# 机械专业英语

# Professional English in Machinery

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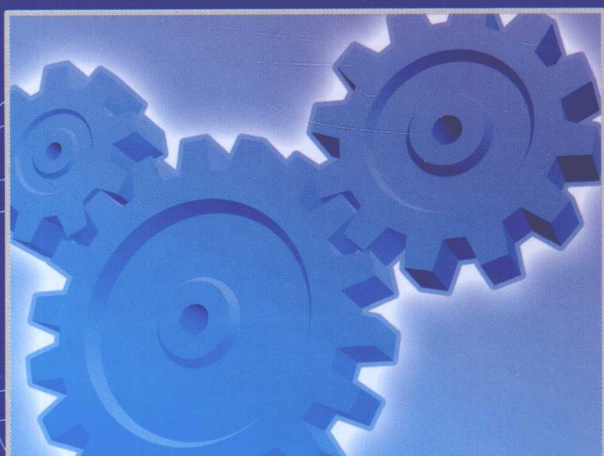

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# 内 容 简 介

本书以培养学生专业英语能力为主要目标。全书共精选27篇课文，其内容包括：数控加工、快速成型、模具设计、材料、机械设计、常见机加工、产品质量、计算机辅助设计、机构分析、科技文献写作等，均附有参考译文。

本书可作为机械设计制造及其自动化、机械工程、机电工程及模具设计等专业的专业英语教材，也可供机械类专业的科技人员参考使用。

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# 前　　言

随着市场经济全球化的普及和知识传播的日新月异，专业英语已经成为获取新知识和进行学术、技术交流的重要工具和必备知识。同时，专业英语作为大学英语教学后期的一个重要部分，是学习基础英语后进行专业实际应用不可缺少的重要环节。

机械专业英语伴随着机械行业新技术、新工艺、新产品的大量涌现，其所涉及的内容也应及时地进行更新和完善，这就要求对相关教材内容进行补充和更新。本书着眼于新技术和实际应用进行编写，以满足高等院校机械工程各专业学生的专业英语教学需求。

本书所涉及的内容相当广泛，主要包括：数控加工、快速成型、模具设计、材料特性与选择、机械设计、常见机械加工、智能制造、工业机器人、机械产品质量、计算机辅助设计、机构分析与设计、科技文献写作等。通过学习本教材，学生不仅可了解一些相关技术知识背景，也可熟悉和掌握应用于该技术中的相关技术单词、词组及其特定用法。本书旨在通过学习这些内容，掌握专业英语所独有的读、写、译等技巧，能完成一定难度的科技论文的读、写工作。

本书选材广泛，内容丰富，语言规范，难度适中，便于自学。在具体编写过程中，我们贯彻以下基本原则：

(1) 课文的选择来源于机械专业科技文献、百科知识互联网等，基本涵盖当前和今后一段时间机械专业研究和发展热点；

(2) 文章内容具有一定权威性、知识性，均为科技普及阅读型内容，篇幅裁剪得当；

(3) 基于本科大三学生英语基础进行内容难度选择，学生可在教师指导下学习，也可自学；

(4) 文章在机械行业专业术语、重难点句子编排、常见专业词汇等方面都进行了精心挑选，力争做到统筹兼顾。

大学机械工程各专业对于专业英语的教学安排一般为 32 课时，建议根据各专业特点选择 10 篇左右课文，其余作为学生课余补充阅读。教学中以 3 课时为一篇课文单位时间进行教学，重点学习专业词汇及专业英语在英汉互译中的技巧与应用等。

本书由桂慧主编，参加编写工作的有孙亮波、宋宜梅、王斌武等老师。由于我们水平有限和时间仓促，书中难免有疏漏之处，恳请读者批评指正，请来信至 E-mail：sunlb1979@163.com。

编者

2009 年 9 月

# Contents





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# Lesson 1　Mold Design

**Mold** or **die** are the common **terms** used to describe the **tooling** used to produce **plastic parts** in molding.

Traditionally, molds have been expensive to manufacture. They were usually only used in mass production where thousands of parts were being produced. Molds are typically constructed from **hardened steel**, pre-hardened steel, **aluminium**, and/or **beryllium-copper alloy**. The choice of material to build a mold is from primarily one of economics, steel molds generally cost more to construct, but their longer lifespan will offset the higher initial cost over a higher number of parts made before wearing out[1]. Pre-hardened steel molds are less wear resistant and are used for lower volume requirements or larger components. The steel hardness is typically 38-45 on the **Rockwell-C scale**. Hardened steel molds are heat treated after machining. These are by far the superior in terms of wear resistance and lifespan. Typical hardness ranges between 50 and 60 Rockwell-C (HRC). Aluminium molds can cost substantially less, and when designed and machined with modern computerized equipment, can be economical for molding tens or even hundreds of thousands of parts. Beryllium copper is used in areas of the mold which require fast heat removal or areas that see the most shear heat generated. The molds can be manufactured by either CNC machining or by using Electrical Discharge Machining processes

Molds separate into two sides at a parting line, the A side, and the B side, to permit the part to be extracted. Plastic resin enters the mold through a sprue in the A plate, branches out between the two sides through channels called runners, and enters each part cavity through one or more specialized gates[2]. Inside each cavity, the resin flows around **protrusions** (called **cores**) and conforms to the cavity geometry to form the desired part. This is similar to someone squeezing **clay** between their hands so that when it is removed, it matches the shape of the hollow of their cupped hands.

The amount of resin required to fill the sprue, runner and cavities of a mold. When a core shuts off against an opposing mold cavity or core, a hole results in the part. Air in the cavities when the mold closes escapes through very slight gaps between the plates and **pins**, into shallow **plenums** called **vents**. To permit removal of the part, its features must not **overhang** one another in the direction that the mold opens, unless parts of the mold are designed to move from between such overhangs when the mold opens (utilizing components called Lifters).

Sides of the part that appear parallel with the direction of draw (the direction in which the core and cavity separate from each other) are typically angled slightly with (draft) to ease release of the part from the mold, and examination of most plastic household objects will reveal this[3]. Parts with **bucket**-like features tend to **shrink** onto the cores that form them while cooling, and **cling** to those cores when the cavity is pulled away. The mold is usually designed so that the molded part reliably remains on the ejector (B) side of the mold when it opens, and draws the runner and the sprue out of the (A) side along with the parts. The part then falls freely when ejected from the (B) side. Tunnel gates tunnel sharply below the parting surface of the B side at the tip of each runner so that the gate is sheared off of the part when both are ejected.

Ejector pins are the most popular method for removing the part from the B side core(s), but air ejection, and **stripper plates** can also be used depending on the application. Most ejection plates are found on the moving half of the tool, but they can be placed on the fixed half if spring loaded. For **thermoplastics**, coolant, usually water with corrosion **inhibitors**, circulates through passageways bored through the main plates on both sides of the mold to enable temperature control and rapid part **solidification**.

To ease maintenance and venting, cavities and cores are divided into pieces, called inserts, and sub-assemblies, also called inserts, blocks, or **chase** blocks. By substituting interchangeable inserts, one mold may make several variations of the same part.

More complex parts are formed using more complex molds. These may have sections called **slides**, which move into a cavity **perpendicular** to the draw direction, to form overhanging part features. Slides are then withdrawn to allow the part to be released when the mold opens. Slides are typically guided and retained between rails called gibs, and are moved when the mold opens and closes by angled rods called horn pins and locked in place by locking blocks, both of which move cross the mold from the opposite side[4].

Some molds allow previously molded parts to be reinserted to allow a new plastic layer to form around the first part. This is often referred to as overmolding. This system can allow for production of one-piece **tires** and wheels. 2-shot or multi-shot molds are designed to "overmold" within a single molding cycle and must be processed on specialized injection molding machines with two or more injection units. This can be achieved by having pairs of identical cores and pairs of different cavities within the mold. After injection of the first material, the component is rotated on the core from the one cavity to another. The second cavity differs from the first in that the detail for the second material is included. The second material is then injected into the additional cavity detail before the completed part is ejected from the mold. Common applications include "soft-grip" toothbrushes and free **lander** grab handles.

The core and cavity, along with injection and cooling **hoses** form the mold tool. While large tools are very heavy weighing hundreds and sometimes thousands of pounds, with the aid of a **forklift** or **overhead crane**, they can be **hoisted** into molding machines for production and removed when molding is complete or the tool needs repairing.

A mold can produce several copies of the same parts in a single "shot". The number of **"impressions"** in the mold of that part is often incorrectly referred to as **cavitation.** A tool with one impression will often be called a single cavity (impression) tool. A mold with 2 or more cavities of the same parts will likely be referred to as multiple cavity tooling. Some extremely high production volume molds (like those for bottle caps) can have over 128 cavities.

In some cases multiple cavity tooling will mold a series of different parts in the same tool. Some toolmakers call these molds family molds as all the parts.

**New words and expressions:**

mold [məuld] *n.* 模具,*v.* 铸造
die [dai] *n.* 钢模,冲模
term [təːm] *n.* 术语
tooling [ˈtuːliŋ] *n.* 工艺装备
plastic parts 塑料件
hardened steel 硬质钢
aluminium [ˌæljuːˈminjəm] *n.* 铝
beryllium-copper alloy 铍铜合金
steel molds 钢模
Rockwell-C scale 洛氏硬度
resin [ˈrezin] *n.* 树脂
sprue [spruː] *n.* 喷嘴
runner [ˈrʌnə(r)] *n.* 流道
gate [geit] *n.* 浇口
protrusion [prəˈtruːʒən] *n.* 突出物,凸模
core [kɔː] *n.* 型芯
clay [klei] *n.* 黏土
pin [pin] *n.* 销钉
plenum [ˈpliːnəm] *n.* 高压
vent [vent] *n.* 通风口
overhang [ˈəuvəˈhæŋ] *v.* 悬挂
household [ˈhaushəuld] *adj.* 家庭的
bucket [ˈbʌkit] *n.* 桶
cling to 黏附
stripper plate 分馏柱塔板
thermoplastics [ˌθəːməˈplæstiks] *n.* 热塑性材料
solidification [ˌsɔlidifiˈkeiʃən] *n.* 凝固

chase [tʃeis] *vt.* 雕镂
slide [slaid] *n.* 滑块
perpendicular [ˌpəːpən'dikjulə] *adj.* 垂直的
gib [gib] *n.* 楔形块
horn pin 推杆
locking block 锁紧块
tire ['taiə] *n.* 轮胎
lander ['lændə] *adj.* 接触的
hose [həuz] *n.* 管道
forklift ['fɔːklift] *n.* 叉式升降机
overhead crane 桥式起重机
hoist [hɔist] *n.* 提升
impressions [im'preʃən] *n.* 压痕，型腔
cavitation [ˌkævi'teiʃən] *n.* 气穴现象

**Analysis for some complex sentences:**

[1]The choice of material to build a mold is from primarily one of economics, steel molds generally cost more to construct, but their longer lifespan will offset the higher initial cost over a higher number of parts made before wearing out.

组成模具的材料，其选择主要考虑经济因素，钢模具一般建造成本较高，但它们的长寿命将抵消较高的初始成本。

[2]Plastic resin enters the mold through a sprue in the A plate, branches out between the two sides through channels called runners, and enters each part cavity through one or more specialized gates.

塑料树脂通过金属板上的喷嘴进入模具，通过流道在 A、B 两边扩散开来，并通过一个或多个专门浇口进入各个部分型腔。

[3]Sides of the part that appear parallel with the direction of draw (the direction in which the core and cavity separate from each other) are typically angled slightly with (draft) to ease release of the part from the mold, and examination of most plastic household objects will reveal this.

双方的表面与开模方向（型芯和型腔分开的方向）平行，通常有轻微的角度，以便从模具释放零件，看看塑料家庭物体就会发现这一点。

[4] Slides are typically guided and retained between rails called gibs, and are moved when the mold opens and closes by angled rods called horn pins, and locked in place by locking blocks, both of which move cross the mold from the opposite side.

滑块的运动由楔形块引导，而且当模具打开或关闭时，滑块移动，以有一定角度的推杆（角棒）闭合，然后由楔紧块锁在某一位置，两个滑块移动方向与模具开合方向垂直，且其两滑块移动方向相对。

# Lesson 2 Injection Molding

With **Injection Molding**, **granular** plastic is fed by **gravity** from a **hopper** into a heated **barrel**. As the granules are slowly moved forward by a **screw**-type **plunger**, the plastic is forced into a heated **chamber**, where it is melted. As the plunger advances, the melted plastic is forced through a **nozzle** that rests against the mold, allowing it to enter the mold **cavity** through a **gate** and **runner system**. The mold remains cold so the plastic **solidifies** almost as soon as the mold is filled.

For the injection molding cycle to begin, four criteria must be met: mold open, **ejector pins** retracted, shot built, and carriage forward. When these criteria are met, the cycle begins with the mold closing. This is typically done as fast as possible with a slow down near the end of travel. Mold safety is low speed and low pressure mold closing. It usually begins just before the **leader pins** of the mold and must be set properly to prevent accidental mold damage. When the mold halves touch **clamp tonnage** is built. Next, **molten** plastic material is injected into the mold. The material travels into the mold via the **sprue bushing**, and then the runner system delivers the material to the gate. The gate directs the material into the **mold cavity** to form the desired part. This injection usually occurs under velocity control.

When the part is nearly full, injection control is switched from velocity control to pressure control. This is referred to as the pack hold phase of the cycle. Pressure must be maintained on the material until the gate solidifies to prevent material from flowing back out of the cavity. Cooling time is dependent primarily on the wall **thickness** of the part but also depends on the material being molded. Production molding usually requires faster cooling. Water is often channeled throughout the dies to produce faster cooling times. During the cooling portion of the cycle after the gate has solidified, **plastication** takes place.

Plastication is the process of melting material and preparing for the next shot. The material begins in the hopper and enters the barrel through the feed **throat**. The feed throat must be cooled to prevent plastic pellets from fusing together from the barrel heat. The barrel contains a screw that primarily uses to shear the melt pellets and consists of three sections. The first section is the feed section which conveys the pellets forward and allows barrel heat to soften the pellets. The flight depth is uniform and deepest in this section. The next section is the transition section and is responsible for melting the material through shear. The flight depth continuously decreases in this section, compressing the material. The final section is the metering section which features a



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shallow flight depth, improves the melt quality and color dispersion. At the front of the screw is the **non-return valve** which allows the screw to act as both an **extruder** and a **plunger.** When the screw is moving backwards to build a shot, the non-return assembly allows material to flow in front of the screw creating a **melt pool** or shot. During injection, the non-return assembly prevents the shot from flowing back into the screw sections.

Once the shot has been built and the cooling time has timed out, the mold opens. Mold opening must occur slow-fast-slow. The mold must be opened slowly to release the **vacuum** that is caused by the injection molding process and prevent the part from staying on the stationary mold half. This is undesirable because the ejection system is on the moving mold half. Then the mold is opened as far as needed, if robots are not being used, the mold only has to open far enough for the part to be removed. A slowdown near the end of travel must be utilized to compensate for the momentum of the mold. Without slowing down the machine cannot maintain accurate positions and may slam to a stop damaging the machine. Once the mold is open, the ejector pins are moved forward, ejecting the part. When the ejector pins retract, all criteria for a molding cycle have been met and the next cycle can begin.

The basic injection cycle is as follows: Mold close-injection carriage forward-inject plastic-metering-carriage retract-mold open-eject part(s). Some machines are run by electric motors instead of **hydraulics** or a combination of both. The **water-cooling** channels that assist in cooling the mold and the heated plastic solidifies into the part. Improper cooling can result in distorted molding. The cycle is completed when the mold opens and the part is ejected with the assistance of ejector pins within the mold.

The **resin**, or raw material for injection molding, is most commonly supplied in **pellet** or **granule** form. Resin pellets are **poured into** the feed hopper, a large open bottomed container, which is attached to the back end of a cylindrical, horizontal barrel. A screw within this barrel is rotated by a motor, feeding pellets up the screw's grooves. The depth of the **screw flights** decreases toward the end of the screw nearest the mold, compressing the heated plastic. As the screw rotates, the pellets are moved forward in the screw and they undergo extreme pressure and friction which generates most of the heat needed to melt the pellets. Electric heater bands attached to the outside of the barrel assist in the heating and temperature control during the melting process.

The channels through which the plastic flows toward the chamber will also solidify, forming an attached frame. This frame is composed of the sprue, which is the main channel from the reservoir of molten resin, parallel with the direction of draw, and runners, which are perpendicular to the direction of draw, are used to convey molten resin to the gate(s), or point(s) of injection[1]. The sprue and runner system can be cut or twisted off and recycled, sometimes being granulated next to the mold machine. Some molds are designed so that the part is automatically stripped through action of the mold.

**New words and expressions:**

Injection Molding　注射模
gravity　['grævɪti] *n.* 重力
hopper　['hɔpə] *n.* 料斗
barrel　['bærəl] *n.* 桶
screw　[skruː] *n.* 螺杆，螺孔
plunger　['plʌndʒə] *n.* 活塞
chamber　['tʃeimbə] *n.* 腔
melt　[melt] *v.* 熔化
nozzle　['nɔzl] *n.* 喷嘴
cavity　['kæviti] *n.* 型腔
gate　[geit] *n.* 浇口
runner system 热流道系统
solidify　['sɔlidifai] *v.* 使凝固
ejector pin　顶针
clamp　[klæmp] *n.* 夹钳
tonnage　['tʌnidʒ] *n.* 吨位
molten　['məultən] *adj.* 熔铸的
sprue bushing　浇口套
mold cavity　模具型腔
thickness　['θiknis] *n.* 厚度
plastication　[ˌplæsti'keiʃən] *n.* 塑化
throat　[θrəut] *n.* 颈部，窄处
non-return valve 单向阀
extruder　[eks'truːdə] *n.* 挤压
plunger　['plʌndʒə] *n.* 活塞
melt pool　熔料池
vacuum　['vækjuəm] *n.* 真空
hydraulics　['hai'drɔːliks] *adj.* 液压的
water-cooling　水冷
resin　['rezin] *n.* 树脂
pellet　['pelit] *n.* 小球
granule　['grænjuːl] *n.* 颗粒
poured into　流入，涌入
screw flight　螺杆上的螺纹
sprue　[spruː] *n.* 浇口

**Analysis for some complex sentences:**

[1]This frame is composed of the sprue, which is the main channel from the reservoir of molten resin, parallel with the direction of draw, and runners, which are perpendicular to the direction of draw, are used to convey molten resin to the gate(s), or point(s) of injection.

这个由熔融的残料构成的框架，是熔化的树脂从料斗流经型腔的主通道，它与模具的开合方向平行；而与开合方向垂直的分流道，用于将熔融塑料传递到浇口。

# Lesson 3 Forming Processes

**Forming** can be defined as a process in which the desired size and shape are obtained through the plastic **deformations** of a material[1]. The stresses induced during the process are greater than the yield strength, but less than the **fracture strength** of the material. The type of loading may be **tensile**, **compressive**, **bending**, or **shearing**, or a combination of these. This is a very economical process as the desired shape, size, and finish can be obtained without any significant loss of material. Moreover, a part of the input energy is **fruitfully** utilized in improving the strength of the product through strain **hardening**.

The forming processes can be grouped under two broad **categories**, namely, cold forming, and hot forming. If the working temperature is higher than the **recrystallization** temperature of the material, then the process is called hot forming. Otherwise the process is termed as cold forming. The flow stress behavior of a material is entirely different above and below its recrystallization temperature. During hot working, a large amount of plastic deformation can be imparted without significant strain hardening. This is important because a large amount of strain hardening **renders** the material **brittle**. The frictional characteristics of the two forming processes are also entirely different. For example, the **coefficient** of friction in cold forming is generally of the order of 0.1, whereas that in hot forming can be as high as 0.6. Further, hot forming lowers down the material strength so that a machine with a reasonable **capacity** can be used even for a product having large **dimensions**.

The typical forming processes are **rolling**, **forging**, **drawing**, **deep drawing**, **bending**, **and extrusion**. For a better understanding of the mechanics of various forming operations, we shall briefly discuss each of these processes.

**Rolling**

In this process, the job is drawn by means of friction through a regulated opening between two power-driven rolls. The shape and size of the product are decided by the **gap** between the rolls and their **contours**. This is a very useful process for the production of **sheet metal** and various common sections, e. g., rail, channel, angle, and round[2].

**Forging**

In forging, the material is squeezed between two or more dies to alter its shape and size. Depending on the situation, the dies may be open or closed.

**Drawing**

In this process, **the cross-section** of a wire or that of a bar or tube is reduced by pulling the workpiece through the conical orifice of a die represents the operation **schematically.** When high reduction is required, it may be necessary to perform the operation in several passes.

**Deep Drawing**

In deep drawing, a cup-shaped product is obtained from a flat sheet metal with the help of a **punch** and a die. The sheet metal is held over the die by means of a **blank holder** to avoid **defects** in the product.

**Bending**

As the name implies, this is a process of bending a metal sheet plastically to obtain the desired shape and is achieved by a set of suitably designed punch and die.

**Extrusion**

This is a process basically similar to the closed die forging. But in this operation, the workplace is compressed in a closed space, forcing the material to flow out through a suitable opening, called a die. In this process, only the shapes with constant cross-sections (die outlet cross-section) can be produced.

**Advantages and Disadvantages of Hot and Cold Forming**

Now that we have introduced the various types of metal working operations, it would not only be appropriate that we provide an overall evaluation of the hot and cold working processes, such a discussion will also help in choosing the proper working conditions for a given situation.

During hot working, a proper control of the grain size is possible since active grain growth takes place in the range of the working temperature. As a result, there is no strain hardening, and therefore there is no need of expensive and time-consuming intermediate annealing. Of course, strain hardening is advisable during some operations (**viz.** , drawing) to achieve an improved strength, in such cases, hot working is less advantageous. Apart from this, strain hardening may be essential for a successful completion of some processes (e. g., in deep drawing, strain hardening prevents the **rupture** of the material around the bottom circumference where the stress is maximum). Large products and high strength materials can be worked under hot conditions since the elevated temperature lowers down the strength and, consequently, the work load. Moreover, for most materials, the **ductility** increases with temperature and, as a result, brittle materials can also be worked upon by the hot working operation. It should, however, be remembered that there are certain materials (viz. , steels containing **sulphur**) which become more brittle at elevated temperatures. When a very accurate dimensional control is required, hot working is not advised because of shrinkage and loss of surface metal due to scaling. Moreover, **surface finish** quality is poor due to oxide **formation** and scaling.

The major advantages of cold working are that it is economical, quicker, and easier to handle because here no extra arrangements for heating and handling are necessary.

Further, the mechanical properties normally get improved during the process due to strain hardening. What is more, the control of grain flow directions adds to the strength characteristics of the product. However, apart from other limitations of cold working (viz., difficulty with high strength and brittle materials and large product sizes), the **inability** of the process to prevent the significant reduction brought about in **corrosion resistance** is an undesirable feature[3].

**New words and expressions:**

forming ['fɔːmiŋ] *n.* 成型
deformation [ˌdiːfɔː'meiʃən] *n.* 变形
induce [in'djuːs] *vt.* 引诱,诱导
yield strength 屈服强度
fracture strength 破裂强度
tensile ['tensail] *adj.* 拉伸的
compressive [kəm'presiv] *adj.* 压缩的
bending ['bendiŋ] *n.* 弯曲,挠度
shearing ['ʃiəriŋ] *n.* 剪切
fruitfully ['fruːtfuli] *adv.* 大部分地
hardening ['hɑːdəniŋ] *v.* 淬水
category ['kætigəri] *n.* 种类,目录
recrystallization [riː'krɪstəlaɪzeiʃən] *n.* 再结晶
render ['rendə] *vt.* 放弃
brittle ['britl] *adj.* 易碎的
coefficient [kəui'fiʃənt] *n.* 系数
capacity [kə'pæsiti] *n.* 容量,能力
dimension [di'menʃən] *n.* 尺寸
rolling ['rəuliŋ] *n.* 滚压
forging ['fɔːdʒiŋ] *n.* 锻造
drawing ['drɔːiŋ] *n.* 拉伸
deep drawing 深度拉伸
extrusion [eks'truːʒən] *n.* 挤出,推出
gap [gæp] *n.* 间隙
contour ['kɔntuə] *n.* 轮廓
sheet metal 金属片
squeeze [skwiːz] *v.* 挤压
cross-section [krɔs-'sekʃən] 横截面
schematically [ski'mætikli] *adv.* 示意性地
punch [pʌntʃ] *vt.* 冲孔,打孔
blank holder 压边



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