



普通高等教育规划教材

数控技术应用 专业英语

第二版

常红梅 主 编
黄崇莉 副主编

SHUOKONG JISHU
YINGYONG
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· 北 京 ·

本书是一本双语版的数控技术入门教材,读者通过阅读学习,可以对数控技术应用有初步的认识和较全面的了解。本书主要介绍了数控技术在工业生产中的应用,内容包括计算机数控机床基础、数控技术应用、数控车床简介、金属切削加工与刀具、数控操作与编程、现代计算机辅助零件编程技术、数控机床的操作、机电一体化技术简介等方面的数控技术知识。

本书可作为本科院校及高职高专数控技术应用专业的专业教材,也可供机械类各专业及其他相近专业作为教学参考书和机械工程技术人员自学参考书。

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第二版前言

数控技术的应用不但给传统制造业带来了革命性的变化,使制造业成为工业化的象征,而且随着数控技术的不断发展和应用领域的扩大,它对国计民生的一些重要行业(IT、汽车、轻工、医疗等)的发展起着越来越重要的作用,因为这些行业所需装备的数字化已是现代发展的大趋势。

根据我国目前的发展状况和对数控人才的需求,面对这一形势,我们清醒地认识到教育要先行,必须以改革开放为动力,以发展壮大我国的民族工业为己任,以努力提高教学质量为目标,构建新的教学模式,为培养我国的数控技术人才而努力!在快速发展的数控技术专业领域,大量的原版英文技术资料 and 互联网提供的最新技术信息与动态,使得英语水平对于专业技术的学习和提高有着举足轻重的作用。为了让更多的学生学好数控技术,特地组织编写了本书。

《数控技术应用专业英语》第一版教材使用情况良好,证明本教材的编写定位合理,内容结构及整个书的逻辑关系明确。鉴于数控技术的迅速发展及该专业学生的需求情况,现对第一版教材进行修订。

与第一版教材相比较,第二版教材具有以下特点:

1. 内容更加丰富,不仅适合数控技术专业本科学生使用,也适合本高职高专学生使用;
2. 布局格式更加完善,在每课英文正文的后面,都附有相关知识的阅读材料,有针对性地扩大学生对所学知识的了解;
3. 附录内容更加全面,以扩展学生在专业方面及相关其他方面的知识。

学生在具备一定数控专业知识的基础上,通过大量阅读与本专业有关且文字内容相对浅显的英文文章,获得专业英语阅读理解能力和英汉转换能力,加深对国内外数控技术专业知识的了解。

本书共计六大部分七单元内容,分别介绍了数控技术的基础知识、数控技术在社会生活各个方面的应用、数控车床及车削加工的基本知识、数控编程、数控机床操作以及机电一体化方面的知识。书后附有科技英语中的语法和翻译,以及与数控技术专业相关的一些阅读材料。不仅可以使读者学习专业英语,而且可熟悉有关数控专业的词汇。在编写本书的过程中,我们尽可能使每篇文章的长短适量、难易适中,每篇课文后均有注释和词汇表。课文中出现的难句和语法难点,均在课后的注释中加以解释,并译为中文。为便于查阅和学习,书后还附有参考译文。同时,考虑到本科学生的需求,还适量地增

加阅读材料内容。

本书由常红梅主编，黄崇莉副主编，王李云、王晓红参编。各部分编写的具体分工如下：其中第一部分的第一单元至第三单元、第二部分的相应参考译文、第四部分至第六部分由常红梅编写，第一部分的第四单元及第二部分的相应参考译文由黄崇莉编写，第一部分的第五单元、第六单元、第二部分的相应参考译文及第三部分由王李云编写，第一部分的第七单元及第二部分的相应参考译文由王晓红编写。

因编者水平有限，不妥之处敬请读者批评指正。

编 者
2011年7月

第一版前言

今天，从乡镇的小企业到全球的 500 强企业，数控技术无处不在，而且应用范围已经超出了机械制造行业。这些创新性的技术触及到制造业的方方面面，因此，从事制造业的人都必须清楚这些复杂数控设备的功能。在快速发展的数控技术专业领域，大量的原版英文技术资料 and 互联网提供的最新技术信息与动态，使得英语水平对于专业技术的学习和提高有着举足轻重的作用。

编者根据高等职业教育数控技术应用专业领域技能型紧缺人才的培养目标，结合专业英语的教学实践编写了本教材。学生在具备一定数控专业知识的基础上，通过大量阅读和本专业有关但文字内容相对浅显的英文文章，获得专业英语阅读理解能力和英汉转换能力，加深对数控专业知识的了解。

本书共 8 个单元，介绍了数控技术的基础知识、数控技术在各个方面的应用、数控车床及车削加工的基本知识、数控车床的编程技术、数控编程、数控机床操作以及机电一体化方面的知识。除此之外，书后还附有科技英语中的语法和翻译，以及一些与数控技术专业相关的阅读材料，不仅可以使读者学习专业英语，而且可熟悉有关数控专业的词汇。在编写本书的过程中，我们尽可能使每篇文章的长短适量、难易适中，每篇课文后均有注释和词汇表。课文中出现的难句和语法难点，均在课后的注释中加以解释，并译为中文。为便于查阅和学习，书后还附有参考译文。

另外，我们还向读者提供一些建议，也许会有所帮助。一般来说，即使掌握了一定程度的英语，在阅读专业英语时，也会有一定的困难。所以，在阅读本书时，可先找出生词，标出词义。然后分析句子的结构，弄清全句的意思。

本书由常红梅主编、孙志学任副主编。本书由曾小珊教授主审。各单元编写的具体分工如下：第一部分的 Unit2、Unit4、Unit6、Unit8、第二部分的相应参考译文、第三部分、第四部分、第六部分由常红梅编写，Unit1、Unit5、Unit7 及其第二部分的相应参考译文由孙志学编写，Unit3 及其第二部分的相应参考译文由王李云编写，第五部分由常红梅、孙志学共同编写，全书由常红梅负责统稿。

在编写过程中，因水平有限，不妥之处在所难免，敬请读者批评指正。

编者
2005 年 8 月

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SECTION ONE ENGLISH TEXT

第一部分 英文课文

UNIT 1 COMPUTER NUMERICAL CONTROL OF MACHINE

Lesson 1 The Computer Numerical Control (CNC) System

Numerical Control, NC for short, is an automatic control method on the machine using digitized signals (numeric and signs). The NC concept was proposed in the late 1940s by John Parsons of Traverse City, Michigan. Numerical Control (NC) is any machining process in which the operations are executed automatically in sequences as specified by the program that contains the information for the tool movements.^① In its earliest stages, NC machines were able to make straight cuts efficiently and effectively.

CNC machine tools are known as machine tools with numerical control technology. According to the 5th Technical Committee of International Federation for Information Processing (IFIP), CNC machine is a machine tool with procedures numerical control system, which can process the program prescript by specific code and other symbolic coding in a logic way.

Compared to the ordinary manual machine tools, the CNC machine operates automatically under the program control (processing instruction). When Numerical Control is performed under computer supervision; it is called Computer Numerical Control (CNC) (Fig. 1-1). CNC system has the computer system instead of a numerical control device. As defined by the EIA-owned CNC Standardization Committee, CNC is a computer with a stored program, performing some or all of the NC device features according to the control program stored in the computer read/write memory; the only device outside computer is the interface. CNC system is composed of procedures, input and output devices, computer numerical control devices, programmable logic controller (PLC), the spindle drive and feed drive device.

Computers are the control units of CNC machines; they are built in or linked to the machines

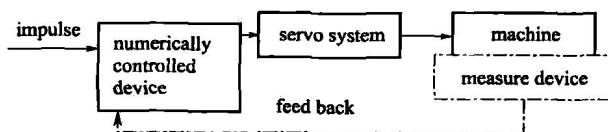


Fig. 1-1 Components of CNC

via communications channels. When a programmer inputs some information in the program by tape disk and so on, the computer calculates all necessary data to get the job done.

New Words and Phrases

numerical control (NC) 数字控制

computer numerical control (CNC) 计算机数字控制

advanced manufacturing technology 先进制造技术

Massachusetts Institute of Technology (M.I. T.) 麻省理工学院

servo system 伺服系统

measure device 测量装置

impulse *n.* 脉冲

milling cutter 铣刀

implementation *n.* 工具, 仪器, 执行过程

hard-wire *n.* 硬线连接

two-axis *n.* 两坐标

versatile *adj.* 多方面的, 多变的, 多用途的

Notes

① Numerical Control (NC) is any machining process in which the operations are executed automatically in sequences as specified by the program that contains the information for the tool movements.

数字控制是按照含有机床(刀具)运动信息程序所指定的顺序自动执行操作的加工过程。

此句中包含两个定语从句, 第一个从句的先行词是 *machining process*, *in which* 引导从句 *the operations are executed automatically in sequences as specified by the program that contains the information for the tool movements* 在从句中 *that contains the information for the tool movements* 作定语从句, 修饰 *the program*。

Lesson 2 NC Machine

1. The Types of NC Machine

Since its introduction, NC technology has found many applications, including lathes and turning centers, milling machines and machining centers, punches, electrical discharge machines (EDM), flame cutters, grinders, and testing and inspection equipment.^① The most complex CNC machine tool is the turning center (Fig.1-2). And the machining center (MC) (Fig.1-3) (Vertical machining center, with the tool magazine on the left and the control panel on the right, which can be swiveled by the operator) and Horizontal machining center (Fig.1-4) (Horizontal machining center, equipped with an automatic tool changer). The EDM and flame cutter are special type of NC machines(Fig.1-5 and Fig.1-6).

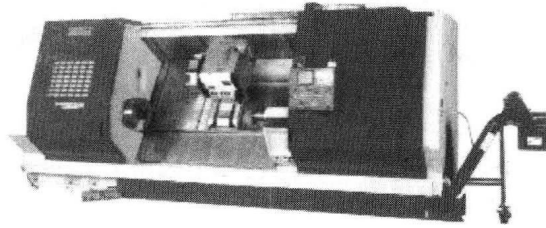


Fig. 1-2 A modern turning center

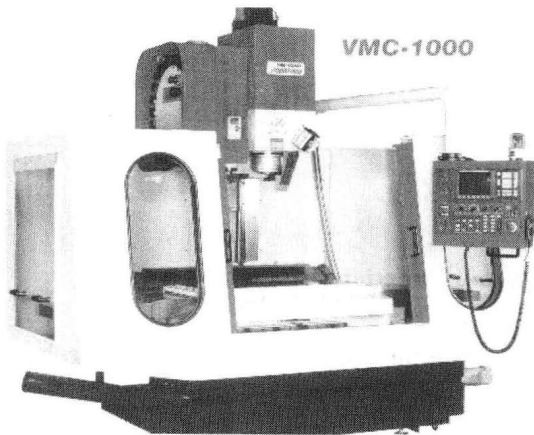


Fig. 1-3 A vertical-spindle machining center

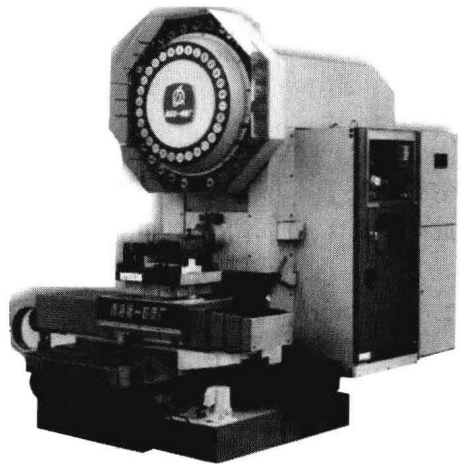


Fig. 1-4 A horizontal-spindle machining center

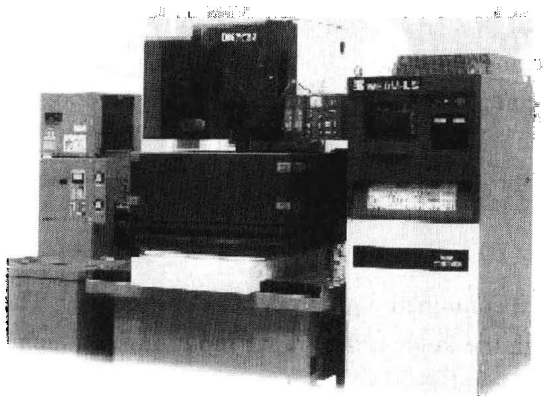


Fig. 1-5 A EDM

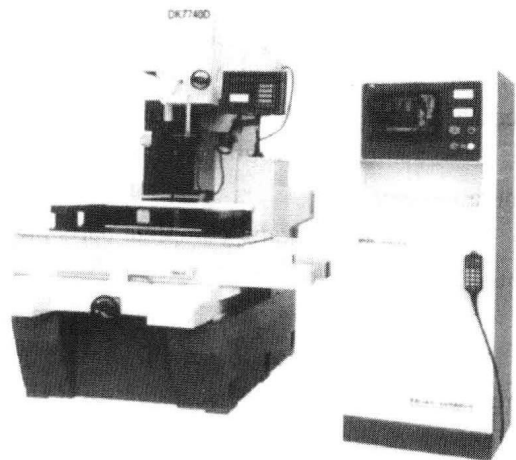


Fig. 1-6 A flame cutter machine

New Words and Phrases

lathe *n.* 车床
turning center 车削加工中心
milling machine 铣床

machining center 铣削加工中心
 electrical discharge machine (EDM) 电火花加工机床
 flame cutter 线切割机床
 grinder *n.* 磨床
 machine center (MC) 加工中心
 vertical *adj.* 立式的, 垂直的
 horizontal *adj.* 水平的, 卧式的
 automatic tool changer 自动刀具交换机构
 tool magazine 刀库

Notes

① Since its introduction, NC technology has found many applications ...

数控技术自发明以来, 得到了广泛的应用……

此句中 its 指代 NC technology

2. The Composition of CNC Machine Tools and Functions of Each Part

(1) CNC Machining Process

① Carry on the processing process study; determine the processing plan, technological parameter and displacement data according to the pattern.

② Write the processing program to work part with the prescriptive code and format; or build the processing program file for parts with the automatic programming software, and perform the CAD/CAM work.

③ Input or output the program. The manual-written program will be input on the NC machine operation panel; the program generated by software will be transferred through serial communication interface (such as RS232C, etc.) of the computer to the numerical control unit of CNC machine tool.

④ The process program in the CNC numerical control unit will operate test run and tool path simulation etc.

⑤ Run the program, complete parts processing through the proper operation of CNC machine tools.

The basic principle of CNC machine tools:

First, write program based on components pattern combined with processing technology. Then input the program to numerical control device through the keyboard or other input device (such as perforated paper tape, floppy disks, etc.), the numerical control device decodes, stores and interpolates the program, give the command signal to the servo system of all the coordinates, in order to drive servo motor rotation, hold the relative position of the tool and workpiece and carry out their movement through the transmission, ensure their position accuracy through the position detection feedback. At the same time, initiate other necessary supporting actions through the PLC system, such as automatic transmission, the automatic opens and stops of the cooling lubricant, the automatic clamp and release of the workpiece, the automatic change of tools, etc. All of these operations, together with the feed movement, guarantee the automatic processing of parts.

(2) Composition of CNC Machine and the Function of Each Part

CNC machine tools comprises of six parts: control media, NC system, servo system, feedback devices, assistive devices and machines body, as shown in Fig. 1-7.

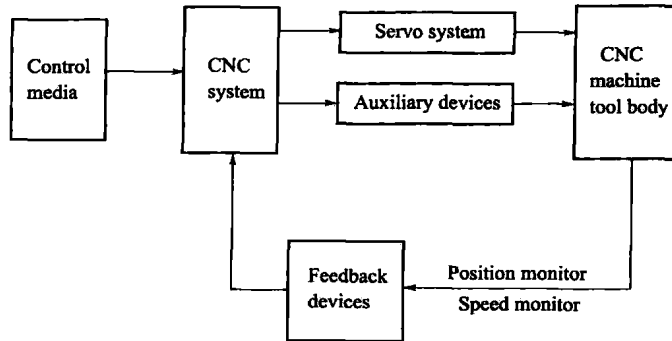


Fig. 1-7 Block diagram of the system of CNC machine tools

① Control media, also known as the information carrier, is the physical medium between people and computers, reflecting all the information in the NC.

② CNC system is the core of the CNC machine tools, which ensure the automatic processing. It mainly consists of input devices, monitors, control system, programmable logic controller (PLC), input and output interfaces and so on.

Monitors are composed by the display and keyboard. Display could be digital LED, CRT, LCD and other forms. It shows the NC program, various parameters, interpolation value, coordinates, fault information, man-machine dialogue programming menu, part graphics, and dynamic cutting tool path.

The main control system consists of CPU, memory, controller and other components. There are two ways of control, computing process control and timing logic control.

Interpolation operation module in the master controller data can carry on the tool path interpolation operation after decoding and coding the input program, and control the displacement of the coordinate axis by comparison to the feedback signals of each axis' position and velocity.

The sequential logic control completes task by programmable logic controller (PLC). It coordinates the requirements of each operation in the machining, determine the detection signals logically, and then control the machine tools to work methodically.

③ Servo system is the electric transmission link between the numerical control system and machine tool body. It consists of a servo motor, drive control system and position sensing feedback device and other components. It is used to control the servo of feed and spindle.

a. Feed servo system is the executive part of the feed movement, including the position control unit, speed control unit, servo motor, measuring feedback unit and other parts. It receives various commands of moves from computer to drive the servo motor movement. Servo motors has three types, stepper motors, DC servo motor and AC servo motor. Performance of feed servo system has immediate affects on the machining accuracy and production efficiency of CNC machine tools.

b. Spindle servo system is the part that transmits torque in cutting machine, generally divided

into gear variable speed and electric continuously variable speed. Spindle servo pump is composed of the spindle drive control system, the spindle motor, and spindle mechanical transmission etc.

④ Feedback devices include optical pulse encoder, grating position sensor, linear sensor synchronizer and other devices.

⑤ Auxiliary devices include automatic tool changer, automatic change pallet table mechanical, clamping and release mechanical, rotary table, hydraulic control systems, lubrication equipment, cutting fluid devices, chip removal device, overload and protection devices.

⑥ CNC machine tool body is the mechanical structure of ontology entities, composed by the main transmission, table, bed and spindle components. Compared with ordinary machine tools, CNC machine tools have had a sweeping change in its overall layout, appearance, transmission, tool system and operating mechanism, and, specifically summarized as follows:

a. Has the great transmission power, high stiffness, good vibration and small thermal deformation with high performance main drive spindle parts.

b. Has the short transmission chain, simple mechanism, high driving precision with the good transmission parts, such as the ball screw, synchronous gear belt etc, so as to ensure the transmission accuracy.

c. Has the perfect tool automatic exchange and management system (especially the CNC machining center).

d. Generally, has the mechanism of automatic exchange workpiece, clamping and relaxing workpiece in CNC machining centers.

e. The machine itself has a very high dynamic and static stiffness with some high precision and small friction coefficient components, such as plastic coated guide rails, linear roller guides rail and static guides rail etc.

f. Totally enclosed cover. As the CNC machine processes in an automatic way, for safety's sake, the machine's machining parts are totally enclosed with lagging and moving door.

3. CNC Machining Object

(1) The Advantages and Characteristics of CNC Machining

- ① Processability of complex-surfaced workpiece.
- ② High machining precision, good size consistency.
- ③ High production efficiency.
- ④ Low labor intensity.
- ⑤ Obvious economic benefits.
- ⑥ Accurate cost calculation and production schedule.
- ⑦ The foundation for CAD / CAM technology and advanced manufacturing.

(2) The Application Range of CNC Machine Tools

- ① The parts produced in much variety and little batch; the parts in new product trial.
- ② The parts with complex geometry.
- ③ The parts demanding multi-processing procedures.
- ④ The parts demanding expensive process equipment when use general machining.
- ⑤ High-precision demanding parts.

- ⑥ The parts need repeated modifying in technical design.
- ⑦ The expensive key parts not allowed scraped.
- ⑧ The parts require the shortest production cycle.

The application range of CNC machine tools is shown in Fig. 1-8.

The relationship between processing batch of various machine tools and their cost is shown in Fig. 1-9.

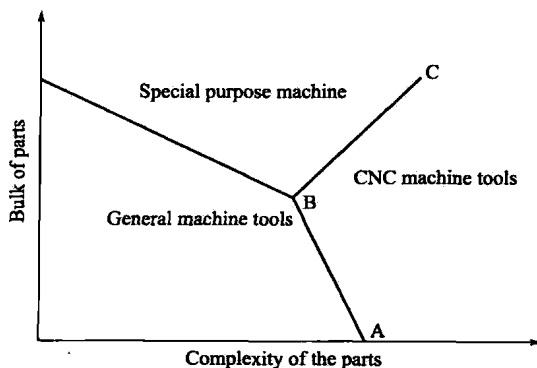


Fig. 1-8 The application range of various CNC machines.

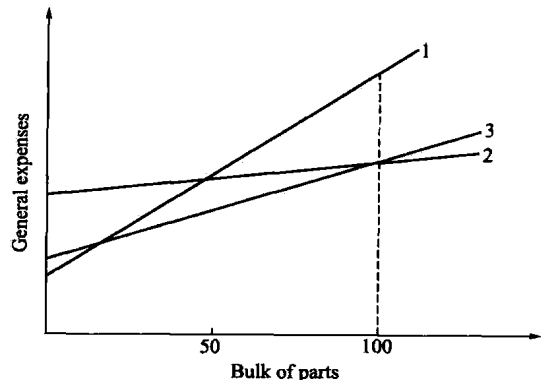


Fig.1-9 The relationship between processing batch of various machine tools and their cost
1—General machine tools; 2—Special purpose machine;
3—CNC machine tools

4. The Construction of CNC Machines

CNC machine tools are complex assemblies. However, in general, any CNC machine tool consists of the following units:

- Computers
- Control systems
- Drive motors
- Tool magazine and changers

(1) Computers

The computer reacts on. As with all computers, the CNC machine computer works on a binary principle using only two characters 1 and 0, for information processing precise time impulses from the circuit. There are two states, a state with voltage, 1, and a state without voltage, 0. Series of ones and zeroes are the only states in which the computer distinguishes a so-called machine language; it is the only language the computer understands. When creating the program, the programmer need not care about the machine language. He or she simply uses a list of codes and keys in the meaningful information. Special built-in software compiles the program into machine language and the machine moves the tool by its servomotors. However, the programmability of the machine is dependent on whether there is a computer in the machine's control.^① If there is a minicomputer programming, say, a radius (which is a rather simple task), the computer will calculate all the points on the tool path. On the machine without a minicomputer, this may prove to be a tedious task, since the programmer must calculate all the points of intersection on the tool path. Modern CNC

machines use 32-bit processors in their computers that allow fast and accurate processing of information.

(2) Control Systems

There are two types of control systems on NC/CNC machines: open loop (Fig. 1-10) and closed loop (Fig. 1-11). The type of control loop used determines the overall accuracy of the machine.

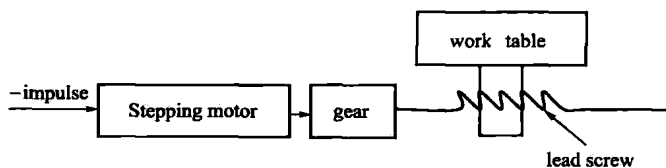


Fig. 1-10 Typical open loop control systems

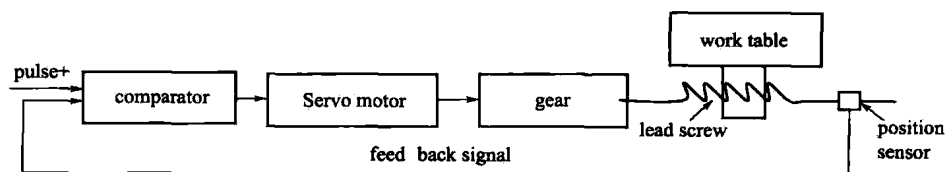


Fig. 1-11 Typical close loop control systems

The open-loop control system does not provide positioning feedback to the control unit. The movement pulses are sent out by the control unit and they are received by a special type of servomotor called a stepper motor. The number of pulses that the control unit sends to the stepper motor controls the amount of the rotation of the motor.^② The stepper motor then proceeds with the next movement command. Since this control system only counts pulses and cannot identify discrepancies in positioning, the machine will continue this inaccuracy until somebody finds the error.

The open-loop control can be used in applications in which there is no change in load conditions, such as the NC drilling machine. The advantage of the open-loop control system is that it is less expensive, since it does not require the additional hardware and electronics needed for positioning feedback. The disadvantage is the difficulty of detecting a positioning error.

In the closed-loop control system, the electronic movement pulses are sent from the control unit to the servomotor, enabling the motor to rotate with each pulse. The movements are detected and counted by a feedback device called a transducer. With each step of movement, a transducer sends a signal back to the control unit, which compares the current position of the driven axis with the programmed position. When the numbers of pulses sent and received match, the control unit starts sending out pulses for the next movement.

Closed-loop systems are very accurate. Most have an automatic compensation for error, since the feedback device indicates the error and the control unit makes the necessary adjustments to bring the slide back to the position. They use AC, DC or hydraulic servomotors.

(3) Drive Motors

The drive motors control the machine slide movement on NC/CNC equipment. They come in