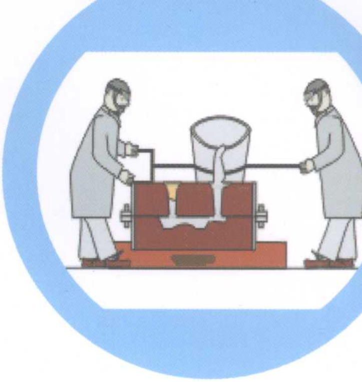
21世纪大学实用行业英语系列



机电英语
Electromechanical English

宋士福 主 审 杨文辉 总主编
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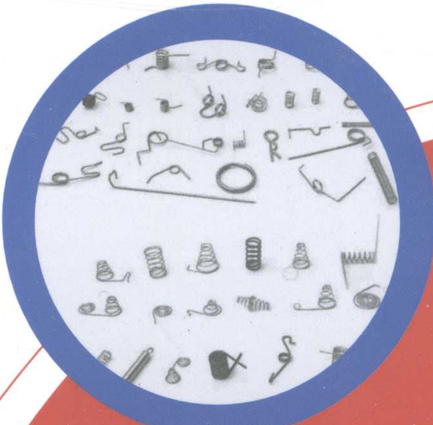

Machinery Foundation
Heat Treatment of Metals
Introduction to Bearings
Introduction to Cams
Dimensions and Tolerances
Properties of Materials
Hydraulic System
Introduction to CAD

复旦大学出版社

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复旦大学出版社

图书在版编目(CIP)数据

机电英语/董丽主编. —上海:复旦大学出版社,2009. 8
(21 世纪大学实用行业英语系列)
ISBN 978-7-309-06841-2

Ⅰ. 机… Ⅱ. 董… Ⅲ. 机电工程-英语-高等学校-教材 Ⅳ. H31

中国版本图书馆 CIP 数据核字(2009)第 148716 号

机电英语
董 丽 主编

出版发行 复旦大學出版社 上海市国权路 579 号 邮编 200433
86-21-65642857(门市零售)
86-21-65100562(团体订购) 86-21-65109143(外埠邮购)
fupnet@fudanpress. com http://www. fudanpress. com

责任编辑 曹 凯
出 品 人 贺圣遂

印 刷 上海申松立信印刷厂
开 本 787×960 1/16
印 张 13. 5
字 数 257 千
版 次 2009 年 8 月第一版第一次印刷
印 数 1—5 100

书 号 ISBN 978-7-309-06841-2/H · 1372
定 价 22. 00 元

前　　言

鉴于高职高专机电专业英语类教材的短缺，以及机电类产品的发展变化和技术工人职业技能培训的实际需要，我们精心组织机械界与电气界的专家学者编写了这本教材，将它奉献给将要工作在一线的学生以及其他对机电类英语感兴趣的读者们。

我们在课文编写中，尽量做到有一定的深度却不艰涩，有必要的广度而不琐乱，主次分明，详略得当，在知识体系上具有一定的针对性，在内容上具有较强的适用性和先进性，因而也就更具有科学性、实用性和易读性，适合从事机电方面工作的技术操作人员学习，同时也适合机电类学生作为教材使用。

本书共分三章，第一章为机械基础篇，第二章为电气基础篇，第三章为机电产品篇，可适合一学期或者两学期使用。全书内容涵盖较广，读者可根据不同专业、不同方向选择必要的部分进行阅读。为了便于读者理解书中内容，课文配有与文字内容相关的插图，做到了图文并茂。

由于本书是一本以学习专业英语为主的阅读材料，因此不可能把机电方面的知识讲得很全面很系统。我们的目的是想让读者阅读这本书后，能够熟悉机电方面的英语词汇，掌握阅读专业英语的方法，为将来阅读机电方面的英语资料打下一定的基础。

本书在编写过程中，不仅参考了最新国内外有关的技术资料，并且得到了青岛港机厂、天津安川电气设备公司、一汽青岛汽车厂的大力协助，在此一并表示感谢。

由于编者水平有限，书中疏漏或差错之处在所难免，敬请读者给予批评指正。

编者

2009 年 8 月

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Chapter 1 Machinery Foundation

Lesson 1 Steel

Generally speaking, there are two kinds of steels in common use: plain carbon steels and alloy steels. Firstly, let's look at plain carbon steels.

Plain carbon steels are the steels that contain only carbon and no other major alloying elements. This kind of steel has 3 types which are low-carbon steel, medium-carbon steel and high-carbon steel. They get their special names from their content of carbon.

If the carbon content is lower than 0.25%, it is called low-carbon steel. It cannot be hardened but can be case-hardened. It has these characteristics which are easy machining & forming, comparatively less strength, least expensive, comparatively less hardness and largest quantity produced. In practice use, bolts, nuts, washers, sheet steel, and shafts use low-carbon steel.

Medium-carbon steel contains from 0.25-0.60 percent carbons. This kind of steel is mostly used in situation where greater tensile strength is required. This kind of steel may be hardened for it has higher carbon content. Its characteristics are as follows, hard & strong after heat treating; medium depth of hardness and more expensive than low carbon steel. Tools such as wrenches, hammers, and screwdrivers are drop-forged from medium-carbon steel and later heat treated.

High-carbon steel (also named as tool steel) contains over 0.60 percent carbon, and it can contain as high as 1.7 percent. It has these characteristics: hard & strong after heat treating; depth of hardness increases and more expensive than low & medium carbon steels. Cutting tools, punches, taps, dies, drills and reamers usually use this kind of steel.

Then is the alloy steel. Alloy steel is the steel whose characteristics are determined by the addition of other elements in addition to carbon. Alloy steels have some special characteristics which are not found in plain carbon steels, so alloy steels are widely used in practice. That is to say, sometimes we prefer alloy steel to plain steel.

Alloy steel has these following characteristics: it increases in tensile strength, hardness, toughness, antiwear property, corrosion resistance and red-hardness.

New Words and Expressions

steel /stiːl/ *n.*	钢，钢铁
plain carbon steel	碳素钢
alloy steel	合金钢
low-carbon steel	低碳钢
medium-carbon steel	中碳钢
high-carbon steel	高碳钢
content /ˈkɒntent/ *n.*	含量
case-harden	表面硬化
hardness /ˈhɑːdnɪs/ *n.*	硬度
characteristic /ˌkærəktəˈrɪstɪk/ *a.*	特性
tensile strength	抗拉强度
toughness /ˈtʌfnɪs/ *n.*	韧性
antiwear property	抗磨性能
corrosion resistance	耐蚀性
red-hardness /ˈredhɑːdnɪs/ *n.*	红硬性

Notes

1. It has these characteristics which are easy machining & forming, comparatively less strength, least expensive, comparatively less hardness and largest quantity produced. 它具有下列特点：容易加工和成形，相对来说强度不足，最便宜，硬度弱，可以大批量生产。

   Characteristics 在这里用的是复数，是"特性，特点"的意思。

2. Alloy steel is the steel whose characteristics are determined by the addition of other elements in addition to carbon. 合金钢是一种其特点由碳以外的其他元素决定的钢。

   be determined by 意为"由……所决定"。by the addition of 中的 addition 为名词，"附加物"；in addition to 为短语，意为"除……之外"。

Exercises

1. What's the classification of steels?
2. What are the characteristics of high-carbon steel?
3. What are the characteristics of alloy steel?

Reading Material

Iron

Iron is a chemical element with the symbol Fe (Latin: ferrum) and atomic number 26. Iron is a group 8 and period 4 elements. Iron and iron alloys (steels) are by far the most common metals and the most common ferromagnetic materials in everyday use.

Iron-56 is the second heaviest stable isotope produced by the alpha process in stellar nucleosynthesis, the heaviest being nickel-62; heavier elements require a supernova for their formation. Iron is the most abundant element in the core of red giants, and is the most abundant metal in iron meteorites and in the dense metal cores of planets such as Earth.

Iron is the most widely used of all the metals, accounting for 95% of worldwide metal production. Its low cost and high strength make it indispensable in engineering applications such as the construction of machinery and machine tools, automobiles, the hulls of large ships, and structural components for buildings.

Copper

Copper is a chemical element with the symbol Cu (Latin: cuprum) and atomic number 29. It is a ductile metal with very high thermal and electrical conductivity. Pure copper is rather soft and malleable and a freshly-exposed surface has a pinkish or peachy color. Gold, caesium and copper are the only metallic elements with a natural color other than gray or white. It is used as a thermal conductor, an electrical conductor, a building material, and a constituent of various metal alloys.

Copper is an essential trace nutrient to all higher plant and animal life. In animals, including humans, it is found widely in tissues, with concentration in liver, muscle, and bone. It functions as a co-factor in various enzymes and in copper-based pigments. Some molluscs have blue-green blood resulting from a copper compound which they use to transport oxygen, instead of heme. In sufficient amounts, copper salts can be poisonous.

Lead

Lead is a main-group element with symbol Pb (Latin: plumbum) and atomic number 82. Lead is a soft, malleable poor metal, also considered to be one of the heavy metals. Lead has a bluish-white color when freshly cut, but tarnishes to a dull grayish color when exposed to air. It has a shiny chrome-silver luster when melted into a liquid.

Lead is used in building construction, lead-acid batteries, bullets and shot, weights, and is part of solder, pewter, fusible alloys and radiation shields. Lead has the highest atomic number of all stable elements, although the next element, bismuth, has a half-life so long (longer than the estimated age of the universe) it can be considered stable. Like mercury, another heavy metal, lead is a potent neurotoxin that accumulates in soft tissues and bone over time. Lead poisoning was documented in ancient Rome, Greece, and China.

Alloy Steel

Alloy steel is steel alloyed with other elements in amounts of between 1 and 50% by weight to improve its mechanical properties. Alloy steels are broken down into two groups: low alloy steels and high alloy steels. The differentiation between the two is somewhat arbitrary.

These steels have greater strength, hardness, hot hardness, wear resistance, hardenability, or toughness compared to carbon steel. However, they may require heat treatment in order to achieve such properties. Common alloying elements are molybdenum, manganese, nickel, chromium, vanadium, silicon and boron.

Lesson 2 Heat Treatment of Metals

Heat treatment is the operation of heating and cooling a metal in its solid state to change its properties.

Heat treatment is often associated with increasing the strength of material, but it can also be used to alter certain manufacturability objectives such as to improve machining, improve formability, restore ductility after a cold working operation. Thus it is a very enabling manufacturing process that can not only help other manufacturing process, but can also improve product performance by increasing strength or other desirable characteristics.

With the proper heat treatment, internal stresses may be removed, grain size reduced, toughness increased, or a hard surface produced on a ductile interior. Steels are particularly suitable for heat treatment, since they respond well to heat treatment and the commercial use of steels exceeds that of any other materials. Steels are heat treated for one of the following reasons:

1. softening;
2. hardening;
3. material modification.

Common Heat Treatments

Softening: Softening is done to reduce strength or hardness, remove residual stresses, improve toughness, restore ductility, refine grain size or change the electromagnetic properties of the steel.

Restoring ductility or removing residual stresses is a necessary operation when a large amount of cold working is to be performed, such as in a cold-rolling operation or wiredrawing. Annealing — full process, spheroid zing, normalizing and tempering — austempering, martempering are the principal ways by which steel is softened.

Hardening: Hardening of steels is done to increase the strength and wear properties. One of the pre-requisites for hardening is sufficient carbon and alloy content. If there is sufficient carbon content, then the steel can be directly hardened. Otherwise the surface of the part has to be carbon enriched using some diffusion treatment hardening techniques.

Material Modification: Heat treatment is used to modify properties of materials in addition to hardening and softening. These processes modify the behavior of the steels in a beneficial manner to maximize service life, e. g. , stress relieving, or strength properties, e. g. , cryogenic treatment.

Tempering is a process done subsequent to quench hardening. Tempering is done immediately after quench hardening. When the steel cools to about 40℃ (104℉) after quenching, it is ready to be tempered. The part is reheated to a temperature of 150 to 400℃ (302 to 752℉). In this region a softer and tougher structure Troostite is formed. Alternatively, the steel can be heated to a temperature of 400 to 700℃ (752 to 1,292℉) that results in a softer structure known as Sorbite. This has less strength than Troostite but more ductility and toughness.

Generally speaking, the purposes of annealing are: alteration of ductility and toughness, induction of softness and refinement of grain structure and removal of gases and stresses.

This process of normalizing is very similar to annealing, which improves strength and machinability.

Spheroidizing is a form of annealing consisting of prolonged heating of iron base alloys at a temperature in the neighborhood of, but generally slightly below the critical range, usually followed by a relatively slow cooling. Spheroidizing causes the graphite to assume a spheroidal shape, hence the name.

New Words and Expressions

heat treatment	热处理
manufacturability /ˈmænjʊˌfæktʃərəˈbɪlɪtɪ/ *n.*	可制造性
formability /ˌfɔːməˈbɪlətɪ/ *n.*	成形性能
ductility /dʌkˈtɪlətɪ/ *n.*	延展性，柔软性
internal stress	内应力
soften /ˈsɒfən/ *v.*	软化

hardening /ˈhɑːdənɪŋ/ *n.*	硬化
material modification	材料改性
tempering /ˈtempərɪŋ/ *n.*	回火
stress relieving	应力消除
quench hardening	淬火硬化
quenching /ˈkwentʃɪŋ/ *n.*	淬火
Troostite /ˈtruːstaɪt/ *n.*	屈氏体
Sorbite /ˈsɔːbaɪt/ *n.*	索氏体
machinability /məˌʃiːnəˈbɪlətɪ/ *n.*	可加工性
spheroidizing /ˈsfɪərɔɪdaɪzɪŋ/ *n.*	球化(处理)

Notes

1. Heat treatment is often associated with increasing the strength of material, but it can also be used to alter certain manufacturability objectives such as to improve machining, improve formability, restore ductility after a cold working operation. 热处理一般是为了增强材料的强度,但也可以用来改变一些可制造性目标,比如:在冷加工操作后改善可加工性,改善成形性能,恢复其展延性。

   be associated with 为短语,意为"与……有关,与……有关系"。objectives 为名词,意为"目标", a cold working operation 可以翻译成"冷加工操作"。

2. Annealing — full process, spheroid zing, normalizing and tempering — austempering, martempering are the principal ways by which steel is softened. 退火——完全退火、球化、正火、回火——奥氏体回火和马氏体回火都是软化钢的主要工艺。

   by which steel is softened 为定语从句,在此 which 指的是 the principal ways。

Exercises

1. What's heat treatment?
2. What's the reason for heat treatment?
3. What process is the process done subsequent to quenching?

Reading Material

Quench Hardening

Quench Hardening is a mechanical process in which steel and cast iron alloys are strengthened and hardened. These metals consist of ferrous metals and alloys. This is done by heating the material to a certain temperature, differing upon material, and then rapidly cooling the material. This produces a harder material by either surface hardening or through-hardening varying on the rate at which the material is cooled. The material is then often tempered to reduce the brittleness that may increase from the quench hardening process. Items that may be quenched include: Gears, Shafts, Wear Blocks, etc.

Process of Quench Hardening

Quenching metals is a progression; first step is soaking the metal. "Soaking" can be done by air (air furnace), or a bath. The soaking time in air furnaces should be 1 to 2 min for each mm of cross-section. For a bath the time can range a little higher. 0 to 6 min is the recommended time allotment in salt or lead baths. Uneven heating or overheating should be avoided at all cost. Most materials are heated from anywhere to 815-900 degrees Celsius (1,500-1,650 degrees Fahrenheit).

The next item on the progression list is the cooling of the part. Water is one of the most efficient quenching media where maximum hardness is acquired, but there is a small chance that it may cause distortion and tiny cracking. When hardness can be sacrificed, whale, cottonseed and mineral oils are used. These often tend to oxidize and form a sludge, which consequently lowers the efficiency. The quenching velocity (time to cool) of oil is much less than water.

The way that an object is placed into the containers to soak is also very important and a step that needs to be discussed. To maximize distortion loss, long cylindrical objects should be quenched vertically, flat sections edgeways and thick sections should enter the bath first. To prevent steam bubbles, the "quenching bath" should be agitated.

Tempering

Tempering is a heat treatment technique for metals, alloys and glass. In steels, tempering is done to "toughen" the metal by transforming brittle martensite into bainite or a combination of ferrite and cementite. Precipitation hardening alloys, like many grades of aluminum and superalloys, are tempered to precipitate intermetallic particles which strengthen the metal. Tempering is accomplished by a controlled reheating of the work piece to a temperature below its lower critical temperature.

The brittle martensite becomes strong and ductile after it is tempered. Carbon atoms were trapped in the austenite when it was rapidly cooled, typically by oil or water quenching, forming the martensite. The martensite becomes strong after being tempered because when reheated, the microstructure can rearrange and the carbon atoms can diffuse out of the distorted BCT structure. After the carbon diffuses, the result is nearly pure ferrite.

In metallurgy, there is always a tradeoff between strength and ductility. This delicate balance highlights many of the subtleties inherent to the tempering process. Precise control of time and temperature during the tempering process are critical to achieve a metal with well-balanced mechanical properties.

Lesson 3 Introduction to Bearings

Stop and consider how many things in your life turn or revolve. Skate wheels, electric motors, car wheels, microwave turntables, even your PC has bearings in it.

The humble bearing makes many of today's machines a reality. Without them we would not be able to make precision items on a massive scale and things would wear out quickly due to excessive friction. This page is designed to give you an idea of what bearings are, what they do and the formats they come in.

All things roll and rotate better than they slide. If the wheel did not exist we would be stuck with sliding things everywhere. Consequently little progress in the world would be achieved. Sliding causes friction. Friction is caused by resisting movement between two surfaces. However, if two surfaces can contact each other by rolling, then friction problems are significantly reduced.

How bearings "bear" load?

Ball bearings are typically capable of dealing with two kinds of loading condition: radial load and thrust load. Depending on the type of application the bearing is used in, it may experience radial load only, thrust load only or a combination of both. A classic example being the car wheel is as shown below. (See Figure 3-1)

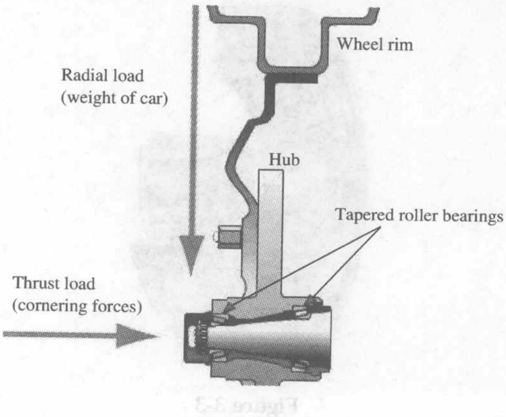

Figure 3-1