different nations.*" 为过去分词短语作定语，修饰前面的先行词 a graphic language，相当于定语从句。

2. ... and the image of the object from six viewing directions creates six projected orthographic views on the principle planes ...
   … 箱内6个方向的投影产生该物体6幅正投影图样…

3. One of its features is that the projection on a plane is perpendicular to one of the principle planes.
   它的一个主要特征就是：一个平面上所产生的投影与其他几个基本投影面之一相垂直。

4. ... it is *not* necessary to draw the whole principle view, *but* to project the local part of the object to the principle plane.
   绘出完整的基本视图没有必要，只需将这一局部形状向基本投影面投射。
   not ... but 为一固定结构。

5. A sectional view is supposed *to have a cutting plane*.
   剖视图有一个假想的剖切面。
   to have a cutting plane 为不定式短语作主语补足语。

6. A full view is derived from a cutting plane *passing entirely through an object*. The resulting section will show the whole model on the datum plane.

当剖面全部通过物体，得到的是一幅全剖视图，所得到的剖面在该基准面上展示出整个物体的模型。
*passing entirely through an object*为现在分词短语作介词from的宾语补足语。

7. In mechanical drawing, a broken view is also an orthographic projection of an object from the position of a plane.
机械绘图中，断面图也是物体“面”的正投影。

8. More plainly, it is supposed to cut through an object along a cutting plane, *where* the parallel cross section can be drawn.
更明确地讲，假想的剖切平面将物体的某一处截断，仅就截断面处的形状绘成图形。
*where*引导了一个非限制性定语从句修饰a cutting plane。

Exercises

I. Tell whether each of the following statements is True (T) or False (F).

1. Engineering drawing is a graphical language that communicates ideas and information from one mind to another.
2. In engineering environment, three views are enough to show fully the size and shape of an object completely; these drawings are the top, front and left side views.
3. The first-angle orthographic projection is an illustration technique in which up to six pictures of an object are produced.
4. A view “in section” is one obtained by imaging the object cut by a cutting plane, the front portion being removed in order to show clearly the interior features.
5. An auxiliary view is derived from projecting to an inclined surface at an angle larger than 90, or more inclined plane.
6. A broken section needs to remove a section between two points in order to make the two remaining sections close together.
7. Not all views are necessarily used, and the determination of what surface constitutes the front, back, top and bottom depends on the projection used.
8. In the first-angle projection, the “top” view is pushed down to the floor, and the “front” view is pushed back to the rear wall.

II. Match the items listed in the following columns.

1. minimum	a. inside of something
2. feature	b. supplementary
3. complicated	c. characteristic
4. internal	d. not easy to understand or analyze

5. partial	e. a flat or level surface
6. plane	f. only a part; not total
7. expose	g. to make visible
8. auxiliary	h. the least possible quantity or degree
9. incline	i. outside part of anything
10. exterior	j. to cause to lean; slant

III. Fill in each blank with a proper word beginning with the letter given.

Section Drawings

Many objects have 1. c_____ interior structure, which can't be clearly shown by 2. m_____ of front, top, side or pictorial views. Section views enable the engineers to show the 3. i_____ in such a way. Features of section drawings are cutting-plane symbols, which show where 4. i_____ cutting planes are passed to produce the sections, 5. a_____ section-lining which appears in the section view on all 6. p_____ that have been in contact with the cutting plane. When only a part of the 7. o_____ is to be shown in section, conventional 8. r_____ such as a revolved, rotated or broken-out section is used. Thus, 9. c_____ engineering drawings will be combination of top and front views, and 10. p_____ or pictorial views.

IV. Translation (Chinese to English).

1. 工程制图是一种在平面上用线条及符号来表达设计者思想的一种手段。**(deal with)**
2. 在制造业中，通常只用限定的几类视图来展示某一物体形状。**(portray)**
3. 迫于就业的压力，学生必须从金工实训中学到实用知识。**(derive ... from)**
4. 剖视图可让设计人员更好地表现某一物体的内部细节。**(enable)**

Section B: Mechanical Drawings and Dimensioning

Mechanical drawings can be classified in two ways. They are recognized as detail drawings and assembly drawings. However, before they are recommended for manufacturing, dimensioning and identifying are required.

1.4 Detail Drawings

A detail drawing is obtained by taking a portion of an existing view and gives complete information for the production of a part. So it is necessary to be indicated with clear specifications, such as, relevant codes, size tolerances, heat treating requirements, finished surfaces, and manufacturing materials (Fig. 1-8).

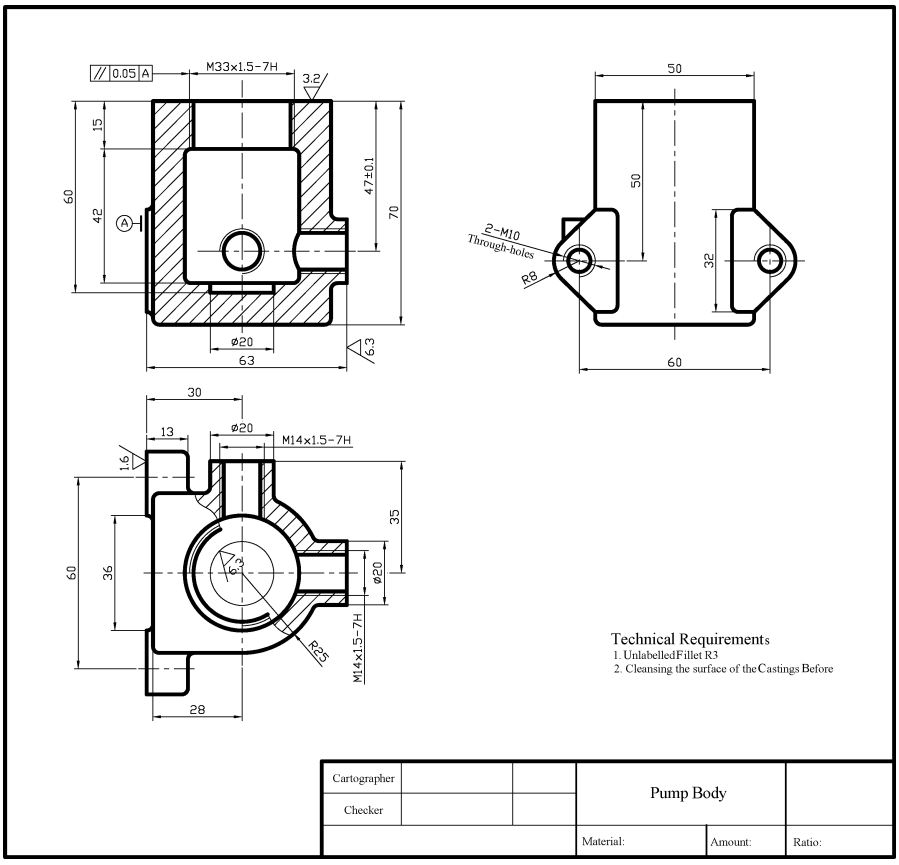


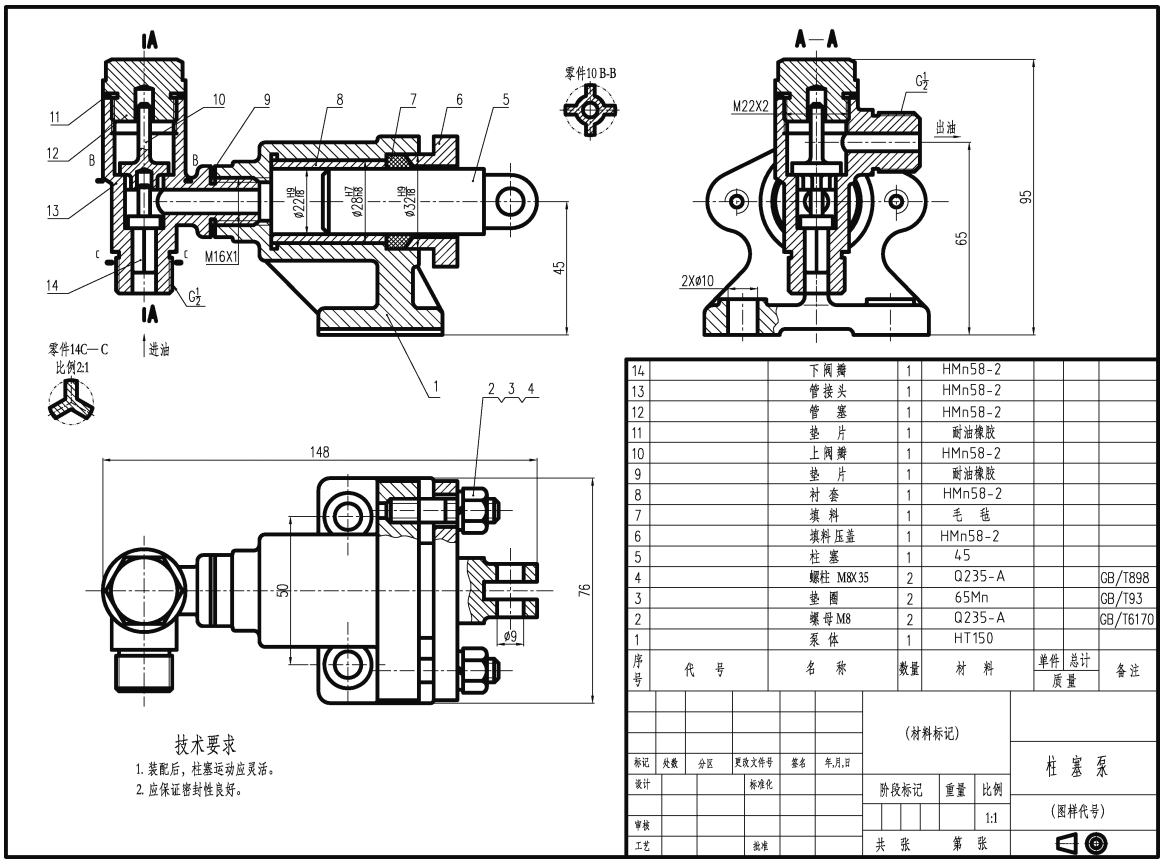
Fig. 1-8 A Detail Drawing

1.5 Assembly Drawings

Assembly drawings show how different parts go together according to a parts list. There are several types of such drawings: design assembly drawings, working assembly drawings, unit assembly drawings, installation diagrams, and so on. A general assembly drawing deals with the parts of a machine or machine unit assembled in their relative working positions (Fig. 1-9). A set of working drawings should include detail drawings of all parts and all relative information.

1.6 Dimensioning

As the purpose of an engineering drawing is to convey the ideas of the designer to workshop, any drawing must be given adequate information, so a part can be made. Before they are introduced to the workshop, careful identifications and labels should be given for the final product or process. Thus, the complete, detailed specification of the elements is required for the completion of this stage of design. In the detailed stage, the task will involve describing the size, shape, orientation, color, material and so on.



序号	代号	名称	数量	材料	单件	总计	备注
14		下阀瓣	1	HMn58-2			
13		管接头	1	HMn58-2			
12		管 塞	1	HMn58-2			
11		垫 片	1	耐油橡胶			
10		上阀瓣	1	HMn58-2			
9		垫 片	1	耐油橡胶			
8		衬 套	1	HMn58-2			
7		填 料	1	毛 毡			
6		填料压盖	1	HMn58-2			
5		柱 塞	1	45			
4		螺柱 M8X35	2	Q235-A			GB/T898
3		垫 圈	2	65Mn			GB/T93
2		螺母M8	2	Q235-A			GB/T6170
1		泵 体	1	HT150			

Fig. 1-9 A General Assembly Drawing

New Words

1. **assemble** /ə'sembl/ *v.* 装配；集合
   assembly/ə'semblɪ/ *n.* 装配；集结
2. **classify** /'klæsɪfaɪ/ *v.* 分类；分等
   classification/ˌklæsɪfɪ'keɪʃən/ *n.* 分类；分级
3. **dimension** /dɪ'menʃən/ *n.* 尺寸，尺度；*v.* 标注
4. **finished** /'fɪnɪʃt/ *a.* 精加工过的；完工的
5. **identify** /aɪ'dentɪfaɪ/ *v.* 识别；确定
   identification/aɪˌdentɪfɪ'keɪʃən/ *n.* 鉴定；认同
6. **indicate** /'ɪndɪkeɪt/ *v.* 指出；预示
7. **label** /'leɪbl/ *v.* 为…标注； *n.* 标签
8. **orientation** /ˌɔːrɪen'teɪʃən/ *n.* 方位；定向
9. **process** /'prəʊses; prəʊ'ses/ *n.* 过程；程序；
   v. 加工；处理
10. **relative** /'relətɪv/ *a.* 有关系的；相对的
11. **standard** /'stændəd/ *n.* 标准；水准

Technical Expressions

1. **assembly drawing** 装配图
2. **design assembly drawing** 设计装配图
3. **detail drawing** 零件图
4. **general assembly drawing** 总装配图
5. **installation diagram** 安装图
6. **working assembly drawing** 施工装配图

Notes

1. They are recognized as detail drawings and assembly drawings.
   它们被公认为零件图和装配图。

2. A detail drawing is obtained by taking a portion of an *existing* view and gives complete information for the production of a part.
   零件图是用现有视图上的一部分为零件生产提供完整信息的图样。
   *existing*是现在分词作定语。

3. A general assembly drawing deals with the parts of a machine or machine unit *assembled in their relative working positions.*
   总装图是一种把机器部件或装配展示在相对工作位置的图样。
   assembled in their relative working positions 是过去分词短语，在句中作定语，相当于定语从句 which are assembled in their relative working positions。

4. In the detailed stage, the task will *involve* describing the size, shape, orientation, color, material and so on.
   标注阶段的工作是对零件的尺寸、形状、方位、颜色、材料等进行详细描述。
   involve “包括”等意思，后接动名词。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. Among the variety of engineering drawings, _____ is recognized as an acceptable standard in today's modern manufacturing industry.
   A. the detailed drawing　　B. the assembly drawing
   C. the sectional drawing　　D. the multi-view drawing
2. What differentiates a detailed drawing from an assembly drawing is that _____.
   A. it should be given complete information for the manufacturer, describing the work with the adequate dimensions to the part's size
   B. it should be given more views to portray the size and shape of an object
   C. it is unnecessary to show shop operations
   D. it should be given an additional assembly drawing for manufacturing the part
3. Which of the following statements does the classification of the assembly drawings not include?
   A. Multi-view drawings.　　B. Design assembly drawings.
   C. Working assembly drawings.　　D. Installation diagrams.
4. _____ is called detailing stage.
   A. Selecting the kinds of components that will be used to make the process or product
   B. Revision and further improvement of the product

C. Finding and using information in machine design
D. Showing dimensions and describing the shape of objects

5. Engineering drawing is referred to "universal language". It can be understood and used by _____.
   A. people interested in art and languages
   B. engineers and other technical personnel associated with the engineering profession
   C. groups and nations in farming and fishing industry
   D. those who live outside the space of the earth

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

specified	indicate	identify	finished	assemble
deals	construction	involve	recognized	classify

1. There are two _____ classes of drawings. They are detail drawings and assembly drawings.
2. The parts must be manufactured within the _____ limits.
3. Raw materials make up only a small proportion of the cost of the _____ product.
4. Fundamentally, engineering design _____ with the process of problem solving.
5. The cracking of the ice _____ a change of temperature.
6. They needed to _____ the object and make sure it would actually be a UFO because UFO is an unidentified flying object.
7. When you buy furniture from IKEA, you must _____ it yourself.
8. The matter is serious because it _____ your reputation.
9. Elements are usually _____ as metals or non-metals.
10. In a developed city, such as Beijing, wherever you go, you see building under _____.

III. Translation (English to Chinese).

1. Layout drawings of different types are used in different manufacturing fields for various purposes.
2. As the purpose of engineering drawing is to express graphically the ideas and information necessary to others, many drawings must show dimensions so that workers can manufacture parts that will fit together.
3. Usually, a set of working drawings includes a detailed drawing of all parts and an assembly drawing of the complete unit.
4. A typical general assembly drawing should include specific use of sectioning and identification of each part with a numbered balloon.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. Engineering drawing _____ a graphic language shared by people in different nations.
2. It deals with the means of representation of a designer's idea by lines or marks _____ the surface.
3. Only the minimum number of views or drawings is _____ to portray completely the size and shape of a part.
4. Generally, there are _____ principle views to represent a machine part.
5. In industry, three views are usually _____ to show fully the shape of an object.
6. Even a simple object may _____ an invisible, complicated internal design.
7. A front part is removed, and _____ the remainder exposing the interior features.
8. A full view is derived _____ the cutting plane passing entirely through an object.
9. If the section of an object is symmetrical, typically, a partial view will be used, _____, two views are sufficient to detail the internal design.
10. A broken section needs to remove a section between two points _____ make the two remaining sections close together.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

An engineering drawing is a type of _____1_____, used to represent a designer's idea by lines or marks _____2_____. Its purpose is to accurately and clearly seize all the geometric features of a product or a component. The end goal of an engineering drawing is to convey _____3_____ that will allow a manufacturer to produce that component. The process of producing engineering drawings, and the skill of producing them, is often _____4_____ as technical drawing, although technical drawings are also required for disciplines that would not ordinarily _____5_____ as parts of engineering.

III. Read aloud the following paragraph.

Engineering drawing is a graphic language shared by people in different nations. It deals with the means of representation of a designer's idea by lines or marks on the surface. In engineering environment, drawings or views are chosen to describe material objects like machine parts. Therefore, only the minimum number of views or drawings is used to portray the size and shape of a part completely.

IV. Describe the following pictures of the first-angle projection in your own words.

Part III Practical Writing

This part is to test your ability to do practical writing. You are required to write a short passage to describe the first-angle projection according to the pictures in exercise IV.

Unit 2

Tolerances and Fits

Part I Reading and Translating

Section A: Limits, Tolerances and Fits

2.1 Limits

2.2 Tolerances

2.3 Fits

Exercises

Section B: Interchangeability and Dimension Measurement

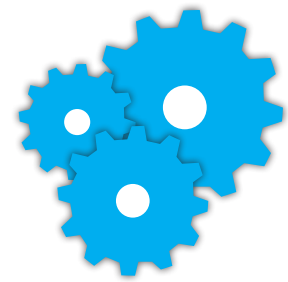
2.4 Interchangeability

2.5 Dimension Measurement

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Limits, Tolerances and Fits

Limits, tolerances, and fits are essential factors used in engineering design and modern manufacturing. Whatever dimension an engineer specifies on a drawing is, the priority for both shopmen and inspectors is to treat them with great care.

2.1 Limits

Limits refer to the maximum and minimum values in dimensions of a component. The extreme dimensions are known as *Upper limit* (the greatest size) and *Lower limit* (the smallest size). For instance, if the nominal diameter of a hole is 20 mm and the limits of size are expressed as 19.99/20.04, then any work not over 20.04 mm, nor under 19.99 mm, is acceptable.

2.2 Tolerances

The difference between upper and lower limits is called Tolerance. It is given to the workshop to achieve a given dimension. Tolerances might be indicated to be bilateral or unilateral. For example, when the tolerance is both above and below the nominal size, it is said to be bilateral (Fig. 2-1).

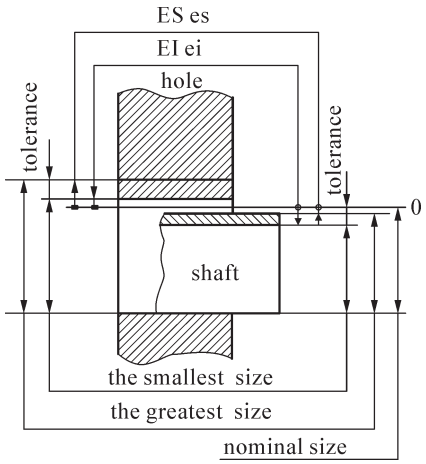


Fig. 2-1 Representation of Limits and Tolerances

Generally, tolerances are commonly expressed in fractions of millimeter, and the millimeter is invariably divided into microns (= 0.001 mm). For example, if a shaft with a nominal diameter of 20 mm is provided to fit a hole, the tolerance of the shaft might be dimensioned with a range from 19.92 mm to 20 mm, and the hole might be specified from 20.08 mm to 20.16 mm. This results in a clearance fit between 0.08 mm and 0.24 mm (largest shaft mating the smallest hole or smallest shaft mating the largest hole). Consequently, the size of the tolerance ranges for both the shaft and hole is located at 0.08 mm.

2.3 Fits

A fit occurs when we practically mate two parts, such as mating a shaft in a hole. Fits can range from clearance, interference to transition (Fig. 2-2).

Clearance Fits

When a shaft is smaller than a hole, and loose in running or sliding, it is said to be a clearance fit.

Transition Fits

Transitional fits occur when the shaft is either larger or smaller than the hole in a mating part. These fits would allow either a small amount of clearance or interference.

Interference Fits

Interference fits (press fits) exist when a male part is larger than a female one and they have to be forced together under pressure without any additional keys or setscrews.

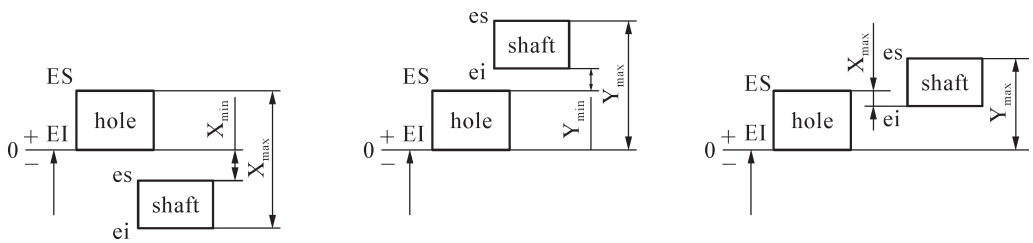


Fig.2-2 Types of Different Fits

New Words

1. **bilateral** /baɪ'lætərəl/ *a.* 双向的；双边的
2. **essential** /ɪ'senʃəl/ *a.* 基本的；本质的
   n. 实质；要素
3. **fraction** /'frækʃən/ *n.* 分数；小部分
4. **invariably** /ɪn'veərɪəb(ə)lɪ/ *ad.* 不变地；总是
5. **locate** /ləʊ'keɪt/ *v.* 设定；找出
6. **loose** /luːs/ *a.* 宽松的，不紧的
7. **mate** /meɪt/ *v./n.* 配套；配合；连接
8. **maximum** /'mæksɪməm/ *n.* 最大限度；极大；*a.* 最大极限的
9. **micron** /'maɪkrɒn/ *n.* 微米
10. **millimeter** /'mɪlɪmiːtə(r)/ *n.* 毫米
11. **nominal** /'nɒmɪnəl/ *a.* 名义上的
12. **occur** /ə'kɜː/ *v.* 发生；出现
13. **priority** /praɪ'ɒrɪtɪ/ *n.* 优先考虑的事；优先权
14. **unilateral** /ˌjuːnɪ'lætərəl/ *a.* 单方面的；单边的

Technical Expressions

1. **clearance fit** 间隙配合
2. **fit** 配合
3. **interference fit** 过盈配合
4. **key** 楔，栓，键
5. **limit** 极限
6. **nominal diameter** 通称 [标称] 直径
7. **nominal size** 通称 [标称] 尺寸
8. **press fit** 压配合
9. **setscrew** 固定螺丝钉
10. **shaft** 机械轴
11. **tolerance** 公差
12. **transition fit** 过渡配合

Notes

1. Whatever dimensions an engineer specifies on a drawing is, the priority for both shopmen and inspectors is to treat them with great care.
   无论工程师在图样上标注的是什么尺寸，加工及检测人员首先都要以极其认真的态度来对待它们。

2. The extreme dimensions are known as *Upper limit* (the greatest size) and *Lower limit* (the smallest size).
   这种极限尺寸被称为上极限尺寸（最大尺寸）和下极限尺寸（最小尺寸）。

3. ... when the tolerance is both above and below the nominal size, it is said to be bilateral.
   ……当公差带位于通称尺寸的上下两侧时，即为双向公差。

4. Fits can range from clearance, interference to transition.
   配合可分为间隙配合、过盈配合及过渡配合。

5. When a shaft is smaller than a hole, and loose in running or sliding, it is said to be a clearance fit.
   当轴径小于孔径且较为宽松时，则为间隙配合。

6. Interference fits (press fits) exist when a male part is larger than a female one and they have to be

forced together under pressure without any additional keys or setscrews.
当配合件大于被配合件时，需靠使用压力将两零件装在一起，而不是用外加键或螺钉来固定，该类配合就是过盈配合。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. The maximum and minimum sizes in part dimensions are limits between which the actual part dimension must fall.
2. When the tolerance is indicated all on one side of the nominal, it is said to be bilateral.
3. Since it is impossible to machine a part to an exact size, a designer must specify an acceptable range of sizes.
4. Allowance is the unintentional difference between maximum limits of mating parts to accomplish the desired fit.
5. Fits can range from free running to sliding, where a certain amount of clearance exists between mating parts.
6. Tolerances for press fits can become very critical because parts can be easily damaged by attempting to press them to fit if there is an addition, and press fitting physically deforms the parts to some extent.

II. Match the items listed in the following columns.

1. loose	a. two-sided
2. mate	b. constantly
3. bilateral	c. not tight-fitting
4. indicate	d. to pair
5. invariably	e. point out
6. maximum	f. necessary
7. nominal	g. something deserving first attention
8. occur	h. to take place
9. priority	i. existing in name only
10. essential	j. the upper limit of variation

III. Fill in each blank with a proper word beginning with the letter given.

Tolerancing

Since it is impossible to produce a part to an 1. a_____ size, a drawing must be specified with an 2. a_____ limit of sizes, which will enable the 3. m_____ part to fit and function

as intended. The maximum and 4. m_____ sizes in part dimensions are limits between which the actual part dimension must fall. The difference between the maximum and minimum limits is 5. t_____, or the total amount by which a part tolerance may vary. Tolerance on 6. d_____ is often indicated by 7. s_____ a limit, or by plus and minus notations. With plus and 8. m_____ tolerancing, when the tolerance is both above and below the 9. n_____ (true theoretical) size, it is said to be bilateral (two sides). When the tolerance is 10. i_____ all on one side of the nominal, it is said to be unilateral (one side).

IV. Translation (Chinese to English).

1. 同处于公称尺寸上、下方时的公差，即为双侧公差。而公差全部位于通称尺寸一侧时，则称为单侧公差 **(whereas)**。
2. 在制造过程中，许多零件之间都有着重要的密切的关系。有一些装配工作要用手工完成 **(have relation to ...)**。
3. 装配配合可以分为滑配合、转配合、压配合和冷缩配合 **(be classified into ...)**。
4. 既然生产出实际尺寸的零件不太可能，那么图纸必须提供一个可以接受的极限尺寸 **(specify)**。

Section B: Interchangeability and Dimension Measurement

2.4 Interchangeability

Fits between two parts are the top priorities whatever manufacturing method may be used. The basic function of mechanical design is to make the manufactured parts interchangeable. That is to say, each part must be made and inspected within the specific limits, so as to fit into any other machine or mechanism of the same type.

The advantages of interchangeability enable the factory to reduce producing cost, assembly time, and facilitate replacement of worn or defective parts. In many cases, however, complete interchangeability cannot always be satisfactory, but fitting allowance may meet the design demands perfectly. Even on heavy machinery, such as a large diesel engine, a considerable degree of interchangeability is usually achieved.

2.5 Dimension Measurement

The dimension determining of a part on a drawing should be measured many times during the manufacturing process. Whether a part, such as a shaft or a hole, is produced to the standard simply depends on checking if the part is within the limits of size.

In practice, the selection of methods, standards and instruments for gauging or measurement

is consequently based on the shape or feature of a part. Although there is a big family of measuring instruments available, from the elementary rule, calipers to modern Pulsed Eddy Current technology, proper education and preparation for workers or inspectors are necessary in achieving a satisfactory dimension accuracy.

New Words

1. **consequently** /'kɒnsɪkwəntlɪ/ *ad.* 从而；因此
2. **defective** /dɪ'fektɪv/ *a.* 有缺陷的；损坏的；故障的
3. **facilitate** /fə'sɪlɪteɪt/ *v.* 使易于；利于；有助于
4. **function** /'fʌŋkʃən/ *n.* 功能，作用
5. **gauge** /geɪdʒ/ *v.* 测量； *n.* 标准尺；规格；量规
6. **instrument** /'ɪnstrʊmənt/ *n.* 器械；手段
7. **interchangeable** /ˌɪntə'tʃeɪndʒəbl/ *a.* 可互换的
8. **manufacture** /ˌmænjʊ'fæktʃə/ *v./n.* 制造；加工
9. **standard** /'stændəd/ *a.* 标准的； *n.* 标准；规格

Technical Expressions

1. **caliper** 卡钳；弯脚圆规
2. **diesel engine** 柴油机
3. **dimension measurement** 尺寸测量
4. **fitting allowance** 配合公差
5. **interchangeability** 可互换性
6. **Pulsed Eddy Current** 脉冲涡流

Notes

1. That is to say, each part must be made and inspected within the specific limits, so as to fit into any other machine or mechanism of the same type.
   更确切地说，每一个零件都必须在详细而精确的极限尺寸范围内制造和检测，以便使其能与其他同一类的机器或机械装置相配合。

2. In many cases, however, complete interchangeability cannot always be satisfactory, but fitting allowance may meet the design demands perfectly.
   然而在多数情况下，做到完全互换总是不太容易，但配合公差却能很好地满足设计要求。

3. The dimension *determining of a part* on a drawing should be measured many times during the manufacturing process.
   在加工过程中，决定一个零件的尺寸应当反复测量。
   ... *determining of a part* 是现在分词短语，在这里用作定语，修饰中心词dimension。

4. Whether a part, such as a shaft or a hole, is produced to the standard simply depends on checking if the part is within the limits of size.
   一个零部件，以轴或孔为例，是否按标准生产完全依靠检查该零部件是否在极限尺寸范围以内。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. To make the part interchangeable, each individual part must be produced _____ .
   A. to a size that will fit the mating part in the correct way
   B. to an actual size
   C. to the nominal size
   D. to mate any other machine
2. With a maximum limit of 1.001 mm. and a minimum limit of 0.999 mm, _____ .
   A. the tolerance would be 0.003 mm
   B. the tolerance would be 0.0002 mm
   C. the tolerance would be 0.0003 mm
   D. the tolerance would be 0.002 mm
3. Considering the inaccuracy of machining processes, we are difficult to get an actual dimension after machining. Therefore, _____ .
   A. tolerance was set for the acceptable variation of size
   B. dimensions may meet the design demands perfectly
   C. limits can answer the question well
   D. a considerable degree of deviation is allowed
4. With exceptional accuracy, the Pulsed Eddy Current technology _____ in metal strip gauging and corrosion defect detecting.
   A. was an old method used a century ago
   B. has opened up a new dimension
   C. is only a very common method
   D. is rarely used by engineers or manufacturing workers
5. In many cases full interchangeability cannot always be achieved, but _____ is often perfectly satisfactory.
   A. deviation　　B. maximum　　C. allowance　　D. fitting conditions

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

facilitating	function	defective	manufacture
gauging	standard	process	consequently

1. Interchangeable manufacture is _____ in quantity produced articles, and it has extended its principles to the production of every field such as aircraft and ships.
2. The most important _____ of limits is to make interchangeable parts be produced.
3. Pulsed Eddy Current technology has effected the dimension in metal strip gauging and _____ detecting.

4. The advantage of interchangeability in service in _____ repair is well known and universally accepted.
5. After all the components had been done, we had to consider the assembly sequence of real components after _____ process.
6. In extreme precision engineering, the required fit is too fine to be obtained directly from a machine _____.
7. When _____ light or special alloy parts, considerable errors may be introduced, particularly on long parts.
8. Mr. Foster has never touched the Science of Heat Treatment of Metal. _____, he knows very little about it.

III. Translation (English to Chinese).

1. Allowance applies particularly to fits, as in the case of a hole and a shaft. It is the intentional difference between maximum limits of mating parts to accomplish the desired fit.
2. With Pulsed Eddy Current technology, it is possible to measure, in real time and in line, dimensions and other attributes of a part with exceptional accuracy.
3. The ISO standards are designed to be independent of any one language and thus much symbology is used to overcome any reliance on any language.
4. To make the manufactured components interchangeable, each individual component must be made to a size that will fit the mating part in the correct way.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. Limits, tolerances, and fits are _____ used in engineering design and modern manufacturing.
2. Limits _____ the maximum and minimum values in dimensions of a component.
3. The difference between upper and lower limits is called Tolerance. It is given to the _____ in achieving a given dimension.
4. When the tolerance is both above and below the nominal size, it is _____ to be bilateral.
5. A fit _____ when we practically mate two parts, such as mating a shaft in a hole.
6. When a shaft is smaller than a hole and loose in _____ or sliding, it is said to be clearance fit.
7. Since it is impossible to _____ a part to an exact size, a designer must specify an acceptable range of sizes.
8. When two parts mate or are _____ in an assembly, a tolerance becomes vitally important.
9. Fits can _____ from free running or sliding, where a certain amount of clearance exists between mating parts.

10. Many times a machinist is _____ with press or interference fits. In this case two parts are forced together.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

GD&T (Geometric dimensioning and tolerancing) is _____1_____ on mechanical drawings. It is used to define the nominal geometry of parts and assemblies, to define the allowable variation in form and possibly _____2_____, and to define the allowable variation between features. All dimensions must have a tolerance. Every feature on every manufactured part _____3_____, therefore, the limits of allowable variation must be specified. Plus and minus tolerances may be applied directly to dimensions or applied from a general tolerance block or general note. For basic dimensions, geometric tolerances are indirectly applied in a related Feature Control Frame. The only exceptions are for dimensions marked _____4_____, stock or reference.

Dimensioning and tolerancing shall completely define _____5_____ and allowable variation. Every dimension and tolerance is required to define the finished part on the drawing.

III. Read aloud the following paragraph.

Limits, tolerances, and fits are essential factors used in engineering design and modern manufacturing. Whatever dimension an engineer specifies on a drawing is, the priority for both shopmen and inspector is to treat them with great care. Transitional fits occur when the shaft is either larger or smaller than the hole in a mating part. Interference fits (press fits) exist when a male part is larger than a female one and they have to be forced together under pressure without any additional keys or setscrews.

IV. Answer the following questions in your own words.

1. What is tolerance?
2. What is fit?
3. Are there any good points of tolerance in manufacturing?

Part III Practical Writing

You are required to write a corporate profile. Some words are given in order to better your writing.
有外宾要来参观我们的生产车间，以便与公司开展业务。你能写一份简单的有关公司的介绍吗?

Key words: 1. Company name: Shanghai Machinery Co., Ltd.
2. Established: 1957
3. Location: Pujiang Hi-tech Park, Jiading District
4. Major products: NC machine tools and components
5. Scale: 1,000 employees: 6 PhDs; 45 engineers with Master's degrees;100 highly skilled technicians; 100,000 m^2; five workshops; one showroom; one R&D center

Unit 3

Engineering Materials

Part I Reading and Translating

Section A: Metals and Its Properties

3.1 Metals and Alloys

3.2 Mechanical Properties of Metals

Exercises

Section B: Nonmetal Materials

3.3 Polymers

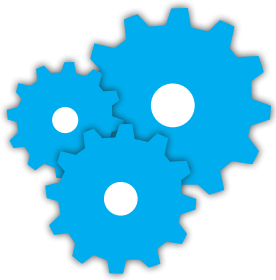
3.4 Composites

3.5 Ceramics

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Metals and Its Properties

As far as engineering materials are concerned, both metals and alloys are chemical elements. They are crystalline when they are in the solid state. With good ductility, desired strength, and other advantages in mechanical properties, metals and alloys are main engineering materials in structural use.

3.1 Metals and Alloys

In the Periodic Table of Elements by a Russian chemist, Dmitri Mendeleev, about half of the elements are metals. Metals are usually divided into two groups: ferrous and nonferrous. In contrast to ferrous, nonferrous metals do not contain any iron. Copper, aluminum and chromium are some examples.

From the standpoint of commerce, however, an absolutely pure metal has never appealed to engineers, such as pure iron, which is too soft for machine parts. And of all these metallic elements, only a few are suitable for the engineering purpose. Cast iron and alloy are the most common metals in use. An alloy is

a mixture of two or more metals. For example, steels are alloys of iron and carbon by adding one or more small amounts of the following elements: nickel, chromium, manganese, silicon, tungsten and so on.

Carbon is the most important element in steel. It determines the mechanical properties by the adding percentage of carbon. In this connection, low-carbon steels (less than 0.25%), with better forming properties, are usually used for low-strength products. And medium-carbon steels (0.25%-0.60%) can meet the requirement of forgings, strength and ductility for mechanical parts or machines; while high-carbon steels (0.60%–1.7%) are good materials for tools and dies.

Among such a large number of metals and alloys, each type has a personality of its own. Hence, in the choices of the proper metals, it is essential to understand the recent engineering standards and datum available.

3.2 Mechanical Properties of Metal Materials

Mechanical properties of materials are tests of how a material actually responds to acting forces or loads. The main properties involve the following: strength, hardness, elasticity, plasticity, ductility, and toughness.

Strength properties include tension, bending, compression, torsion, shear and fatigue. As the mechanical strength represents the ability of a material to withstand the maximum loads or forces before yield, it is an important item in the tests of mechanical properties.

Hardness refers to the resistance of a metal to indenting or penetrating forces by an indenter. The commonly used methods for hardness testing are both Brinell and Rockwell.

Elasticity is the ability of a material to resume its original shape after the loads are removed. Some parts like springs should possess this kind of quality.

Plasticity refers to the ability of a material undergoing non-reversible changes of shape in response to applied forces before being deformed.

The quality of **ductility** shows the ability of a material undergoing permanent changes of shape in destructive testing.

The property of toughness expresses the ability of absorbing mechanical energy from the external. Strength and ductility determine the toughness of a metal. By this definition, copper is by far tougher than cast iron.

New Words

1. **appeal** /ə'pi:l/ *v.* 投合…的心意；引起…的兴趣(to)
2. **crystalline** /'krɪstəlaɪn/ *a.* 晶体的
3. **destructive** /dɪs'trʌktɪv/ *a.* 破坏（性）的
4. **external** /ɪks'tɜ:nəl/ *n.* 外部； *a.* 外部的
5. **forge** /fɔ:dʒ/ *v.* 铸造；伪造
6. **indent** /ɪn'dent/ *v.* 切割成锯齿状
7. **penetrate** /'penɪtreɪt/ *v.* 穿透；渗透
8. **permanent** /'pɜ:mənənt/ *a.* 永久的；持久的
9. **resume** /rɪ'zju:m/ *v.* 重新开始；恢复
10. **standpoint** /'stændpɔɪnt/ *n.* 观点；立场
11. **undergo** /ˌʌndə'gəʊ/ *v.* 经历，遭受；忍受
12. **withstand** /wɪð'stænd/ *v.* 抵挡；经受住
13. **yield** /ji:ld/ *v.* 屈服；生产

Technical Expressions

1. alloy 合金
2. carbon 碳
3. cast iron 铸铁
4. chromium 铬
5. copper 铜
6. die 冲模
7. ductility 延展性
8. elasticity 弹性
9. hardness 硬度
10. manganese 锰
11. mechanical properties 机械性能
12. metal 金属
13. nickel 镍
14. silicon 硅
15. strength properties 强度性能
16. toughness 韧性
17. tungsten 钨

Notes

1. In the Periodic Table of Elements by a Russian chemist, Dmitri Mendeleev, about half of the elements are metals.
   在俄罗斯化学家德米特里·门捷列夫的元素周期表中，大约有一半的元素是金属元素。
   德米特里·伊凡诺维奇·门捷列夫：（1834 — 1907）俄罗斯化学家，是第一个设计并出版元素周期表的人（1869年）。

2. From the standpoint of commerce, however, an absolutely pure metal has never appealed to engineers, such as pure iron, which is too soft for machine parts.
   从商业的角度来看，工程师们对绝对纯金属是不感兴趣的，比如纯铁，由于其太软而不适合用来制作机器零件。

3. For example, steels are alloys of iron and carbon by adding one or more small amounts of the following elements: nickel, chromium, manganese, silicon, tungsten and so on.
   例如，钢是铁和碳的合金，其中加入了一种或几种少量的如下金属元素：镍、铬、锰、硅及钨等。

4. Mechanical properties of materials are tests of how a material actually responds to acting forces or loads.
   材料的力学性能是用来测定一种材料抵抗外力或载荷时所作出的实际反应。

5. Strength properties include tension, bending, compression, torsion, shear and fatigue.
   强度特性包括抗拉伸、弯曲、耐压、扭转、剪切及抗疲劳等性能。

6. Elasticity is the ability of a material to resume its original shape after the loads are removed. Some parts like springs should possess this kind of quality.
   弹性是指某一材料卸去载荷后能恢复原始状态的能力。某些类似弹簧的零件，应具备这种性能。

7. Plasticity refers to the ability of a material undergoing non-reversible changes of shape in response to applied forces before being deformed.
   塑性指的是材料变形前其应对不可抗逆塑性变形的能力。

8. The quality of ductility shows the ability of a material undergoing permanent changes of shape in destructive testing.
延展性能表示某一材料在破坏性测试中对永久性形变的承受能力。

9. The property of toughness expresses the ability of absorbing mechanical energy from the external.
韧性表示（某一材料）可吸收外来机械能的能力。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. Although plain carbon steels work well for many uses and are the cheapest, they cannot completely fulfill the requirements for some work.
2. High carbon steel contains from 0.3% to 0.5% of carbon.
3. Carbon is the most important element in determining the mechanical properties of steel.
4. The most practical means of increasing the strength is by adding some carbon.
5. Shear strength refers to how well a part can withstand two equal forces acting in same directions.
6. Torsional strength is the ability of a part to undergo forces to cause the body to twist.
7. In the tensile test, the material is loaded in such a way that tensile forces are brought to play in it.
8. Impact strength is the strength of a material when subjected to high rates of loading, usually in bending, tension or torsion.

II. Match the items listed in the following columns.

1. standpoint	a. connected with the outside
2. appeal	b. to take back again
3. forge	c. to resist or endure successfully
4. withstand	d. to form by a mechanical or hydraulic press
5. yield	e. to be attractive or interesting
6. penetrate	f. a point of view
7. resume	g. to give way to pressure or force
8. permanent	h. lasting or remaining
9. destructive	i. ruinous
10. external	j. to enter or force a way into

III. Fill in each blank with a proper word beginning with the letter given.

Hardening and Tempering

When steel is heated above the lower critical temperature of 721℃, the carbon begins to

1. d_____ in the iron and form a solid solution. When this solution of iron and carbon is suddenly 2. c_____, a new microstructure is formed. This is called Martensite (马氏体). Martensite is very 3. h_____ and brittle. It is quite unstable, and must be tempered to 4. r_____ internal stresses in order to get useful ductility and 5. t_____.

Tempering is a 6. p_____ of reheating a hardened steel part. The 7. h_____ the tempering temperature is used, the softer and tougher the part 8. b_____. A part should be tempered as soon as 9. p_____ after hardening, and not be allowed to cool completely, since the untempered part contains very high 10. i_____ stresses and tends to split or crack.

IV. Translation (Chinese to English).

1. 普通碳素钢是一种铁与碳组成的合金，其含碳量低于2.11%。**(contain)**
2. 金属的抗拉强度是指抵抗其被拉断的能力。**(pull ... apart)**
3. 抗疲劳强度是指材料在各种急速交变应力作用下的抵抗能力。**(resist)**
4. 抗扭强度是指金属可承受扭转变形的能力。**(withstand)**

Section B: Nonmetal Materials

Nonmetallic may be classified into two groups: organic and inorganic materials. The former are either from the nature like wood, leather and rubber, or by chemical process such as polymers and composites. And the latter include ceramics, glass, carbon and graphite and so on. Although nonmetallic is inferior to metallic in strength and toughness, low electric and heat conductivity, lightness and corrosion-resistance make them universal.

3.3 Polymers

Easy softening and melting are the outstanding advantages of polymers in manufacturing various products. All polymers, taking plastics for example, can be divided into two processing groups: thermoplastics and thermosetting.

When thermoplastics are heated to a flowing state, they are molded by ways such as compression, injection, extrusion, lamination or casting. The products of thermoplastics are shaped in the mold, and solidified by cooling in order to remove them without distortion.

Unlike thermoplastics, processes of thermosetting are an irreversible chemical reaction. At room temperature or under heat and pressure, the reactive agents are compounded into thermosetting materials and cause them to set up. Of course, the resultant material will not flow or be softened by heating.

3.4 Composites

A composite is the combination of two or more materials, such as fiberglass, metals, ceramics, and polymers. When combined, the different components produce a new material with enhanced mechanical properties.

Both thermoplastics and thermosetting polymers can be combined with fibre, mineral or other materials to form advancing composite materials. These composites are widely used in aerospace or defense applications. For instance, polymer matrix composites with greater specific strength and stiffness are finding growing acceptance in the design of modern aircraft structures in the Joint Strike Fighter and the Boeing 787.

3.5 Ceramics

Ceramic materials are made by shaping and then firing a nonmetallic mineral, such as clay, at a high temperature. Obviously, each ceramic material has its own benefits and weaknesses. Despite brittleness or poor toughness, ceramic materials possess superior properties including hardness, high strength, durability, electric insulation, particularly heat, and corrosion-assistance. These benefits make ceramic items very popular in civil and military use.

With the development of reinforced ceramic matrix composites and improvements in processing techniques, however, new high performance ceramics have directly replaced many metal parts. An important example is the ceramic turbocharger in automotive applications.

New Words

1. **agent** /'eɪdʒənt/ *n.* 试剂；代理
2. **automotive** /ˌɔːtə'məʊtɪv/ *a.* 汽车的；自动推进的
3. **brittleness** /'brɪtlnɪs/ *n.* 脆性，脆度
4. **clay** /kleɪ/ *n.* 粘土；泥土
5. **component** /kəm'pəʊnənt/ *n.* 构件；成分
6. **compound** /kəm'paʊnd/ *v.* 混合，配合 /'kɔmpaʊnd/ *n.* 化合物
7. **compression** /kəm'preʃən/ *n.* 压缩；浓缩
8. **distortion** /dɪs'tɔːʃən/ *n.* 扭曲；失真
9. **enhance** /ɪn'hɑːns/ *v.* 增强；提高
10. **extrusion** /eks'truːʒən/ *n.* 挤出，推出
11. **fibre** /'faɪbə/ *n.* 纤维；构造
12. **inferior** /ɪn'fɪərɪə/ *a.* 下等的；差的
13. **injection** /ɪn'dʒekʃən/ *n.* 注射；注入
14. **insulation** /ˌɪnsjʊ'leɪʃən/ *n.* 绝缘
15. **irreversible** /ˌɪrɪ'vɜːsəbl/ *a.* 不能还原的
16. **military** /'mɪlɪtərɪ/ *adj.* 军事的；军用的
17. **mineral** /'mɪnərəl/ *n.* 矿物；矿石
18. **organic** /ɔː'gænɪk/ *a.* 有机的；器官的
19. **resultant** /rɪ'zʌltənt/ *adj.* 作为结果而发生的；合成的
20. **superior** /sjuː'pɪərɪə/ *n.* 上级； *a.* 上级的；出众的

Technical Expressions

1. **casting** 铸件；铸造
2. **ceramic** 陶瓷制品
3. **composite** 合成物
4. **conductivity** 传导性；传导率

5. **corrosion-assistance** 抗腐蚀
6. **fiberglass** 玻璃纤维
7. **graphite** 石墨
8. **lamination** 叠片结构
9. **nonmetallic** 非金属物质
10. **polymer** 高分子材料
11. **reinforced ceramic matrix composites** 增强陶瓷基质复合材料
12. **thermoplastics** 热塑性塑料
13. **thermosets** 热固塑料
14. **turbocharger** 涡轮增压器

Notes

1. The former are either from the nature like wood, leather and rubber, or by chemical process such as polymers and composites.
前者或直接从自然中提取，诸如木材、皮革及橡胶，或可用化学方法获得，如高分子聚合物及合成材料。

2. All polymers, taking plastics for example, can be divided into two processing groups: thermoplastics and thermosetting.
所有高分子聚合材料，以塑料为例可分成两个类别，即：热塑性及热固性。

3. Unlike thermoplastics, processes of thermosetting are an irreversible chemical reaction.
与热塑性塑料不同，热固性塑料加工是一个不可逆的化学反应过程。

4. At room temperature or under heat and pressure, the reactive agents are compounded into thermosetting materials and cause them to set up.
在室温或热压下，反应物与热固材料相复合而促成固化。

5. A composite is the combination of two or more materials, such as fiberglass, metals, ceramics, and polymers.
复合材料是由两种或多种不同基本材料组合而成，如玻璃纤维、金属、陶瓷、聚合物混合生成的复合材料。

6. For instance, polymer matrix composites with greater specific strength and stiffness are finding growing acceptance in the design of modern aircraft structures in the Joint Strike Fighter and the Boeing 787.
例如，具有更高强度及硬度的聚合基质材料在现代航空器结构设计中被广泛应用 —— 联合攻击机及波音787飞机就使用了该类材料。

7. Ceramic materials are made by shaping and then firing a nonmetallic mineral, such as clay, at a high temperature.
陶瓷是一种由非金属矿物，如粘土，成型后在高温下烧结而成的材料。

8. With the development of reinforced ceramic matrix composites and improvements in processing techniques, however, new high performance ceramics have directly replaced many metal parts.
然而，随着以陶瓷为增强基体的复合材料的发展及加工工艺的改进，新型高性能陶瓷材料已直接用来替代许多金属零件。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. Metal objects can often be broken down and the metals recycled; _____.
   A. thermosetting plastics can only be reused or dumped
   B. thermosetting plastics can also be recycled and reused
   C. thermosetting plastics cannot be recycled and reused
   D. thermosetting plastics can only be burnt or softened
2. Polymer matrix composites are finding growing acceptance in the design of modern aircraft structures for _____.
   A. lightweight, greater specific strength and stiffness
   B. the property of elasticity
   C. the quality of ductility
   D. low electric and heat conductivity
3. High voltage insulators and spark plugs are made from ceramics due to _____.
   A. their electrical conductivity properties
   B. hardness and toughness
   C. compressive strength
   D. their high temperature capabilities
4. Although ceramics have been used by man for many centuries, until recently their applications have been limited _____.
   A. due to their manufacturing process
   B. because of their high cost
   C. for their brittleness
   D. by their mechanical properties
5. A nonmetallic material is generally used because of _____.
   A. the minimum cost
   B. the required strength, and other properties
   C. easy manufacturing
   D. all of the above

II. Complete each of the following sentences with one suitable word or phrase from the box.

agents	inferior	universal	distorted
enhance	resultant	mold	irreversible

1. Despite claims made by skincare manufacturers, the effects of aging are _____.
2. Newspaper readers are usually given a simplified and often _____ version of events.
3. The blast and _____ fire destroyed the whole building.
4. The method of scientific investigation has broken the _____ and led to a new discovery.
5. Personal computers are of _____ interest; everyone is learning how to use them.

6. The product that was produced did not sell well because it was _____.
7. Sulphur dioxide and carbon dioxide are two common chemical _____.
8. We're using technology to _____ our levels of service.

III. Translation (English to Chinese).

1. These lightweight materials used in shipbuilding reduce weight above the waterline, thus minimizing the tendency of the ship to roll in heavy seas.
2. Composites are engineering materials fabricated from two or more constituent materials (matrix and reinforcement), which remain separate and distinct while forming a new component.
3. The use of plastics to replace metal and other traditional materials is becoming a key strategy in many markets.
4. It is known that ceramic materials have the potential to achieve mechanical properties equal to or better than most metals.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording

1. From the standpoint of _____, however, an absolutely pure metal has never appealed to engineers.
2. Carbon is the most important _____, determining the mechanical properties by the adding percentage of carbon.
3. Among such a large number of metals and alloys, each type has a _____ of its own.
4. As far as engineering materials are concerned, both metals and alloys are _____ elements.
5. The mechanical strength is an important _____ in the tests of mechanical properties.
6. Mechanical properties are the _____ responses of a material to applied forces.
7. Strength is the _____ of a metal to resist applied forces.
8. Compression is the opposite of tension with _____ to the direction of the applied load.
9. When a force is applied to a material, it produces a _____ in the material.
10. Some metallic materials show elastic properties up to _____ high stresses, while others have little.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recoring.

Polymer can be broken into two words, *poly* and *mer*. *Poly* means "many" and *mer* means "unit". So a polymer is made up of _____1_____. In polymer science a unit is called a monomer

or one-unit. Monomers are chemical compounds that have the capacity to bond with other _____2_____ chemical compounds. The molecular weights of polymers therefore are _____3_____ large compared to other chemical compounds.

Polymer is an ever _____4_____ of engineering. This field covers _____5_____ of polymers, from chemical and physical analysis of the material to research of modifying current polymer materials for usage _____6_____. Polymer engineering is an important branch of engineering, when it comes to material _____7_____, as it provides knowledge regarding chemical nature of the substance to enable _____8_____ of this material. Since polymer has replaced many _____9_____ like woods and metals in various applications nowadays, moreover it is a broad field of studies with _____10_____ possible alteration in the material itself, polymer engineering is getting more important and prominent in engineering fields today.

III. Read aloud the following paragraph.

From the standpoint of commerce, however, an absolutely pure metal has never appealed to engineers, such as pure iron, which is too soft for machine parts. And of all these metallic elements, only a few are suitable for the engineering purpose. Cast iron and alloy are the most common metals in use. An alloy is a mixture of two or more metals. For example, steels are alloys of iron and carbon by adding one or more small amounts of the following elements: nickel, chromium, manganese, silicon, tungsten and so on.

IV. Answer the following questions in your own words.

1. What are often used as engineering materials?
2. Could you tell some uses of ceramic materials in engineering work?
3. How are mechanical properties described?

Part III Practical Writing

In this part you are required to write a letter for failing to accommodate customers' requests according to the following situation.

William 先生：您订购的50吨宝钢卷板Q235A 16*2500*8510，由于产品热销而供不应求，我们得知下次到货要在下月初。不过，Q345B 25*W*L(by Baotou Iron and Steel Company)有现货，且质量与价格都有优势。如有需要，我方可立即发货。

Dear Mr. William,

Thank you for your order for steel plate Q235A 16*2500*8510 _____

_____

_____

_____

Fortunately, we have Q235B 25*W*L _____

_____

_____

I look forward to your reply soon.

Sincerely,
Wang Hai
Sales Representative

Unit 4 Machine Elements

Part I Reading and Translating

Section A: Transmissions

4.1 Gear Drives

4.2 Belt Drives and Chain Drives

Exercises

Section B: Shafts and Other Components

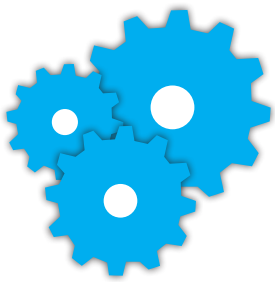
4.3 Shafts

4.4 Other Components

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Transmissions

Transmissions, shafts, bearings and other components are examples of machine elements that are used in a wide variety of different applications. Transmissions are set to reduce or increase a speed-torque to a suitable output; shafts, bearings and other components are also equipped in all kinds of machinery and mechanical devices.

Mechanical transmission systems are sets of mechanism arranged to transfer rotational torque from one part of a mechanical system to another. Usually, they are classified into gear driving, belt driving as well as train driving systems according to their features respectively.

4.1 Gear Drives

In a mechanical transmission system, gears as mechanical components are designed to transmit rotational force to other gears at different speeds, torques, or in different directions. According to their

construction and arrangement, gears of unequal diameters can be combined to produce a constant drive, so that the rotational speed and torque of the second gear are different from those of the first.

Gear drives are the most common of all types of drives. They are used for transmitting rotary motion from one shaft to another with teeth. The accurately shaped teeth mesh with the teeth of another gear to provide positive-motion drive. The different types of gear drives have been developed for different purposes as follows:

a. Spur and Helical Gears

If the shafts are parallel, three types of gears are provided for use, that is, spur, helical and herringbone gears. Spur gears are the simplest type. They are generally used on drives requiring moderate speeds to parallel axles (Fig. 4-1-4).

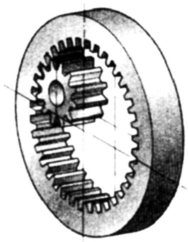


Fig. 4-1 Internal Gears

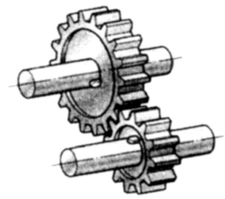


Fig. 4-2 Spur Gears

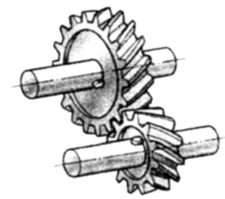


Fig. 4-3 Helical Gears

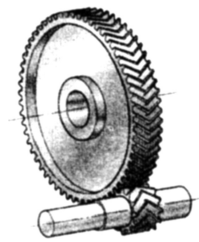


Fig. 4-4 Herringbone Gears

b. Bevel and Hypoid Gears

Bevel gears are used, when two shafts are at right angles to each other and their centerline extensions intersect. The transmission of power between them is served by the bevel gearing. However, some bevel gears are at angles other than 90 degrees. Hypoid gear is another kind of bevel spiral gear used for non-parallel and non-intersecting shaft axes, especially designed to operate with shafts at 90 degrees, as they were originally developed for rear-axle automobiles (Fig. 4-5-6)

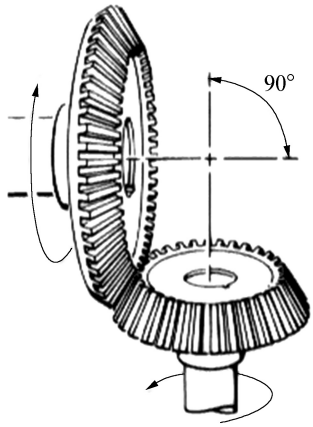


Fig. 4-5 Bevel Gears

Fig. 4-6 Hypoid Gears

c. Spiral and Spiral Bevel Gears

Spiral gears are capable of connecting two shafts that are nonparallel and nonintersecting; spiral bevel gears can be used as straight tooth bevel gears and higher speeds and quieter operation (Fig. 4-7-8).

d. Worm Gears

Gears of this type are used for crossed shafts usually at right angles. In operation, the worm turns the worm wheel, and the teeth on the worm mesh with the teeth of the worm wheel, thus producing a positive-motion drive. They are less noisy and vibration-sensitive than the other types of gear drives (Fig. 4-9).

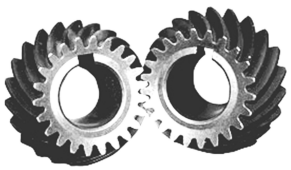


Fig. 4-7 Spiral Gears

Fig. 4-8 Spiral Bevel Gears

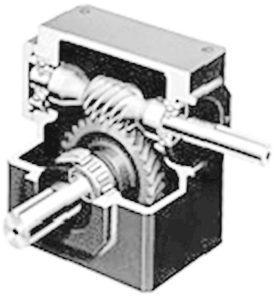


Fig. 4-9 Worm Gears

e. Rack and Pinion

A rack and pinion is a pair of gears which convert rotational motion into linear motion. The circular pinion engages teeth on a flat bar — the rack. Rotational motion applied to the pinion will cause the rack to move to the side, up to the limit of its travel (Fig. 4-10-11).

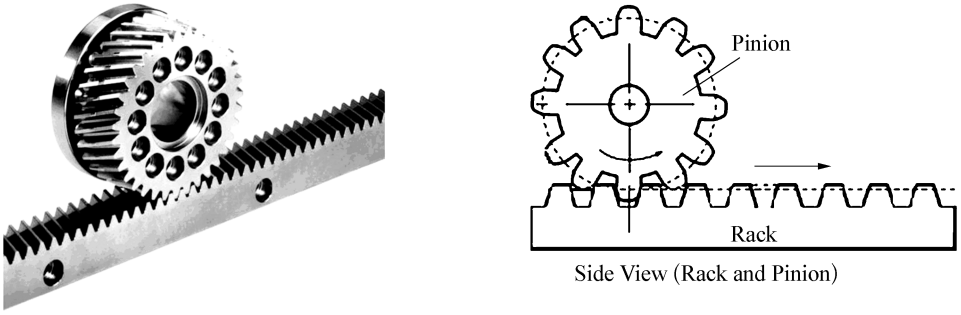


Fig. 4-10-11 A Rack and Pinion

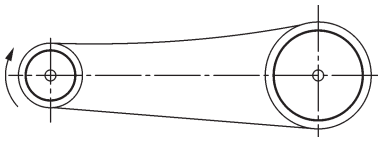
4.2 Belt Drives and Chain Drives

a. Belt Drives

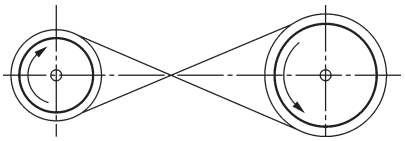
Belt drive is widely-used methods of transmitting power from one shaft to another with pulleys and belts. They are not only used for parallel shafts but for crossed shafts as well. And they also feature simple construction, silent operation, less vibration and shock transmission. When compared with gear driving and chain driving, they are likely to slip when overloads are applied, and they occupy more space and larger

center distance.

There are several typical belts for this kind of drive: open-belt, cross-belt, serpentine belt, and quarter-turn belts (Fig. 4-12-13). Two popular types of belts used for the drives are flat belt and V-belt (Fig. 4-14-15).

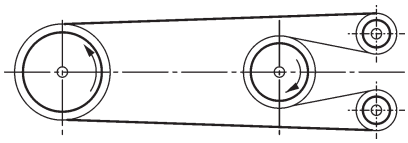


a. Open Driven

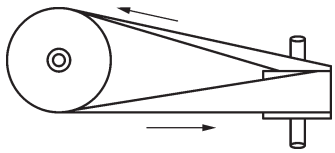


b. Cross Driven

Fig. 4-12 Open/ Cross Driving



c. Serpentine Driven



d. Quarter Driven

Fig. 4-13 Serpentine/Quarter Driving

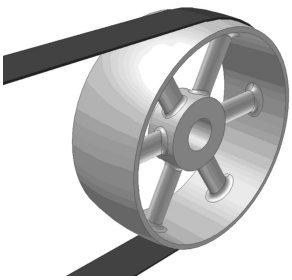


Fig. 4-14 Flat Belt

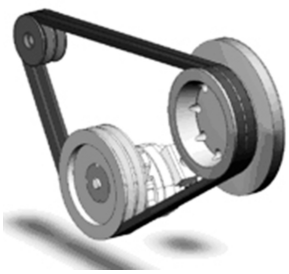
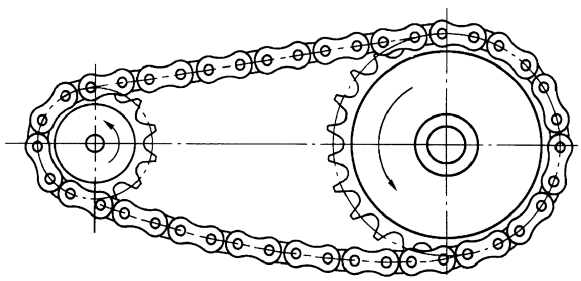


Fig. 4-15 V-belt

b. Chain Drives

Similar to the open-belt drives, chain drives are fit for parallel shafts at larger centre distances than those of gearing drives. With a chain connecting sprockets (wheels) on the driving and driven shafts, both the input and output rotation of shafts can be driven in the same direction or in the opposite direction. However, their velocity ratio transmitted from one shaft to another depends on the size of the two sprockets (Fig. 4-16-17). Although chain drives are distinguished by good efficiency and no slip (unlike belt drives), the contact between the chain and the tooth on the sprockets is often noisy.



Single
Steel

Double
Steel

Double
Cast Iron

Figs. 4-16-17 Chain Drives

New Words

1. **applicable** /'æplɪkəbl/ *a.* 可适用的；可应用的
   applicable to 适用于
2. **centerline** /'sentəlaɪn/ *n.* 中心线
3. **distinguish** /dɪs'tɪŋgwɪʃ/ *v.* 区别；辨别
4. **efficiency** /ɪ'fɪʃənsɪ/ *n.* 效率；功效
5. **extension** /ɪk'stenʃən/ *n.* 延长；扩充
6. **feature** /'fiːtʃə/ *n.* 特征；容貌；
   v. 是…的特色
7. **intersect** /ˌɪntə'sekt/ *v.* 横断；相交
8. **mesh** /meʃ/ *v.* 啮合；相啮合
9. **moderate** /'mɒdərɪt/ *a.* 中等的；适度的
10. **occupy** /'ɒkjʊpaɪ/ *v.* 占用；占领
11. **opposite** /'ɒpəzɪt/ *a.* 对面的；相反的
12. **overload** /'əʊvə'ləʊd/ *v.* 使超载；*n.* 超载
13. **shock** /ʃɒk/ *v.* 震动； *n.* 打击；震惊
14. **similar** /'sɪmɪlə/ *a.* 相似的；类似的
    similar to 与…相似
15. **slip** /slɪp/ *n.*/ *v.* 滑倒；滑动
16. **torque** /tɔːk/ *n.* 力矩；扭转力
17. **velocity** /və'lɒsɪtɪ/ *n.* 速度，速率
18. **vibration** /vaɪ'breɪʃən/ *n.* 振动；摇动

Technical Expressions

1. **bevel gear** 斜齿轮；锥齿轮
2. **cross-belt drive** 交叉式皮带驱动
3. **flat belt** 平皮带
4. **gear** 齿轮；传动装置
5. **helical gear** 螺旋状齿轮
6. **herringbone gear** 人字形齿轮
7. **hypoid gear** 准双曲面齿轮
8. **open-belt drive** 开式皮带传动
9. **pulley** 滑轮；皮带轮
10. **quarter-turn belt drive** 直角挂轮皮带驱动
11. **serpentine belt drive** 蛇形皮带驱动
12. **shaft** 轴；杆状物
13. **spiral gear** 螺旋齿轮
14. **sprocket** 链齿轮
15. **spur gear** 正齿轮
16. **V-belt** V-皮形带；三角带
17. **worm wheel** 蜗轮
18. **worm** 蜗杆；螺纹

Notes

1. According to their construction and arrangement, gears of unequal diameters can be combined to produce a constant drive, so that the rotational speed and torque of the second gear are different from those of the first.
   根据其结构及设置，直径不等的齿轮可以通过组合，产生恒定的传动比，以使得后一个传动装置获得不同于前一个齿轮的转速及扭力。
   so that the rotational speed and torque ... 引导的是一个结果状语从句，意思是“以使得…”。

2. Bevel gears are used, when two shafts are at right angles to each other and their centerline extensions intersect.
   当两轴相互垂直且与中心线的延长线相交，则采用锥齿轮。

3. Spiral gears are capable of connecting two shafts that are nonparallel and nonintersecting.
   螺旋齿轮能够连接两个既不平行也不相交的轴。

4. In operation, the worm turns the worm wheel, and the teeth on the worm mesh with the teeth of the worm wheel, thus producing a positive-motion drive.
蜗杆在工作时带动蜗轮，杆齿与轮齿相互咬合，由此产生无滑动运动的驱动。

5. And they also feature simple construction, silent operation, less vibration and shock transmission.
它们还具有结构简单、工作噪声小、传动更加稳定的特点。

6. When compared with gear driving and chain driving, they are likely to slip when overloads are applied, and they occupy more space and larger center distance.
与齿轮传动及链传动相比，当其负载过大时，皮带就有可能打滑，此外，它们所占用的空间更多，中心距离也更长。

7. Similar to the open-belt drives, chain drives are fit for parallel shafts at larger center distances than those of gearing drives.
与开式传动类似，链式传动比齿轮传动占据更大中心距离，适用于两根平行轴间的传动。

8. With a chain connecting sprockets (wheels) on the driving and driven shafts, both the input and output rotation of shafts can be driven in the same direction or in the opposite direction.
由一条链子将驱动轴与从动轴上的链轮连接在一起，轴与轴间输入与输出的转动方向可以是相同的，也可以是相反的。

9. However, their velocity ratio transmitted from one shaft to another depends on the size of the two sprockets.
然而，轴与轴间的传动速比是根据两个链轮的大小来确定的。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. Spur gears are the simplest and most expensive type used on drives requiring moderate speeds.
2. Some bevel gears are at angles larger than 90 degrees.
3. Spiral gears are used for connecting two shafts nonparallel and nonintersecting.
4. The worm turns the worm wheel and the teeth on the worm mesh with the teeth of the worm wheel so as to provide a positive-motion drive.
5. Belt drives are used only for parallel shafts which are unfit for crossed shafts.
6. Compared with gear driving, belt drives are likely to slip when overloaded.
7. Like the open-belt drives, both the input and output rotation of shafts are always driven in the same direction.
8. We can distinguish chain drives from belt drives by good efficiency and no slip.

II. Match the items listed in the following columns.

1. precision	a. an excessive load
2. moderate	b. a heavy blow
3. applicable	c. to fill up
4. overload	d. alike though not identical
5. shock	e. to perceive or indicate differences
6. occupy	f. contrary to another
7. similar	g. the ratio of the effective or useful output
8. opposite	h. exactness
9. distinguish	i. of medium or average quantity or extent
10. efficiency	j. appropriate

III. Fill in each blank with a proper word beginning with the letter given.

Cams

Cams are widely used 1. e_____ in mechanisms. Driven by a motor, a cam can change 2. c_____ motion into reciprocating motion.

Technically, a cam is designed and manufactured for specific purposes. Although the cams are quite different in 3. s_____ and types, all of them work in a 4. s_____ way. As in the 5. c_____ of plate cam, when the cam on the shaft is rotated and 6. t_____, the follower is driven to move 7. t_____ two strokes (BDC* to TDC* and TDC to BDC). The follower is connected to 8. o_____ parts on the machine to complete a desired action. The direction of the follower 9. d_____ on the position of the framework. If the follower loses 10. c_____ with the cam, it will fail to work.

* BDC (bottom dead center) 下死点
* TDC (top dead center) 上死点

IV. Translation (Chinese to English).

1. 同样的考虑也适用于斜齿轮的设计与制造上。**(applicable to)**
2. 从某种意义上讲，链驱动与皮带驱动基本相类似。**(similar to)**
3. 我们完全可以将两种设计的风格区分开来。**(distinguish)**
4. 这种设计的效果和预期的正相反。**(opposite to)**

Section B: Shafts and Other Components

4.3 Shafts

Shafts usually refer to those relatively long elements of round cross section. They are used for the receiving and transmission of rotary motion and are subjected to torsion, bending, or a combination of the two.

Among various shafts, we classify them into crank and straight shafts, which are either solid or hollow in shape. Hollow shafts are more expensive and weigh relatively less than solid shafts, but their strength is comparably similar. Fig.4-18 shows the typical shafts.

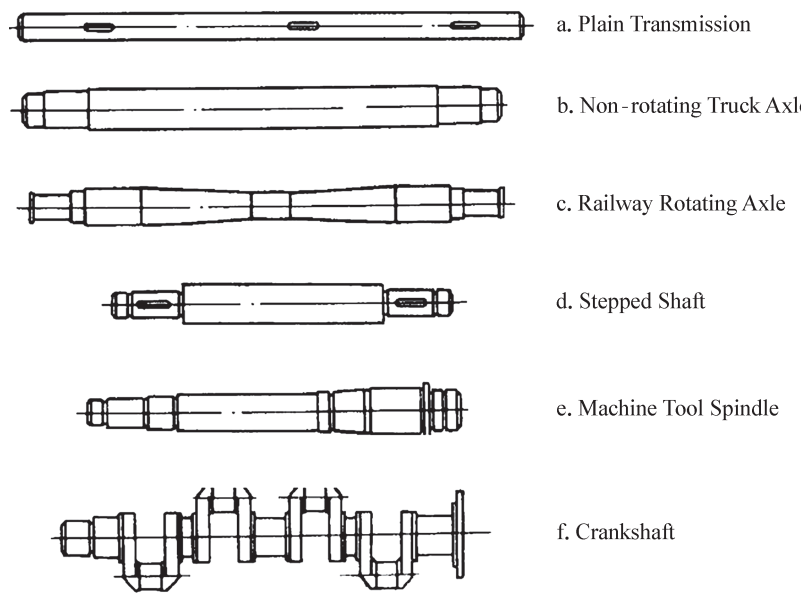


Fig. 4-18 Typical Shafts

Rolling Bearings

In the family of bearings, either the rolling bearings or the sliding bearings have their own advantages, but none of them can satisfy all the requirements. However, which is better suitable for use depends on their respective characteristics in a particular case of application. As in the case of rolling bearings, they are almost maintenance-free, less heat producing, and must be provided with adequate mounting, lubrication and sealing.

A rolling bearing consists of two rings (inner and outer ring), the rolling bodies (balls, rollers, barrels or needles), and separator. The roller runs in grooves of the rings, the bearings adjust themselves to small amount of angular misalignment in the assembled shaft and the separator keeps the roller evenly spaced and prevents them from touching each other. Fig. 4-19 shows the structures of different types of rolling bearings.

a. Ball Bearing b. Roller Bearing c. Needle Bearing d. L-MPL201 Bearing

Fig. 4-19

4.4 Other Components

Other fundamental machine elements have been evolved for applications in specific construction. They are clutches, springs, couplings, shaft accessories and so on.

A clutch is a device for quickly and easily connecting or disconnecting a rotary shaft with coaxial shaft (Fig. 4-20).

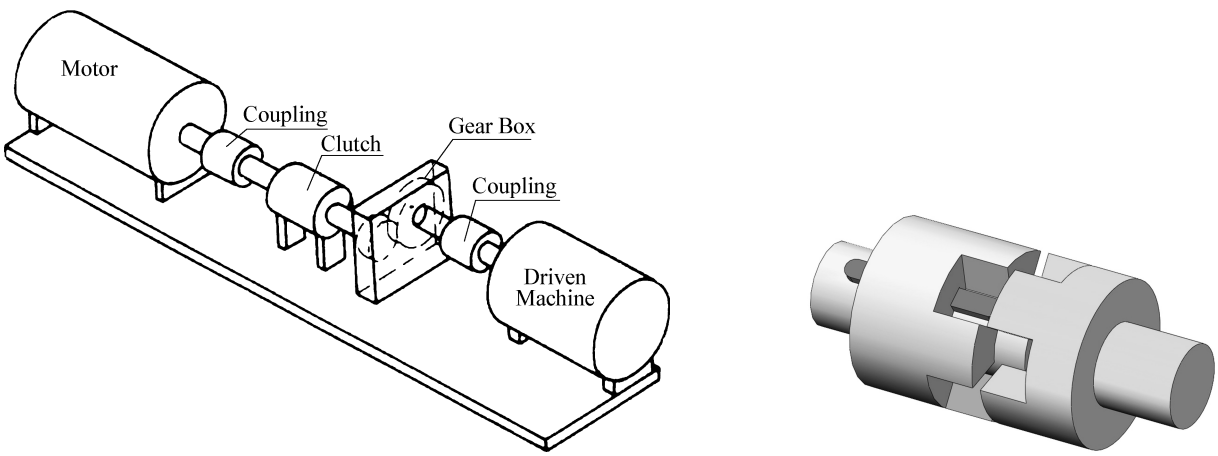


Fig. 4-20-21 A Clutch Device

Springs are load-sensitive, energy-storing devices which are useful for various purposes. They deform under an external force and return to their initial state when the load is removed.

A coupling is a connecting mechanical element for transmitting torque, which serves permanent or semi-permanent connection between the ends of adjacent rotary shafts (Fig. 4-22).

Shaft accessories include keys, splines and pins. Their main function is to restrain relative rotational movement.

Fig. 4-22 Couplings

New Words

1. adjacent /ə'dʒeɪsənt/ *a.* 邻近的；接近的
2. advantage /əd'vɑ:ntɪdʒ/ *n.* 优势；有利条件
3. bend /bend/ *v.* 弯曲；屈服
4. characteristic /ˌkærɪktə'rɪstɪk/ *a.* 特有的；典型的；*n.* 特性；特征
5. combination /ˌkɒmbɪ'neɪʃən/ *n.* 结合；合并
6. crank /kræŋk/ *n.* 曲柄
7. deform /dɪ'fɔ:m/ *v.* （使）变形
8. evolve /ɪ'vɒlv/ *v.* （使）发展；（使）进化
9. external /eks'tɜ:nl/ *a.* 外部的； *n.* 外部
10. fundamental /ˌfʌndə'mentl/ *a.* 基础的；*n.* 基本原则
11. groove /gru:v/ *n.* 凹槽； *v.* 开槽于
12. hollow /'hɒləʊ/ *a.* 空的；凹的； *n.* 洞；窟窿
13. initial /ɪ'nɪʃəl/ *a.* 最初的； *n.* 词首大写字母
14. lubrication /ˌlu:brɪ'keɪʃən/ *n.* 润滑油
15. misalignment /'mɪsəlaɪnmənt/ *n.* 未对准
16. mount /maʊnt/ *v.* 安装；镶嵌
17. respective /rɪs'pektɪv/ *a.* 分别的；各自的
18. rolling /'rəʊlɪŋ/ *a.* 滚动的，转动的
19. seal /si:l/ *v.* 密封
20. semi-permanent /ˌsemɪ'pɜ:mənənt/ *a.* 非永久（性）的；暂时的
21. solid /'sɒlɪd/ *a.* 实心的；固体的；*n.* 固体；立体
22. subject /'sʌbdʒɪkt/ *v.* 使屈从于…
    subject to 使服从；使遭受
23. torsion /'tɔ:ʃən/ *n.* 扭转；转矩

Technical Expressions

1. ball bearing 球轴承
2. barrel bearing 圆柱轴承
3. bearing 轴承
4. clutch 离合器
5. coaxial shaft 同心轴
6. coupling 联轴器
7. crankshaft 曲轴
8. key 键
9. machine tool spindle 机床轴
10. needle bearing 滚针轴承
11. non-rotating truck axle 非旋转转向架轴
12. pin 销
13. plain transmission 普通轴
14. railway rotating axle 轨道旋转轴
15. roller bearing 滚柱轴承
16. rolling bearing 滚动轴承
17. shaft accessories 轴的附件
18. sliding bearing 滑动轴承
19. spline 花键
20. spring 弹簧
21. stepped shaft 级形轴

Notes

1. They are used for the receiving and transmission of rotary motion and are subjected to torsion, bending, or a combination of the two.
   它们用来接受及传递旋转运动并承受扭转应力和弯曲应力或这两种的合力。

2. As in the case of rolling bearings, they are almost maintenance-free, less heat producing, and must be provided with adequate mounting, lubrication and sealing.

以滚动轴承为例，它们几乎是免维护，不易发热，还必须满足安装、润滑和密封要求。

3. The roller runs in grooves of the rings, the bearings adjust themselves to small amount of angular misalignment in the assembled shaft.
滚珠在轴套圈中滑动，轴承对轴与支座之间出现的少量角度误差会自行进行调整。

4. ... and the separator *keeps the rollers evenly spaced* and prevents them from touching each other.
… 隔离支架将滚珠均匀地分隔开来以防止滚珠间相互接触。
keeps the rollers evenly spaced 是动词加宾语加宾补的句型，evenly spaced 过去分词短语作宾语 the rollers 的补语。

5. Springs are load sensitive, energy storing devices which are useful for various purposes.
弹簧是对载荷敏感、可储存能量的零件, 其用途非常广泛。

6. They deform under an external force and return to their initial state when the load is removed.
它们受力而变形，卸压后又恢复到初始状态。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. Although a hollow shaft is somewhat more expensive, it weighs _____ a solid shaft of comparable strength.
   A. considerably less than　　B. much more of
   C. absolutely less than　　D. as much as
2. Compared to sliding bearings, ball bearings have the advantage of _____.
   A. small evolution of heat for same load　　B. simple and almost maintenance-free
   C. permanent lubrication　　D. both A and B
3. Which of the following statements is **TRUE** according to the text?
   A. The self-aligning ball bearings will take care of large amount of angular misalignment.
   B. The bearings adjust themselves to a lot of angular misalignment in the assembled shafts.
   C. A bearing can adjust itself to large amount of angular misalignment in the assembled shaft.
   D. Bearings can not be adjusted to a small amount of angular misalignment in the assembled shaft.
4. Which of the following statements is **NOT TRUE** according to the text?
   A. Springs change their forms under an internal force and return to their initial state when the load is removed.
   B. The chief characteristics of a spring are the ability to stand large deflections without failure and to recover its initial size and shape when the load is removed.
   C. A spring deforms under an external force and returns to their initial state when the load is removed.

D. Springs are of the components which can largely change their sizes and shapes without failure and return to their initial state when the load is removed.

5. For what purpose does a coupling mainly serve in machine construction?
   A. To minimize the harmful effects of shaft misalignment.
   B. To effect a permanent connection between adjacent rotating shafts.
   C. To connect the ends of adjacent shafts.
   D. To reduce the intensity of shock load from one shaft to another.

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

subjected to	applicable to	similar to	opposite	adjust ... to
distinguish ... from	feature	evolve	mesh	classify

1. According to shapes of shafts, we _____ the crankshafts _____ the usual straight shafts.
2. Axles are _____ the support of stationary, rotating machine parts, but do not transmit any torque.
3. Shafts for transmitting torque are _____ twisting and bending.
4. If the workbench is too high, you can _____ it _____ suit you.
5. Chain drives are _____ gear drives, both types transmit a positive velocity ratio.
6. If you want to go to the machine shop, you should be walking in the _____ direction.
7. When two gears _____, the pitch circles must be exactly tangent if the gears are to function properly.
8. Although manufacturing industries continued to _____, it was not until the 1950s that the next major development occurred.
9. It's an Australian company whose logo _____ a red Kangaroo.
10. Shafts _____ according to their shapes and functions.

III. Translation (English to Chinese).

1. Permanent couplings are referred simply as coupling while those, which may be readily engaged to transmit power, or disengaged when desired, usually are called clutches.
2. Spur gears are used to transmit rotary motion between parallel shafts; they are usually cylindrical, and the teeth are straight and parallel to the axis of rotation.
3. Flexible shafts can be bent to small radii without being overstressed.
4. Clutches are usually mounted between the input to a machine and output shaft from the driving motor, for starting and stopping the machine and permitting the driver or engine to be started in an unloaded state.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. The column and base, made from cast iron, _____ the foundation of the complete machine.
2. The saddle has dovetail guide-ways, to provide a _____ to the table in a longitudinal direction.
3. Gear drives are the most _____ of all types of drives, used for transmitting rotary motion from one shaft to another with teeth.
4. If the shafts are parallel, three types of gears are _____ for use, such as spur, helical and herringbone gears.
5. Hypoid gears are used for non-parallel and non-intersecting shaft axes, and they were originally _____ for rear-axle automobiles.
6. Belt drive is a _____ method of transmitting power from one shaft to another with pulleys and belts.
7. Two _____ types of belts used for the drives are flat belt and V-belt.
8. With a chain connecting the driving and driven shafts, both the input and output rotation can be _____ in the same direction or in opposite direction.
9. Machine tools that have the capability of _____ in two or more axes are classified as continuous path.
10. A closed-loop system _____ the actual output with input signal and compensates for any errors.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

Gear drives are the most common of all types of ___1___. They are used for transmitting rotary ___2___ from one shaft to another with ___3___. The different types of gear drives ___4___ developed for different purposes. ___5___ drive is a widely used method of transmitting ___6___ from one shaft to another with pulleys and belts. They are ___7___ used for parallel shafts but for crossed shafts as well, and they also ___8___ simple construction, silent operation, less vibration and shock transmission. When compared with gear driving and chain driving, they are ___9___ to slip when overloads are applied, and they ___10___ more space and larger center distance.

III. Read aloud the following paragraph.

In the family of bearings, either the rolling bearings or the sliding bearings have their own advantages, but none of them can satisfy all the requirements. However, which is better suitable for use depends on their respective characteristics in a particular case of application. As in the case of rolling

bearings, they are almost maintenance-free, less heat producing, and must be provided with adequate mounting, lubrication and sealing.

IV. Tell the uses of the following machine elements as many as possible in your own words.

a

b

c

Part III Practical Writing

In this part, you are required to complete an Email according to the following information.

A. Sunfloweraaa@tech.com
B. J. M. xl, co. @bs.cn
C. Order for spur gears
D. Monday, Sept. 18th
E. All the Best
F. Dear Mr. Ho

From: ___1___

Date: ___3___

To: ___2___

Subject: ___4___

___5___,

We are interested in your mechanical products, especially components such as spur gears, bearings, spring, shafts and other accessories. Would you please send us a brochure and price list of your products?

Xing Long Company is a special retail business for machine elements and has arranged the business over 30 years in Shanghai. Our sales network has extended to many other countries in Asia. Would you consider us as your representative in Asia-Pacific Region?

We are looking forward to your response.

___6___,

Jing Mee

Sales Manager

Unit 5

Hydraulic Drive

Part I Reading and Translating

Section A: Pumps and Actuators

5.1 Hydraulic Pumps

5.2 Hydraulic Actuators

Exercises

Section B: Valves and Basic Hydraulic Circuits

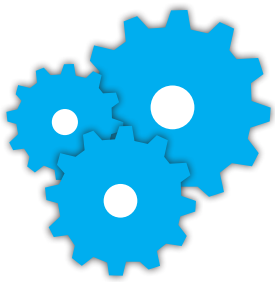
5.3 Control Valves

5.4 Basic Hydraulic Circuits

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Pumps and Actuators

China is a country with a large population and one of the world's oldest civilizations with nearly 5,000 years of continuous history. Among the technological accomplishments of ancient China, the use of hydraulic drive system in Chinese history dates from the beginning of grain cultivation. The early greatest inventions used on farming may be water-powered mills, water-powered trip hammers — the first hydraulic transmission systems.

Hydraulic drive systems make use of pressurized hydraulic fluid to drive mechanical load. A hydraulic drive system involves four basic groups of elements, and each group performs a specific function such as the generation, actuation, and control of pressure and flow and so on. They are the power source (pumps), actuators (hydraulic motor or hydraulic cylinder), control unit (valves) and some other ancillary elements.

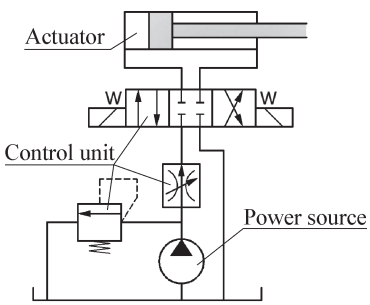


Fig. 5-1 Hydraulic drive system

5.1 Hydraulic Pumps

A pump is a device for the conversion of mechanical energy into hydraulic power. In this sense, a hydraulic pump supplies fluid power flow to develop fluid pressure by an electric motor or an engine. Common types of hydraulic pumps are: gear pumps, vane pumps and piston pumps.

a. Gear Pumps

A gear pump is fixed displacement, for it pumps a constant amount of fluid for every revolution. All gear pumps fall into external gear pumps and internal gear pumps according to the different meshing.

In an external gear pump shown in Fig.5-2-3, two inter-meshing gears of the same diameter and form are mounted on separate spindles and housed in a close fitting casing. Inlet and outlet ports are formed directly in the sides. Pumps of this type have the advantages of high speed, high pressure, no overhung bearing loads, and relatively quiet operation, and they are often used as lubrication pumps in machine tools, in fluid power transfer units, and as oil pumps in engines.

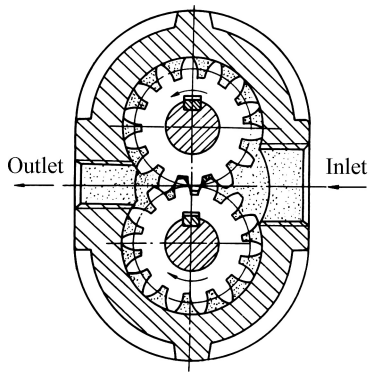


Fig. 5-2 External Gear Pump

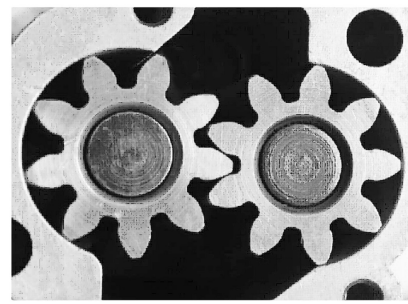


Fig. 5-3

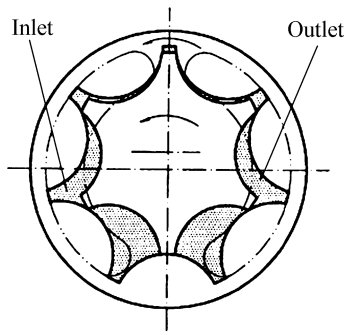


Fig. 5-4 Internal Gear Pump

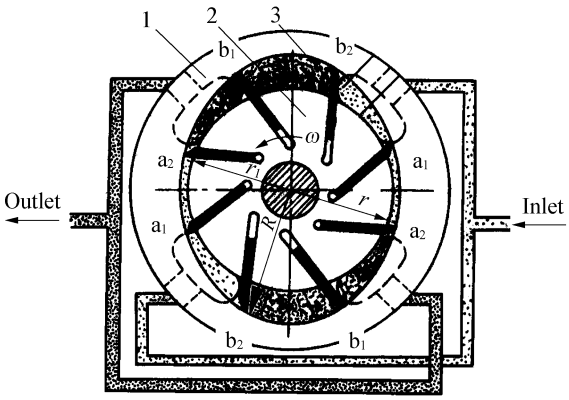
Fig. 5-5

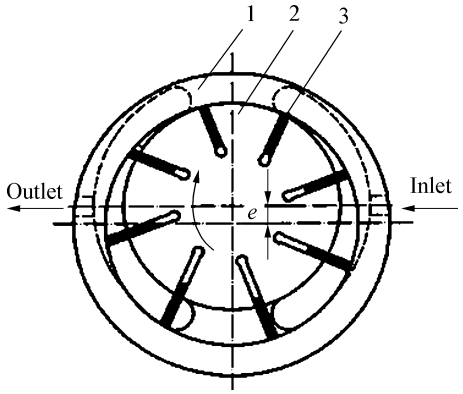
In an internal gear pump shown in Fig.5-4-5, a (small) gear is located within an inter gear ring. Pumps of this type perform better at lower speeds and with higher viscosity fluids than external gear pumps.

Gear pumps are cheap, durable and simple, but less efficient, and mainly suitable for pressures below 200 bar.

b. Vane Pumps

There are two kinds of vane pumps — fixed capacity vane and variable capacity vane pumps. A vane pump mainly includes cam ring, rotor and vanes, as shown in Fig.5-6-7. The major advantages of vane pumps are compact design, reliable operation, uniform flow, and low need for maintenance.





(1-cam ring 2-rotor 3-vane)

Fig. 5-6 Fixed Capacity Vane

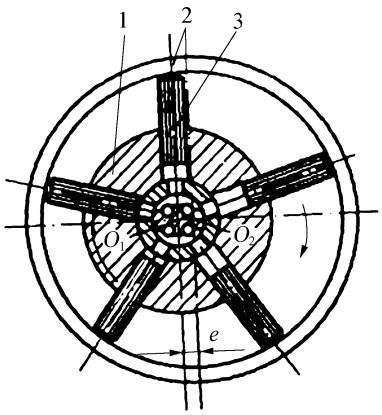
Fig. 5-7 Variable Capacity Vane Pump

Common uses of vane pumps are high pressure hydraulic pumps and automotive uses including supercharging, power steering and automatic transmission pumps.

c. Piston Pumps

Piston pumps are classified into radial piston pump and axial piston pump, as shown in Fig.5-8-9.

Radial piston pumps include pistons, rotor (cylinder body) and cam ring, and they are used especially for high pressure and relatively small flow area. A radial piston pump has found its main applications in aircraft and marine industry.



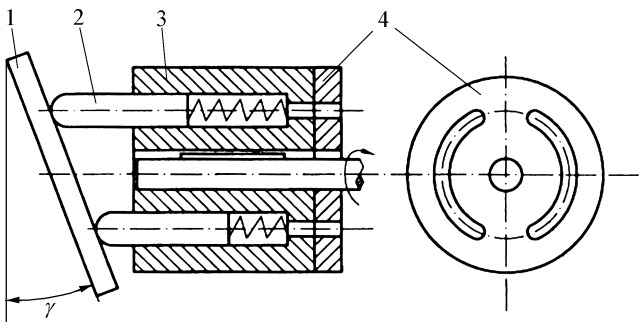


Fig. 5-8 Radial Piston Pumps
(1-rotor 2-cam ring 3-piston)

Fig. 5-9 Axial Piston Pump
(1-wobble plate 2-piston 3-cylinder body 4-valve plate)

Axial piston pumps mainly consist of piston, cylinder body, valve plate, wobble plate and so on. They have the advantages of being more compact in design, easier and more economical to manufacture; the disadvantage is that they are more sensitive to oil contamination. Pumps of this type are used in general industrial hydraulics.

Comparatively, piston pumps are more expensive than gear or vane pumps, but they provide longer life operating at higher pressure.

5.2 Hydraulic Actuators

Hydraulic actuators are used to convert hydraulic power to usable mechanical power output where required. The main components of a hydraulic actuator include hydraulic cylinders and hydraulic motors. Hydraulic cylinders (Fig.5-10-11) are the standard forms for linear actuators, as they each are used to give a linear force through a linear stroke; and hydraulic motors (Fig.5-12-13) are also the standard forms for rotating actuators, which convert the energy of pressurized liquid flow into mechanical motion.

Fig.5-10 Symbol of Hydraulic Cylinders

Fig.5-11 A Hydraulic Cylinder

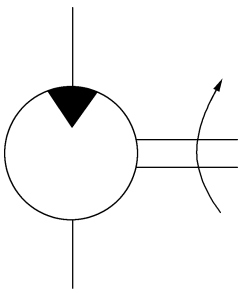


Fig.5-12 Symbol of Hydraulic Motors

Fig.5-13 A Hydraulic Motor

New Words

1. **aircraft** /'eəkrɑ:ft/ *n.* 航空器；飞行器
2. **ancillary** /æn'sɪlərɪ/ *a.* 辅助的；附属的
3. **capacity** /kə'pæsɪtɪ/ *n.* 容量; 负载量
4. **convert** /kən'vɜ:t/ *v.* 转换；把…改变为
5. **cultivation** /ˌkʌltɪ'veɪʃən/ *n.* 耕种；栽培
6. **date** /deɪt/ *v.* 源于…的年代；相约
7. **displacement** /dɪs'pleɪsmənt/ *n.* 位移; 排量
8. **hydraulic** /haɪ'drɔ:lɪk/ *a.* 液压的；水力的
9. **linear** /'lɪnɪə/ *a.* 线性的；长度的
10. **marine** /mə'ri:n/ *a.* 海的; 海军的

11. **reliable** /rɪ'laɪəbl/ *a.* 可靠的；可信赖的
12. **supercharging** /'sju:pətʃɑ:dʒɪŋ/ *n.* 增压(作用)
13. **symbol** /'sɪmbəl/ *n.* 符号；标志
14. **vary** /'veərɪ/ *v.* 改变; 变换
15. **viscosity** /vɪs'kɒsɪtɪ/ *n.* 黏稠; 黏性
16. **watermill** /'wɔtəˌmɪl/ *n.* 水力磨

Technical Expressions

1. **axial piston pump** 轴向活塞泵
2. **cam ring** 凸轮环，滑盘，定子
3. **external gear pump** 外啮合齿轮泵
4. **gear pump** 齿轮泵
5. **hydraulic actuator** 液压执行元件
6. **hydraulic brake** 液压制动器
7. **hydraulic cylinder** 液压缸
8. **hydraulic motor** 液压马达
9. **hydraulic transmission system** 液压传动系统
10. **internal gear pump** 内啮合齿轮泵
11. **light-viscosity silicone oil** 低粘度硅油
12. **piston pump** 柱塞泵
13. **power steering** 动力转向器
14. **pump** 泵；打气筒
15. **radial piston pump** 径向柱塞泵
16. **rotor** 转子
17. **valve** 阀；活门
18. **vane pump** 叶片泵
19. **vane** 轮叶，叶片

Notes

1. Hydraulic drive systems make use of pressurized hydraulic fluid to drive mechanical load.
液压传动系统是利用流体的压力来驱动机械负载。

2. A hydraulic drive system involves four basic groups of elements, and each group performs a specific function such as the generation, actuation, and control of pressure and flow, and so on.
液压传动系统由四组基本元件组成，每个元件在系统中承担其特定的功能，如：提供动力、驱动和控制压力及流量等。

3. In this sense, a hydraulic pump supplies fluid power flow to develop fluid pressure by an electric motor or an engine.
从这个意义上讲，液压泵利用电动机或发动机来提供液压流，以产生流体压力。

4. A gear pump is fixed displacement, for it pumps a constant amount of fluid for every revolution.
齿轮泵属于定量泵，因为它每转抽出的液体量是不变的。

5. In an external gear pump shown in Fig.5-2, two inter-meshing gears of the same diameter and form are mounted on separate spindles and housed in a close fitting casing.
如图5-2所示，在外啮合齿轮泵上，密闭的泵体内有两个安装在不同轴上的形状相同、尺寸相等的

相互啮合的齿轮。

6. Pumps of this type perform better at lower speeds and with higher viscosity fluids than external gear pumps.
这类泵在较低的速度和较高的流体粘度条件下比外啮合齿轮泵性能更好。

7. Axial piston pumps mainly consist of piston, cylinder body, valve plate, wobble plate and so on.
轴向柱塞泵主要由柱塞、缸体、配油盘和斜盘等组成。

8. Hydraulic actuators are used to convert hydraulic power to usable mechanical power output where required.
液压执行元件是用来将液压能转换成所需要的、可用机械能输出的装置。

9. Hydraulic cylinders are the standard forms for linear actuators, as they each are used to give a linear force through a linear stroke; and hydraulic motors are also the standard forms for rotating actuators, which convert the energy of pressurized liquid flow into mechanical motion.
液压缸是标准线性执行元件，它们通过直线冲程运动提供线性力。而液压马达则属标准旋转运动的执行元件, 用于将液压能转换成机械运动。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. The watermill, the first hydraulic motor, may be an early invention in the world.
2. The ways of classifying elements may be different, but selecting the four basic groups forms a convenient structure for the definition of hydraulic control systems.
3. Hydraulic machinery is machines and tools with fluid power flow to do work.
4. Axial piston pump is made with a constant displacement mechanism, to vary output flow for automatic control of pressure.
5. Radial piston pumps are normally used for very high pressure at small flows.
6. Piston pumps can provide longer life operating at higher pressure, with different fluids and longer continuous duty cycles.
7. Piston pumps make up most of a hydrostatic transmission, because they are cheap, simple and reliable.
8. Hydraulic cylinders are pressurized by hydraulic pressure and get their power for the hydraulic fluid under pressure. They transform the oil's energy to linear work.

II. Match the items listed in the following columns.

1. hydraulic	a. relating to the sea and the creatures living there
2. cultivation	b. to change something to make it different
3. ancillary	c. something you can trust
4. symbol	d. a liquid that does not flow easily
5. linear	e. the amount of liquid a container can hold
6. capacity	f. in the form of a straight line
7. viscosity	g. a picture that has a particular meaning
8. reliable	h. additional
9. vary	i. the planting and growing of plants and crops
10. marine	j. operated by the pressure of water or liquid

III. Fill in each blank with a proper word beginning with the letter given.

Hydraulic Brake

When the brake pedal is 1. p_____, a multiplied force is generated from the pedal to a vacuum booster. The booster multiplies the force 2. a_____. Then, the force is 3. a_____ to a piston in the master cylinder and pressure in the hydraulic system increases, forcing fluid 4. t_____ the lines to the slave cylinders.

The slave cylinders include a 5. p_____ of opposed pistons which are forced 6. a_____ by the fluid pressure (drum brake), and a single piston which is 7. f_____ out of its housing (disc brake).

The slave cylinder pistons 8. t_____ apply force to the brake linings. The force applied to the linings causes them to be pushed 9. a_____ the drums and rotors. The friction 10. b_____ the linings and drum/rotor causes a braking torque to be generated, slowing the vehicle.

IV. Translation (Chinese to English).

1. 该厂的年度奖金根据技术水平和产量高低而有所不同。**(vary according to)**
2. 液能的使用自古以来就有。**(date from)**
3. 这个国家的制造业中妇女人口的比例只占一小部分。**(make up)**

Section B: Valves and Basic Hydraulic Circuits

Except pumps and actuators, other basic groups of hydraulic power transmission are concerned with the control valves and hydraulic circuits. Valves are designed to control the direction of pump-flow, the power level, and the amount of fluid-flow to the actuators. The power level is determined by controlling both the flow and pressure level. The hydraulic circuit refers to the path through which the fluid flows to the actuator, then returns to the tank.

5.3 Control Valves

Control valves mainly include three categories by function: (1) directional-control valves; (2) pressure-control valves; and (3) flow-control valves.

a. Directional-control Valves

Directional-control valves determine the routing of the fluid in a circuit. There are two kinds: non-return valve and directional-change valve.

Non-return valves are used in circuits, or combined in the body of other valves, to provide flow in one direction only. The simplest type is the spring-loaded ball valve. Its symbol is shown in Fig.5-14.

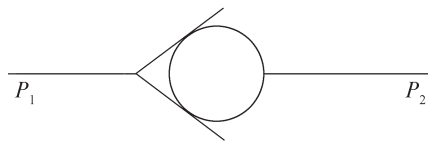


Fig.5-14 Symbol of Non-return Valve

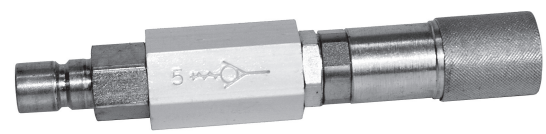


Fig.5-15 A Non-return Valve

Directional-change valves are usually spool valves. It has many types, such as two-position two-way, or three-position four-way magnetic directional-change valve. A typical symbol of directional-change valve is shown in Fig.5-16.

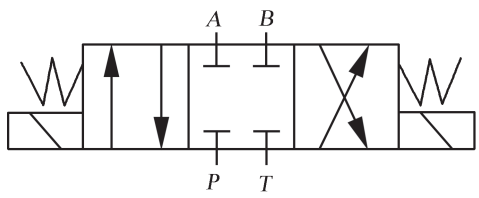


Fig.5-16 Symbol of Directional-change Valve

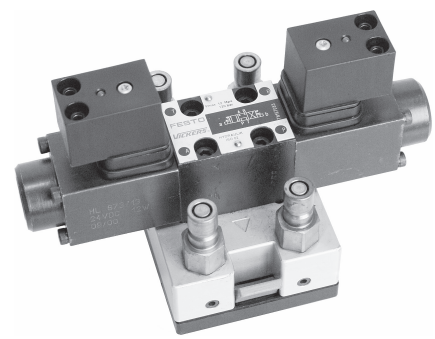


Fig.5-17 A Directional-change Valve

b. Pressure-control Valves

The common types of pressure-control valves mainly include three categories: (1) pressure release valves (also called relief valves); (2) pressure-reducing valves; and (3) sequence valves. Symbols of these three valves are shown as Fig.5-18~5-20.

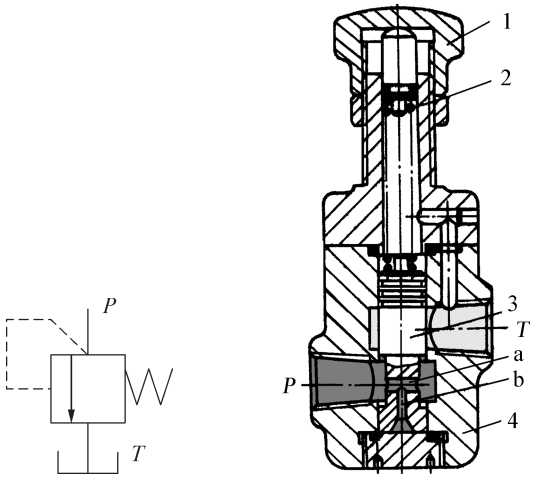


Fig.5-18 Symbol of Pressure Release Valves (direct)

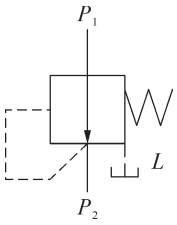


Fig.5-19 Symbol of Pressure-reducing Valves (preminded)

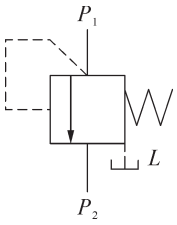


Fig.5-20 Symbol of Sequence Valves (direct)

The relief valve is set to open at a predetermined pressure to protect pressure vessels and other equipment from exceeding their design limits. **Pressure reducing valves** reduce the supply pressure as needed for various circuits. And **sequence valves** control the sequence of hydraulic circuits, to ensure that one hydraulic cylinder is fully extended before another starts its stroke.

c. Flow-control Valves

Simple flow-control valves work on the basis of restricting the flow with either a fixed or variable orifice. They mainly include two kinds: throttle valve and governor valve. The symbols of them are shown in Fig.5-21 and Fig.5-23.

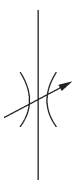


Fig.5-21 Symbol of Throttle Valves

Fig.5-22 A Throttle Valve

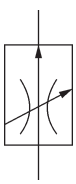


Fig.5-23 Symbol of Governor Valves

Throttle valves regulate the flow of a fluid, which are commonly used in throttling speed control system. While governor valves are suitable for high speed-load of actuators and speed steadiness of control systems.

5.4 Basic Hydraulic Circuits

The aim of hydraulic-circuit design is to carry out the functions of which the system is required. The following are flow controlling circuits and pressure controlling circuits. They are shown in Fig.5-24 and Fig.5-25.

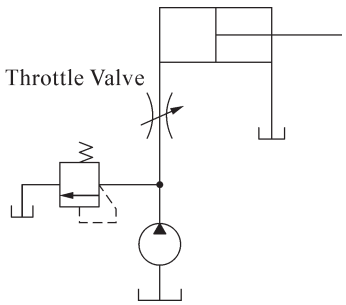


Fig.5-24 Flow Controlling Circuits

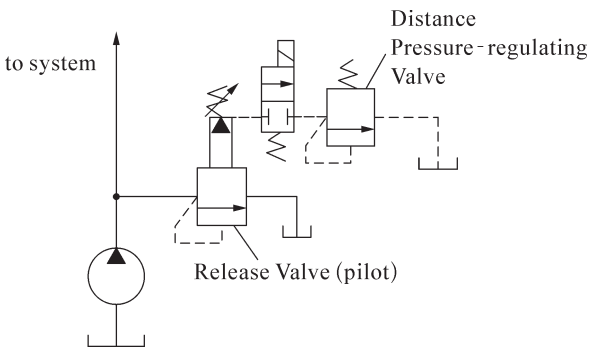


Fig.5-25 Pressure Controlling Circuit (two-stage)

By regulating the orifice of throttle valves, the inlet flow of fluid to hydraulic cylinders can be controlled.

If a directional valve (e.g. 2/2 way directional change valve) is off power supply, the system pressure will be controlled through a release valve; when electricity is on, the system pressure will be controlled by a remote pressure regulating valve.

New Words

1. **actuate** /'æktjʊeɪt/ *v.* 开动；促使
2. **circuit** /'sɜ:kɪt/ *n.* 电路；线路
3. **exceed** /ɪk'si:d/ *v.* 超过；超越
4. **filter** /'fɪltə/ *n.* /*v.* 过滤器；过滤
5. **fuel** /fjʊəl/ *n.* 燃料；燃烧剂
6. **orifice** /'ɒrɪfɪs/ *n.* 孔；节流口
7. **predetermine** /ˌpri:dɪ'tɜ:mɪn/ *v.* 预定；预先确定
8. **restrict** /rɪs'trɪkt/ *v.* 限制；约束
9. **routing** /'ru:tɪŋ/ *n.* 行程安排；路线
10. **spool** /spu:l/ *n.* 滑阀；滑柱（塞）；阀芯

Technical Expressions

1. **closed center circuit** 中位闭路
2. **directional-change valve** 换向阀
3. **directional-control valve** 方向控制阀
4. **flow controlling circuit** 流量控制回路
5. **flow-control valve** 流量控制阀
6. **governor valve** 调速阀
7. **non-return valve** 单向阀
8. **open center circuit** 中位开路
9. **pressure controlling circuit** 压力控制回路
10. **pressure-control valve** 压力控制阀
11. **pressure-reducing valve** 减压阀
12. **release valve** 溢流阀
13. **sequence valve** 顺序阀
14. **spool valve** 滑阀
15. **spring-loaded ball valve** 弹簧球阀
16. **throttle valve** 节流阀

Notes

1. Valves are designed to control the direction of pump-flow, the power level, and the amount of fluid-flow to the actuators.
   阀是用来控制泵输出流体的运动方向、压力的大小，以及到执行元件流量的多少。

2. The hydraulic circuit refers to the path through which the fluid flows to the actuator, then returns to the tank.
   液压回路是指液体流向执行元件，然后返回到油箱所经之路。

3. Non-return valves are used in circuits, or combined in the body of other valves, to provide flow in one direction only.
   单向阀用于回路或与其他阀结合使用，仅提供单向的液体流动。

4. It has many types, such as two-position two-way, or three-position four-way magnetic directional-change valve.
   换向阀种类繁多，如二位通或三位四通电磁换向阀。

5. The relief valve is set to open at a predetermined pressure to protect pressure vessels and other equipment from exceeding their design limits.
   溢流阀的设置为在预定压力下打开，以保护压力容器和其他设备不至于超过其设计限制。

6. And sequence valves control the sequence of hydraulic circuits, to ensure that one hydraulic cylinder is fully extended before another starts its stroke.
   顺序阀控制液压回路的顺序（动作），以保证液压缸在下一次行程开始前完全伸出（缩进）。

7. Simple flow-control valves work on the basis of restricting the flow with either a fixed or variable orifice.
   简单的流量控制阀基于采用固定式或可调式节流口限制流量来进行工作。

8. The aim of hydraulic-circuit design is to carry out the functions of which the system is required.
   液压基本回路设计的目的是实现液压系统所需的功用。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. For the hydraulic fluid to do work, it must flow to the actuator or motors, and then return to the tank, _____.
   A. after the fluid is filtered and re-pumped
   B. before fluid is filtered and re-pumped
   C. when the fluid is filtered and re-pumped
   D. the fluid is then filtered and re-pumped

2. If the pressure rises too high, the fluid may return to tank through _____.
   A. a pressure relief valve
   B. a throttle valve
   C. a governor valve
   D. a sequence valve
3. If a circuit supplies full pressure to the control valves, whether any valves are actuated or not, what kind of circuit does it belong to?
   A. It belongs to an open center circuit.
   B. It belongs to a closed center circuit.
   C. It belongs to a closed-loop system.
   D. It belongs to open-loop system.
4. Open center circuits use pumps which supply a continuous flow. This type of circuit can use _____.
   A. reliable, variable capacity vane pumps
   B. inexpensive, fixed capacity vane pumps
   C. expensive, variable displacement pumps
   D. inexpensive, constant displacement pumps
5. The path taken by hydraulic fluid is called _____.
   A. an oil circuit of which there are a lot of types
   B. an electric circuit of which there are several types
   C. a hydraulic circuit of which there are several types
   D. a hydraulic circuit of which there are only two types

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

carry out	work on	belong to	provide
regulate	exceed	restrict	avoid

1. We'd better _____ our discussion to matters concerning this hydraulic systems.
2. Cars must not _____ thirty miles an hour in certain areas.
3. Customs officers _____ spot check on incoming car.
4. We _____ science experiments, and inspect and repair any equipment that needs work.
5. Who does that enormous yellow Rolls Royce _____?
6. As a general rule, you should _____ this kind of food.
7. The project is designed to _____ young people with work.
8. In hydraulic system, a _____ is used to regulate the speed of an engine.

III. Translation (English to Chinese).

1. Hydraulic hose is the general description given to flexible pipes and tubes designed as suitable for containment of hydraulic fluids under pressure.
2. In hydraulic systems the prime requirement of the fluid is to transmit pressure, hence low viscosity and low compressibility are important features.
3. Connectors which link the various system components provide power conductors for the fluid under pressure, and fluid flow returns to tank reservoir.

4. Fluid storage and conditioning equipment ensure sufficient quality and quantity as well as cooling of the fluid.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. All hydraulic control systems can be reduced to a few basic groups of elements, each group performing a specific _____ in the system.
2. Selecting the four groups form a convenient structure for _____ the hydraulic control systems.
3. Generally, an internal gear pump on (small) gear is _____ within an inter gear ring.
4. There are two _____ of vane pump, fixed capacity vane and variable capacity vane pump.
5. The radial piston has found its main uses as an aircraft hydraulic pump and for marine _____.
6. Hydraulic cylinders are the standard form for linear actuators, _____ hydraulic motors are the standard form for rotating actuators.
7. Directional-control valves determine the routing of the fluid in a circuit, _____ two kinds: non-return valve and directional-change valve.
8. Simple flow-control valves work on the basis of restricting the flow with _____ a fixed or variable orifice.
9. The aim of hydraulic-circuit design is to _____ out the functions of which the system is required.
10. Standard sizes of tubing produced for hydraulic lines are _____ produced in two wall thicknesses.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

Pipe sizes ___1___ used for hydraulic lines range ___2___ 6 mm to 20 mm, with smaller sizes down to 3 mm in ___3___ applications. Material ___4___ for rigid lines is normally seamless drawn low-carbon steel of hydraulic quality. ___5___ materials used are copper, aluminium alloy, ___6___ brass alloys, stainless steel and titanium. Hydaulic hose is the most ___7___, if not the only solution, for lengths of hydraulic lines connecting components where ___8___ has to be accommodated. Another primary ___9___ is to provide easy coupling or decoupling of lines at particular points in a system. In hydraulic systems the prime ___10___ of the fluid is to transmit pressure.

III. Read aloud the following paragraph.

Simple flow-control valves work on the basis of restricting the flow with either a fixed or variable orifice. They mainly include two kinds: throttle valves and governor valves. The aim of hydraulic-circuit design is to carry out the functions of which the system is required. The following are flow controlling circuits and pressure controlling circuits.

IV. Describe how directional valve works.

Part III Practical Writing

This part is to test your ability to do practical writing. You are required to write an advertisement according to the following information.

水泵求购信息

类型：卧式、离心、单级泵
数量：8
容量：400 m^3/hr
排出扬程：40米
有效净吸水高度：0.8米
转速：1 500 rpm
旋转：顺时针（电机方向）
电机特点：380±20 V/3 – phase/50赫兹的IP – 55
守则要求：现行守则（美国ANSI 标准），质检报告和测试文件齐全。供应商的报价应为离岸价格，基价有效期为至少90天，并注明消费税以及其他费用已包含在报价内。详细信息可上网查询：www.fsc.org.fh.
买方机构：凤凰农场
地　　址：丰收市凤凰城
发布日期：2016年5月18日
截止日期：2016年5月24日
电　　话：050–9225255
传　　真：050–9225213

Unit 6

Machine Tools

Part I Reading and Translating

Section A: Machine Tools

6.1 Types of Lathes

6.2 Milling Machines

6.3 Grinders

6.4 Planers and Shapers

6.5 Drilling Machines

Exercises

Section B: Machine Shop Practice

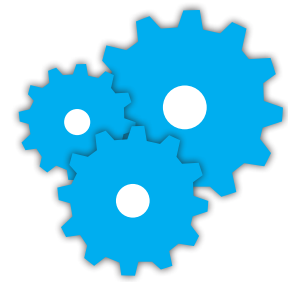
6.6 Machining Operations

6.7 Relative Motion

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Machine Tools

There are various types of machine tools in machine shops, which are designed for different purposes. The main purpose of a machine tool is used to remove solid materials like metal. The basic machine tools are lathes, milling machines, planers, shapers, drilling and grinding machines. Moreover, some machines are developed for several different operations, and they are not restricted to a particular job, as the case of milling machines.

6.1 Types of Lathes

Whatever type of a lathe may be, the main parts of the lathe are the bed, headstock, tailstock, carriage and feed-box. The tool post for holding the cutting tool is mounted on the carriage assembly.

The basic purpose of the lathe is to machine cylindrical shapes. In turning operation, the workpiece is rotated and a cutting tool is fed by the cross slide. The carriage is driven along the bed by a lead screw or feed rod, both of them are connected to the main spindle through a series of gears.

The most common types of a lathe are: engine lathe, bench lathe, vertical lathe and turret lathe.

An engine lathe can perform various turning operations, and they also are suited for operations such as drilling, threading and boring (Fig.6-1).

A bench lathe is smaller in size which is used to machine smaller parts.

Vertical lathes are well suitable for turning heavy and short workpieces (Fig.6-2).

A turret lathe is equipped with different cutting tools for use in proper sequence (Fig.6-3).

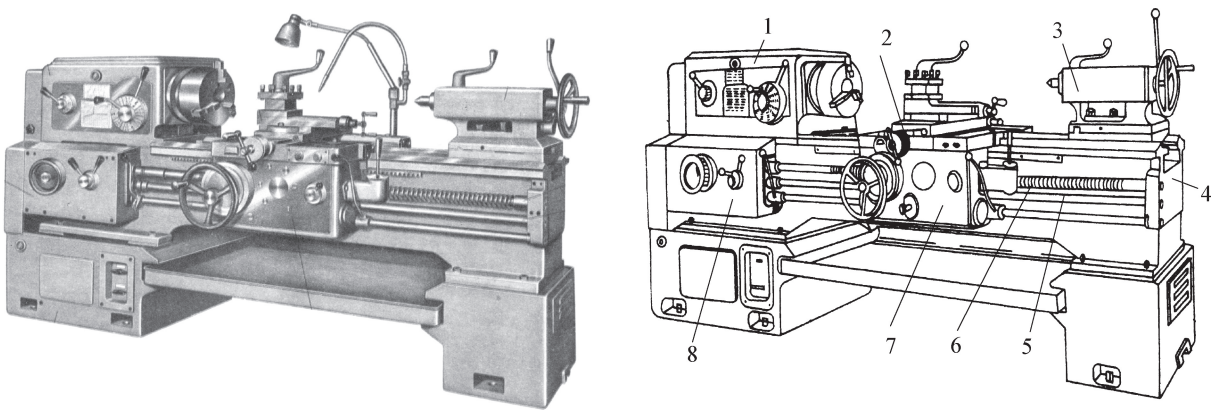


Fig. 6-1 Engine Lathes

1. Headstock 2. Tool Post 3. Tailstock 4. Bed
5. Feed Rod 6. Lead Screw 7. Carriage-box 8. Feed-box

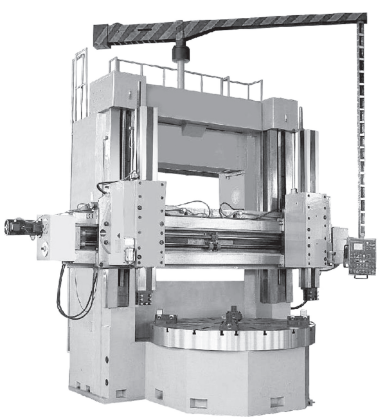


Fig. 6-2 A Vertical Lathe

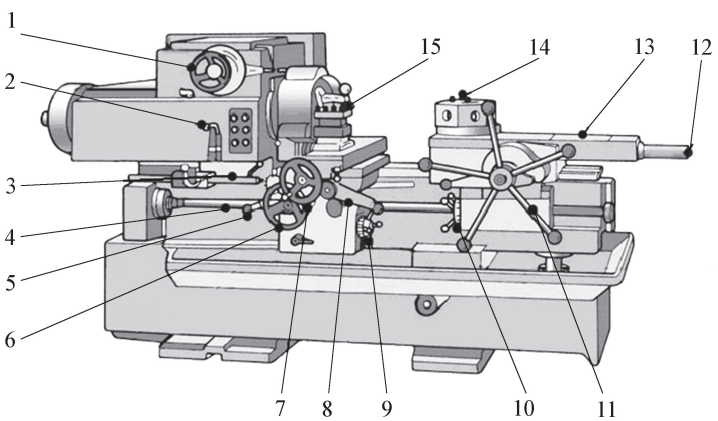


Fig.6-3 A Turret Lathe

1. Spindle Speed Selector 2. Forward and Reverse 3. Stop Rod
4. Feed Shaft 5. Longitudinal Feed Lever 6. Carriage Hand-wheel
7. Cross Slide Hand-wheel 8. Cross-feed Lever 9. Feed Selector
10. Feed Selectors 11. Capstan Wheel 12. Turret Stops
13. Ram 14. Main Turret 15. Squire Turret

6.2 Milling Machines

Milling machines are suitable for half-finished, complicated and precision machine parts. With various special attachments, modern milling machines are extensively used for drilling, milling and boring.

A plain milling machine consists of a column, a base, a slide, a knee, a saddle, a spindle and a table (Fig.6-4). The boxlike column houses the motor and gears or belt mechanism for driving the spindle and table. The face of the base makes a very accurate slide, and the knee slides vertically. The saddle can make transverse movements. A feed screw extends from the base to the knee. And the table moves longitudinally in front of the column. The surface of the table with T slots makes the vise clamped to them.

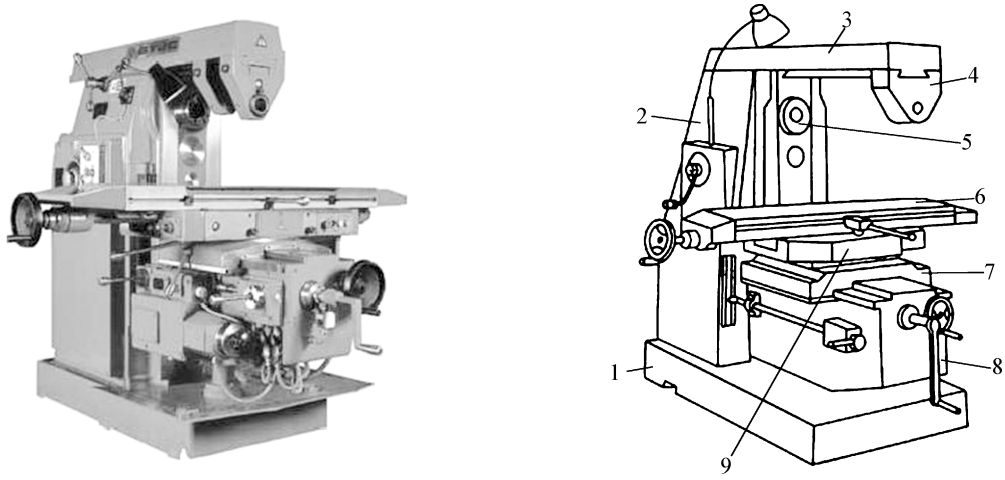


Fig. 6-4 Milling Machine

1. Base 2. Column 3. Overarm 4. Tool Post 5. Spindle 6. Table 7. Saddle 8. Knee 9. Rotary Base

6.3 Grinders

Generally speaking, grinders are used for finishing process. However, there are so many products that special grinding machines have to be designed for each purpose.

The plain center-cylindrical grinder is set up for grinding the outside of cylindrical surfaces (Fig.6-5). The machine table is capable of back-and-forth movement with 10 degrees on either side of the center line. The workpiece is held between center holes. The grinding wheel on the spindle can be moved to and from the workpiece.

Both the grinding wheel and the workpiece rotate during the machining operation. The grinding wheel turns much more rapidly than the regular feed rates of the workpieces. Also, the surfaces of the grinding wheel and the workpiece move in opposite directions at their line of contact. The table is used to move the workpiece across the front of the wheel.

Fig.6-5 Cylindrical Grinder

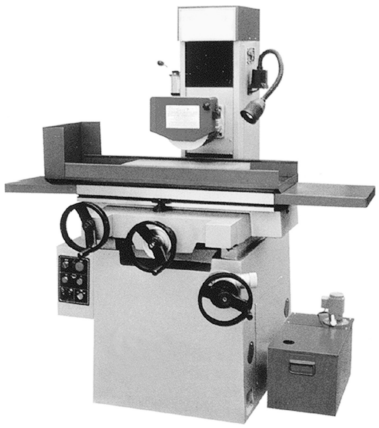


Fig.6-6 Surface Grinder

6.4 Planers and Shapers

Either planers or the shapers are designed for machining flat surfaces, but their construction and the method of operations are quite different (Fig.6-7, Fig.6-8).

1. Planers are capable of accommodating large workpieces which cannot be easily moved. And, the shapers are adapted to smaller workpieces.
2. In the operation of the planer the workpiece is moved against a stationary tool, while on the shaper, the tool moves across the stationary work.
3. The tool of the planer is fed into the workpiece, whereas the workpiece on the shaper is usually fed across the tool.
4. On shapers, external and internal surface can be produced; however, planers are primarily used to produce flat and angular surface.

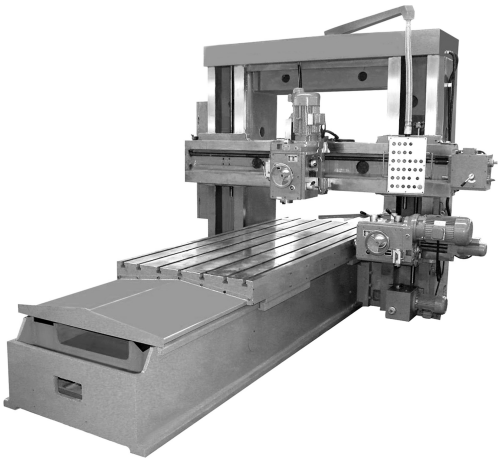


Fig.6-7 Planer

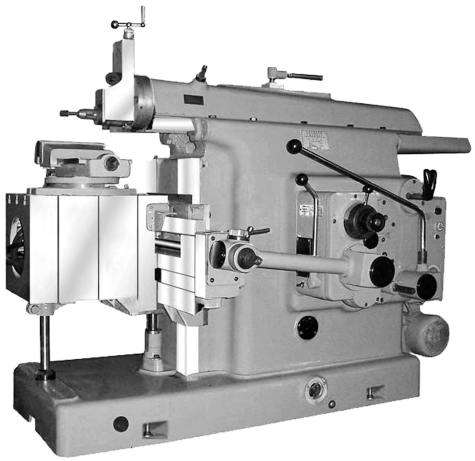


Fig.6-8 Shaper

6.5 Drilling Machines

Drilling machines are used for cutting round holes in metal stock. There are three basic types of drilling machines: the sensitive drill press, the upright drill press, and the radial drill press (Fig.6-9，Fig.6-10，Fig.6-11).

The radial drill press is the most versatile drilling machine, designed for handling operations from small holes to large heavy workpieces.

In drilling operation, the movement of the arm, drill head, spindle and the depth of feed, as well as speeds are controlled by hand or powered mechanism. In addition to drills, other tools such as reamers and boring heads can also be used on it.

Fig.6-9 Sensitive Drill Press

Fig.6-10 Upright Drill Press

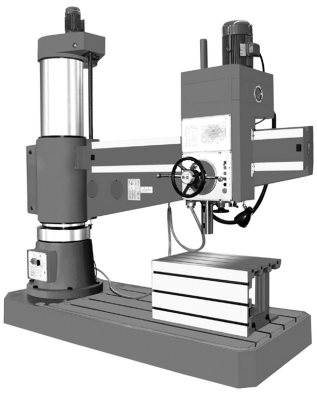


Fig.6-11 Radial Drill Press

New Words

1. **accurate** /'ækjʊrɪt/ *a.* 准确的；精确的
2. **angular** /'æŋgjʊlə/ *a.* 有角的；斜（面）的
3. **complicated** /'kɒmplɪkeɪtɪd/ *a.* 复杂的
4. **cylindrical** /sɪ'lɪndrɪkəl/ *a.* 圆柱体的；圆筒形的
5. **horizontal** /ˌhɒrɪ'zɒntl/ *a.* 水平的；卧式的
6. **longitudinally** /ˌlɒndʒi'tju:dinəlɪ/ *ad.* 纵向的；经度的
7. **precision** /prɪ'sɪʒən/ *n.* 精密；精确
8. **primarily** /'praɪmərɪlɪ/ *ad.* 主要地；原本地
9. **radial** /'reɪdɪəl/ *a.* 径向的；辐射的
10. **restrict** /rɪs'trɪkt/ *v.* 限制；约束
11. **rigid** /'rɪdʒɪd/ *a.* 坚固的；刚性的
12. **rotate** /rəʊ'teɪt/ *v.* 旋转；转动
13. **sequence** /'si:kwəns/ *n.* 连续；顺序
    in sequence 先后；按顺序
14. **stationary** /'steɪʃənərɪ/ *a.* 固定的；不动的
15. **transverse** /'trænzvɜ:s/ *a.* 横向的；横截的
16. **versatile** /'vɜ:sətaɪl/ *a.* 多用途的
17. **vertical** /'vɜ:tɪkəl/ *a.* 立式的；垂直的

Technical Words & Expressions

1. **attachment** 附件
2. **belt** 传动带
3. **bench lathe** 台式车床
4. **boring head** 镗刀

5. **boring** 镗削
6. **carriage assembly** 拖板组件
7. **column** 立柱；机床身
8. **drilling** 钻削
9. **engine lathe** 普通车床
10. **feed screw** 进给螺丝
11. **feed-box** 进给箱
12. **gear** 齿轮
13. **grinder** 磨床
14. **hand wheel** 轮；手柄
15. **headstock** 床头箱
16. **knee** 升降台
17. **lathe** 车床
18. **main spindle** 主轴
19. **metal stock** 金属材料
20. **milling** 铣削
21. **move back and forth** 前后移动
22. **planer** 龙门刨床
23. **radial drill press** 摇臂钻床
24. **reamer** 铰刀
25. **saddle** 滑动座架
26. **sensitive drill press** 台式钻床；手压钻床
27. **shaper** 牛头刨
28. **slide** 滑板；刀架
29. **slot** 槽；缝
30. **tailstock** 尾架
31. **threading** 车削螺纹
32. **turning** 车削
33. **turret lathe**（六角）车床
34. **upright drill press** 立式钻床
35. **vertical lathe** 立式车床
36. **vise** 台钳；老虎钳
37. **workpiece** 工件

Notes

1. The tool post *for holding the cutting tool* is mounted on the carriage assembly.
用来固定刀具的刀架安装在拖板组件上。
for holding the cutting tool 介词短语作定语，修饰tool post。

2. In turning operation, the workpiece is rotated and a cutting tool is fed by the cross slide.
在车削时，工件转动，刀具在滑板上做进给运动。

3. A turret lathe is equipped with many different cutting tools for use in proper sequence.
六角车床装有多把按正确顺序使用的刀具。

4. The boxlike column houses the motor and gears or belt mechanism for driving the spindle and table.
箱式立柱内装有电机及齿轮或皮带轮装置。

5. The surface of the table with T slots makes the vise *clamped to them*.
工作台面的T形槽能使台钳固定在T形槽上。
the vise 是make 的宾语, *clamped to them* 作宾语的补语。

6. The machine table is capable of back-and-forth movement with 10 degrees on either side of the center line.
装在机床上的工作台做往复运动，并能向中心线任意一端侧转10度左右。

7. Also, the surfaces of the grinding wheel and the workpiece move in opposite directions at their line of contact.
砂轮面与工件相接触时做径向运动。

8. Planers are capable of accommodating large workpieces which cannot be easily moved. And, the shapers are adapted to smaller work.
龙门刨适用于加工不易被搬动的大工件，而牛头刨只用于加工小工件。

9. In drilling operation, the movement of the arm, drill head, spindle and the depth of feed, as well as speeds are controlled by hand or powered mechanism.
在操作过程中，无论是摇臂、钻头、主轴的运动，还是进刀深度、速度，既可用手动控制也可以用机动控制。

Exercises

I. Tell whether each of the following statements is True (T) or False (F).

1. An engine lathe can perform various turning operations, and other operations such as drilling, threading, boring and grinding.
2. The turret lathe is equipped with a turret for mounting a number of different cutting tools in readiness so as to be used in sequence.
3. Modern milling machines can be further used for drilling, milling and boring, machining flat surfaces, therefore the scope of application will be widely enlarged.
4. Milling machines are only suitable for half-finished, complicated and precision parts, such as fixtures, jigs and machining tools, etc.
5. The surfaces of the grinding wheel and the workpiece move in the same directions at their line of contact.
6. The workpiece turns at a much slower rate while the grinding wheel turns rapidly during the machining operation.
7. On the shaper the work is moved against a stationary tool; on the planer the tool moves across the work which is stationary.
8. The sensitive drill press, as the name implies, allows the operator to “feel” the cutting action of drill as his hand feeds it into the work.

II. Match the items listed in the following columns.

1. precision	a. not flexible
2. vertical	b. operated by the pressure of water or other liquid
3. fasten	c. made or done in a very exact way
4. rigid	d. the right angles to a horizontal plane
5. stationary	e. difficult to understand or deal with
6. complicated	f. to attach something firmly to another object
7. back and forth	g. an upright pillar
8. in sequence	h. to and fro
9. hydraulic	i. the order that something happens or exists in
10. column	j. standing still instead of moving

III. Fill in each blank with a proper word beginning with the letter given.

Arc Welding

Arc welding is one of the welding 1. p_____, wherein joining 2. o_____ with arcs by intense heating (temperature ranging from 2,760℃ to 5,537℃). There are 3. v_____ arc welding methods. 4. H_____, the most widely used process may be the shielded metal-arc welding.

During the processing, an 5. i_____ electric arc is produced between a metal electrode and the work-piece. The electrode is 6. a_____ which permits the welding of materials 7. s_____ as ferrous metals, carbon steels, copper alloys, nickel, and other metal alloys. It melts as a source of filler metal. The electrode may 8. e_____ be consumable or non-consumable metal.

Other 9. f_____ of arc welding in use in industry are carbon-arc (CAW), flux cored arc (FCAW), gas metal arc (GMA), gas tungsten arc (GTA), submerged arc (SAW), plasma arc (PAW). And stud welding (SW) is another available by 10. m_____ of stud-welding gun.

IV. Translation (Chinese to English).

1. 一般说来，普通车床由若干部件组成。**(consist of)**
2. 龙门刨适用于加工那些大型且笨重的工件。**(adapt ... to)**
3. 六角车床的刀具是按一定的逻辑顺序安装的。**(in sequence)**
4. 在钻削过程中，钻头沿着床臂做前后运动。**(back and forth)**

Section B: Machine Shop Practice

In machine shop practice, we use various machine tools, and each type of them has their own features in machining operations. In the machining operation, relative motion is engaged, that is, a primary motion (cutting speed), and a secondary motion (feed). With these motions, the desired shape of a certain part and surface texture can be produced.

6.6 Machining Operations

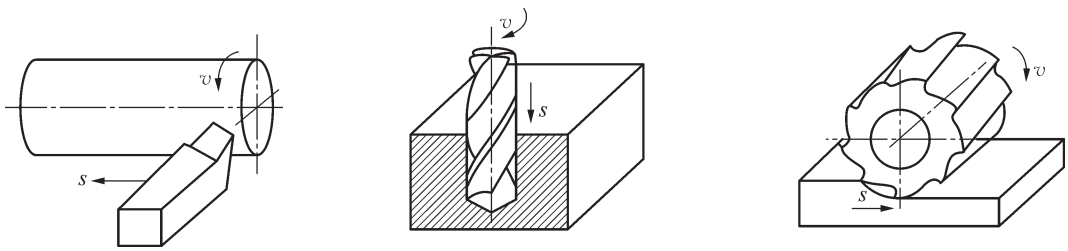
There are many kinds of machining operations, but only three processes are regarded as primary machining operations, which are called chip machining, non-chip machining and electric discharge machining. Turning, drilling, milling, boring, shaping and planing all belong to chip machining.

In **turning** operation, the workpiece is rotated and a cutting tool is fed to produce cylindrical parts. The speed motion in turning is provided by the rotating workpiece, and the feed motion is achieved by the cutting tool, moving in the direction parallel to the axis of rotation of the workpiece (Fig.6-12a).

A **drilling** process is used to produce a round hole in metal stock. It is done by rotation and feeding of the cutting tool into the stationary workpiece. The cutter is fed parallel to its axis of rotation into the workpiece to form the round hole (Fig.6-12b).

In **milling**, the cutting tool is rotated and moved against the material to generate a plane or straight surface. Unlike a drill press, where the workpiece is stationary, the milling cutter and workpiece move relatively to each other, creating a tool-path where chips are removed (Fig.6-12c).

The other operations, technically speaking, do not belong to machining operations as the cutting tools are caused to change during their machining performance. Certainly, these operations are carried out through specific machine tools. Take the example of electric discharge machining, metal removal is due to the metal erosion by interrupted electrical discharges.



a. Turning　　b. Drilling　　c. Milling

Fig.6-12　Common Machining Operations

6.7 Relative Motion

In machine shop practice, two basic kinds of relative motion must be provided by a machine tool — the primary motion and feed motion. Combination of these two motions brings a chip removal from the

workpiece, generating a machined surface with desired geometry.

As a rule, the primary motion absorbs most of the total power to perform a machining operation. By comparison, the feed motion requires only a small proportion of total power.

The primary motion is accomplished at a certain cutting speed. To the feed motion, it is much slower and the cutting tool must be moved laterally across the workpiece. In addition, the depth of the cut is achieved by the penetration of the cutting tool below the original work surface. All together, speed, feed, and depth of cut form the three dimensions of the machining process, and they are called the cutting conditions.

New Words

1. **accomplish** /ə'kɒmplɪʃ/ *v.* 完成；实现
2. **axis** /'æksɪs/ *n.* 轴；基准线
3. **chip** /tʃɪp/ *n.* 切屑碎片；芯片
4. **combination** /ˌkɒmbɪ'neɪʃən/ *n.* 结合；组合
5. **geometry** /dʒɪ'ɒmɪtrɪ/ *n.* 几何形状；几何学
6. **lateral** /'lætərəl/ *a.* 横向的；侧面的
7. **motion** /'məʊʃən/ *n.* 运动
8. **parallel** /'pærəlel/ *n.* 平行；对比
   a. 平行的；类似的
9. **reciprocation** /rɪˌsɪprə'keɪʃən/ *n.* 往复运动；互换
10. **texture** /'tekstʃə/ *n.* 纹理；质地

Technical Expressions

feed motion 进给运动

primary motion 主运动

Notes

1. In the machining operation, relative motion is engaged, that is, a primary motion (cutting speed), and a secondary motion (feed).
   加工操作涉及相对运动，也就是说，一个主运动（切削速度），及一个辅助运动（进给）。

2. The speed motion in turning is provided by the rotating workpiece, and the feed motion is achieved by the cutting tool，moving in the direction parallel to the axis of rotation of the workpiece.
   车削的速度运动由旋转的工件获得，而进给运动则由切削刀具提供，刀具运动方向与带动工件转动的轴平行。

3. The cutter is fed parallel to its axis of rotation into the workpiece to form the round hole.
   刀具进给方向与刀具旋转轴平行，进入工件后形成圆孔。

4. In milling, the cutting tool is rotated and moved against the material to generate a plane or straight surface.
   在铣削工作业时，铣刀旋转迎向工件将其加工成一个平面或连续表面。

5. Unlike a drill press, where the workpiece is stationary, the milling cutter and workpiece move

relatively to each other, creating a tool-path where chips are removed.
与钻床不同，其加工时工件是固定不动的。而铣削时，工件相对于铣刀做相向运动，形成一条切削路径以除去铣屑。

6. Combination of these two motions brings a chip removal from the workpiece, generating a machined surface with desired geometry.
这两种运动结合用以从工件上去除削片，将加工面切削成所需要的几何形状。

7. To the feed motion, it is much slower and the cutting tool must be moved laterally across the workpiece.
对于进给运动，其速度要慢得多，并且刀具必须横穿工件。

8. In addition, the depth of the cut is achieved by the penetration of the cutting tool below the original work surface.
此外，切削深度是由下端原工件表面吃刀产生的。

9. All together, speed, feed, and depth of cut form the three dimensions of the machining process, and they are called the cutting conditions.
切削速度、进给率及进刀深度一起构成机械加工的三个方面。称之为切削三要素。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. In machining the precision of workpiece, a multiple-tooth cutter is usually used so that the metal removal rate can be high, and frequently, _____ surface or geometry is obtained in a single pass of the work.
   A. the most perfect　　B. the desired
   C. a designed　　D. the grinded
2. On the planer the work is moved against a stationary tool; while on the shaper _____.
   A. the tool moves across the work which is stationary
   B. the tool moves longitudinally
   C. the work moves across the stationary tool
   D. both the work and the tool move in opposite directions at their line of contact
3. In either planning or shaping, one of the basic types of motion between workpiece and tool is _____.
   A. the absolute reciprocation　　C. comparative reciprocation
   B. up and down in the cylinder　　D. backwards or forwards
4. What kind of motion consumes most of the total power which is required to perform a machining operation?
   A. The total motion.　　B. The additional motion.

C. The feeding motion. D. The primary motion.

5. Which types of the following machines are used to produce the precision of workpiece and improve its surface finish?
   A. Milling and boring machines. B. Drilling machines.
   C. Engine lathes. D. Grinding machines.

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

consists of	in combination	by comparison	parallel	consideration
various	provided	a series of	relative	supplied

1. A modern milling machine can produce _____ shapes with different cutters.
2. The team _____ four American engineers and two European technicians.
3. Power is _____ to the spindle by means of an electric motor through a V-belt or silent chain drive.
4. In milling or turning, the primary motion and feed motion must be _____ by a machine tool.
5. After a month of practice in workshop, he felt dull and fed up in classroom _____.
6. Some drugs which are safe when taken separately are harmful _____.
7. _____ reciprocation between workpiece and tool is the second basic type of motion.
8. For a second CNC machine, the price is fairly cheap, but you've got to take into _____ the money you'll spend on repairs.
9. He wrote _____ articles devoted to modern molding technique.
10. The cutting tool moves in the direction _____ to the axis of rotation of the workpiece to form a desired geometry.

III. Translation (English to Chinese).

1. In up milling, the cutter rotates against the direction of feed of the workpiece, whereas in down milling, the rotation is in the same direction as the feed.
2. Grinding is not a high-removal-rate process and it is often used as finishing operation following other machining process.
3. The radial arm drill press is useful for operation on large castings that are too heavy to be repositioned by the operator for drilling each hole.
4. Lathes in various forms have existed for more than two thousand years. Modern lathes date from about 1797, when Henry Maudsley developed one with a lead-screw.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. Which machine tool to be used for a particular job _____ to a large extent upon the type of machining required.
2. Some machine tools can be utilized for several different operations but it must not be _____ that the particular machine tool is restricted to the operation shown.
3. Milling is an operation in which metal is removed from a _____ by a rotating milling cutter.
4. An engine lathe can perform _____ turning operations, and they also are suited for operations.
5. Milling machines are _____ for half-finished, complicated and precision machine parts.
6. The face of the base makes a very _____ slide, and the knee slides vertically.
7. However, there are so many _____ that special grinding machines have to be designed for each purpose.
8. The grinding wheel turns much more _____ than the regular feed rates of the workpieces.
9. Planers are capable of holding large workpieces which cannot be easily moved; the shapers are _____ to smaller work.
10. In the drilling operations, speeds can also be _____ by hand or by power.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

There are various types of lathes in machine shop practice, ___1___ for different purposes. The main ___2___ of a lathe are the headstock and tailstock at ___3___ ends of a bed. The turning motion is ___4___ by a lathe to produce desired cylindrical ___5___. In turning operation, the workpiece is rotated and a cutting tool is fed by the gears powered from V-belts. The carriage is ___6___ along the bed by a lead screw or feed rod; both of them ___7___ to the main spindle through a series of gears. Milling machines are widely used for metal ___8___ manufacture. They are suitable for ___9___, complicated and precision machine parts. With various special attachments, modern milling machines are ___10___ used for drilling, milling and boring.

III. Read aloud the following paragraph.

A machine tool provides relative movement between the cutting tool and the workpiece. Material is removed in this process to produce a part of the desired shape. Four basic types of relative motion are provided by machine tools to produce various desired shapes. During the first of these motions, the workpiece is rotated and a cutting tool is fed to produce parts of cylindrical section. Turning operation makes use of this type of motion.

IV. Tell each other different types of lathe and their different uses in your own words.

Part III Practical Writing

You are required to write an English letter to a company exporting some machine tools. Some words are given in order to better your writing.

Key words: C6160 机床(C6160 machine tools); 西门子802D数控机床(Siemens 802D NC machine tools); 出口代理 (an export agent)：上海国际贸易有限公司；市场部主任

Oct. 16, 2016

Re: Machine Tools

Dear Sirs,

Our Marketing Department informs us that you are interested in the import of _____ made in Germany. We shall be pleased to receive your enquiries for the tools. Our Machinery Division mainly acts as _____ on a commission basis.

In order to prepare quotations, however, we would need some additional information with respect to _____ which are attached on the sheet.

Looking _____ to receiving your reply ASAP, and your requirements will have our prompt attention.

Yours truly,

Wang Ming

_____

_____

Unit 7

Forming

Part I Reading and Translating

Section A: Hot Working

7.1 Forging

7.2 Hot Extruding

Exercises

Section B: Cold Working

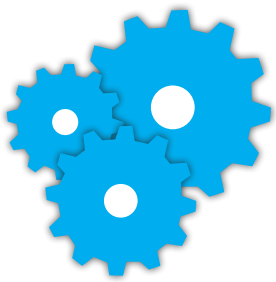
7.3 Deep Drawing

7.4 Cold Forging

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Hot Working

The applicable processes for shaping metal products are various, such as forging or deep drawing. Normally, they fall into two categories: hot forming and cold forming. During hot working, plastic deformation of the workpiece occurs under the pressure or hammering, consequently, the desired sizes and shapes of products are obtained. Furthermore, during this process, the grain flow is going on above the recrystallization temperature, and this helps improve the quality of the workpiece in strength, ductility, resistance of impact and fatigue.

7.1 Forging

Hot forging is one of the most important processes available in deforming metal. It includes open-die forging, impression-die forging and the like. Whatever process is employed, the work is done either by means of pressure, or impact blows (or by a combination of both).

Hammer forging (open die forging) may date back to 4 000 B.C. It was used to deform metals by

hammer blows in the "blacksmith shop". When a billet is heated to forging temperature, the operator strikes it constantly with smith tools (now most of the work done by means of semi-automatic hammers or mechanism), so as to make the workpiece into expected shapes. However, the quality of the products mainly depends on the skill of the operator.

Impression-die forging uses a combination of pressure and a pair of dies to change heated billet into proper shapes. When the preheated workpiece undergoes plastic deformation between two dies under force, the metal flow is directed toward the die walls and achieves a complete filling.

Closed-die forging is a special form of impression-die forging, which makes good use of materials and has excellent reproducibility. It is advisable to use this method for obtaining products with good dimensional accuracy, and in large quantities.

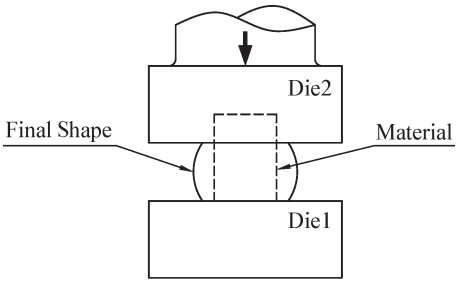


Fig. 7-1 Open-die Forging

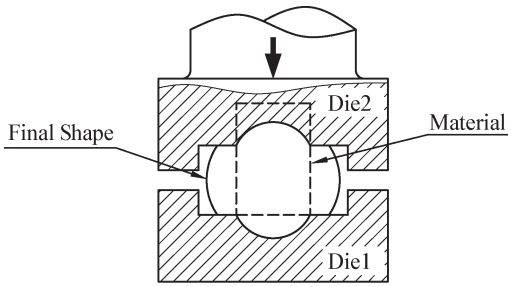


Fig. 7-2 Closed-die Forging

7.2 Hot Extruding

In the example of hot extrusion, when the preheated billet for shaping is placed in the container, which is connected with a die at the end, it is forced through an aperture (hole) to fill the die completely. The common hot extrusion products are hollow in shape, such as containers, pipes and vacuum bottles. One type of hot extrusion is shown in Fig. 7-3.

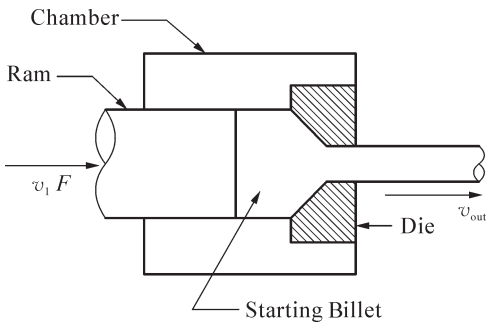


Fig. 7-3 Methods of Hot Extrusion

New Words

1. **advisable** /əd'vaɪzəbl/ *a.* 适宜的；明智的
2. **aperture** /'æpətjʊə/ *n.* 孔；隙缝
3. **category** /'kætəgərɪ/ *n.* 种类，类别
4. **fatigue** /fə'ti:g/ *n.* 疲劳
5. **furthermore** /ˌfɜ:ðə'mɔ:/ *ad.* 而且；此外
6. **hammer** /'hæmə/ *n.* 铁锤 *v.* 锤打
7. **impact** /'ɪmpækt/ *v./ n.* 冲击；影响
8. **reproducibility** /rɪprəˌdju:sə'bɪlɪtɪ/ *n.* 可重复性；再生性
9. **resistance** /rɪ'zɪstəns/ *n.* 抵抗；阻抗力
10. **vacuum** /'vækjʊəm/ *n.* 空间; 真空

Technical Expressions

1. **closed die forging** 模锻（闭模锻）
2. **cold forging progressive die** 冷压模锻
3. **cold forming** 冷成形
4. **deep drawing** 深冲压
5. **hammer forging** 锤锻
6. **hot extrusion** 热挤压
7. **hot forming** 热成形
8. **open die forging** 自由锻（开模锻）
9. **recrystallize** （使）再结晶
10. **smith tools** 锻工工具

Notes

1. Normally, they fall into two categories: hot forming and cold forming.
   通常，它们分为两类：热成形和冷成形。
   fall into ... 在此意思为：把…分成…

2. During hot working, plastic deformation of the workpiece occurs under the pressure or hammering, ...
   在热加工中，压力及锤击作用使工件发生了塑性变形，…

3. Furthermore, during this process, the grain flow is going on above the recrystallization temperature, ...
   此外，在这一过程中，当温度高于再结晶温度时，金属晶粒产生滑移，…

4. It was used to deform metals by hammer blows in the "*blacksmith shop*".
   从前，改变金属的形状都是在通过铁匠铺里用铁锤锻打的方式来完成。
   "*blacksmith shop*"就是铁匠铺之意。

5. However, the quality of the products mainly depends on the skill of the operator.
   然而，产品的质量主要依赖于工匠的手艺。

6. Impression-die forging uses a combination of pressure and a pair of dies to change heated billet into proper shapes.
   模锻是将压力和模具（上模与下模）配合使用，以把加热的钢坯变成适当的形状。

7. Closed-die forging is a special form of impression-die forging, which makes good use of materials and has excellent reproducibility.
   闭模锻是模锻的一种特殊形式，该工艺能充分利用材料，且模具有良好可重复使用的性能。

8. ... when the preheated billet for shaping is placed in the container, which is connected with a die at the end, it is forced through an aperture (hole) to fill the die completely.
   预热钢坯置于底部与模具相通的存料容器内，经过出料孔，把材料压入模具内，并将其填满成型。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. Forging is a production method whereby heated metal stock is shaped to a desired form by compressive forces or by sharp hammering.
2. Open die forgings are made by using hammers or presses in conjunction with blacksmith tools or flat type dies.
3. Closed-die forgings possess good reproducibility and poor accuracy.
4. Open-die forging process is very common in villages of northern part of China, where horses are main powers for farming. The work of deforming workpieces is done under the hammer blows in their "blacksmith shops".
5. Hot extrusion process may be used to manufacture hollow products like tubes, cans, cases and vacuum bottles.
6. In hammer forging, the quality of forged products depends mainly on the skill of the operator.
7. Closed-die forging is a very common form of impression die forging.
8. In impression-die forging, two dies are forced together, and the billet undergoes plastic deformation against the die walls until the flash is burst out of the dies.

II. Match the items listed in the following columns.

1. reproducibility	a. against change
2. resistance	b. duplicability
3. fatigue	c. in addition
4. impact	d. appropriate
5. hammer	e. emptiness
6. category	f. hole
7. aperture	g. class
8. vacuum	h. to hit with a mallet
9. advisable	i. exhaust
10. furthermore	j. collision

III. Fill in each blank with a proper word beginning with the letter given.

Electric Discharge Machining (EDM)

Some metals like Tungsten carbide or new space-age alloys, for example, are very 1. d_____ to machine with conventional processes. Electric Discharge Machining (EDM) is intended to 2. s_____ these problems.

The 3. b_____ working principles of EDM is that the workpiece is the anode and the tool

is the cathode. As the two ends get near, the sudden pulse of high intensity discharge 4. b_____ out spark with high temperature, melting the surface layer. The machining action is 5. c_____ out by the deformation of electric sparks between the 6. t_____ and the workpiece in a dielectric medium (kerosene).

Many advantages of EDM have been 7. d_____ up to now, one of which is that it can 8. r_____ a workpiece to close dimension in a hardened state. Another 9. m_____ advantage is that tools of soft materials (such as copper, brass, aluminum, graphite, etc.) can be used to erode very hard and 10. b_____ materials.

IV. Translation (Chinese to English).

1. 当今，可用的锻造技术有很多，通常把它们分为两大类：冷锻和热锻。**(fall into)**
2. 顺序模冷锻技术能迅速而高质量地生产出形状复杂的产品。**(in high quality)**
3. 砂型铸造工艺用于生产各种各样的铸件。**(a variety of)**
4. 他的时间花在研究CAD/CAE技术在锻造中的使用上了。**(employ)**

Section B: Cold Working

Cold forming processes are conducted at the ambient temperatures to produce metal components to close tolerances and final shape. Besides, cold forming is economical, quicker, easier to shape, and the processes of this type can improve mechanical strength of the finished products. In addition, for some metals like steels containing sulphur, hot working is not available, whereas cold forming processes work.

7.3 Deep Drawing

Flat sheet metal can be coldly drawn into various shapes with only a simple punch and die. However, most of the products formed are cylindrical or box-like by means of stamping or deep drawing (cup drawing).

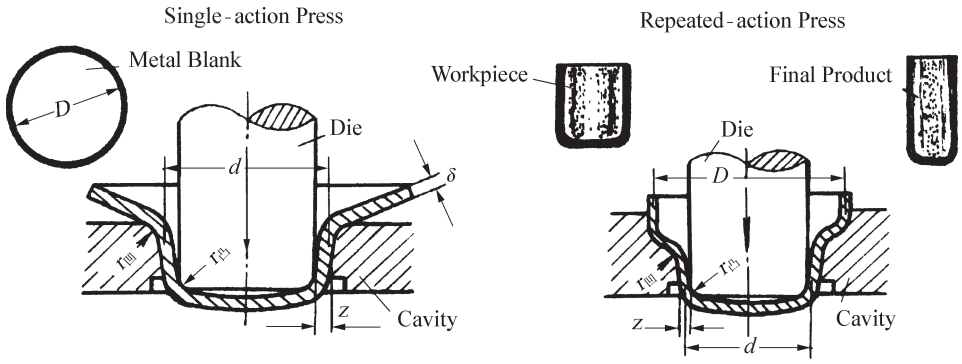


Fig. 7-4 Deep Drawing Operation

If the shaping products are shallow, the simple stamping process is practically introduced. As deep drawing refers to the operation for production of hollow vessels, it may be fit for the size of parts from 0.25 mm diameter or smaller, to parts large enough for aircraft or car body members.

In deep processing, a metal blank is punched into the die cavity. With the metal movement into the die, deformation occurs, and required depth is obtained by pushing the blank from the flange region. Thus, the bottom of the vessel is completed in this single-action press that could not possibly be done repeatedly.

7.4 Cold Forging

Compared to the hot working processes, cold forging technology is beneficial in production of precise and complex shape products. As the example of cold heading, it is an ideal process for large quantities and rapid production of symmetrical components such as gears, shafts, axles and so on.

Cold hobbing is another kind of forming process. It is particularly used for the production of cavities by forcing a male hob into a relatively soft steel blank. Technically, the hobbed products have a good surface finish.

Nowadays, there are various cold forging machines in use for bending, cold drawing, cold heading, punching, thread rolling and others. Closed cold forging equipment is one type. It consists of a NC precise forging hydro-press and a set of hydraulic drive female die, hence to realize the precision die forging of key parts for car, such as bevel gears.

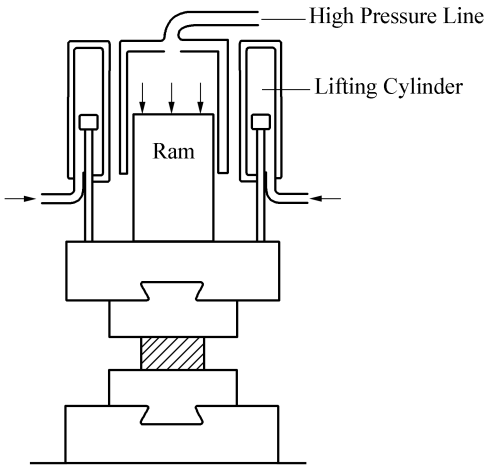


Fig. 7-5 Forging Machinery

New Words

1. **ambient** /'æmbɪənt/ *a.* 周围的；包围着的
2. **beneficial** /ˌbenɪ'fɪʃəl/ *a.* 有益的，有利的
3. **blank** /blæŋk/ *n.* 原坯；*a.* 空白的
4. **flange** /flændʒ/ *n.* 凸缘；飞边
5. **hence** /hens/ *ad.* 因此；所以
6. **punch** /pʌntʃ/ *v.* 冲压；打孔
7. **stamp** /stæmp/ *v.* 模锻；压花
8. **vessel** /'vesl/ *n.* 容器
9. **whereas** /ˌ(h)weə'æz/ *conj.* 但是；而

Technical Expressions

1. **bending** 折弯
2. **closed cold forging equipment** 闭式冷精锻设备
3. **cold drawing** 冷拉伸
4. **cold forging** 冷锻
5. **cold heading** 冷镦
6. **cold hobbing** 冷挤压
7. **hydro-press** 液压机
8. **NC=Numeral Control** 数控
9. **single-action press** 单次冲压
10. **sulphur** 硫；硫磺
11. **surface finish** 表面粗糙度
12. **thread rolling** 滚丝

Notes

1. However, most of the products formed are cylindrical or box-like by means of stamping or deep drawing (cup drawing).
   然而，大部分成品都为圆柱形或罐状，加工方法不外乎落料与拉深（杯形拉深）。

2. As deep drawing refers to the operation for production of hollow vessels, it may be fit for the size of parts from 0.25 mm diameter or smaller, to parts large enough for aircraft or car body members.
   拉深工艺旨在生产空心管材，从小到0.25毫米或更小的零件到飞机部件及汽车车身等更大的零件。

3. With the metal movement into the die, deformation occurs, and required depth is obtained by pushing the blank from the flange region.
   由于受冲压作用，金属毛坯从凸缘处挤入凹模，金属材料发生形变，从而使工件得到了所需要的深度。

4. Thus, the bottom of the vessel is completed in this single-action press that could not possibly be done repeatedly.
   因此，某些零件的底部成型只能在一次拉深中完成，不能多次拉深。

5. As the example of cold heading, it is an ideal process for large quantities and rapid production of symmetrical components such as gears, shafts, axles and so on.
   以冷镦为例，它是一种理想的工艺，可批量而快速生产对称形部件，如：齿轮、轴及轮轴等。

6. Cold hobbing is another kind of forming process. It is particularly used for the production of cavities by forcing a male hob into a relatively soft steel blank. Technically, the hobbed products have a good surface finish.
   冷挤压制模法是另一种成型工艺，它尤其适用于生产模具的型腔，挤压中，凸模被强行压入一个相对较软的钢坯中形成模具的型腔。从理论上讲，所压出的成品都具有良好的表面粗糙度。

7. It consists of a NC precise forging hydro-press and a set of hydraulic drive female die, hence to realize the precision die forging of key parts for car, such as bevel gears.
   它是由一台数控精密水压机和一套水压传动凹模构成，可生产出诸如圆锥齿轮等轿车中主要的精密零件。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. A cold forming process involves the production of metal components to close tolerances and final

shape at an ambient temperature. The proper meaning of the underlined part refers to _____.

A. forging temperature
B. crystallizing temperature
C. recrystallizing temperature
D. room temperature

2. In sheet metal, drawing is a process of forming flat sheet metal into _____ by means of a punch that causes the metal to flow into the die cavity.

A. shapes
B. any shape you want
C. hollow shapes
D. the shapes both solid and hollow

3. During the hobbing operation, a male hob is pressed into a relatively soft steel blank under compressive force. Here "a relatively soft steel blank" maybe refers to _____.

A. a low carbon steel billet
B. a very soft steel sheet
C. a high carbon steel workpiece
D. a special steel bar

4. If a part requires high accurate dimensions, hot forming is not adaptable. This is because the final product will _____.

A. become more brittle at the crystallizing temperature
B. oxide deformation of metal surface
C. shrink and lose surface finish
D. be hard to control the grain flow direction

5. In deep drawing process, the sheet material is drawn through the aperture between punch and die, this will reduce the wall thickness of the final products, but it will _____ of the finished products.

A. increase the toughness
B. improve the mechanical strength
C. impact property
D. increase the ductility

II. Complete each of the following sentences with one suitable word or phrase from the box.

whereas	beneficial	hence	ambient
hydraulic	advisable	category	blank

1. Forging has a noticeable _____ effect on strength and toughness of metals.
2. Cold heading process is conducted at or near _____ temperatures to produce metal components.
3. A group of apprentices were operating the _____ press.
4. It is _____ to generate the geometry of associated forging.
5. These gases trap the sun's heat _____ sulphur dioxide cools the atmosphere.
6. These questions may be included in the same _____.
7. The cost of transport is a major expense for an industry. _____ factory location is an important consideration.
8. In the _____ spaces at the bottom of the chart, add other words you need.

III. Translation (English to Chinese).

1. Sheet steel can be coldly formed into various products of complex and hollow shapes by different processes, such as deep drawing, stretch forming, spinning, and pressing.

2. Cold forging is a kind of precise forming process, which possesses unique advantages compared to the traditional machining techniques.
3. In general, the use of forging press gives more accurate products than that of hammer forging.
4. Stamping process is practically introduced, when the shaping products are shallow and simple in shape.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. For any _____ hammer size the power-assisted steam hammer can give a greater forging capacity.
2. With a press, as opposed to a hammer, pressure is slowly applied and plastic deformation tends to occur fairly uniformly _____ the material.
3. Most metals can be extruded in one way or another, but _____ some more easily than others.
4. The die is the item of _____ that contains the workpiece and forms the external shape of the product.
5. During hot working, plastic deformation of the workpiece occurs, consequently, the _____ sizes and shapes are obtained.
6. When heated to forging temperature, the operator strikes it constantly with smith tools, _____make the workpiece into expected shapes.
7. When the preheated workpiece _____ plastic deformation, the metal flow is directed toward the die walls and achieves a complete filling.
8. Cold forming is _____, quicker, easier to shape, and the processes of this type can improve mechanical strength of the finished products.
9. The bottom of the vessel is completed in the single-action press that could not possibly be done _____.
10. Nowadays, there are various cold _____ machines in use for bending, cold drawing, cold heading, punching, thread rolling and others.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

_____1_____ is one of the most important processes in deforming a metal. It includes open-die forging, impression-die forging and _____2_____. Whatever process is employed, the work is done _____3_____ pressure, or impact blows. Cold forming _____4_____ are conducted

to produce metal components to close tolerances and final shape. _____5_____, cold forming is economical, quicker, easier to shape, and the processes of this type can improve mechanical strength of the _____6_____ products. In addition, sometimes, hot working is not _____7_____, whereas cold forming processes work. _____8_____ the hot working processes, cold forging technology is beneficial in production of precise and complex shape products. As the _____9_____ of cold heading, it is an ideal process for large quantities and rapid production of symmetrical components _____10_____ gears, shafts, axles and so on.

III. Read aloud the following paragraph.

The applicable processes for shaping metal products are various, such as forging and deep drawing. Normally, they fall into two categories: hot forming and cold forming. During hot working, plastic deformation of the workpiece occurs under the pressure or hammering, consequently, the desired sizes and shapes of products are obtained. Furthermore, during the process, the grain flow is going on above the recrystallization temperature, and this helps improve the quality of the workpiece in strength, ductility, resistance of impact and fatigue.

IV. Answer the following questions in your own words.

1. In what way can we shape metal products?
2. Do you know the history of hammer forging? Try to describe it briefly.
3. When is hot extruding used?
4. What functions are carried out in cold forging?

Part III Practical Writing

In this part you are required to write a complaint letter according to the following situation.

史密斯先生，贵公司生产的车床配件极易磨损且互换性差，我们对此感到十分失望。我方意见，请贵公司业务代表来我处协商理赔事宜，并务必在20天内与我方联系。联系电话：021-12345678，联系人：董发

Dear Mr. Smith,

I want to inform you of our disappointment with _____

_____

What we mean is that _____

_____

We are looking forward to _____

_____

Thank you for your cooperation with this business.

Sincerely,
Dong Fa

Unit 8 Molding

Part I Reading and Translating

Section A: Metal Casting

8.1 Sand Casting

8.2 Permanent-mold Casting

Exercises

Section B: Plastic Molding

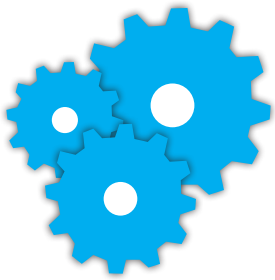
8.3 The Molding System

8.4 The Injection Molding

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Metal Casting

Casting was first used in China about four thousand years ago. Although it is a traditional process in the world for manufacturing workpieces as well as precision parts, it is still an important process adaptable to intricate shapes, the largest bulk of parts and very small pieces.

All processes of metal casting are based on three fundamentals: pouring molten metal into a mold, cooling and solidification; withdrawing the cast product from the mold.

A successful casting work may be determined by various factors, however, two important considerations in casting operation should be taken into, that is, the flow of molten metal in the mold or cavity and solidification and cooling of the metal in the mold.

Among various casting products, generally they are sorted into two groups: cast-ingot and cast-to-shape. These cast products are manufactured by two major techniques known as sand casting (expendable-mold) and permanent-mold casting (non-expendable-mold casting).

8.1 Sand Casting

Sand casting (expendable-mold casting) refers to molds that have to be broken to remove the cast pieces from the non-reusable molds. The materials for the casting molds are various, typically including sand, plaster, ceramics, resins, polystyrene foam, and even wax.

Sand casting makes use of a shaping-pattern (molding-box) actually filled with a mixture of sand grains (90%), water (7%), and other materials. The mixture is usually called "green" or "wet" sand. The cost of green sand molding is relatively low, and the sand can be easily recycled for later use. In the sand molding process, when the set of mold is placed in position, the molten metal then is poured into it. After the metal solidifies, the mold is broken and the casting is removed. The advantage of this method is that it has less limitation to the size and shape of the products.

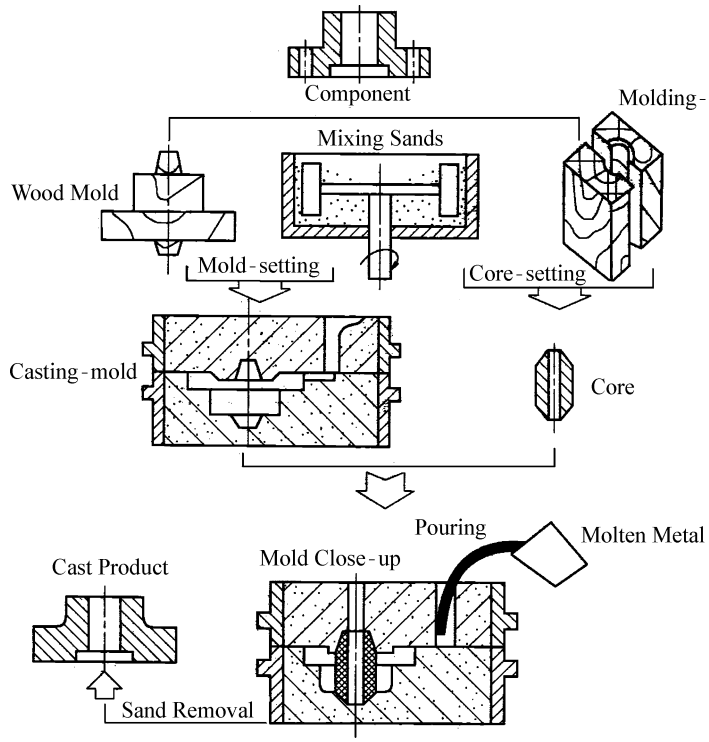


Fig. 8-1 Sand-casting Process

The dry sand casting is somewhat similar to the green sand casting. The common dry sand mold is basically a set of cavity and core system. This process is usually used to produce smaller parts or cast-to-shape.

8.2 Permanent-mold Casting

Permanent-mold casting is also called special casting, as its name implies, involving the molds that can be used repeatedly after the removal of the cast materials. Die casting is probably the most well-known

special casting process. In this process, molten metal is forced to fill the die cavity under high pressure. Once the material has been solidified by cooling system, the die is opened to ease the cast part, and a lubricant is sprayed on the inside of the die for the next casting.

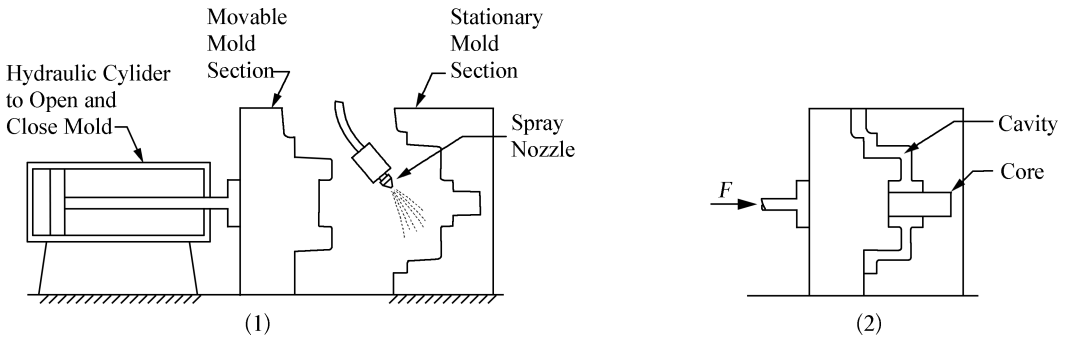


Fig. 8-2

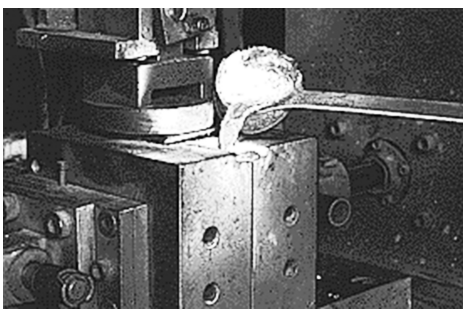


Fig. 8-3 Pour Molten Metal

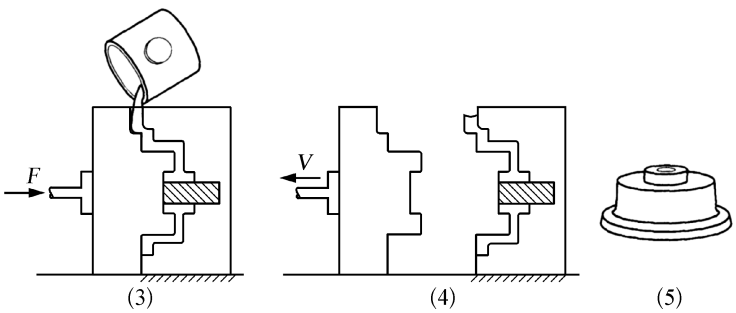


Fig. 8-4 Finished Part

The major advantages of die casting are: the mold or die can be used repeatedly; the surface finish is quite smooth; and products have excellent dimensional accuracy. Although this method is costly, it is economical for large production run. At the same time, the mold can be used to replicate certain intricate and complex patterns ranging from small to large pieces.

Another common permanent-mold-casting technique is centrifugal casting (Fig. 8-5). This process is an optimistic choice for manufacturing relatively large and bulk parts, such as pipes, hollow shafts, long sleeves and so on. In the casting operation, the molten material is poured into a rotating mold, the axial rotation can be either horizontal or vertical.

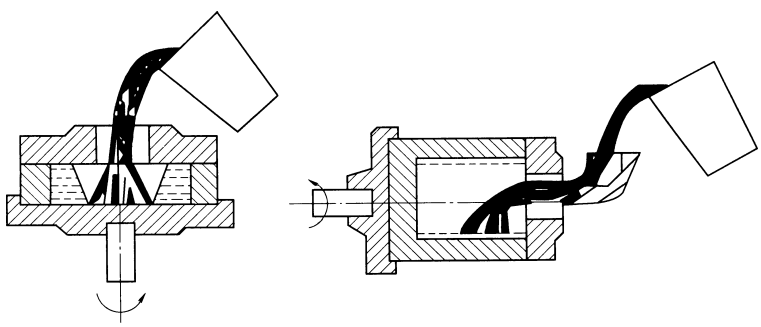


Fig. 8-5 Centrifugal Casting Process

New Words

1. **bulk** /bʌlk/ *n.* 大小；体积；大批；大多数；散装
2. **erosion** /ɪ'rəʊʒən/ *n.* 腐蚀
3. **imply** /ɪm'plaɪ/ *v.* 暗示，暗指
4. **intricate** /'ɪntrɪkɪt/ *a.* 错综复杂的
5. **optimistic** /ˌɒptɪ'mɪstɪk/ *v.* 乐观的
6. **plaster** /'plɑːstə/ *v.* 粘贴；*n.* 灰泥；石膏
7. **pour** /pɔː, pɒə/ *v.* 涌出
8. **replicate** /'replɪkɪt/ *v.* 复制；重复
9. **spray** /spreɪ/ *v.* 喷射
10. **wax** /wæks/ *n.* 蜡；*v.* 给…打蜡

Technical Expressions

1. **cast-ingot** 铸锭
2. **cast-to-shape** 精密铸造
3. **centrifugal casting** 离心铸造
4. **dry sand casting** 干型铸造
5. **expendable-mold** 消耗性模具
6. **green sand casting** 湿型铸造
7. **lubricant** 润滑剂［油］
8. **metal casting** 金属铸件
9. **permanent-mold** 永久模
10. **polystyrene-foam** 聚苯乙烯泡沫塑料
11. **resin** 树脂，松香
12. **sand-casting** 砂模铸造；翻沙
13. **sleeves** 吸水管；套管
14. **thermal fatigue** 热疲劳

Notes

1. ... it is still an important process adaptable to intricate shapes, the largest bulk of parts and very small pieces.
… 它仍然不失为一种用于复杂成型，从体积极大零件的生产到很小的工件均能加工的重要工艺。

2. All processes of metal casting are based on three fundamentals: pouring molten metal into a mold, cooling and solidification; withdrawing the cast product from the mold.
所有金属铸造工艺都基于三个基本要素：将熔融金属浇入型腔；冷却和凝固；从模具中取出铸件。

3. ... however, two important considerations in casting operation should be taken into, that is, ...
… 然而，在铸造过程中，应考虑两个重要因素，即：…

4. Expendable-mold casting refers to molds that have to be broken to remove the cast pieces from the non-reusable molds.
消耗性铸造是指该铸造工艺所使用的模具不能重复使用，因在取出工件时不得不破坏模具。

5. Sand casting makes use of a shaping-pattern (molding-box) actually filled with a mixture of sand grains (90%), water (7%), and other materials.
砂型铸造所使用的型砂，其实是一个由混合物，包括砂粒（90%）、水（7%）和其他材料所构成的“砂箱”。

6. The cost of green sand molding is relatively low, and the sand can be easily recycled for later use.

使用绿砂 (湿砂) 成型的成本比较低，沙子可以很容易地回收以供日后使用。

7. Permanent-mold casting is also called special casting, as its name implies, involving the molds that can be used repeatedly after the removal of the cast materials.
永久模铸造也称特种铸造，顾名思义，就是指铸件取出后其模具仍可以反复使用。

8. Although this method is costly, it is economical for large production run.
尽管该工艺成本不菲，但若大批量生产是非常经济的。

9. ... the mold can be used to replicate certain intricate and complex patterns ranging from small to large pieces.
… 模具可用来重复生产某些结构复杂、难度极高、规格大小不一的各类工件。

10. Another common permanent-mold-casting technique is centrifugal casting.
另一种常用的永久模铸造工艺就是离心铸造。

11. In the casting operation, the molten material is poured into a rotating mold, the axial rotation can be either horizontal or vertical.
在铸造过程中，熔融材料被注入旋转模具中，轴的转动既可以横向也可以纵向。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. Casting is a mass production process which involves molten materials being poured into a mold, allowed to solidify and then extracted for use.
2. As its name implies, expendable mold casting makes use of expendable molds for the casting process.
3. Casting process can be used to manufacture complex parts which would prove too expensive or time-consuming to produce using other methods such as cutting or shaping these from solid materials.
4. Casting can be thought of as a method for reproducing something — whether a mere part or a single unit by itself.
5. The term “green” refers to the fact that the sand in the mold is moist while the metal is being poured into it.
6. In the casting operation, the molten material is poured into a rotating mold, the rotation of the axis should be horizontal.
7. Although die casting method is costly, it is uneconomical for large production run.
8. Once the material has been solidified by room temperature, the die opens automatically to eject the cast part.

II. Match the items listed in the following columns.

1. optimistic	a. spendable
2. replicate	b. being away from the centre of ...
3. spray	c. complicated
4. imply	d. majority
5. plaster	e. to make a substance flow out of a container
6. pour	f. to stick
7. bulk	g. to hint
8. intricate	h. liquid sent through the air in tiny drops
9. centrifugal	i. copy
10. expendable	j. expecting something good to happen

III. Fill in each blank with a proper word beginning with the letter given.

Ejection

Technically, all thermoplastic materials contract 1. a_____ solidification. This means that when a moulding cools, it will shrink, which makes it 2. d_____ to remove from the core.

If a moulding has no core for 3. i_____ form, the moulding will shrink off the cavity walls by a simple ejection 4. d_____. Generally, the amount of shrinkage 5. d_____ on the required material.

If a moulding has an internal form, when it 6. c_____, it contracts and sticks onto the core. Thus, an ejector system in a mould is 7. n_____.

However, in normal practice, several positive ejection means are 8. a_____ depending on the shape of the moulding. The 9. c_____ ejection techniques are: pin ejection, bar ejection, air ejection, blade ejection and sleeve ejection as 10. w_____.

IV. Translation (Chinese to English).

1. 传统的铸造工艺仍然是当今用于生产形状复杂、体积大小不一的零部件的重要方法之一。**(adaptable for)**
2. 肖氏熔模铸造工艺比较适用于生产专业模具的型芯与型腔。**(applicable to)**
3. 理论上讲，用同一模具生产的零件属于可互换零件。**(identical)**
4. 非消耗性铸造技术可以用来复制从小到大错综复杂的模式。**(range from ... to)**

Section B: Plastic Molding

Plastic products are made of organic materials called polymers. While there are many methods of molding products with these materials, such as hot compression molding, injection molding, cold molding, casting and so on. Products shaped by methods like these basically depend on the design of molds.

8.3 The Molding System

A common plastic mold system has three basic parts: the moving half unit; the cavity section and the feed system.

In the halves units, the moving half is attached to the moving platen of the machine, while the fixed half (the floating cavity plate) is amounted on the stationary platen. Usually, the core is located in the moving section, and the other half is designed for fixing the cavity.

However, the majority of molds consist of two plates: namely, the cavity plate and the core plate. The former is used for shaping the outside form of a product, and the core plate forms its inside shape. When the two plates work identically together, an impression (a space) is left between the cavity and the core. It is the impression that gives the molding a shape.

The feed system is also called flow-way system. It includes a sprue, runner and gate. When the granular material is heated, the molten plastic passes through the sprue, the runner, the gate, and then is injected down to the impression, wherein the shapes are formed (Fig.8-6).

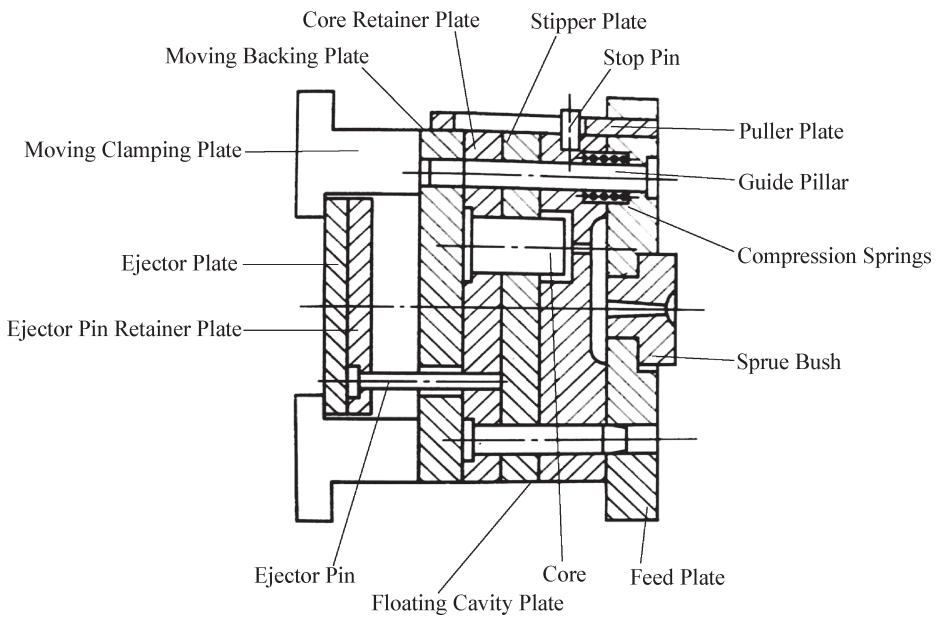


Fig. 8-6 Underfeed Mold

8.4 The Injection Molding

Similar to the principle of die casting, injection molding method is applied for the production of thermoplastic parts. When thermoplastic material is fed from the hopper and melts into a semi-liquid state, it is injected into the mold cavity. After a short period of cooling, the plastic solidifies in the impression and the part is consequently ejected with the mold open. However, all thermoplastics contracts after cooling and solidification, which makes the molding difficult to remove.

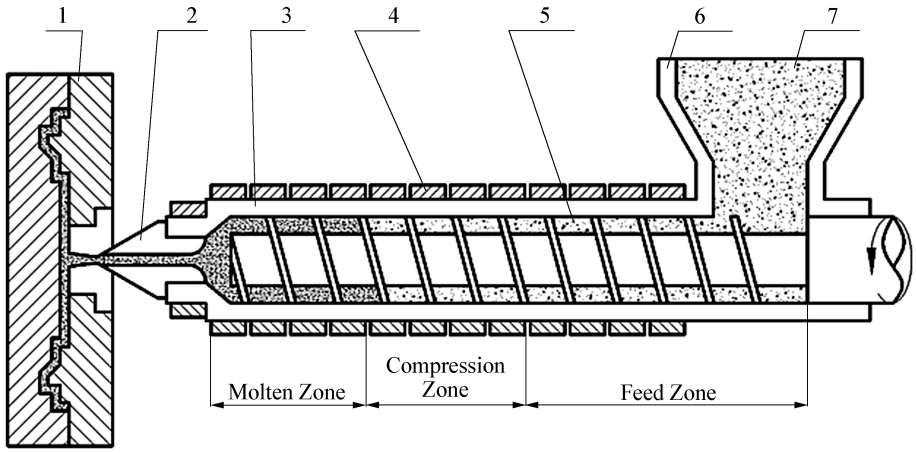


Fig.8-7 Injection-molding Process

1. Mold 2. Nozzle 3. Barrel 4. Heaters 5. Extrusion Screw 6. Feed Hopper 7. Raw Plastic

Owing to the improvement of injection molding machines, this process can be widely used for mass production of parts with good surface finish and high accurate dimension. Take the example of molding threaded components, costly labor and accuracy of both the internal and external threads make the maximum use of automatic operation. So in modern production, it is necessary for an engineer to choose an optimistic ejection technique to satisfy the special requirements of the products.

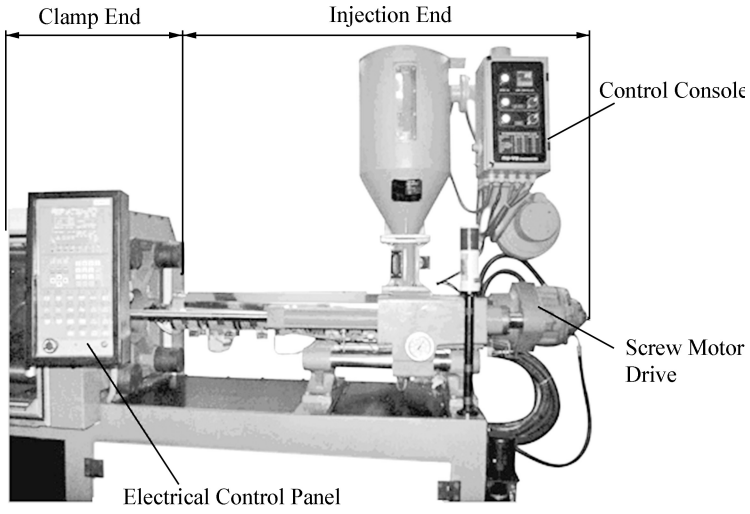


Fig. 8-8 Injection-molding Machine

New Words

1. **contract** /kən'trækt/ *v.* 收缩
   /'kɒntrækt/ *n.* 合同
2. **granular** /'grænjʊlə/ *a.* 颗粒状的
3. **impression** /ɪm'preʃən/ *n.* 成型腔；印象
4. **mass** /mæs/ *n.* 大批量；群众
5. **mold** /məʊld/ *v.* 制模；塑造
   n. 模；铸模
6. **platen** /'plætən/ *n.* 压板；平板
7. **semi-liquid** /ˌsemɪ'lɪkwɪd/ *n.* 半流体
8. **thread** /θred/ *n.* 螺纹；线

Technical Expressions

1. **cavity** 型腔
2. **cold molding** 冷模塑；冷压
3. **compression molding** 模压成型
4. **core** 型芯
5. **gate** 浇口
6. **hopper** 装料斗
7. **injection molding machine** 注塑机
8. **injection molding** 注模；注射成型
9. **runner** 分流道
10. **sprue** 主流道

Notes

1. While there are many methods of molding products with these materials, such as hot compression molding, injection molding, cold molding, casting and so on.
   然而，使用这类材料成型产品的方法有很多，如：热压缩成型、注塑成型、冷成型、铸造等。

2. In the halves units, the moving half is attached to the moving platen of the machine, while the fixed half (the floating cavity plate) is amounted on the stationary platen.
   在模具的这两个部件中，动模部分固定在注塑机的移动板上。而定模部分（浮动型腔）则安装在固定板上。

3. Usually, the core is located in the moving section, and the other half is designed for fixing the cavity.
   通常，型芯安装在动模部分， 而定模则用来安装型腔。

4. When the two plates work identically together, an impression (a space) is left between the cavity and the core.
   当两部分同时向一处挤压，型芯与型腔之间留出的空间就是成型腔。

5. When the granular material is heated, the molten plastic passes through the sprue, the runner, the gate, and then is injected down to the impression.
   当颗粒材料加热后，熔融塑料首先通过主流道、分流道，然后到达浇口，随即被注入到型腔内。

6. Similar to the principle of die casting, injection molding method is applied for the production of thermoplastic parts.
   与压力铸造原理相同，注塑成型方法适用于生产热塑性部件。

7. After a short period of cooling, the plastic solidifies in the impression and the part is consequently ejected with the mold open.
   短期内冷却后，塑料在型腔内固化后，型腔打开，塑件也被随后弹射出来。

8. ... costly labor and accuracy of both the internal and external threads make the maximum use of automatic operation.
   … 昂贵的劳动成本及内外螺纹的精准性，都要求最大程度地使用机械自动操作。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. If the molding has an internal form, _____ after solidification and a positive type of ejection is necessary.
   A. it will shrink on to the cavity
   B. it will expand outside of the core
   C. it will shrink onto the core
   D. it will expand inside the cavity
2. A cavity is the male portion of the mould, _____.
   A. which decides the internal shape of the casting
   B. which decides the external shape of the casting
   C. which decides the dimension of the casting
   D. which decides the accuracy of the casting
3. The “impression” of a mould is the space where _____.
   A. the internal shape of the mould is formed
   B. the external shape of the mould is formed
   C. all shapes of the mould are formed
   D. both the internal and external shape of the mould are formed
4. A gate is an entrance through which molten plastic _____.
   A. is forced into the core
   B. enters the cavity
   C. is guided into the impression
   D. is pulled from the cavity
5. When a casting cools, it will shrink, the amount of shrinkage generally depends on _____.
   A. the dimension of the cavity
   B. the design of the mould
   C. the material being processed
   D. the ejection method

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

stationary	contract	attached to	majority
adapted to	taken into	similar to	injected into

1. Transfer molding process is _____ the injection molding which avoids some of the disadvantages of hot molding.
2. In the molten stage, the thermoplastic material is delivered to the nozzle and _____ the cavity.
3. The stripping design (外模设计) can be _____ the fast production of components with roll threads.
4. The split design (拼块设计) may be _____ consideration for external threaded components.
5. The other half of the mold _____ the moving platen of the machine is the moving half for the core situation.
6. A _____ object is easy to be aimed at.
7. The draft resolution for improving working environment was adopted by a _____ of the workers.
8. All thermoplastic materials _____ as they become cool.

III. Translation (English to Chinese).

1. The ejector grid is that part of the mould which supports the mold plate and provides a space into which the ejector plate assembly can be fitted and operated.
2. During the injection process, the molten plastic is injected from the nozzle of the machine, then it is transferred to the impression through a sprue.
3. In transfer molding, the product is formed not so much by pressure as by the free low of the melted plastic.
4. During molding an even-walled part, it is necessary to ensure that the cavity and core are corrected in alignment.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. Injection molding is mainly used for the production of the thermoplastic parts, although some progress has been made in _____ a method for injection molding some thermosetting materials.
2. Of the many manufacturing processes available for preparing moulds only two are _____ used in a case.
3. To maintain the required temperature differential between the mould and plastic material, water is _____ through holes or channels within the mould.

4. The _____ of a circuit is often complicated by the fact that flow ways must not be drilled too close to any other hole in the same mould plate.
5. Although casting is a _____ process in the world for manufacturing workpieces as well as precision parts, it is still an important process.
6. Sand casting makes use of a shaping-pattern actually filled with a _____ of sand grains, water, and other materials.
7. Once the material has been solidified by _____ system, the die is opened to ease the cast part.
8. In the casting _____, the molten material is poured into a rotating mold, and the axial rotation can be either horizontal or vertical.
9. Usually, the core is _____ in the moving section, and the other half is designed for fixing the cavity.
10. In modern production, it is necessary for an _____ to choose an optimistic ejection technique to satisfy the special requirements of the products.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

Permanent-mold casting ___1___ the molds that can be used repeatedly after the removal of the cast materials. Die casting is probably the most ___2___ casting process. In this ___3___, molten metal is forced to fill the die cavity under high pressure. Once the material has been solidified by cooling system, the die is ___4___ to ease the cast part, and a lubricant is sprayed on the ___5___ of the die for the next casting. ___6___ die casting is costly, it is economical for large production run. At the same time, the mold can ___7___ replicate certain intricate and complex patterns ranging from small to large pieces. Another main permanent-mold-casting ___8___ is centrifugal casting. This process is an ___9___ choice for manufacturing relatively large and bulk parts, such as pipes, hollow shafts, long sleeves ___10___.

III. Read aloud the following paragraph.

Similar to the principle of die casting, injection molding method is applied for the production of thermoplastic parts. When thermoplastic material is fed from the hopper and melts into a semi-liquid state, it is injected into the mold cavity. After a short period of cooling, the plastic solidifies in the impression and the part is consequently ejected with the mold open. However, all thermoplastics contracts after cooling and solidification, which makes the molding difficult to remove.

Part III Practical Writing

Write a paragraph to introduce the sand casting in your own words according to the given information.

1. sand casting (expendable casting)
2. pouring molten metal into a sand mold
3. cooling and solidification
4. withdrawing the cast product from the mold

Unit 9

NC and CNC

Part I Reading and Translating

Section A: Numeral Control (NC)

9.1 Control System of NC Machine Tools

9.2 Machining Center

Exercises

Section B: Computerized Numeral Control (CNC/DNC)

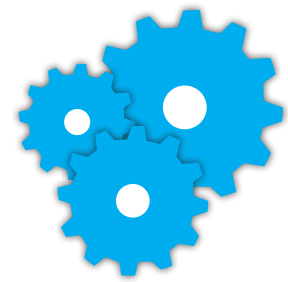
9.3 Closed-loop Control vs. Open-loop Control

9.4 DNC vs. CNC

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: Numeral Control (NC)

With the emphasis on automation in industry, numerically controlled systems for machines are gradually replacing the human machine operator. Numeral control refers to the operation of machine tools by means of programmable instructions or programmable automation. The most commonly used NC machines are program-controlled, because the information has been stored on memory devices (floppy disks, magnetic tape or random-access memory). In NC machining process, the programmed information on a memory device is converted into numeral data blocks. The reading device with the control unit recognizes the data blocks at a fast speed and interprets them into operating instructions. Thus, according to the instructions, a specific machine tool is directed to machine the raw material into a desired part.

9.1 Control System of NC Machine Tools

As far as the operating systems are concerned, NC machine tools fall into two basic types: point-to-point and contouring (continuous-path).

The point-to-point control system is also called positioning control system (Fig. 9-1). NC machine tools of this type are equipped with unsynchronized motors and programmed to move only along a straight line. In a point-to-point control, a cutting tool and a workpiece are positioned sequentially before a cutting work is engaged, but the path between points is not particularly important. Thus, point-to-point control systems are simple and less expensive, mainly used for straight-line cut, drilling, straight milling, and boring operations.

The contouring control systems are normally controlled by computers. They have the capability of moving the workpiece or cutter from point to point along a straight line, or along the instructed paths with different velocities (Fig. 9-2).

Compared to those point-to-point NC machine tools, in contouring system, the positioning control of the tool and the movement along the coordinate axes at proportional speeds are necessarily concerned. These control systems are more expensive, and are only equipped in complex machinery like lathes, milling machines and machine centers.

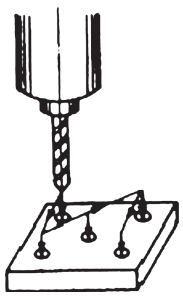


Fig. 9-1 Point-to-point

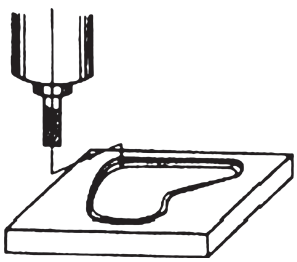


Fig. 9-2 Contouring

9.2 Machining Center

Machining center is also called tool changers, where different cutting tools are equipped for automatic changes. As in the case of machining a part, several different cutting tools are needed. When the program calls for a required tool for the next machining process, the change operation must be completed in seconds under the instruction. Thus, the machine can proceed to do the following work without interference.

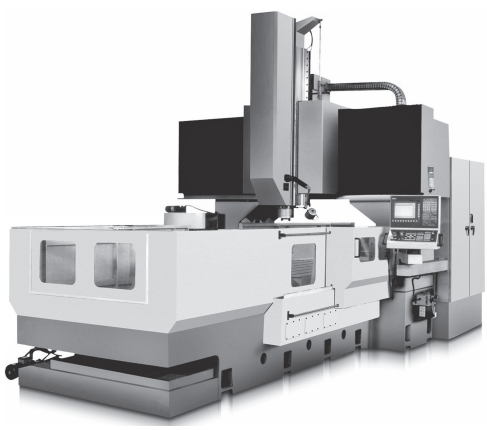


Fig. 9-3-4 Horizontal Machining Centers

A modern horizontal machining center (Fig. 9-3-4) can store 200 or more tools in its magazine. As each of the cutting tools is coded, it can be indexed automatically into waiting position. When an instruction for tool change is received, the automatic tool changer quickly removes the used tool from the spindle, and inserts the newly-selected one to replace it. On NC machine tools, the turret or magazine can rotate, either clockwise or counterclockwise. Automatically, the former tool is placed in the turret or magazine in preparation for the next selection.

New Words

1. **clockwisely** /'klɒkwaɪzlɪ/ *a.* 顺时针方向的
2. **convert** /kən'vɜːt/ *v.* （使）转变，（使）转化
3. **coordinate** /kəʊ'ɔːdɪnɪt/ *v.* 使协调; 使调和
4. **emphasis** /'emfəsɪs/ *n.* 强调；重点
5. **index** /'ɪndeks/ *n.* 索引
6. **insert** /ɪn'sɜːt/ *v.* 插入，嵌入
7. **interference** /ˌɪntə'frərəns/ *n.* 干涉；介入
8. **magazine** /ˌmægə'ziːn/ *n.* 链式刀库；期刊
9. **proceed** /prə'siːd/ *v.* 前进; 行进
10. **programmable** /'prəʊgræməbl/ *a.* 可设计的；可编程的
11. **proportional** /prə'pɔːʃənl/ *a.* 比例的；成比例的
12. **unsynchronized** /ʌn'sɪŋkrənaɪzd/ *a.* 非同步化的

Technical Expressions

1. **automatic tool changer** 自动换刀装置
2. **floppy disks** 软磁盘
3. **machining center** 加工中心
4. **magnetic tape** 磁带
5. **memory device** 存储器
6. **random-access memory** 随机存储
7. **unsynchronized motor** 异步电机

Notes

1. Numeral control refers to the operation of machine tools by means of programmable instructions or programmable automation.
数控是指运用可编程指令技术（也称可编程自动化技术）来操作机床。

2. The reading device with the control unit recognizes the data blocks at a fast speed and interprets them into operating instructions.
控制单元的阅读装置快速识别数据程序块并将其转换成操作指令进行操作加工。

3. As far as the operating systems are concerned, NC machine tools fall into two basic types: point-to-point and contouring (continuous-path).
就操作系统而言，数控机床分为两种基本类型：即点位控制系统（也称位置控制）和连续控制系统（也叫连续路径控制）。

4. In a point-to-point control, a cutting tool and a workpiece are positioned sequentially before a cutting work is engaged, but the path between points is not particularly important.

使用点位控制型机床时，刀具及工件在切削前依次安装到位，而点与点间的路径倒不十分重要。

5. Compared to those point-to-point NC machine tools, in contouring system, the positioning control of the tool and the movement along the coordinate axes at proportional speeds are necessarily concerned.
与点位控制型机床相比，在连续控制系统中，刀位的控制及其沿坐标轴所做的匀速运动都必须要考虑到。

6. When the program calls for a required tool for the next machining process, the change operation must be completed in seconds under the instruction.
当程序要为下一道工序换刀时，在换刀指令下达后，换刀操作需在几秒钟内完成。

7. Thus, the machine can proceed to do the following work without interference.
因此，机器在不受干扰的情况下，继续着手随后的工作。

8. As each of the cutting tools is coded, it can be indexed automatically into waiting position.
由于刀库中的刀具都是按编码录入程序的，因此，它能自动完成检索，并处于待换状态。

9. Automatically, the former tool is placed in the turret or magazine in preparation for the next selection.
前一次用过的刀具被自动安置在刀架上或刀库中以备下次选用。

Exercises

I. Tell whether each of the following statements is True (T) or False(F).

1. In NC operations, data concerning all aspects of the machining operations are stored on paper or magnetic tapes, hard disks, or direct computer information.
2. Point-to-point systems are generally used on drilling and simple milling machines where straight-line cutting wok is operated.
3. A continuous-path machine requires a computer to aid programming when machining complex contours.
4. In a point-to-point control, a cutting tool and a work-piece are positioned sequentially before a cutting work is engaged, but the path between points is not particularly important.
5. One of the limitations of the numeral control system is that machine adjustments are difficult to make.
6. The NC machine tools are so advanced that the preventive maintenance is not necessary.
7. The mechanical hand removes the next tool to be used from the turret and places it in the interchange station in preparation for the next operation.
8. On NC machine tools, the turret can rotate in either direction, clockwise or counterclockwise.

II. Match the items listed in the following columns.

1. blueprint	a. put or introduce into something
2. index	b. in the direction the hands of a clock rotate
3. convert	c. storage
4. velocity	d. continue
5. proportional	e. intervention
6. interference	f. properly related in size
7. proceed	g. speed of motion
8. magazine	h. change
9. insert	i. an alphabetical list
10. clockwise	j. technical drawings

III. Fill in each blank with a proper word beginning with the letter given.

Principles of Location

In NC machining process, it is necessary to define the three rotational axes. As each axis of motion is 1. c_____ by a separate driving source, the required movement of tools and workpieces is 2. o_____.

With the three axes of 3. m_____, a workpiece can move in either of two 4. o_____ directions. The three axes are 5. r_____ to as the *x*, *y* and *z*. The *z* axis is perpendicular to both the *x* and *y* 6. a_____. In addition, the workpiece can rotate in either direction, clockwise or 7. c_____ around each axis. The workpiece may be located 8. p_____ by six points of contact in the fixture. These six points possess three points on a plane. The three-point locations prevent the workpiece from moving 9. d_____ and from rotating around the *x* and *y* axes. Following this 10. p_____, all the locating points on each plane are specified, and unwanted movements and rotations are prevented in these locators.

IV. Translation (Chinese to English).

1. 在数控车床上， 每一根运动轴都配有单独的电机。**(equip ... with)**
2. 在点位控制时，刀具行进路径的选择并没得到特别的关注。**(concern)**
3. 数控车床中的刀架或刀库既可顺时针转动，也可以逆时针转动。**(either ... or)**
4. 当代数控机床十分复杂，因此，保养尤为重要。**(so ... that ...)**

Section B: Computerized Numeral Control (CNC/DNC)

The first decade of the 21st century witnesses China's CNC stepping into a new stage. Today's machine tools have microcomputers to control the machining processes. With software to replace hardware, any machine tool with Computer Numerically Control system performs much better and is more versatile where traditional NC systems may fail.

A typical CNC machine tool includes: a computer, control system, drive motors and tool changers. Although the type of the control system is different between CNC and the NC systems, their work principles are basically similar. By comparison, direct numeral control (DNC) after the development of CNC is another technology around us now.

9.3 Closed-loop Control vs. Open-loop Control

The open-loop control system is also called non-feedback control system. This implies that this system is unable to compare the actual operating conditions with the input signals.

Most of the traditional NC machines use open-loop control systems, in which the movement pulses are sent out to a stepper motor. The stepper motor controls the amount of the rotation of the motor according to the pulses received. Since the compensation for the errors between the input and output signals does not exist, this system lacks accuracy. Unfortunately, it is only used for simple work such as drilling and straight-line cutting operations.

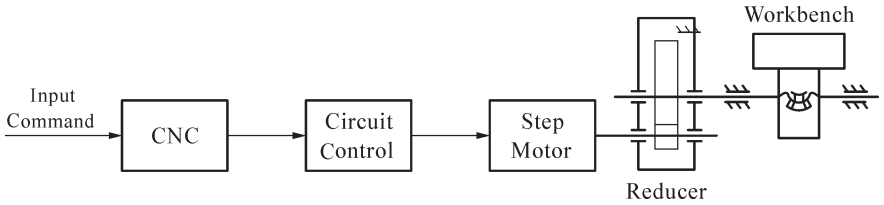


Fig. 9-5 An Open-loop Control System

Different from the open-loop control system, the closed-loop control system has a feedback checking device on the work table. With this device, the information of the actual location of the moving slides on the machine is directly relayed back to the control unit. Thus, the output signals are automatically compared with the input signals, if any deviation exists between them, it will sequentially be rectified.

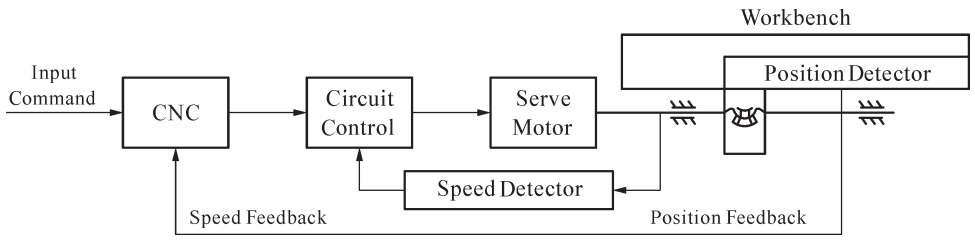


Fig. 9-6 A Closed-loop Control System

Semi-closed-loop control is another kind of closed-loop control system. Its feedback checking device (speed-feedback and position-feedback sensors) is installed directly on the serve-motors, along with the photoelectric encoder to construct the semi-closed-loop. In the case of C6160, the newly-innovated digital control machine tool based on Siemens 802D NC is a typical model in the use of the semi-closed-loop control system. Thanks to the lower cost and higher precision, this kind of control system is very suitable for small and medium-sized CNC machine tools in China.

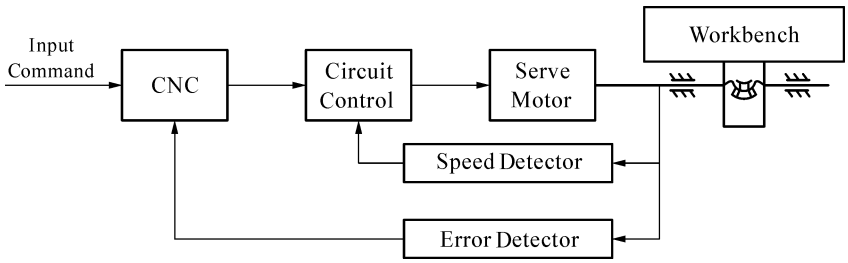


Fig. 9-7 A Semi-loop Control System

9.4 DNC vs. CNC

A modern CNC machine tool has a minicomputer installed in the control unit. When the control unit is connected to the machine tool, the graphical user interface is completed by programming the computer — not by hardware operating.

As CNC systems use binary system as their programming language, the computer can easily turn the binary codes into electronic pulses to the serve-motors, when the execution cycle is on. Accordingly, the control unit of the CNC machines automatically compares the number of the input pulses with the received ones. When the pulses are received, the serve-motors will automatically convert them into rotation to drive lead screws and gear mechanism.

CNC machines require little human intervention at work, and even an unskilled worker can easily operate them. In the case of machining a component, when the button is pressed, the CNC machine tool moves automatically from one machining operation to another, changing the cutting tools and applying coolant until the workpiece is machined according to the highest quality standards.

Fortunately, the latest progress in digital control system has made flexible manufacturing more popular in manufacturing industry.

When speaking of the direct numerical control (DNC), what we really mean is the next development after CNC. In this system, a number of NC or CNC machines are connected together and controlled directly by a remote central computer. Through a remote terminal, the operator can get access to the central computer by entering password. Vice versa, the operating status of all machine tools can be monitored and assessed from the central computer. Owing to the onboard microcomputers with large memory, even if the central computer shuts down, the individual machine tool can still satisfy the manufacturing process.

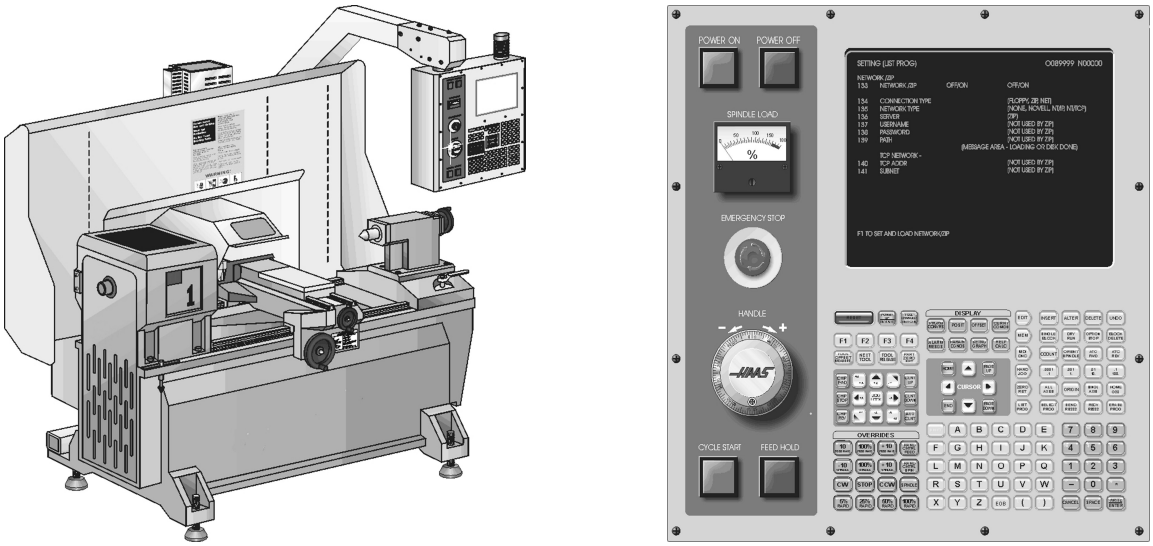


Fig. 9-8-9 A Computer Numerical Control Lathe

New Words

1. **access** /'ækses/ *n.* 通道；数据库
2. **assess** /ə'ses/ *v.* 评估
3. **compensation** /ˌkɒmpen'seɪʃən/ *n.* 补偿；酬金
4. **decade** /'dekeɪd/ *n.* 十年，十年间
5. **deviation** /ˌdiːvɪ'eɪʃən/ *n.* 偏差；误差
6. **digital** /'dɪdʒɪtl/ *a.* 数字式的；数码的
7. **feedback** /'fiːdbæk/ *n.* 反馈；反馈信息
8. **individual** /ˌɪndɪ'vɪdjʊəl/ *n.* 个体；*a.*个体的
9. **innovate** /'ɪnəʊveɪt/ *v.* 革新，创新
10. **intervention** /ˌɪntə(ː)'venʃən/ *n.* 介入；干预
11. **monitor** /'mɒnɪtə/ *n.* 监控器；(学校)班长
12. **rectify** /'rektɪfaɪ/ *v.* 改正；矫正
13. **relay** /'riːleɪ/ *n.* 传送；接力
14. **witness** /'wɪtnɪs/ *v.* 见证；目击
n. 目击者；证人

Technical Expressions

1. **binary system** 二进制
2. **closed-loop control system** 闭环控制系统
3. **digital control system** 数字（码）控制系统
4. **execution cycle** 执行循环
5. **graphical user interface** 图形用户界面
6. **open-loop control system** 开环控制系统
7. **photoelectric encoder** 光电编码器
8. **remote terminal** 远程终端
9. **semi-closed-loop control system** 半闭环控制系统

Notes

1. The first decade of the 21st century witnesses China's CNC stepping into a new stage.
21世纪的头十年目睹了中国的CNC机床步入了一个新的阶段。

2. With software to replace hardware, any machine tool with Computer Numerically Control system performs much better and is more versatile where traditional NC systems may fail.
由于控制系统软件替代了硬件，所谓的计算机数控系统无论是工作性能还是使用功能方面都更加优越，相比之下，传统的数控系统却难以做到。

3. Although the type of the control system is different between CNC and the NC systems, their work principles are basically similar.
尽管 CNC 与 CN 控制系统不是同一类别，但它们的工作原理基本类似。

4. The stepper motor controls the amount of the rotation of the motor according to the pulses received.
步进电机根据接收到的信号量来控制电机的旋转角度。

5. Since the compensation for the errors between the input and output signals does not exist, this system lacks accuracy. Unfortunately, it is only used for simple work such as drilling and straight-line cutting operations.
由于输入与输出信号间的误差不能修正，因此，该控制系统缺乏精准性。令人遗憾的是，它只适合从事一些类似钻削及直线切削的简单加工工作。

6. With this device, the information of the actual location of the moving slides on the machine is directly relayed back to the control unit.
有了这套装置，机床移动滑台的实际工位信息就会直接传回控制系统。

7. Its feedback checking device (speed-feedback and position-feedback sensors) is installed directly on the serve-motors, along with the photoelectric encoder to construct the semi-closed-loop.
伺服电机上直接装有检测反馈装置（速度反馈环与位置反馈环传感器），与光电编码器一起构成半闭环。

8. In the case of C6160, the newly-innovated digital control machine tool based on Siemens 802D NC is a typical model in use of the semi-closed-loop control system.
以C6160 机床为例，基于西门子802D数控机床而新改进的数字控制机床，就是使用半闭环控制系统的典型机床。

9. When the pulses are received, the serve-motors will automatically convert them into rotation to drive lead screws and gear mechanism.
当接收到脉冲信号，伺服电机便自动将其切换成旋转运动以驱动丝杠及齿轮装置。

10. Fortunately, the latest progress in digital control system has made flexible manufacturing more popular in manufacturing industry.
幸运的是，数字控制方面的最新成就使得柔性制造更加普及。

11. Vice versa, the operating status of all machines can be monitored and assessed from the central

computer.
反过来，所有机器的工作状况都可以通过中央计算机进行监测和评估。

12. Owing to the onboard microcomputers with large memory, even if the central computer shuts down, the individual machine tool can still satisfy the manufacturing process.
由于机载微机拥有强大的存储功能，即使中央计算机系统关机，每台机床也能满足加工过程。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. The difference between NC and CNC systems _____.
   A. may be the types of drive motors
   B. is the requirement of the additional hardware and electronics
   C. is the position measuring system
   D. may be the way in which the execution is controlled
2. If a system lacks more accurate and more adaptable control, it may be of _____.
   A. open-loop control system
   B. semi-closed-loop control system
   C. half open-loop control system
   D. closed-loop control system
3. The machine tools with semi-closed-loop control system are very popular in China owing to _____.
   A. being more efficient and less expensive than the closed-loop system
   B. being most economical and simplest
   C. lower cost than the closed-loop control system and higher accuracy than the open-loop control system
   D. being easy to start up and operate
4. If an NC machine tool is performed under computer supervision, _____.
   A. it is called closed-loop control system
   B. it must be equipped with feedback system
   C. it is called CNC machine tool
   D. it must be a DNC machine tool
5. When the central computer shuts down, _____.
   A. all of the machine tools in the whole system are dead
   B. the CNC machine tools can still function
   C. only the CN machines work
   D. only the machine tools with DNC can carry out the manufacturing process

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

has witnessed	by comparison	lack of	based on
thanks to	access to	intervention	individual

1. CNC machines require minimum operator's _____, and even an unskilled worker can easily operate them.
2. _____ Siemens 802D NC, this control is perfectly suitable for turning and milling machines in the lower and medium performance range.
3. Unfortunately, open-loop control systems _____ accuracy, and they are used only in the simplest type of applications.
4. _____ the development of computer technology, the machining industry has realized Computer-Aided Manufacturing.
5. _____, CNC machine tools are more productive and competitive.
6. Advances in computing and communications provide _____ Web Database and public Web page via the Internet to students and adults all over the world.
7. Technically, each type of CNC machine tools has its own _____ feature.
8. This century _____ machinery to become more automated in the manufacturing process.

III. Translation (English to Chinese).

1. The requirements for tolerance of a precision in ten thousand make the best human mechanic reach the limited class of their ability.
2. Alternative current (AC) serve motors are used to drive lead screws and gear mechanism by varying the voltage frequency to control speed.
3. Processing center is a high degree of integration of mechanical and electrical products. When a workpiece is clamped, the CNC machine tool automatically controls the selection of different processes, and completes the whole work, such as drilling, boring, milling, hinges, tapping, and other processes.
4. With the advances in computer technology, modern CNC machine tools require little human intervention at work, and even an unskilled worker can easily operate them.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recording.

1. Numeral control _____ to the operation of machine tools by means of instructions, also called programmable automation.

2. The reading device with the control unit recognizes the data blocks at a fast speed and _____ them into operating instructions.
3. Based on the instructions, a specific machine tool is directed to machine the raw _____ into a desired part.
4. In a _____ control, a cutting tool and a work-piece are positioned in time order before a cutting work is engaged.
5. The contouring control systems, which have the capability of moving the workpiece or cutter, are normally controlled by _____.
6. The control systems are more _____, only equipped in complex machinery like lathes, milling machines and machine centers.
7. Machining center is also called the _____ changer, where different cutting tools are equipped for automatic changes.
8. With software to replace _____, any machine tool with Computer Numeral Control system performs much better.
9. Most of the _____ NC machines use open-loop control systems where the movement pulses can be sent out to a stepper motor.
10. Different from the open-loop control system, the closed-loop control system has a _____ checking device on the work table.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

As CNC systems use such a system as ___1___ programming language, the computer can ___2___ turn the binary codes into electronic pulses to the serve-motors, when the execution ___3___ is on. When the pulses are ___4___, the serve-motors will automatically ___5___ them into rotation to drive lead screws and gear mechanism. CNC machines require little ___6___ intervention at work, and even an unskilled worker can easily ___7___ them. In the case of machining a part, when the ___8___ is pressed, the CNC machine tool moves ___9___ from one machining operation to another. Fortunately, the latest ___10___ in digital control system has made flexible manufacturing more popular in manufacturing industry.

III. Read aloud the following paragraph.

With the emphasis on automation in industry, numeral control systems for machines are gradually replacing the human machine operator. The most commonly used NC machines are tape-controlled, because the information was stored on either punched tape or magnetic tape. In NC machining process, the blueprint of a part is converted into numeral data blocks on a tape or a hard disk. The reading device with the control unit recognizes the data blocks at a fast speed and interprets them into operating instructions. Thus, according to the instructions, a specific machine tool is directed to machine the raw material into a desired part.

Part III Practical Writing

You are required to complete an English letter to a company based on the following information.

请代Sunny 公司销售部经理Luther K先生写催购数控机床的信函。

大意是：贵方已同用户研究过我方的数控产品，为了双方共同的利益，冀希在近期能得到对方有利成交的好消息。

Dear Sirs,

We confirm our letter of _____ as per the copy annexed and acknowledge with thanks your favor dated _____.

We trust by now you have carefully studied _____ with your customers and expect to hear from you presently that business has resulted for our _____ _____.

Awaiting your esteemed favors and orders.

Yours very faithfully,

Luther kings

_____

Unit 10 Contemporary Manufacturing

Part I Reading and Translating

Section A: CAD and CAM

10.1 The CAD System

10.2 Models in CAD

10.3 Structure of the CAM System

10.4 Flexible Manufacturing System

10.5 Computer Simulation

Exercises

Section B: The Third Industrial Revolution

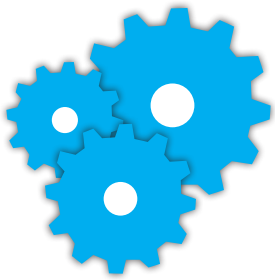
10.6 Big Data — 4V's

10.7 3D Printing

Exercises

Part II Listening and Speaking

Part III Practical Writing



Part I Reading and Translating

Section A: CAD and CAM

Different from the conventional manufacturing, the contemporary industry uses computer systems to assist in designing and manufacturing products, known as CAD (Computer-aided Design) and CAM (Computer-aided manufacturing). The CAD uses an interactive computer graphics system effectively to aid the engineering design process, while the CAM is the use of computer software to control machine tools in manufacturing workpieces.

10.1 The CAD System

A CAD system consists of three major units: Hardware; Operating System; Application Software. The hardware in a CAD system includes the PC and I/O unit. The former is used to carry the heavy

computational load for solid modeling and storage, while the (I/O) device is made to input or output programs into or from the CNC unit.

The operating system (O/S) is a software platform for *application programs to* run on. It serves as the bridge between the application software and the hardware. Different operating systems have different user interfaces and run the same applications. Common contemporary operating systems include Microsoft Windows, Mac OS X, Linux and Solaris.

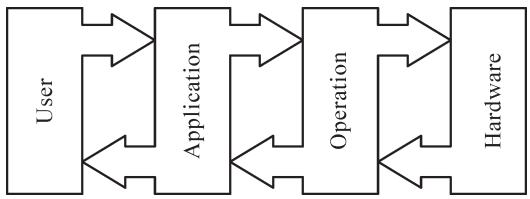


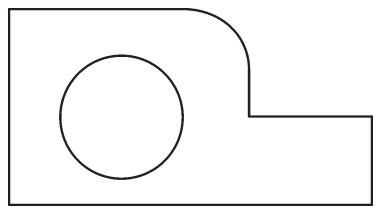
Fig.10-1 Structure of CAD System

Structurally, the application software sits on top of operating systems because it is unable to run without it. The application software is actually the *end-user programs*. It includes database programs for performing 2D or 3D modeling, drafting and engineering analysis. There have been emerging a lot of application software manufactures in the world, and their products — the CAD packages, can be shared on different operating systems owing to the ISO10303. The updated versions of CAD packages are easily attainable from the internet and many companies even provide free download if you are a member of their users.

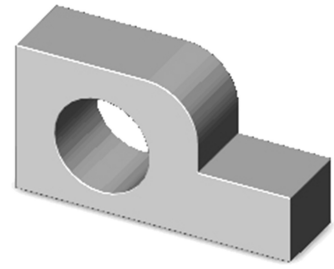
10.2 Models in CAD

In the application software of CAD system, the drawing is stored in an electric format and represented in the form of geometric models. A geometric model is a kind of mathematical description of a physical object. There are three types of models to represent an object — wire-frame models, surface models and solid models.

In wire-frame models, all of the edges of the model are visible as solid lines. Surface models may be constructed with all visible surface features and edges of objects. In the solid model, all surfaces are combined to construct a solid model, but the interior structure must be described with the data.



2D



3D

Fig. 10-2-3

10.3 Structure of the CAM System

Computer-aided Manufacturing is a very complex system, which involves many areas of technologies in all phases of manufacturing a product, such as computer-aided design and engineering, manufacturing and process planning, simulation of manufacturing process and group technology, database management

and integrated manufacturing, flexible manufacturing and so on. The application of these technologies in real time manufacturing relies basically on the aid of computers.

Technically, computer-aided manufacturing and computer-aided design are usually integrated into a whole system. This system encompasses a hierarchy structure.

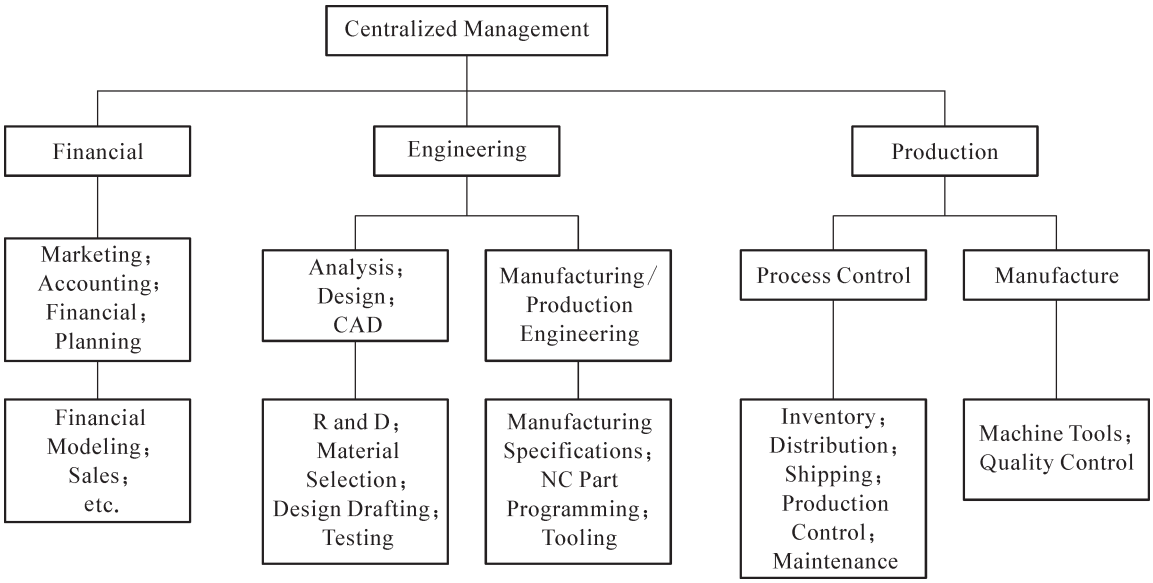


Fig.10-4 The General Structure of CAM

10.4 Flexible Manufacturing System

A reprogrammable manufacturing system for producing a variety of products automatically is called flexible manufacturing system (FMS). In a competitive international marketplace, it is necessary for producers to be more versatile and adaptable in realizing customizable, one-off production.

FMS consists of hardware and software elements. The hardware elements are those solid components such as CNC machine tools, material handling equipment, computer hardware elements, tooling systems, and coordinate measuring machines. While the software is intangible including tooling information, program work-order files, NC programs, management software, and FMS software.

A FMS may be an individual machine or a group of machines with an automated material and tool handling system. The material-handling system must be able to accommodate the load and bulk of the part in order to move it from station to station. Because the system is computer controlled, it enables manufacturers to machine a wide variety of workpieces on fewer machines with lower staffing levels, productively, reliably, and predictably.

10.5 Computer Simulation

Thanks to advances in computer science, currently, computer simulation is playing an important role in many scientific and industrial areas. A computer simulation or numerical simulation is a process to model a real-life situation (actually a virtual situation) on a computer so as to see how the system works and

how the analytical product would be manufactured before its eventual construction. On the platform of integrated software and hardware components of the computer, the operator interacts with a virtual world, in which a truly immersive experience can be produced.

Mathematical modeling has been used for decades, and there have been a plenty of modeling techniques available, typically the discrete-event simulation, which is a powerful tool and feasible to model the complex dynamics. It has been used in manufacturing system design and control system design for flexible manufacturing systems (FMS).

Now, computer simulation has become a standard tool in both science and modern design of products, and we can hardly imagine drugs or an aircraft manufacturing without simulation process. Although there are limitations to the current application of simulation tools and systems, the development of computers has revolutionized our society in the preceding decades and will continue to change it in the future.

New Words

1. **accommodate** /ə'kɒmədeɪt/ *vt.* 使适应；容纳
2. **contemporary** /kən'tempərərɪ/ *a.* 当代的；现代的
3. **database** /'deɪtəbeɪs/ *n.* 资料库
4. **emerge** /ɪ'mɜːdʒ/ *vi.* 出现；暴露
5. **encompass** /ɪn'kʌmpəs/ *vt.* 围绕；包括
6. **format** /'fɔːmæt/ *v.* 编排格式
   n. 版式
7. **hierarchy** /'haɪərɑːkɪ/ *n.* 层次；等级制度
8. **immersive** /ɪ'mɜːsɪv/ *a.* 身临其境的
9. **integrate** /'ɪntɪgreɪt/ *v.* 使一体化，使结合
10. **interactive** /ˌɪntər'æktɪv/ *a.* 交互的；互动的
11. **interface** /'ɪntəfeɪs/ *n.* 接口；界面
12. **phase** /feɪz/ *n.* 阶段；时期
13. **predictable** /prɪ'dɪktəb(ə)l/ *a.* 可预言[预报]的
14. **reliably** /rɪ'laɪəbl/ *ad.* 可靠地
15. **simulation** /ˌsɪmjʊ'leɪʃən/ *n.* 模仿；模拟
16. **staffing** /'stɑːfɪŋ/ *n.* 人员配备；人事
17. **update** /ʌp'deɪt/ *v.* 更新；使现代化
18. **version** /'vɜːʃən/ *n.* 版本；形式
19. **virtual** /'vɜːtjʊəl/ *a.* 虚拟的

Technical Expressions

1. **CAD packages** CAD 软件包
2. **CIMS = computer-integrated manufacturing system** 计算机集成制造系统
3. **Computer Simulation and Modeling** 计算机仿真与建模
4. **I/O (input and output)** 输入与输出端口
5. **ICAD = intelligent computer-aided design** 智能计算机辅助设计
6. **IMS = intelligent maintenance system** 智能维护系统
7. **Linux, Mac** 美国苹果公司生产的操作系统
8. **online translation service** 在线翻译服务
9. **Solaris** 美国SUN微系统公司开发的一种网络操作系统
10. **STEP (Standard for Product Data Exchange)** 产品数据交换标准
11. **the discrete-event simulation** 离散事件仿真
12. **the ISO 10303** 国际标准化组织认证的10303标准
13. **Windows all** 由美国微软公司生产的Windows系列操作系统，如：UNIX、XENIX、Windows XP 等。

Notes

1. The former is used to carry the heavy computational load for solid modeling and storage, while the (I/O) device is made to input or output programs into or from the CNC unit.
前者为实体建模承担着繁重的计算和存储工作，而（I/O）装置则用于从数控单元输入或输出程序。

2. The operating system（O/S）is a software platform for *application programs to* run on.
操作系统（O/S）是一个用来运行*应用程序*的软件平台。

3. Different operating systems have different user interfaces and run the same applications.
不同的操作系统有不同的用户界面并能运行相同的应用程序。

4. It includes database programs for performing 2D or 3D modeling, drafting and engineering analysis.
它包括运行2D/3D建模、制图和工程分析的数据库程序。

5. ... and their products — the CAD packages, can be shared on different operating systems owing to the ISO10303.
… 他们的产品 —— CAD软件包，由于采用了国际标准化组织认证的10303标准，在不同的操作系统中都能使用。

6. In wire-frame models, all of the edges of the model are visible as solid lines. Surface models may be constructed with all visible surface features and edges of objects. In the solid model, all surfaces are combined to construct a solid model, but the interior structure must be described with the data.
在线框模型中，模型的各边缘都为可见的实线。曲面模型由所有可见的表面特征和物体的边缘构成。在实体模型中，物体的各个表面一起构成实体模型，但内部结构必须用数据加以描述。

7. Computer-aided Manufacturing is a very complex system, which involves many areas of technologies in all phases of manufacturing a product.
计算机辅助制造是一个非常复杂的系统，零件生产的各个环节涉及到众多的技术领域。

8. ... such as computer-aided design and engineering, manufacturing and process planning, simulation of manufacturing process and group technology, database management and integrated manufacturing, flexible manufacturing and so on.
… 如：计算机辅助设计及工程、计算机辅助制造和工艺规划、计算机辅助仿真制造工艺和成组技术、数据库管理和集成制造及柔性制造等。

9. In a competitive international marketplace, it is necessary for producers to be more versatile and adaptable in realizing customizable, one-off production.
在竞争激烈的国际市场里，要实现客制化、一次性的生产，生产商必须灵活善变、适应性更强。

10. A FMS may be an individual machine or a group of machines with an automated material and tool handling system.
柔性制造系统可以是一台或是一组装备了自动送料和工具处理系统的机器。

11. The material-handling system must be able to accommodate the load and bulk of the part in order to move it from station to station.
为了便于工件在工作台间移动，该材料处理系统必须能够承载负荷并适应于大件加工。

12. ... it enables manufacturers to machine a wide variety of workpieces on fewer machines with lower staffing levels, productively, reliably, and predictably.
… 它能够使制造商能以较少的机器及水平较低的操作人员，高效、稳定地如期生产出各式各样的工件。

13. A computer simulation or numerical simulation is a process to model a real-life situation (actually a virtual situation) on a computer so as to see how the system works and how the analytical product would be manufactured before its eventual construction.
计算机模拟或数值模拟是以计算机为手段，模拟一个真实的情景（实际上是虚拟情景），以观测该系统是如何工作，并分析产品在最终加工出来前存在问题的处理。

Exercises

I. Tell whether each of the following statements is True (T) or False (F).

1. Computer provides the designer with a powerful tool for analyzing proposed designs and for preparing formal drawings of the final design.
2. Before entering the marketplace, newly-released CAD software should be certified to run on any graphics driver of operating systems.
3. The operating system acts as a host for application programs that are run on the machine.
4. Different operating systems have different user interfaces and run different applications.
5. A two and one-half D model can present solid model of an object by simply rotating the two-dimensional model.
6. A geometric model is a kind of physical description of a physical object.
7. Solid edge will run on any graphics driver that supports Windows NT® 4.0, Windows 2000®, Windows XP®, Windows ME® or Windows 98®.
8. In the solid model, all surfaces are combined to construct a solid model, but the interior volume must be described with the data.

II. Match the items listed in the following columns.

1. mature	a. belonging to the present time
2. release	b. to officially give something to someone
3. update	c. a gradual change from one thing to another
4. transition	d. to add the most recent information to something
5. allocate	e. to make something available for people to buy

6. emerge	f. fully grown and developed
7. contemporary	g. to appear or come out from somewhere
8. convert	h. to change something into a different form
9. primitive	i. useful and helpful
10. constructive	j. belonging to an early stage

III. Fill in each blank with a proper word beginning with the letter given.

Group Technology

Any new component design needs its own 1. u_____ identification number, usually the drawing number, and traditionally these were just allocated in 2. s_____. Components with low drawing numbers were designed some time 3. a_____, drawings with high numbers are 4. m_____ recent; nothing more could be learned 5. f_____ the drawing number. With computer techniques the drawings can be 6. s_____ on a CAD system and stored in a database. Group 7. t_____ provides components with meaningful drawing numbers. Each drawing number is 8. a_____ by a coding system, and each digit has meaning. If the 9. c_____ number is known, many of the component features can be reduced without 10. r_____ to the drawing.

IV. Translation (Chinese to English).

1. 一个国家的工业发展与其科技的进步是密切相关的 **(keep advance with ...)**。
2. 新的应用软件可将加工过程转换成自动操作 **(convert ... to ...)**。
3. 风扇可以防止计算机过热 **(act as ...)**。
4. 由于机械故障，新的数控机床已无法工作 **(owing to ...)**。

Section B: The Third Industrial Revolution

The Britain Industrial Revolution in the late 18th century shaped the whole structure of the modern world. It was the transition to new manufacturing processes from hand production methods to machines that brought home weavers together in a single factory. The increasing adoption of steam-powered boats, ships and railways, the development of machine tools as well as the increasing use of steam powered factories evolved into the Second Industrial Revolution.

The first two industrial revolutions made the world richer and more civilized. Now the third revolution is dramatically advancing, and manufacturing has stepped into a digital era.

10.6 Big Data — 4V's

Big data refers to the data sets which the computers with powerful software tools are used to capture, curate, manage, and process. As Gartner defined it as follows: "Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization." Additionally, a new V "Veracity" is added by some organizations to describe it.

As Jeremy Rifkin describes on the Third Industrial Revolution (TIR) website, "The intelligent TIR infrastructure — the first smart infrastructure in history — will connect everyone and everything in a seamless network. People, machines, natural resources, production lines, logistics networks, consumption habits, recycling flows, and virtually every other aspect of economic and social life will be connected via sensors and software to the TIR platform, continually feeding Big Data to every node — businesses, homes, vehicles, etc. — moment to moment in real time. The Big Data, in turn, will be analyzed with advanced analytics, transformed into predictive algorithms, and programmed into automated systems, to improve thermodynamic efficiencies, dramatically increase productivity, and reduce the marginal cost of producing and delivering a full range of goods and services to near zero across the entire economy. "

10.7 3D Printing

3D printing is commonly called "additive manufacturing". Unlike the traditional "subtractive manufacturing " process, 3D printing techniques use CAD Software to instruct the 3D printer to produce an object by building successive layers of material， until the entire object is complete. It is the very process that joins design with the production through the use of 3D model data and additive manufacturing processes, which brings us to a new reality of customizable, one-off production.

Printing Materials

The 3D printing materials vary depending upon the manufactured products and the building processes. With the fast development of 3D printing technologies, every aspect of industry puts forward new requirements for the material science. Since the beginning of the 21st century, 3D printing materials have become the focus that engineers and scientists pay close attention to together. In the recent markets,

Fig.10-5　3D Printer

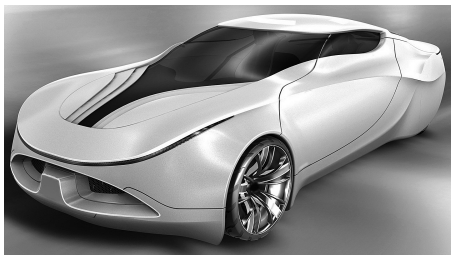


Fig.10-6　A 3D Printed Car

printing materials are increasingly diverse and colorful. They can be anything from chocolate, plastic, metal, full color sandstone, carbon fiber, inorganic nano particles, bio-ink, titanium alloy matrix composites and so on, which exist in either liquid or particle form.

Printing Methods

Although there are many different types of 3D printers available to meet the different needs of our society, the printing process is basically consistent from one to the other. With the new manufacturing techniques, the customized products are made from a raw material in either liquid or granular form. What differs among them is the way layers are built to complete the products. Though, the new printing methods are emerging in an endless stream, only insofar as some are commercially used at best. They include Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Electron-beam melting (EBM), Selective laser melting (SLM), Stereolithography (SLA), Plaster-based 3D printing (PP), Direct Metal Laser Sintering (DMLS), and Laminated Object Manufacturing (LOM) as well.

The technology of the SLS, DMLS, SHS, EBM and SLM uses powder granules as building materials like thermoplastics, any alloys, metal powders, ceramic powders; while the raw materials for the methods of FDM and the PP are relatively eutectic such as thermoplastics, edible materials, and rubber. As it is concerned to the procedure of the LOM, the printing materials are paper, metal foil, plastic film and so on.

3D Printing in China

In China, many universities and institutes have established 3D printing R&D labs or centers, and the government has committed billions of RMB towards the new industry. So far, Chinese experts have made great contributions to 3D technologies. Taking the medical area for example, researchers have successfully printed human organs such as ears, livers and kidneys with their own 3D printers and bio-ink or living cells. It is predicted that fully functional printed organs will be realized within the next years. As 3D printing technologies are affecting almost every aspect of industry and our personal lives, what kind of surprises we will have in the near future is beyond our expectation, and it is supposed to change our lives for good.

In recent years, China has made great achievements in high-tech and high-end equipment manufacturing, such as high-performance computer, quantum communications as well as new materials. At the same time, the world is going to see that China will lead the world to live in a brand new era by the international cooperation of One Belt, One Road, Made-in-China 2025 and “Industry 4.0”.

New Words

1. **algorithm** /'ælgərɪðəm/ *n.* 算法
2. **consistent** /kən'sɪstənt/ *a.* 一致的
3. **customizable** /'kʌstəmaɪzəbəl/ *a.* 客制化；可定制的
4. **eutectic** /ju:'tektɪk/ *a.* 容易溶解的
5. **evolve** /ɪ'vɒlv/ *vt.* 发展；进化
6. **infrastructure** /'ɪnfrəstrʌktʃə/ *n.* 基础设施
7. **only insofar as** 只有
8. **organ** /'ɔ:gən/ *n.* [生物] 器官
9. **revolution** /ˌrevə'lu:ʃən/ *n.* 革命
10. **sandstone** /'sændstəʊn/ *n.* 砂岩
11. **seamless** /'si:mlɪs/ *a.* 无缝的
12. **successive** /sək'sesɪv/ *a.* 连续的
13. **veracity** /və'ræsɪtɪ/ *n.* 精确性

Technical Expressions

1. Direct Metal Laser Sintering (DMLS)
   直接金属激光烧结工艺
2. Electron-beam Melting (EBM)
   电子束熔炼制造
3. Fused Deposition Modeling (FDM)
   熔融沉积制造
4. Gartner, Inc. 美国信息技术研发咨询公司
5. Jeremy Rifkin 美国经济、社会学家
6. Laminated Object Manufacturing (LOM)
   叠层实体制造法
7. logistics network 物流网络
8. Plaster-based 3D printing (PP)
   石膏基三维打印工艺
9. Selective Laser Melting (SLM)
   选择性激光熔融工艺
10. Selective Laser Sintering (SLS)
    选择性激光烧结法
11. Stereolithography (SLA) 光固化成形技术
12. subtractive manufacturing 减成法加工
13. thermodynamic efficiency 热力学效率

Notes

1. Big data refers to the data sets which the computers with powerful software tools are used to capture, curate, manage, and process.
   大数据由巨型数据集组成，需依靠计算机强大的功能软件工具对这些数据集进行收集、存储、管理和处理。

2. Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization.
   大数据是一类体量巨大、速度极快、千奇百怪的信息资产，需要一种新型处理技术去促成更强的决策能力、洞察力与优化处理能力。

3. The Big Data, in turn, will be analyzed with advanced analytics, transformed into predictive algorithms, and programmed into automated systems, ...
   反过来，大数据通过晋阶分析处理，转化为预测调度算法，并被编制成自动化系统，…

4. It is the very process that joins design with the production through the use of 3D model data and additive manufacturing processes, ...
   正是这个处理程序通过使用3D模型数据和加层法制造工艺的使用，将设计与制造融为一体，…

5. They can be anything from chocolate, plastic, metal, full color sandstone, carbon fiber, inorganic nano particles, bio-ink, titanium alloy matrix composites and so on, which exist in either liquid or particle form.
   他们可以是任何材料，从巧克力、塑料、金属、全彩砂岩、碳纤维、无机纳米粒子、生物墨水、钛合金基复合材料等，这些材料的形态要么是液态要么是微颗粒形状。

6. What differs among them is the way layers are built to complete the products.
   它们之间的区别在于其堆叠薄层完成产品的方式不尽相同。

7. Though, the new printing methods are emerging in an endless stream, only insofar as some are commercially used at best.
尽管新的打印方法层出不穷，但商业化使用成熟的仍然为数不多。

8. It is predicted that fully functional printed organs will be realized within the next years.
据预测，功能齐全的机体器官将在未来几年被打印出来。

9. What kind of surprises we will have in the near future is beyond our expectation, and it is supposed to change our lives for good.
不久的将来，3D技术会带给我们什么样的惊喜，将远超我们的预期，或许它将永远改变我们的生活。

Exercises

I. Choose the best answer for each of the following statements or questions according to the text.

1. In the 3D world, a 3D printer also needs to have instructions for what to print. It needs a (CAD) file as well. The file is created with the use of _____.
   A. a 3D modeling program
   B. a program such as Microsoft Word
   C. the Word Document
   D. 2D modeling program
2. 3D printing moves us away from the mass production line, and will bring us _____.
   A. back to the Henry Ford era
   B. to steam-powered engine industrial age
   C. to new personally customized products
   D. to an unknown world
3. Big data is so large and complex that _____.
   A. it must use on-hand database management tools to process
   B. it becomes difficult to process using traditional data processing applications
   C. powerful computers should be used
   D. it is feasible to work with using most relational database management systems and desktop statistics
4. The internet of energy, Shifting to Renewable Energy, Buildings as Power Plants, Renewable Energy and Transitioning the transport fleet to electric, all the five sectors belong to _____.
   A. the First Industrial Revolution
   B. the Third Industrial Revolution
   C. the Second Revolution
   D. the evolution of the Second Revolution
5. 3D entrepreneurs are particularly bullish about additive manufacturing, _____.
   A. because it uses less of the earth's resources
   B. because the earth's resources become much higher
   C. because it is the third industrial revolution
   D. because the process requires about 10 percent of the raw material and uses less energy than conventional production

II. Complete each of the following sentences with one suitable word or phrase in the proper form.

hierarchy	encompass	commit	intangible
reliable	evolve	suppose	accommodate

1. The system is new, but so far it seems to be _____.
2. The first two industrial revolutions _____ to the Third Industrial Revolution.
3. Such products will _____ the plug-and-play demands of users.
4. There is a rigid _____ of management in modern cooperative enterprises.
5. Racial harmony should _____ three main factors: mutual respect, social harmony and good public security.
6. 3D printing technology is _____ to change our lives forever.
7. Customer goodwill is an important _____ asset of any business.
8. The local government _____ some of those funds to the research of renewable energy last year.

III. Translation (English to Chinese).

1. Selective laser sintering (SLS) is one kind of rapid prototyping (RP) technology, which uses a laser to sinter powdery material selectively to produce 3D mechanical parts.
2. Some methods use melting or softening material to produce the layers. Selective laser sintering (SLS) and fused deposition modeling (FDM) are the most common technologies using this way of printing.
3. As the new 3D technology becomes more widespread, on site, just in time customized manufacturing of products will also reduce logistics costs with the possibility of huge energy savings.
4. The lateral scaling of the Third Industrial Revolution allows small and medium size enterprises to flourish.

Part II Listening and Speaking

I. Fill in the blanks with what you have heard on the recoring.

1. CAD means using an interactive computer graphics system to _____ the engineering design process.
2. A CAD system consists of three major units: hardware; operating system _____ ; application software.
3. The operating system (O/S) _____ as a host for application programs that are run on the machine.
4. Different operating systems have different user interfaces and run the _____ applications.

5. The CAD models can be _____ into the following types: two-dimensional models, two and one-half, three-dimensional models, and super models.
6. Application software is the _____ design of computer programs for finishing user tasks.
7. Computer-aided Manufacturing is a very complex system, which involves many areas of technologies in all phases of _____ a product.
8. A general CAM system has three or more levels of computers to control and monitor the manufacturing _____.
9. With standard computer data processing methods, the product with higher quality and less expense is _____.
10. For example, when a part program is generated by a CAD-based system, a realistic picture of the workpiece can be _____ on screen.

II. Listen to the following paragraph three times and try to fill in the blanks with the words you have heard on the recording.

In China today, the ___1___ from Labor-intensive industry to knowledge-intensive industry is a general ___2___. Computers help human ___3___ not only for data processing, but also do ___4___ for decision-making in some big companies. Without doubt, 3D printing ways will ___5___ the future manufacturing mode. Today, the use of computer integrated manufacturing systems is ___6___ a problem, which has become the most important ___7___ of improving productivity, responding to ___8___ changing market demands, and improving the control of both manufacturing and the ___9___ functions of an organization. Although CAM does decrease human involvement, the roles of humans has in ___10___ will not be replaced.

III. Read aloud the following paragraph.

Since China's accession to the WTO, the world economic structure has undergone major changes. Under the context of economic globalization, international competition becomes even more intense, especially in manufacturing industry. In the competitive international marketplace, increasing demand for high quality products forces manufacturers to provide better design, manufacturing, management and marketing.

Part III Practical Writing

You are required to write an adjustment letter to a company based on the following form.

November 8th, 2016

Dear Mr. Smith,

I'm writing to you with regards to the NC milling machine tool we bought from your company last month. We are sorry to inform you that something is wrong with the operating control unit, which occasionally makes the tool changer unavailable, besides, when the work is fed, somehow the cutting tool is slow to act as it should do. It is not supposed to have such defects for a newly-produced machine tool. So we inform you in the hope of a replacement for THIS defect unit.

Looking forward to your early reply.

Sincerely yours

John Edward