ДОНСКОЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

УПРАВЛЕНИЕ ЦИФРОВЫХ ОБРАЗОВАТЕЛЬНЫХ ТЕХНОЛОГИЙ

Кафедра «Научно-технический перевод и профессиональная коммуникация»

Учебно-методическое пособие

«Художественная обработка металлов»
по дисциплине

«Иностранный язык в профессиональной сфере»

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Ростов-на-Дону, 2020

Аннотация

Учебно-методическое пособие предназначено для студентов очной, заочной форм обучения направления 29.03.04 «Технология художественной обработки материалов».

Цель пособия – познакомить студентов с базовой профессиональной терминологией, закрепить навыки чтения и перевода, развить навыки реферирования и аннотирования специальных текстов на английском языке. При использовании данного пособия предполагается отработка следующих умений и навыков на английском языке: а) участие студентов в речевом общении – умение участвовать в беседе и делать сообщение по профессиональной тематике; б) чтение текстов по профессиональной тематике для получения необходимой информации. Текстовый материал пособия аутентичен и подобран в соответствии с темами и уровнем сложности.

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Оглавление

1. MATERIALS FOR ART METALWORK

Text 1.1

Ex. 1.1.1 Transcribe the following words and read them aloud:

properties, materials, weight, amount, volume, aluminium, measure, modulus, ratio, structure, area, yield, fracture, inversely, proportional, tough, tensile, composite, constituent, especially.

Ex. 1.1.2 Read and translate the text:

MECHANICAL PROPERTIES OF MATERIALS

Density (specific weight) is the amount of mass in a unit volume**.** It is measured in kilograms per cubic metre. The density of water is 1000 kg/m^3 but most materials have a higher density and sink in water. Aluminium alloys, with typical densities around 2800 kg/m are considerably less dense than steels, which have typical densities around 7800 kg/m^3.

Stiffness (rigidity) is a measure of the resistance to deformation such as stretching or bending. The Young modulus is a measure of the resistance to simple stretching or compression. It is the ratio of the applied force per unit area (stress) to the fractional elastic deformation (strain). Stiffness is important when a rigid structure is to be made.

Strength is the force per unit area (stress) that a material can support without failing. The units are the- same as those of stiffness, MN/m^2, but in this case the deformation is irreversible. The yield strength is the stress at which a material first deforms plastically. For a metal the yield strength may be less than the fracture strength, which is the stress at which it breaks. Many materials have a higher strength in compression than in tension.

Ductility is the ability of a material to deform without breaking. One of the great advantages of metals is their ability to be formed into the shape that is needed. Materials that are not ductile are brittle. Ductile materials can absorb energy by deformation but brittle materials cannot.

Toughness is the resistance of a material to breaking when there is a crack in it. For a material of given toughness, the stress at which it will fail is inversely proportional to the square root of the size of the largest defect present. Toughness is different from strength: the toughest steels, for example, are different from the ones with highest tensile strength. Brittle materials have low toughness: glass can be broken along a chosen line by first scratching it with a diamond. Composites can be designed to have considerably greater toughness than their constituent materials**.** The example of a very tough composite is fiberglass that is very flexible and strong.

Creep resistance is the resistance to a gradual permanent change of shape, and it becomes especially important at higher temperatures. (1887)

Ex. 1.1.3 Scan the reading text to find the word expressions which denote:
удельный вес; сплавы алюминия; модуль Юнга; упругая деформация; предел текучести; сопротивление излому; деформироваться без разрушения; вязкие и хрупкие вещества; обратно пропорционально; квадратный корень; композиты; составные материалы; предел прочности при растяжении (сопротивление растяжению); сопротивление ползучести; постепенное изменение формы

Ex. 1.1.4 Find the terms in the text which are appropriate for the following definitions:
1) … is the force per unit area (stress) that a material can support without failing; 2) … is the ability of a material to deform without breaking; 3) … is the resistance to a gradual permanent change of shape; 4) … is the stress at which a material first deforms plastically; 5) … is the resistance of a material to breaking when there is a crack in it; 6) … is a measure of the resistance to deformation such as stretching or bending; 7… is the relation of the amount of matter (the mass) to the space into which the matter is packed (its volume**);** 8) … is a thin line on the surface of something when it is broken but has not actually come apart 9) … is a measure of the resistance to simple stretching or compression; 10) … is a measurement of the amount of space that a substance or object fills.

Text 1.2

Ex. 1.2.1 Transcribe the following words and read them aloud:
conductivity, electricity, lustre, iron, zinc, quantities, precious, platinum, palladium, berillium, titanium, bismuth, sulphur, variety, chemical, coatings, corrosion-resistant, barrier, environment.

Ex. 1.2.2 Read and translate the text:

METALS AND NONMETALS

There are some distinctions between metals and nonmetals. Metals are distinguished from nonmetals by their high conductivity for heat and electricity, by metallic lustre and by their resistance to electric current. Their use in industry is explained not only by those properties, but also by the fact that their properties, such as strength and hardness, can be greatly improved by alloying them with other metals.

There are several important groups of metals and alloys. The common metals such as iron, copper, zinc. etc. are produced in great quantities.

The so-called precious metals include silver, gold, platinum and palladium. The light metals are aluminium, berillium and titanium. They are important in aircraft and rocket construction

Many elements are classified as semimetals (bismuth, for example) because they have much poorer conductivity than common metals.

Nonmetals (carbon, silicon, sulphur) in the solid state are usually brittle materials without metallic lustre and are usually poor conductors of electricity. Nonmetals show greater variety of chemical properties than common metals do.

Metals can undergo corrosion, changing in this case their chemical and electromechanical properties. In order to protect metals from corrosion the products made of metals and steel arc coated by some films (coatings). Organic coatings protect metals and steel from corrosion by forming a corrosion-resistant barrier between metal or steel and the corrosive environment. (1259)

Ex. 1.2.3 Scan the reading text to answer the following questions:

1. By what properties are metals distinguished from nonmetals?
2. What common metals are produced in great quantities?
3. What metals are called light?
4. What properties do nonmetals have?

5. What is done to protect metals from corrosion?

Ex. 1.2.4 Scan the reading text to fill in the following table:

	Metals	Nonmetals
Distinctions		
Examples of substanc-es		

Text 1.3

Ex. 1.3.1 Transcribe the following words and read them aloud:
colour, thermal, capacity, visual, aluminium, volume, liquid, definite, temperature, iron, property, transfer, account, manufacturing, alloy, nichrome, vary, purity, associated, cobalt.

Ex. 1.3.2 Read and translate the text:

PHYSICAL AND CHEMICAL PROPERTIES OF METALS

Обычная температурная шкала, применяемая в Великобритании и США, называется шкалой Фаренгейта, в которой температура замерзания воды 32° F, а кипения воды 212°: Water freezes at 32° F = Water freezes at thirty-two degrees Fahrenheit ['færənhaɪt]. В науке и технике применяется привычная нам шкала Цельсия: Water freezes at 0° C = Water freezes at nought degrees Centigrade ['sentɪgreɪd] / Celsius ['selsɪəs]

The physical properties of metals include colour, density, melting, temperature, thermal conduction, thermal expansion, heat capacity, electrical conduction and magnetism.

The colour is the property of a metal to induce a visual sensation in accordance with the spectrum and intensity of the visible radiation, which the metal reflects of absorbs. For example, copper is seen as reddish and aluminium as silvery-white. The density is the mass per unit volume. Melting is the conversion of a metal from the solid to the liquid state at a definite melting temperature, or melting point. The melting point of iron, tin, and copper is 1539, 232, and 1083°C respectively. Thermal conduction is the property of a metal to transfer heat. Silver, copper, and aluminium are the best conductors of heat. Thermal expansion is the property of a metal to expand on heating and contract on cooling. This property is taken into account in constructing, for example, bridge trusses and railway tracks and in manufacturing plain bearing. Heat capacity is the ability of a metal to absorb a definite amount of heat during heating. Electrical conduction is the property of a metal to conduct electric current. Copper and aluminium, which nave high electric conductivity, go into the production of current-carrying wire. The Alloys of a high electrical resistance, such as nichrome, constantan, and manganin are used in electric heating devices and electric furnaces. The density and melting point of some metals can vary depending on the methods of their production, purity, and internal structure. Magnetism is the metal property associated with magnetic interaction. Iron, nickel, cobalt, and their alloys, called ferromagnetic alloys, display good magnetic properties and find the widest application for electric motors, generators, transformers, and telephone and telegraph networks. (1583)

Ex. 1.3.3 Fill in the blanks with information taken from the text:

1) The physical properties of metals include …; 2) … the property of a metal to induce a visual sensation in accordance with the spectrum and intensity of the visible radiation, which …; 3) The density is …; 4) … is the conversion of a metal from the solid to the liquid state …; 5) … is the property of a metal to transfer heat; 6) Thermal expansion is …; 7) … the ability of a metal to absorb a definite amount of…; 8) … go into the production of current-carrying wire; 9) The Alloys of a high electrical resistance…; 10) … display good magnetic properties and find the widest application for **...**

Ex. 1.3.4 Find the terms in the text which are appropriate for the following definitions:

1) … is the property of a metal to conduct electric current; 2) … is the property of a metal to expand on heating and contract on cooling; 3) … is the mass per unit volume; 4) … is the metal property associated with magnetic interaction; 5) … is the conversion of a metal from the solid to the liquid state at a definite melting temperature; 6) … is the property of a metal to induce a visual sensation in accordance with the spectrum and intensity of the visible radiation; 7… is the property of a metal to transfer heat; 8) … is the ability of a metal to absorb a definite amount of heat during heating.

Text 1.4

Ex. 1.4.1 Transcribe the following words and read them aloud:

mechanical, technological, properties, determine, ability, composition, structure, behavior, during, elasticity, toughness, rupture, residual, surface, substance, resume, external, physicochemical, machine, possess, fluidity, flowability, weldability, malleability, forgeability, piece, pressure, acquire.

Ex. 1.4.2 Read and translate the text:

MECHANICAL AND TECHNOLOGICAL PROPERTIES OF METALS

The mechanical properties determine the ability of a metal to resist the effect of mechanical forces (loads). They depend on the chemical composition of a metal, its structure, the method of metalworking, and other factors. Knowing the mechanical properties we can judge the behavior of the metal during its treatment and in the course of operation of the parts produced from this metal. The mechanical properties of a metal indicate its strength, hardness, elasticity, and impact strength, or toughness.

Strength is the resistance of a metal to forces that tend to rupture it or cause residual deformation. Hardness is the ability of a metal to resist surface deformation under the action of a harder substance. Elasticity is the ability of a metal to resume its original size and shape after removal of external forces. Impact strength (toughness) is the resistance of a metal to impact.

In addition to physicochemical and mechanical properties, machine elements must possess technological properties. These are the casting properties characterized by the fluidity, i.e. flowability in the liquid state, shrinkage, weldability, malleability (forgeability), and other properties. Weldability is the ability of metals to form strong permanent joints between metal pieces by heating the surfaces to be welded to the plastic or liquid state. Malleability is the property a metal to be worked under pressure in forging, rolling, and stamping. This property enables a metal to acquire the desired shape in the cold or hot state. Workability is the ability of a metal to lend itself to any kind of metalworking. (1354)

Ex. 1.4.3 Scan the reading text to find the word expressions which denote:

химический состав; детали машин; внешние силы; способы металлообработки; в жидком состоянии; сопротивляться воздействию; механические свойства; под действием; поверхностная деформация; механические нагрузки; крепкие соединения; давать возможность; исходный размер и форма

Ex. 1.4.4 Find the terms in the text which are appropriate for the following definitions:

1) … is the property a metal to be worked under pressure in forging, rolling, and stamping; 2) … is the ability of a metal to resist surface deformation under the action of a harder substance; 3) … is the resistance of a metal to forces that tend to rupture it or cause residual deformation; 4) … is the ability of a metal to lend itself to any kind of metalworking; 5) … is the ability of a metal to resume its original size and shape after removal of external forces; 6) … is the resistance of a metal to impact; 7) … is the ability of metals to form strong permanent joints between metal pieces by heating the surfaces to be welded to the plastic or liquid state.

Ex. 1.4.5 Write 10 sentences most essential for the contents of the text.

Text 1.5

Ex. 1.5.1 Transcribe the following words and read them aloud:

colour, weigh, malleability, ductility, possess, properties, mechanical, annealing, tenacity, gravity, commercial, oxidized, cuprous, oxide, hydrogen, monoxide, sulphur, dioxide, solidification, porosity, difficulty, volatilized, temperature, furnace, powdered, conductivity, electricity, impurities, phosphorus, arsenic, antimony.

Ex. 1.5.2 Read and translate the text:

COPPER. Part One: Physical Properties.

В химических формулах все химические элементы произносятся по буквам, их составляющим. Причем названия букв такие, как в английском алфавите, например: H_2O [eiʧ tu: ou], Cu_2O [si: ju: tu: ou], H_2SO_4 [eiʧ tu: es ou fɔ:], HBr [eiʧ bi: a:], etc.

Copper is distinguished by its red colour from all other metals. Atomic weight is 63.57.

Malleability and Ductility. — It can be rolled into very thin sheets beaten out into, leaves and drawn into fine wire, and thus possesses the properties of malleability and ductility in a high degree. By cold rolling or other mechanical treatment it becomes hard, but its malleability is regained by annealing. It is immaterial whether the copper be quenched in water or cooled slowly after the annealing process.

Tenacity. — Its tenacity when cast is 8 to 10 tons per s. i.; when rolled or drawn 16 to 23 tons or even more, according to the amount of mechanical treatment it has received.

Specific Gravity.— The specific gravity of pure Cu, rolled, forged, or drawn, and afterwards annealed, may be taken as 8.89 at 20°C, but that of ordinary commercial copper usually ranges from 8.2 to 8.6.

Action of Heat. — The melting point of Cu lies somewhat about 1,083°C. When molten it is rapidly oxidized with the formation of cuprous oxide (Cu_2O), which dissolves in the metal. It also absorbs hydrogen, carbon, monoxide, and sulphur dioxide, which are given off during solidification, part, however, remains in the metal producing more or less porosity. Hence arises the difficulty of obtaining sound casting of copper [отсюда возникает трудность получения доброкачественных отливок меди].

The metal is not volatilized at the temperature of ordinary furnaces, but readily in the electric furnace, its boiling point being about 2,100°C. When heated to near its melting point it becomes so brittle that it may be easily powdered.

Electrical Conductivity. — As a conductor of electricity copper is only surpassed by silver, and hence is largely used for electric wires and cables. Its electrical conductivity is 976 if silver be taken as 1000. This is greatly reduced by the presence of impurities, especially by cuprous oxide, phosphorus, arsenic, antimony, and silicon

Conductivity for Heat. — Copper Is an excellent conductor of heat, and in this property is about two and a half times more efficient than iron. (1914)

1.5.3 Scan the reading text to find the word expressions which denote:

теплопроводимость; температура плавления; пористость; растворяться; при нагревании; окисляться; прочность на разрыв; холодная прокатка; электропроводность; ковкость; отжиг; удельный вес; температура кипения; вязкость.

Ex. 1.5.4 Scan the reading text to answer the following questions:

1) How does the malleability and ductility of copper manifest? 2) What can we say about the specific gravity of pure copper? 3) What can we say about the tenacity of copper? 4) What temperatures are the melting point and the boiling point of copper? 5) How does copper behave when molten? 6) How does copper behave when heated? 7) Why does the difficulty of obtaining sound casting of copper arise? 8) Why is copper largely used for electric wires and cables? 9) How many times is copper more efficient than iron as a conductor of heat?

Text 1.6

Ex. 1.6.1 Transcribe the following words and read them aloud:

temperature, carbonate, annealing, cuprous, oxide, sulphuric, acid, soluble, aqua regia, cupric, fusible, furnace, hydrogen, monoxide, charcoal, carbonaceous, affinity, oxygen, sulphide, engineering, alloys, industries, mould, aperture, vesicular.

Ex. 1.6.2 Read and translate the text:

COPPER. Part Two: Chemical Properties.

Copper undergoes no change in dry air at ordinary temperatures, but in moist air a green coating of basic carbonate is formed.

When heated to redness with access of air, as in annealing sheets, etc., a dark coloured scale is formed, which consists almost wholly of cuprous oxide. <u>It may be removed by plunging the copper when red-hot into cold water</u> [она (окалина темного цвета) может быть удалена, тем что медь погружают, когда она нагрета до красного каления, и холодную воду]; in practice the water used contains sulphuric acid. Copper is slowly dissolved by weak acids in the presence of air. It is soluble in nitric acid, "aqua regia", and in hot concentrated sulphuric acid.

Copper Oxides. — There are two oxides of copper—viz. red or cuprous oxide (Cu_2O) and black or cupric oxide (CuO).

Cuprous oxide is readily fusible at furnace temperature, and at a red heat is easily reduced by hydrogen, carbon monoxide, charcoal or other carbonaceous matters, and by iron, zinc, and metals having a strong affinity for oxygen. When heated with iron sulphide or cuprous sulphide it is reduced to metallic copper, according to the following equations —

$$3Cu_20 + FeS = 6Cu + FeO + S0_2$$

$$2Cu_20 + Cu_2S = 6Cu + S0_2.$$

Cupric Oxide. — This oxide is as easily reduced as cuprous oxide and by the same reducing agents, but it is not fusible.

Alloys of Copper. — In addition to the extensive application of copper itself, it is largely used in the manufacture of alloys. Its alloys, especially those with zinc (the brasses) and with tin (the bronzes) are of vast importance for engineering and other purposes, while its alloys with other metals have numerous uses in many industries. When copper is cast in what is termed a closed mould — i.e., a mould with a small aperture or "ingate"—unsound vesicular castings only can be produced. To obtain a sound casting the mould must be an open one, hence none but articles of simple forms can be cast of the metal. This is why alloys of copper have come into such extensive use. (1790)

Ex. 1.6.3 Scan the reading text to answer the following questions:

1) Does copper undergo any change in air at ordinary temperatures?

2) How do acids affect copper?

3) How many oxides does copper have?

4) What physical and chemical properties does cuprous oxide have?

5) What is the difference between the physical and chemical properties of the two copper oxides?

6) What alloys of copper with other metals can you name?

7) Why have alloys of copper come into such extensive use?

Ex. 1.6.4 Write 10 sentences most essential for the contents of the text.

Text 1.7

Ex. 1.7.1 Transcribe the following words and read them aloud:
Ferrous, carbon, iron, silicon, industry, alloys, quantity, properties, percentage, chromium, ductility, machinability, chemical, engineering.

Ex. 1.7.2 Read and translate the text:

FERROUS METALS AND STEELS

Ferrous metals consist of iron combined with carbon, silicon and other elements. But carbon is the most important element in ferrous alloys.

Ferrous metals are used in industry in two forms: steel and cast iron, which differ in the quantity of carbon content.

Alloys consist of a simple metal combined with some other element.

Steel is a ferrous material having some carbon content. There are two kinds of steel: carbon steel and alloy steels.

Carbon steel should contain only iron and carbon without any other alloying element.

Alloy steels are those in which in addition to carbon an alloying element is present. These alloying elements have an effect on the properties of steel. They increase its strength and hardness, for example, high percentage of chromium makes steel rust-resistant, and we call it "stainless steel".

Strength, ductility and machinability are the most important industrial and commercial properties of steel. Such properties as resistance to wear, electrical conductivity, magnetic properties are important in special uses of metals.

According to their chemical and mechanical properties steels may be used in different branches of industry, for example, in machine building, rocket engineering, automobile industry, etc. (1055)

Ex. 1.7.3 Scan the reading text to answer the following questions:

1. What elements do ferrous metals consist of?

2. What is carbon steel?

3. What are alloy steels?

4. What are the most important properties of steel?

5. In what branches of industry are steels used?

Ex. 1.7.4 Write 10 sentences most essential for the contents of the text.

ADDITIONAL TEXTS

Familiarize yourself with the text and make a summary of the texts:

METALS

By John Vivian

Metal is classified as either ferrous, which means it contains iron (*ferrum* in Latin), nonferrous or precious. Nonferrous metals include copper and its alloys — brass and bronze — plus aluminum and its alloys. All are softer than iron and its alloys — gray iron, wrought iron and malleable iron — and the many types of steel.

Around the farm we use copper, lead and aluminum in sheets for roof flashing around chimneys and in roof valleys to keep water out of the house; in a few shop uses, such as forming copper plate into jaws for the vise to hold scratchable chrome-plate and polished metal; and in specialty nail, and bolts.

Copper is soft and easily cut. Copper roofing nails are used to hold slates on the roof, largely because they can be cut with a long flat hook knife when broken slates need to he removed and replaced. Copper clench nails are driven through wood planking of boats, then bent over to hold. when it comes time to replace a damaged or rotted plank, it's easy to unclench or cut the soft copper.

Copper and brass are soft enough to be hammered cold into ornaments, fittings and fixtures. Copper sheets, plumbing pipe, fittings and nails are sold in hardware stores.

Bronze is harder and needs heat to become malleable. You can get worn machined auto parts of brass and bronze in the scrap pile behind a transmission shop. Bronze is the king of art metals, because it metal casts beautifully and lasts forever. That, however, is another story.

The metals we use most are ferrous-alloys of iron and carbon plus other metals, including steel. Most steel we encounter in nails, tailpipes, bars, rods and plates is relatively soft, low-carbon or mild metal that is tough enough, but easy to work. Soft-steel clench nails are used to hold on horseshoes; they can be cut with one tap on a clench tool to remove the shoe. Shoes themselves are of a higher-grade steel, made tough to withstand wear, but soft enough to be malleable and easily worked by a faster to fit the hoof.

Keep in mind that low carbon steel can not be hardened (with heat and controlled cooling) to make a culling or hammering tool. For that you need medium-carbon steel, as found in hammer heads, or high-carbon steel as found in edged tools. Tool steel is a special high-carbon alloy— that can hold a thin, good cutting edge under heavy use. High-speed tool steel will hold an edge and keep cutting even when friction makes it so hot it glows red.

Stainless steel is hard, so will hold an edge longer than carbon steel, but it is more difficult to sharpen. It contains chromium, which hardens the alloy and corrodes to that familiar reflective sheen the instant it is exposed to air, forming a protective coating over rust-prone iron.

Many kinds of steel in various stock shapes (rods, bars, angles, sheets, hardened nails and bolts) can be found in hardware stores and steelyards. The way they were formed, whether cold rolled or hot rolled, influences how they will wear and other characteristics. Different steel is identified by complicated color coding. However, when we're on the farm we use whatever is at hand-mild steel Cot the most part. Any time we're needed a steel for a particular use (a good-tampering) but-not-too-brittle steel for fancy knifemaking, for example), we've been able to get it from catalogs. Or else the steelyard guys or hardware store clerks have had all the resource material and advice needed. (Usually, I use the tool steel in cheap nail removers, pry bars or flat demolition bars that you find for a dollar apiece in bins at mall stores. Much of this steel comes from the Far East and is of uneven quality. But the chickens don't care what quality of steel is in the hasp that keeps the henhouse door closed.)

If we're not sure if a metal is ferrous, a magnet will solve the puzzle. If the grainy texture of a break in iron doesn't distinguish it enough from steel, I hit it with a hammer. Steel rings: iron clunks.

Granted, wood is intuitively more inviting than cold metal. But you work metal the same as you work wood, whether you're building a wooden storage crate or a sheet-metal evaporating tray. (3443)

WROUGHT ALUMINUM ALLOYS

For many purposes, castings are not suitable, and worked or wrought articles are required. In general, their production starts with a casting operation in which an ingot of suitable size and shape is formed. This ingot is then rolled, pressed, extruded, or otherwise deformed by the application of severe mechanical stresses so as to produce the article desired.

Of all the working processes, hammer forging is the simplest in its essence and probably was the first to develop in the history of metal working [ковка молотом по существу является простейшим и вероятно первым способом, который применялся в истории обработки металлов]. In connection with aluminum, however, it was one of the later developments. One of the difficulties to be overcome is that, the temperature range over which aluminum can be forged satisfactorily is rather narrow, particularly for the strong alloys. Also, at their forging temperature these alloys are much stronger than steel is at its forging temperature, so that the size of hammer and the power required to forge a connecting rod (for example) out of aluminum are greater than that required to forge the same article out of steel.

Any mechanical working, such as rolling, breaks down the cast structure of the original ingot and tends to produce a fibrous structure, which very much improves the physical properties of the article. Working under a hammer — the simplest method of forging — may sometimes be advantageously replaced by a press-forging operation in which the lump of metal, preferably previously broken down by rolling, is formed into the desired shape while hot, by successive strokes of a press provided with suitable dies. In any forging operation, care must be taken to control and direct the flow of the metal during the working operation, so that the direction of the resulting "fiber" gives the results desired in the finished article. The dominant characteristic of the forging process, as compared with any casting process for producing the same article, is the marked metallurgical superiority of the product. Not only are the mechanical properties higher but forgings are also inherently much freer of hidden defects, such as dross or porosity, and at the same time have nearly the dimensional accuracy of permanent-mold castings.

A special kind of permanent-mold casting process is spoken of as "die casting", or sometimes "pressure die casting". In this, the water-cooled steel mold or "die" is mounted adjacent to a crucible of molten metal, and by an ingenious device successive "shots" of molten metal arc squirted into the die, so that the die is filled at each "shot" with the molten metal under pressure. In the subsequently developed "cold-chamber" process, the charge of molten metal is cooled to partial solidification and then forced into the die by heavy hydraulic pressure. By both processes, it is possible to fill the die in a fraction of a second. Consequently, castings with extremely thin walls can be made, with the assurance that the metal will not freeze before the narrow cavities of the mold have been properly filled.

The oldest of the wrought aluminum alloys now in production is the one called 3S, which contains about 1.25 pct of manganese added to commercial aluminum. The addition of this small amount of manganese increases the tensile strength of the sheet or other wrought article by about one third without very seriously reducing its elongation. Moreover, manganese is one of the few elements that can be added to aluminum without decreasing its corrosion resistance. This alloy is said to have been developed under stress in the early days to meet a very serious condition threatening the loss of a large amount of business because of the inferior corrosion resistance of the binary copper-alloy sheet that was then being produced, and it was extensively made and sold for many years before it was introduced abroad. Its most common use is in cooking utensils, where it increases the hardness and strength of the utensil without increasing its weight, and without unduly increasing its fabrication cost.

Attempts to add copper and zinc in alloys for the production of sheet were at first unsuccessful because of the poor corrosion resistance of such sheet. It was only after the introduction of the heat treatment of copper alloys that their corrosion resistance became satisfactory. Early attempts to produce aluminum-magnesium alloys, on the other hand, failed because of rolling difficulties. The alloys themselves had excellent properties but their economical fabrication was beyond the skill of the industry at that time. As the result of intensive study and improvements in fabricating technique, these alloys are now coming into their own [эти сплавы в настоящее время получают должное (внимание)], and are among our most corrosion-resistant aluminum alloys. (4288)

BRASS

Brass is an alloy of copper and zinc in various proportions.

The color of brasses varies widely with the composition. When increasing amounts of zinc are added to copper, the resulting brasses show a range of color all the way from copper red, which persists for about 5 pct of zinc through a bronze color at about 10 pct, a golden color at about 15 pct and increasing dilution of color to the typical brass yellow at around 30 pct of zinc. With more than 38 pct of zinc (alloys obtainable only in rod form) the alloy again takes on a buff red cast. This question of color is tremendously important in some applications, particularly costume jewelry, fasteners, fuse boxes, architectural trim, and so forth. In the range from about 80 to 90 pct of copper, the color changes very rapidly, and for such uses a given nominal alloy must be held within rather narrow limits in order that different parts of an assembly may not show variations in color.

Red brass, containing 85 pct of copper, is, next to cartridge brass, the most important of the nonleaded brasses, being produced in very large quantities in all the common forms but particularly favored for pipe for use in plumbing because of its high resistance to aqueous corrosion, and- for a host of manufactured parts for which a combination of ductility, good fabricating properties, golden color, and ease of polishing render it especially well suited.

A 90-10 mixture, commonly known as commercial bronze because of its color, finds a wide field of application for such things as angles, channels, costume jewelry, etching bronze, grille work, hardware, projectile rotating bands, screen cloth, screws, rivets, and many others.

The brasses containing from 61 to 54 pct of copper are called "Muntz metal". The essential features that distinguish the Muniz metal brasses from the plain brasses are extreme plasticity at red heat followed by conditions tending in the opposite direction when cooled to room temperature; viz., these alloys can be worked hot easily and drastically by rolling, extrusion, and other methods, but are not suitable for severe cold-working operations. The former condition makes for cheapness of production [первое условие способствует удешевлению производства] because heated billets may be almost instantly extruded through dies into rod or other shapes at a minimum expenditure of energy, and the long extruded rods may be finished by a cold-drawing operation to give them the exact dimensions and mechanical properties required by a given specification.

Moreover, the qualities of hardness, stillness, and strength, not softness and pliability, are desired in countless objects such as screws and other shapes rapidly turned from rod on high-speed automatic screw machines. The necessary shortness of chip or general free-cutting quality is secured by adding amounts of lead up to approximately 3.5 pct. Some manufacturing operations are favored by combining hot-working in the breaking down or initial processing followed by a series of cold-working and annealing operations substantially as would be conducted with plain alpha brasses.

The alloy that is used in greater quantity than all others in this group combined is free-cutting brass, containing 61.5 pct of copper, 3 of lead and 35.5 of zinc. It can be cut at high speeds with low tool pressure, causing minimum rate of tool wear and with very short chips that clear the tool well [и с очень короткой стружкой, которая хорошо отходит от фрезы (не завиваясь)]. However, since free-cutting brass does not lend itself particularly well to cold-working procedures often required in addition to machining operations, a medium-leaded or high-leaded brass, or perhaps leaded Muntz metal, might be used in preference; viz., a compromise is necessarily made between optimum machining properties obtainable only with the higher lead content and good cold- fabricating properties obtainable with lower lead content (and usually somewhat higher copper content).

Where hot pressing or hot forging is to be used as the principal shaping procedure, forging brass containing nominally 60 pct of copper, 2 of lead and 38 of zinc is by all odds the favored material [ковкая латунь, содержащая номинально 60% меди, 2% свинца и 38% цинка, несомненно более предпочтительна]. This alloy, which is extruded readily, also can be forged into intricate shapes over a wide range of temperature, and the 2 pct of lead facilitates extensive and ready machining thereafter.

In fabricating various articles from strips involving drawing or forming operations and where some machining operations are also necessary, various lead-bearing alloys are available, including low- leaded brass, medium-leaded brass, high-leaded brass and extra-high-leaded brass. The choice between cartridge brass containing no lead and one of these four lead-bearing brasses will depend on the relative importance of the cold-fabricating operations necessary, on the one hand, and the degree of machining required, on the other, it being impossible to attain the maximum of both these qualities in any one material.

Of the tin and aluminum brasses admiralty and aluminum brass are used almost exclusively for heat-exchanger tubes, primarily because of their high resistance to most conditions of aqueous corrosion encountered in such service. The admiralty alloy, which has been a leader in this field for many years, is now usually modified by the addition of a few hundredths of one per cent of an element from the group including antimony, arsenic, phosphorus, and silver, for the purpose of inhibiting dezincification (preferential removal of zinc by corrosion, leaving spongy metal), which otherwise might occur under some conditions of operation. The aluminum brass is more specifically used where high water velocities are encountered, as for instance in marine condensers, it having been found highly resistant to so-called impingement attack frequently resulting from such conditions of use. It also is now currently made with an inhibitor, as is the admiralty mixture.

The plain and leaded naval brasses and manganese bronze are widely applied where a high-strength structural material resistant to salt-water corrosion is needed. In point of strength, the manganese bronze is distinctly superior to the naval brasses. A leaded variety of the latter is of course used in preference to the nonleaded one when extensive machining is necessary.

Phosphor bronzes containing 5, 8, or 10 pct phosphorus are the preferred alloys for springs or other applications requiring high strength, great resiliency, and corrosion resistance. The 1.25 pct phosphor bronze finds its principal application in electrical contacts, flexible hose, and pole-line hardware.

Although cupronickels of varying nickel content up to some 40 pct are often employed, by far the most important is the 30 pct nickel variety [хотя медноникелевые сплавы с содержанием никеля вплоть до 40°/₀ применяются часто, наиболее важным является сплав с 30°/₀ содержанием никеля] presently considered to be the outstanding alloy for heat- exchanger use, owing to its exceptionally high resistance to most of the conditions of corrosion there encountered.

The two nickel silvers listed are in demand mostly for their color, which is desired as a base for plated flat and hollow tableware, for zippers, costume jewelry, nameplates, radio dials, and other articles.

The silicon bronzes are general-purpose structural alloys of very wide application where a combination of high strength, great toughness, ease of forming, resistance to corrosion, and other properties are essential. (6942).

2. TYPES OF ART METALWORK

Text 2.1

Ex. 2.1.1 Transcribe the following words and read them aloud:

variety, jewelry, silverware, millennia, properties, ores, malleability, ductility, Neolithic, exquisite, iron, damascening, enamel, filigree, hydraulic, metallurgy.

Ex. 2.1.2 Read and translate the text:

THE ART OF METALWORKING

Metalworking is the process of making decorative or useful objects out of metal. It can create a variety of objects, ranging from jewelry and silverware to large scale structures such as ships, bridges, and oil refineries. Hence, there is a wide range of metalworking skills, processes, and tools.

The history of metalworking began a few millennia ago. Primitive human beings discovered the properties of certain ores. They found that they could produce metal by smelting ores, and within a short time, metal became an indispensable part of their lives. Metal's inherent qualities of malleability and ductility enabled humans to turn it into weapons, tools, adornments, and other useful objects.

The oldest technique of metalworking is hammering. Around 2500 BC, people learnt the art of casting, or pouring molten metal into a mold. Then, in the Neolithic Period, metals like copper, silver, and gold were shaped into jewelry, and later in the Bronze Age, there were a number of talented artisans who worked on ornaments, silver jewelry, sculptures, and inlays. The Bronze Age was a period when people started making bronze sculptures, and alloy brass was also produced around this time. The next major development in metal-working took place during the Iron Age, when iron was utilized for making a variety of useful tools and structures. It was not until the modern age that great advancements in metalworking were made, especially in the making of alloys and the utilizing of metals for industrial purposes.

In the 12th century, silver was used to be made into finely-crafted jewelry. Silversmiths started organizing guilds as a result of the enormous demand for jewelry. Exquisite silver wares and jewelry were also in great demand in Europe during the 17^{th} and 18 century. Moreover, it was during this period that pre-Columbian America started dealing in wholesale jewelry supply of silver ornaments.

Metalworking includes hammering, drawing, spinning, and casting. Few of the decorative processes in metalworking are embossing, chasing, repoussé, damascening, enamel work, filigree, inlaying, and gilding. Forming is a set of processes by which metal is heated and molded. Hot forging involves the deforming of metal with the help of hydraulic presses and hammer. There are several types of casting, including sand casting, shell casting, investment casting, centrifugal casting, spin casting, and die casting.

The cutting processes transform a metal into a geometric shape, which will eventually be sold as a jewelry item or ornament. Cutting silver generally results in excess material and the finished product. The chip producing process is also known as machining, and it involves drilling holes in the silver. Milling is yet another process of shaping silver, and a milling machine is usually used for the purpose. Other important processes used include grinding, soldering, brazing, broaching, and marking out. Marking out or laying out refers to the transferring of a jewelry design onto a work piece. The final step of making silver jewelry is machining or manufacturing.

Metalworking is a broad term which incorporates industry, science, and metallurgy. It is also an art form and hobby for many people. It is an important practice that has brought many cultures, races, and civilizations together. (2793)

Ex. 2.1.3 Find key terms in the text and make your sentences with them.

Ex. 2.1.4 Write ten special questions to the text and answer them.

Text 2.2

Ex. 2.2.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
basic, process, industry, production, define, solidify, determine, cavity, commercial, numerous, method, foundry, assume, detail, machine, product, specified, tolerance, assembly, rapid, technological, comparison, complexity.

Ex. 2.2.2 Read and translate the text:

FOUNDRY. METAL CASTING — A BASIC MANUFACTURING PROCESS

One of the basic processes of the metalworking industry is the production of metal castings. A casting may be defined as "a metal object obtained by allowing molten metal to solidify in a mold", the shape of the object being determined by the shape of the mold cavity. A foundry is a commercial establishment for producing castings.

Numerous methods have been developed through the ages for producing metal castings but the oldest method is that of making sand castings in the foundry. Primarily, work consists of melting metal in a furnace and pouring it into suitable sand molds where it solidifies and assumes the shape of the mold.

Most castings serve as details or component parts of complex machines and products. In most cases they are used only when they are machined and finished to specified manufacturing tolerances providing easy and proper assembly of the product.

At present the foundry industry is going through a process of rapid transformation, owing to modern development of new technological methods, new machines and new materials. Because of the fact that casting methods have advanced rapidly owing to the general mechanical progress of recent years there is today no comparison between the quality of castings, the complexity of the patterns produced and the speed of manufacture with the work of a few years ago. (1118)

Ex. 2.2.3 Find key terms in the text and make your sentences with them.

Ex. 2.2.4 Write ten special questions to the text and answer them.

Text 2.3

Ex. 2.3.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
Selection, quantity, tolerance, characteristics, configuration, commercial, cavity, bottom, top, cope, cheeks, require, joints, sprue, reservoir, riser, porosity, hollow, foundry.

Ex. 2.3.2 Read and translate the text:

SAND CASTING

Selection of a casting method depends primarily upon: 1. Quantity of parts. 2. Size of the part. 3. Tolerances and finish. 4. Physical characteristics. 5. Part configuration. 6. The metal to be cast.

Process (Fig.1).

The oldest commercial method of making metal castings consists of forming a cavity in sand and filling the cavity with molten metal. After the metal solidifies, the sand is broken away, and the casting is removed, trimmed, and cleaned.

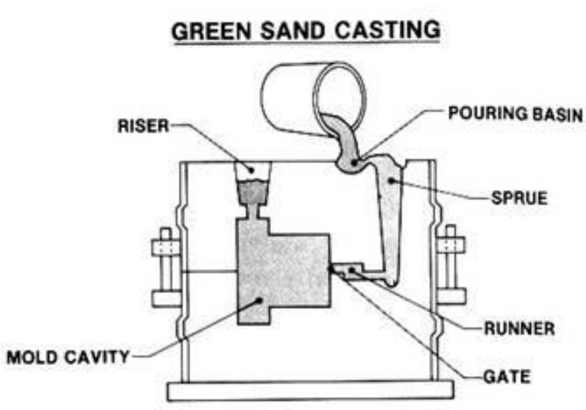

Fig.1 Process of sand casting

Sand molds are made in two or more sections: bottom (drag), top (cope), and intermediate sections (cheeks) when required. Joints between sections are the parting lines. The sand is contained in flasks, made of metal or sometimes wood.

Molten metal is poured into the sprue, find connecting runners conduct the metal to the casting cavity. Riser cavities in the cope sand over heavy sections of the cast in serve as metal reservoirs. They fill with molten metal as the cavity is filled and, as the casting solidifies and shrinks, the risers feed molten metal to the heavy, slowly solidifying sections, thus minimizing porosity in the part. Slag floats to the top of the risers and thus is not incorporated into the casting. Sprue, runner, and risers are trimmed from the casting after it is removed from the sand.

Cores are hard shapes of sand placed in the mold to produce hollow castings.

Patterns of wood or metal are used to prepare the mold.

Extremely large or heavy castings are made by floor molding. Here, the mold is made in the floor of the foundry using the earth as the flask.

Advantages and disadvantages: Sand casting offers the least expensive method for producing general-purpose castings. Pattern equipment is relatively inexpensive and long lasting.

Sand castings are more subject to human control than parts made by other casting processes. More material must be left on a sand casting to permit machining for a finished surface. Thin sections cannot be cast (1/3 in. is generally considered a practical minimum). (1648)

Ex. 2.3.3 Translate into Russian the following terms:
cavity, drag, cope, cheeks, joints, flasks, sprue, runners, riser, gate, molten metal, porosity

Ex. 2.3.4 Find key terms in the text and make your sentences with them.

Ex. 2.3.5 Write ten special questions to the text and answer them.

Text 2.4

Ex. 2.4.1 Read the following words aloud paying attention to the right pronunciation: *ciré perdue* [sɪ`reɪ pər`dju:], Theophilus [θɪ`ɔfɪləs], Benvenuto Cellini [bemve`nu:to ʧel`li:nɪ].

Ex. 2.4.2 Guess the meaning of the following words, checking the dictionary their pronunciation:
Antiquity, alloy, proportion, ingredients, applicable, successful, various, substance, thoroughly, sufficiently, further, require, occupy.

Ex. 2.4.3 Read and translate the text:

THE USE OF BRONZE

The use of bronze dates from remote antiquity. This important metal is an alloy composed of copper and tin, in proportion which vary slightly, but may be normally considered as nine parts of copper to one of tin. Other ingredients which are occasionally found are more or less accidental. The result is a metal of a rich golden brown colour, capable of being worked by casting — a process little applicable to its component parts, but peculiarly successful with bronze, the density and hardness of the metal allowing it to take any impression of a mould, however delicate. It is thus possible to create ornamental work of various kinds.

The process of casting is known as *ciré perdue*, and is the most primitive and most commonly employed through the centuries, having been described by the monk Theophilus, and also by Benvenuto Cellini. Briefly, it is as follows: a core, roughly representing the size and form of the object to be produced, is made of pounded brick, plaster or other similar substance and thoroughly dried. Upon this the artist overlays his wax, which he models to the degree required in his finished work. Passing from the core through the wax and projecting beyond are metal rods. The modelling being completed, the outer covering which will form the mould has to be applied; this is a liquid formed of clay and plaster sufficiently thin to find its way into every detail of the wax model. Further coatings of liquid are applied, so that there is, when dry, a solid outer coating and a solid inner core held together by the metal rods, with the work of art modelled in wax between. Heat is applied and the wax melts and runs out, and the molten metal is poured in and occupies every detail which the wax had filled. When cool, the outer casing is carefully broken away, the core raked out as far as possible, the projecting rods are removed and the object modelled in wax appears in bronze. If further finish is required, it is obtained by tooling. (1623)

Ex. 2.4.4 Make an outline for a story of yours based on the vocabulary of the text.
Ex. 2.4.5 Make a close-to the text retelling of the contents.

Text 2.5

Ex. 2.5.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
Forging, useful, blacksmith, advantages, hammering, inherent, improvement, occur, propagate, desirable, coarse, homogeneous, wrought, soundness, deformation, diversity, virtually, temperature, determines.

Ex. 2.5.2 Read and translate the text:

THE FUNDAMENTALS OF FORGING

Forging is the oldest known metalworking process. It is believed to have begun when early man discovered he could beat pieces of ore into useful shapes. History tells us that forging was widely practised at the time when written records first appeared.

The blacksmith was one of the first to realize the advantages of forging. Although he did not know why, he knew that hammering a piece of hot metal not only resulted in a usable shape, it improved its strength. It is this inherent improvement in strength of metal that has placed forgings in the most highly stressed applications in machines.

To understand why forging improves the mechanical properties of metal, it is important to recognize that metal is made up of grains. Each grain is an individual crystal, and when the grains are large, cracks can occur and propagate along the grain boundaries. Therefore, it is desirable to minimize the grain size in a metal.

Reducing the metal's grain size-is one of the things forging does so well. Forging breaks down a coarse grained structure producing a chemically homogeneous wrought structure with much smaller grains by controlled plastic deformation. In forging, controlled plastic deformation whether at elevated temperature or cold (at room temperature) results in greater metallurgical soundness and improved mechanical properties of the metal.

Metal shaping by controlled plastic deformation is the basis for all forging operations. Because of the diversity of forging end-use applications, however, a wide range of processes and equipment have been developed to produce forgings. Some processes are ideally suited to make large parts, others, small parts, and still others, rings. Modern forging is not only carried out in virtually all metals, it is done at temperatures ranging from more than 2500 °F to room temperature. Part configuration generally determines the forging method chosen. (1602)

After-text Discussion:

Practice 1. Прочитайте 3-й и 4-й абзацы. Выделите предложения, в которых сообщается: а) о недостатках металлов с крупнозернистым строением; б) о том, что дает, с точки зрения улучшения свойств, уменьшение размеров зерна решетки. Переведите эти предложения на русский язык.

Practice 2. В последнем абзаце подчеркивается (1-е предложение), что пластическая деформация металла лежит в основе всех ковочных процессов. Однако далее сообщается о большом многообразии ковочных процессов и оборудования. Чем это обусловлено?

Practice 3. Заполните следующую схему, представляющую собой логическую структуру текста, английскими предложениями из текста. Из каждого абзаца должно быть по одному предложению.

I. Определение процесса ковки. …

↓

II. Наиболее важная характеристика процесса ковки. …

↓

III. Вывод о необходимости уменьшения размера зерна кристаллической решётки металла. …

↓

IV. Результат пластической деформации при ковке. …

↓

V. Вывод о важности процесса пластической деформации. …

Ex. 2.5.3 Find key terms in the text and make your sentences

with them.

Text 2.6

Ex. 2.6.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
repoussage, repoussé, technique, malleable, relief, diversity, adjectival, plasticity, surface, continuous, essentially, apparent, evidence, chasser.

Ex. 2.6.2 Read and translate the text:

REPOUSSAGE

Repoussage or **repoussé** is a metalworking technique in which a malleable metal is ornamented or shaped by hammering from the reverse side to create a design in low relief (Fig.1).

There are few techniques that offer such diversity of expression while still being relatively economical. **Chasing** is the opposite technique to repoussé, and the two are used in conjunction to create a finished piece. It is also known as **embossing**.

Fig. 1 Repoussé work

While repoussé is used to work on the reverse of the metal to form a raised design on the front, chasing is used to refine the design on the front of the work by sinking the metal. The term chasing is derived from the noun "chase", which refers to a groove, furrow, channel or indentation. The adjectival form is "chased work".

The techniques of repoussé and chasing utilise the plasticity of metal, forming shapes by degrees. There is no loss of metal in the process, as it is stretched locally and the surface remains continuous. The process is relatively slow, but a maximum of form is achieved, with one continuous surface of sheet metal of essentially the same thickness. Direct contact of the tools used is usually visible in the result, a condition not always apparent in other techniques, where all evidence of the working method is eliminated.

The word *repoussé* is French and means "pushed up", ultimately from Latin: *pulsare*, which means "to push". Repoussage is the noun to refer to the technique, with repoussé being an adjective referring to a piece to which the technique has been applied (e.g. "*repoussé work*", "*repoussé piece*"). Chasing comes from the French word, *chasser* meaning to drive out, or to chase around which is what the artists are doing as they "chase" the forms on their metal in order to create their final design. (1464)

Ex. 2.6.3 Find key terms in the text and make your sentences with them.

Ex. 2.6.4 Write ten special questions to the text and answer them.

Text 2.7

Ex. 2.7.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
Engraving, grooves, intaglio, burin, machines, ancient, Renaissance, relief, sculpture, jewellery, trophies, techniques, discipline, survive, specialize, variety, titanium, weaponry, motorcycle.

Ex. 2.7.2 Read and translate the text:

ENGRAVING

Engraving is the practice of incising a design onto a hard, usually flat surface, by cutting grooves into it. The result may be a decorated object in itself, as when silver, gold, steel are engraved, or may provide an intaglio printing plate, of copper or another metal, for printing images on paper as prints or illustrations; these images are also called *engravings* (Fig. 1).

Traditional engraving, by burin or with the use of machines, continues to be practised by goldsmiths, glass engravers, gunsmiths and others. Engraved gems were an important art in the ancient world, revived at the Renaissance, although the term traditionally covers relief as well as intaglio carvings, and is essentially a branch of sculpture rather than engraving, as drills were the usual tools.

"Hand engraving" is a term sometimes used for engraving objects other than printing plates, to

Fig.1 Engravings

inscribe or decorate jewellery, firearms, trophies, knives and other fine metal goods. Traditional engravings in printmaking are also "hand engraved", using just the same techniques to make the lines in the plate.

The modern discipline of hand engraving, as it is called in a metalworking context, survives largely in a few specialized fields. The highest levels of the art are found on firearms and other metal weaponry, jewellery, and musical instruments.

Each graver is different and has its own use. Engravers use a hardened steel tool called a burin, or graver, to cut the design into the surface, most traditionally a copper plate. However, modern hand engraving artists use burins or gravers to cut a variety of metals such as silver, nickel, steel, brass, gold, titanium, and more, in applications from weaponry to jewellery to motorcycles to found objects. Modern professional engravers can engrave with a resolution of up to 40 lines per mm in high grade work creating game scenes and scrollwork.

Dies used in mass production of molded parts are sometimes hand engraved to add special touches or certain information such as part numbers. (1689)

Ex. 2.7.3 Translate into Russian the following terms:
Burin, goldsmiths, relief, intaglio carvings, drills, engravings, metalworking, jewelery, graver, engravers, burin, copper plate, silver, nickel, brass, gold, titanium, scrollwork, dies molded parts.

Ex. 2.7.4 Make a close-to the text retelling of the contents.

Text 2.8

Ex. 2.8.1 Guess the meaning of the following words, checking the dictionary their pronunciation:

Etching, surface, intaglio, chemicals, covered, échoppe, texture, acid, preferable, popularity, substrate, alternative, quality, natural, aquatint, armour, antiquity, century, techniques.

Ex. 2.8.2 Read and translate the text:

ETCHING

Etching is traditionally the process of using strong acid or mordant to cut into the unprotected parts of a metal surface to create a design in intaglio (incised) in the metal. In modern manufacturing, other chemicals may be used on other types of material. In traditional pure etching, a metal (usually copper, zinc or steel) plate is covered with a waxy ground which is resistant to acid. The artist then scratches off the ground with a pointed etching needle where he or she wants a line to appear in the finished piece, so exposing the bare metal. The échoppe, a tool with a slanted oval section, is also used for "swelling" lines. The plate is then dipped in a bath of acid, technically called the mordant or *etchant*, or has acid washed over it. The acid "bites" into the metal (it dissolves part of the metal) where it is exposed, leaving behind lines sunk into the plate. The remaining ground is then cleaned off the plate.

Copper is a traditional metal, and is still preferred, for etching, as it bites evenly, holds texture well, and does not distort the color of the ink when wiped. Zinc is cheaper than copper, so preferable for beginners, but it does not bite as cleanly as copper does, and it alters some colors of ink. Steel is growing in popularity as an etching substrate. Increases in the

Fig. 1 Etching

prices of copper and zinc have steered steel to an acceptable alternative. The line quality of steel is less fine than copper, but finer than zinc. Steel has a natural and rich aquatint.

Etching by goldsmiths and other metal-workers in order to decorate metal items such as guns, armour, cups and plates has been known in Europe since the Middle Ages at least, and may go back to antiquity (Fig.1). The elaborate decoration of armour, in Germany at least, was an art probably imported from Italy around the end of the

15th century — little earlier than the birth of etching as a printmaking technique.

Etching has often been combined with another intaglio techniques such as engraving. (1635)

Ex. 2.8.3 Find the sentences, the translation of which begins with the following words:
1) Травление традиционно является способом…; 2) В традиционном чистом травлении металлическая пластина покрыта…; 3) Затем пластину окунают в ванну…; 4) Медь является традиционным металлом…; 5) Цинк дешевле меди, поэтому он…; 6) Сталь имеет естественный…; 7) Разработанное украшение брони…; 8) Травление часто сочеталось с…

Ex. 2.8.4 Find key terms in the text and make your sentences with them.

Ex. 2.8.5 Make a close-to the text retelling of the contents.

Text 2.9

Ex. 2.9.1 Guess the meaning of the following words, checking the dictionary their pronunciation:
embossing, relief, material, ductile, ability, variation, diameter, tensile, machine, stationary, pressure, aforementioned, tonnage, capacity, 6" wide, aluminum, galvanize.

Ex. 2.9.2 Read and translate the text:

SHEET METAL EMBOSSING

Embossing is a metal forming process for producing raised or sunken designs or relief in sheet material by means of matched male and female roller dies, theoretically with no change in metal thickness, or by passing sheet or a strip of metal between rolls of the desired pattern.

Metal sheet is drawn through the male and female roller dies producing a pattern or design on the metal sheet. Depending on the roller dies used, different patterns can be produced on the metal sheet.

Characteristics of the metal embossing process include:

- Its ability to form ductile metals,

- Its use in medium to high production runs,
- The ability to maintain the same metal thickness before and after embossing,
- The ability to produce unlimited patterns, depending on the roll dies, and
- The ability to reproduce product with no variation.

Located within the embossing stand itself are two engraved and mated hardened steel rolls, geared together to maintain top-to-bottom pattern registration. The width and diameter of these rolls depends on the strip width, material thickness, pattern depth, and material tensile strength and hardness.
In most machines, the upper roll blocks are stationary, while the bottom roll blocks are movable. The pressure with which the bottom roll is raised is referred to as the tonnage capacity. This figure also depends on the aforementioned parameters.

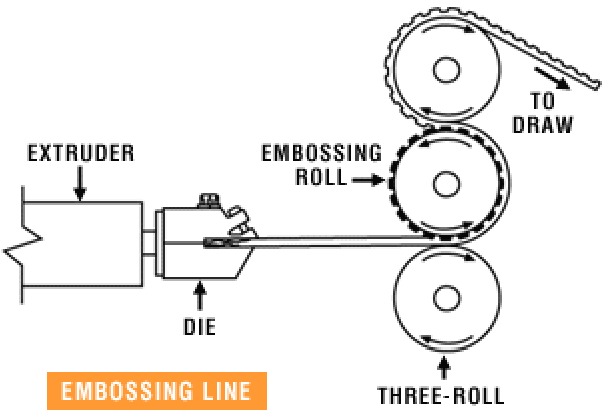

Fig. 1 Embossing line

Embossing machines are generally sized to give 2" of strip clearance on each side of an engraved embossing roll. Many embossing machines are custom-manufactured, so there are no industry-standard widths. It is not uncommon to find embossing machines in operation producing patterns less than 6" wide all the way up to machines producing patterns 70"+ wide.
Materials commonly used in the metal embossing process include:

- Aluminum (All Alloys)

- Aluminum (T1/T2)
- Brass
- Cold rolled steel
- Copper
- Galvanized steel
- High strength, low alloy, steel
- Hot rolled steel
- Steel (All Alloys)
- Zinc (1665).

Ex. 2.9.3 Find the sentences, the translation of which begins with the following words: 1) Тиснение представляет собой…; 2) В зависимости от используемых штампов для роликов…; 3) В большинстве машин верхние рулонные блоки…; 4) Характеристики процесса тиснения металла…; 5) Расположенная внутри самой стойки для тиснения – это…; 6) Типовые машины обычно…; 7) Нередко можно найти тиснильные машины…

Ex. 2.9.4 Find key terms in the text and make your sentences with them.

Ex. 2.9.5 Make a close-to the text retelling of the contents.

Text 2.10

Ex. 2.10.1 Read the following words aloud paying attention to the right pronunciation:
Jirzah [`ʤə:zɑ:], Mesopotamia [ˌmesəpə`teɪmɪə], Hittites [hɪ`taɪts], Aegean [i:`ʤi:ən], Notre Dame de Paris [ˌnɔtr`deɪm dɪ `pærɪs], Baroque [bə`rɔk], Rococo [rə`koukou], Jean Tijou [`ʒɑ:n ti`ʒu:]

Ex. 2.10.2 Guess the meaning of the following words, checking the dictionary their pronunciation:

architectural, feature, wrought, occasionally, purification, techniques, utilitarian, Canterbury Cathedral, acetylene, utensil, furnace.

Ex. 2.10.3 Read and translate the text:

IRONWORK

Ironwork is any weapon, artwork, utensil or architectural feature made of iron especially used for decoration. There are two main types of ironwork: wrought and cast iron.

Wrought ironwork is forged by a blacksmith using an anvil. The earliest known ironwork are beads from Jirzah in Egypt dating from 3500 BC and made from meteoric iron with the earliest use of smelted iron dates back to Mesopotamia. However, the first use of conventional smelting and purification techniques that modern society labels as true iron-working dates back to the Hittites in around 2000 BC.

Knowledge about the use of iron spread from the Middle East to Greece and the Aegean region by 1000 BC and had reached western and central Europe by 600 BC. However, its use was primarily utilitarian for weapons and tools before the Middle Ages. Due to rusting, very little remains of early ironwork.

From the medieval period, use of ironwork for decorative purposes became more common. Iron was used to protect doors and windows of valuable places from attack from raiders and was also used for decoration as can be seen at Canterbury Cathedral, Winchester Cathedral, and Notre Dame de Paris. Armour also was decorated, often simply but occasionally elaborately.

From the 16th century onwards, ironwork became highly ornate especially in the Baroque and Rococo periods. In France, highly decorative iron balconies, stair railings and gateways were highly fashionable from 1650. Jean Tijou brought the style to England and examples of his work can be seen at Hampton Court and St. Paul's Cathedral. Wrought ironwork was widely used in the UK during the 18th in gates and railings in London and towns such as Oxford and Cambridge. In the US, ironwork features more prominently in New Orleans than elsewhere due to its French influence.

As iron became more common, it became widely used for cooking utensils, stoves, grates, locks, hardware and other household uses. From the beginning of the 19th century, wrought iron was being replaced by cast iron due to the latter's lower cost. However, the English Arts and Crafts movement produced some excellent work in the middle of the 19th century.

In modern times, much modern wrought work is done using the air hammer and the acetylene torch.

Cast iron is produced in a furnace stoked with alternate layers of cooking iron then poured into molds. After the iron cools off, the sand is cleaned off. The Chinese were the first to use cast iron from the 6th century AD using it as support for pagodas and other buildings.

Fig. 1 Garden furniture

It was introduced into Europe by the 14th century with its main decorative uses being as firebacks and plates for woodburning stoves in Germany, the Netherlands and Scandinavia. By the end of the 18th century, cast iron was increasingly used for railings, balconies, banisters and garden furniture (Fig. 1) due to its lower cost. (2382)

Ex. 2.10.4 Make an outline for a story of yours based on the vocabulary of the text.

Ex. 2.10.5 Make a close-to the text retelling of the contents.

ADDITIONAL TEXTS

Familiarize yourself with the text and make a summary of the texts:

CASTINGS

For many purposes, the simplest process of producing metal articles is that of casting the molten metal into a suitable mold. The relatively low melting point of aluminum permits the use of a variety of casting processes that are not suitable for metals like iron and copper. The cheapest type of mold is one made of moist ("green") sand, which is rammed around a wooden or metallic pattern. Where only a limited number of castings are to be made, or where the casting is very large or intricate, sand molds produce the cheapest castings. If very large numbers of the same casting are to be produced, and if the casting is not too large, a permanent mold (usually iron) may be used, because of the moderate casting temperatures employed, and may produce castings that are both cheaper and metallurgically superior. By rapidly forcing metal under pressure into a suitable permanent mold, "die castings" are produced. They have very high surface smoothness and dimensional accuracy. A special type of plaster used for molds produces castings with surface smoothness and dimensional accuracy comparable with those of die castings, but with somewhat lower mechanical properties.

Of the alloying elements used with aluminum, zinc was the cheapest and was the one earliest used. It very decidedly increases the strength of the aluminum and at least 15 or 20 pct of it may be added with beneficial results, as far as the strength and ease of casting are concerned. It was soon found, however, that binary aluminum-zinc casting alloys were quite inferior to pure aluminum, from the standpoint of hot shortness and resistance to corrosion as well as specific gravity, and that they had a marked tendency to become brittle with age, so they have not been used extensively for many years.

Zinc was very largely replaced more than 40 years ago by copper, and for years the standard aluminum casting alloy was the binary aluminum-copper alloy containing 8 pct of the latter metal. This is a very stable alloy with good casting characteristics and better corrosion resistance than the type of zinc alloys previously used. Its strength was adequate for most purposes (about 22,000 psi sand-cast) although its elongation was low. Some improvements were made over a series of years by the addition of 1 or 2 pct of zinc and an increase in the iron content to around 1.2 pct, and later by adding up to 2.5 pct of silicon; and such alloys have produced many of the aluminum castings used in the automobile field. One of their strong points is their great ease of machining. This is particularly advantageous in automobile castings, where large numbers of castings are put through Complicated machining operations and the time required for each operation must be reduced to a minimum. This time is considerably less for these aluminum-alloy castings than for iron castings.

Silicon and iron are the two most common impurities in aluminum and traditionally both were generally looked upon as undesirable. Iron, indeed, in amounts up to perhaps 1.5 pct or a little more, may improve the tensile strength of some of the alloys, but if there is much more than this the high-melting iron-aluminum constituent increases the viscosity of the alloy at the pouring temperature and also tends to make the castings brittle. In the early days of the aluminum industry, metallic silicon was not available as an alloying ingredient, and although a number of investigators showed that aluminum alloys containing considerable amounts of silicon had reasonably good properties, it was not until after World War I that serious attempts were made to introduce such alloys. (3031)

METHODS OF REPOUSSÉ AND CHASING

It can be laborious to create jewellery or art using repoussé and chasing techniques, although with practice, complex and delicate pieces can be made which would be virtually impossible to complete using any other method.

There are different metals you can use for chasing and repoussé work, such as drawn steel, silicon bronze, copper, gold, silver and pewter.

The process of chasing / repoussé takes a lot of time due to the repetition of a number of time-consuming stages: The first step is the preparation of the metal by annealing; cleaning to remove the pitch between annealing and work; setting up; and careful work with punches. This process is typically repeated many times during the creation of a chasing/ repoussé work.

One method of repoussé and chasing is to place a thin sheet of metal on a bowl of chasers pitch. This chasers pitch can be pine rosin–based that can be kept slightly soft with a heat gun or plumbers torch for relief work and hardens when cooled for chasing/planishing work. It can become extremely soft or liquefied when heated too much, becoming somewhat of a burn hazard. It is not recommended, nor necessary to heat the pitch to this degree.

The purpose of using pitch is to provide a solid base to work on, whilst allowing the metal to be pushed out and shaped without obstruction. The pitch is best worked on in a *pitch bowl* or "pitch board." The pitch bowl is a cast iron bowl which sits on a bag stuffed with sand or on a rubber ring specifically made for this purpose. This allows for greater stability, rotation and angling. The pitch is heated using a hairdryer, or an industrial blowdryer. If the pitch is too hard, the metal will be thinned. If it is too soft, you have very little control over the form. A good medium grade chasers pitch works well because it softens enough to allow for satisfactory relief and cools to a firmness that is sufficient for chasing, planishing and detail work.

Steel tools are used to work the metal. A "liner" is a steel tool/punch with a very thin, slightly rounded end, that is used to create the initial lines on the metal. The liner is hit on the end with a *chasing hammer*, pushing a thin line of metal into the pitch. The side facing up will consequently be the front of the piece. Once all the lines have been chased, the metal is then turned over on the pitch, and repoussé technique is then applied, using other various steel punches/tools to push the metal so that it is raised on the front of the finished piece.

Once the repoussé is done - the design raised, the piece is inverted, and the voids are filled with warm pitch to help maintain its shape. The pitch should be allowed to set in the voids and cool before the piece is turned over and placed back on the pitch. Once the piece of metal is turned over and then chased, in that the details are refined and brought out. The design is worked many times, with numerous tools, before the final result is achieved.

Every time the metal is removed from the pitch bowl, it needs to be cleaned and re-annealed. Turpentine is used to remove the pitch, and a blow torch can also be used to burn it off.

When working with the pitch, make sure you are working with gloves, safety glasses and good ventilation and as always, when working with any type of open flame, make sure there is an appropriate fire extinguisher close by.

Intro to Chasing and Repoussé: Ancient Ways to Create Dimension in Metal

Chasing and repoussé are tied with gem cutting at the top of my techniques-to-learn wish list. I can't think of any other jewelry-making or metalsmithing technique that can create so many unique designs on metal or one that creates such an impressive effect–all made using techniques that are thousands of years old. Chasing and repoussé are used to create dimensional works of art in various metals, most commonly silver, for jewelry, flatware, serving pieces, accessories, home décor, and more (Fig. 1).

What is Chasing and Repoussé?

In simple terms, repoussé means to push forward or push up (it means "push up" in French); it refers to the metal being raised by hammering from the back to create dimension on the front. Chasing (from the French chasser, meaning "to chase") essentially outlines the pushed-forward designs by pushing back around their edges to help define them.

Fig.1 A piece of chasing

So the technique of chasing and repoussé means you'd hammer a general design onto the back of a piece of metal, flip it over, and outline the design from the front. You'd use pointed chasing tools (punches – see Fig. 2) and a chasing hammer (Fig. 3 – yes, that's where that comes from!) to outline the design; you may or may not use larger rounded chasing punches for the repoussé work. Alternately, you can use those chasing punches (metal stylus-type tools with a variety of tips) to "draw" your design onto the metal, flip it over, and hammer within (or around the outside of) the design, depending on what it is.

Fig. 2 Chasing punches

Fig. 3 Chasing hammer

Chasing punches are very personal tools that are typically forged or at least modified by their owners. Many of the chasing punches found for sale are blanks that are ready to be modified to suit your needs. Their tips can be flat, domed, or detailed like flat- and Philips-head screwdrivers, pointed like awls, or textured in a variety of ways. (1506)

Metalsmithing How-To: Chasing and Repoussé

Chasing and repoussé are ancient techniques (possibly since 3000 B.C.) that are still done today basically the same way they were done hundreds and even thousands of years ago. Now as then, metal is placed in a pitch pot or pitch bowl (pitch is usually hard clay, wax, or resin) that supports the metal while it's hammered upon. Pitch is typically heated to soften it for repoussé work and allowed to harden for more detailed chasing work. If metal is hammered during the repoussé process on pitch that is too hard, it can create so much resistance that the metal is thinned, so the right temperature and hardness of pitch is important for successful repoussé work. Likewise, if chasing is attempted on metal with too soft a backing, it won't provide enough support and the punches can distort the metal too much or even pierce it. What a heartbreaking mistake that would be!

After the first round of repoussé work is completed, the raised areas are filled with softened pitch to support them. The pitch is allowed to cool and harden before the piece is returned to the pitch pot, face up this time, and the chasing work begins to outline and define the areas raised with repoussé. In very detailed designs, this process can be repeated many times–with cleaning and annealing between each step. Chasing and repoussé is a time-consuming technique that involves many steps and quite a bit of repetition, making it a true artisan craft that is becoming more and more rare.

Another ancient chasing and repoussé method involved using wooden tools or punches to press and hammer malleable gold, silver, or copper sheet into the carved cavities of hard rock, bone, or other harder metals to imprint the carved design onto the metal sheet. Early metalsmiths would carve one design into the harder material in a labor-intensive process, but then that one carved mold could be used to produce multiple pieces of dimensional gold work. Alternately, decorative designs using something as simple as wire were made and then metal sheet was hammered upon it. (1734)

REPOUSSÉ AND CHASING TECHNIQUE

by Jeremy Maronpot

Repoussé and chasing are techniques for creating 3 dimensional relief in sheet metal. The process is a very old one which is often overlooked by metal artists today. It is a direct method of sculpting metal using simple hand tools and hammers. There is no loss of material when forming metal with these techniques - the metal is not cut by the tools but pushed into shape in small increments. There are as many approaches to repoussé and chasing as there are artists.

Here are some of my frequently used chasing tools. These punches have a variety of specially shaped faces which push the sheet metal around by tapping on the tool with a hammer. Most chasing tools are made from hardened and tempered tool steel. Tool steel has a higher carbon content than typical steel which makes it much harder and more durable. I have found that for my purposes, tools made of mild steel with lower carbon content work just fine. In fact, I have done some repoussé work with wooden tools with good results. Matt Weber from Delta Terra Studios makes some very high quality, high carbon chasing tools.

The texture of the business end of the chasing tool will be transferred to the surface of the metal. Smooth faced tools like these are often used to move the metal into shape. Chasing tools with textured faces can produce different surface effects and are often used in the refinement stages of repoussé work.

Repoussé and chasing are commonly performed over pitch. Pitch is a resinous tar-like substance which is semi-fluid when hot and hard when cold. It provides a backing for forming the metal that supports it yet allows it to be deformed. The pitch holds the metal in place during hammering and prevents the material from being pushed around, other than what is directly under the chasing tool. The pitch is used at different temperatures depending on the amount or depth of forming required. The final stages of refinement, called planishing, are typical done on cold, hard pitch. Soft pitch has the resistance of wet clay if you were to press something into it - Not your finger! Pitch burns can be very severe and painful. A good source for pitch is Northwest Pitchworks.

This is the lid to a box that I formed in the pitch bowl. I worked the metal from the front and back sides of the design by flipping it over in the pitch multiple times. Repoussé refers to pushing the metal out from the back side of the piece - chasing is pushing the metal down from the front. There is a lot of back and forth between repoussé and chasing when creating a relief.

Fig. 1 Process of metalworking

As the metal is moved around it becomes stiff, or work hardened. The metal will crack if the stresses are not relieved. Think of bending a paper clip back and forth until it snaps. The metal can be returned to it's soft, malleable state by heating it to very high temperatures. This process is called annealing. Annealing temperatures are different for each metal and alloy but generally occur when the metal is red hot. Some metals must cool down slowly after annealing but copper and other non-ferrous metals can be quenched in water for a quick cool down.

I began this piece by drawing the design on the flat sheet metal and embossing the lines with a tool called an outliner or tracer. This tool has a business end similar in shape to a screwdriver but with rounded edges and corners. After the design was outlined I flipped the metal over and began pushing up the high points in between my traced lines. This is the back side of the design showing the types of tools used to create the depth. The piece was then flipped back over to define the shapes from the front.

In this photo you can see the faint impression left by the outliner tool in the lower right. This section has not yet been pushed out from the back side. Starting a project from the front with the outliner is a common strategy but not necessary. Some pieces are started by pushing out a large undefined area from the back and then pushing the low points back down, establishing the design by moving the metal from high to low.

Here is a sample I did for a client a few years back (Fig. 1). The fingers and details were created with repoussé and chasing, and then the metal was bent up into the cupped shape.

I do a lot of my repoussé work with the aid of a hand held pneumatic hammer (Fig. 2). This is an air chisel with adjustable speeds. The chisel tools have been modified by grinding, forging, and welding. The tools are just bigger versions of my chasing tools. The air hammer moves the metal quickly and with pretty uniform results. Saves lots of wear and tear on the hammering arm as well! Here are some pieces that I formed with the pneumatic hammer.

Fig. 2 Pneumatic hammer

Some of the most famous sculptures created using these techniques are the Statue of Liberty, Portlandia, and King Tut's bural mask. I have lots more to say on the subject of repoussé and chasing. I will be posting step by step images of the techniques soon. (4032)

3. EQUIPMENT AND INSTRUMENTS FOR ART METALWORK

Text 3.1

Ex. 3.1.1 Guess the meaning of the following words, checking the dictionary their pronunciation:

Smithing, fine-toothed, high-speed, fine-grinding wheel, workbench, sawmill, chisels, punches, indent-end nailset, sufficient, hammer-and-anvil, forging.

Ex. 3.1.2 Read and translate the text:

ESSENTIAL BLACKSMITHING TOOLS

In our first smithing adventures we bought a small and finely machined vise, a fine-toothed flat metal file, a little 1/4 inch steel-cutting chisel and a matching pointed pick-punch. The next shop extras were a high-speed electric bench grinder with both a coarse- and fine-grinding wheel, plus the capacity to accept buffing wheels and grinding discs. If you intend to do any serious metalwork, you will also need a heavy workbench to hold your grinder and vice. Don't invest in anything fancy, as it will be burned by hot metal repeatedly. We have built several and found that native oak, bought aged but rough-cut from a local sawmill is best, Make the top of your bench from planks at least two inches thick, and two times that is better (if you have plenty of help to lift and carry the wood).

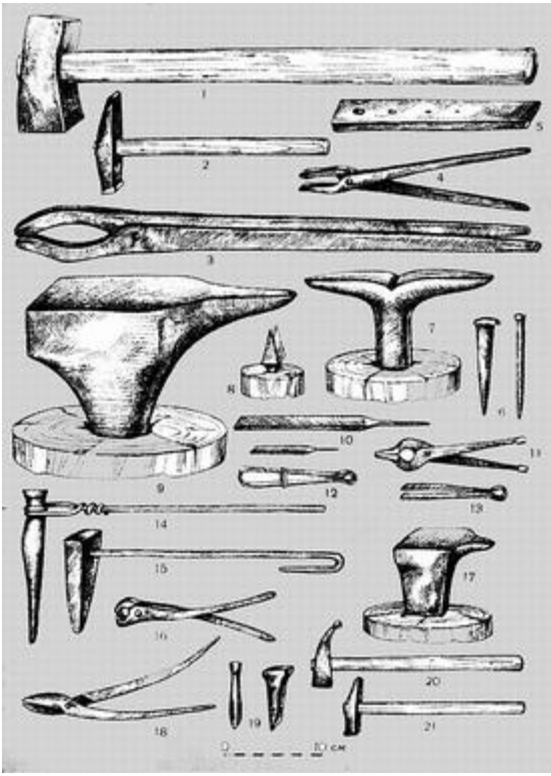

Fig. 1 Blacksmithing tools

You can save trips to the hardware store by getting a few items at once: a set of chisels, a set of metal-cutting files, a set of punches (pointed, indent-end nailset type and flat-tips) and the largest vise and grinder you can afford. You can save half by ordering a China-made vise from a discount tools catalog, but be sure the vise has an ample flat anvil surface in back and that the anvil is located on top of the bolts that hold the vise to the bench rather than extending back (where it will wobble). Common vises have tempered lawns but the attached anvils are made of an untreated steel that is sufficient for occasional gentle flat forging although its easily dented. Look into a Wilton or other premium U.S. brand to get a tempered vise surface that won't dent of scar when hit by tempered tools suds as a hammer brad, pick or punch. For serious hammer-and-anvil forging, get a real anvil — one made of properly treated steel, not cast iron. As noted below, you can make or buy one. (1470)

Ex. 3.1.3 Find key terms in the text and make your sentences with them.

Ex. 3.1.4 Write ten special questions to the text and answer them.

Text 3.2

Ex. 3.2.1 Transcribe the following words and read them aloud:

anvil, temperature, annealing, occasionally, charcoal, precious, jeweler, techniques.

Ex. 3.2.2 Read and translate the text:

TOOLS, MATERIALS AND TECHNIQUES OF SILVERSMITHS

Silversmiths saw or cut specific shapes from sterling and fine silver sheet metal and bar stock, and then use hammers to form the metal over anvils and stakes. Silver is hammered cold (at room temperature). As the metal is hammered, bent, and worked, it 'work-hardens'. Annealing is the heat-treatment used to make the metal soft again. If metal is work-hardened, and not annealed occasionally, the metal will crack and weaken the work.

Silversmiths can use casting techniques to create knobs, handles and feet for the hollowware they are making. After forming and casting, the various pieces may be assembled by soldering and riveting.

During most of their history, silversmiths used charcoal or coke fired forges, and lung-powered blow-pipes for soldering and annealing. Modern silversmiths commonly use gas burning torches as heat sources. A newer method is laser beam welding.

Silversmiths may also work in copper and brass, although this is usually confined to practice pieces due to the cost of the metals.

Although jewelers also work in silver and gold, and many of the techniques for working precious metals overlap, the trades of jeweler and silversmith have distinct histories. Chain-making and gem-setting are common practices of jewelers that are not usually considered aspects of silversmiths.

The tradition of making armour was interrupted sometime after the 17th century. Silversmithing and goldsmithing, by contrast, have an unbroken tradition going back many millennia. The techniques used to make armor today (whether for movies or for historical recreation groups) are an amalgam of silversmith forming techniques and blacksmith iron-handling techniques. (1418)

Ex. 3.2.3 Find key terms in the text and make your sentences with them.

Ex. 3.2.4 Write ten special questions to the text and answer them.

Text 3.3

Ex. 3.3.1 Transcribe the following words and read them aloud:

variety, yield, burin, unique, quality, deliberate, appearance, Florentine, mezzotint, roulette, burnisher, square, jewelry, techniques.

Ex. 3.3.2 Read and translate the text:

TOOLS AND GRAVERS OR BURINS

Gravers come in a variety of shapes and sizes that yield different line types (Fig. 1). The burin produces a unique and recognizable quality of line that is characterized by its steady, deliberate appearance and clean edges. The angle tint tool has a slightly curved tip that is commonly used in printmaking. Florentine liners are flat-bottomed tools with multiple lines incised into them, used to do fill work on larger areas or to create uniform shade lines that are fast to execute. Ring gravers

Fig. 1 Gravers and burins

are made with particular shapes that are used by jewelry engravers in order to cut inscriptions inside rings. Flat gravers are used for fill work on letters, as well as "wriggle" cuts on most musical instrument engraving work, remove background, or create bright cuts. Knife gravers are for line engraving and very deep cuts. Round gravers, and flat gravers with a radius, are commonly used on silver to create bright cuts (also called bright-cut engraving), as well as other hard-to-cut metals such as nickel and steel. Square or V-point gravers are typically square or elongated diamond-shaped and used for cutting straight lines. V-point can be anywhere from 60 to 130 degrees, depending on purpose and effect. These gravers have very small cutting points. Other tools such as mezzotint rockers, roulettes and burnishers are used for texturing effects. Burnishing tools can also be used for certain stone setting techniques.

Musical instrument engraving on American-made brass instruments flourished in the 1920s and utilizes a specialized engraving technique where a flat graver is "walked" across the surface of the instrument to make zig-zag lines and patterns. The method for "walking" the graver may also be referred to as "wriggle" or "wiggle" cuts. This technique is necessary due to the thinness of metal used to make musical instruments versus firearms or jewelry. Wriggle cuts are commonly found on silver Western jewelry and other Western metal work. (1639)

Ex. 3.3.3 Find key terms in the text and make your sentences with them.

Ex. 3.3.4 Write ten special questions to the text and an-

swer them.

Text 3.4

Ex. 3.4.1 Transcribe the following words and read them aloud:

leather, apron, anvil, disappear, farriers, romance, anthracite, charcoal, variety, riveted, square, through, threaded, ingenuity, Fahrenheit, squirrel-cage, rheostat, barbecue.

Ex. 3.4.2 Read and translate the text:

THE FORGE

The most romantic aspect of metalworking is the forge, leather apron and clang of hammer on anvil. Blacksmithing as a craft and art did not disappear with Longfellow's village smith and his chestnut tree. The old-time skills are kept alive by a small army of teachers, re-enactors, skilled art smiths and the 7,000 professional farriers that shoe over 2 million riding hones in America today. There are courses you can take and books and videos you can buy if the romance appeals. We typically find smithing hard, hot and dirty work — smelly, too, if super-hot-burning anthracite coal is used rather than charcoal - and do as little as we can get away with. Still, we did inherit the use of a small coal forge and huge anvil for a time a while back, and learned that some things can be made right only one way — by forging them yourself.

We needed a set of steel grills to put across doors and windows of the cabin to keep out a variety of unwanted critters. Such a grill is best made of tempered steel, fabricated before hardening. The grill is riveted or welded at crosspoints, then installed using long, flat-headed, square-shanked 1/2 inch steel bolts. (The bolts extend through square holes punched into fiats hammered into the steel, thence through holes bored through the logs to be threaded and scored with holts on the inside.) A metalworking shop could do the work, but it would cost more than the stuff we want to protect.

To forge our own, we are in the process of assembling a budget-priced smithy; following is the plan in case you would like to do the same. This is how smithies are built on sheep stations in the Australian Outback, where store goods are in short supply, but ingenuity is not.

All forges contain a firebrick or cast-iron firepot to hold the 2700 degree Fahrenheit fire needed to forge-weld steel. The Aussie forge uses an old truck-size cast-iron brake drum. They are large and thick enough and have an axle hole in the middle. On ours, an iron perforated-disc runoff drain cover will be placed over the opening and let rust in place. Using 2 inch or 3 inch iron plumbing pipe and flanges. a tube will be run to a surplus squirrel-cage fan. A rheostat regulates the blower speed. The Aussie firepot is placed in a home-welded angle-iron forge table with a hood and chimney rigged over it. We plan to set ours in a bed of sand in the firebox of a fancy cast-ton wheeled backyard gas barbecue that somebody left at the dump when the burner broke. We shall get a pair of sheet-metal flanging pliers and form a hood and flue to fit from sheet metal and blinds. (2118).

Ex. 3.4.3 Make an outline for a story of yours based on the vocabulary of the text.

Ex. 3.4.4 Make a close-to the text retelling of the contents.

HOW TO MAKE UP A SYNOPSIS AND A SUMMARY OF THE TEXT

Навыки аннотирования и реферирования технического текста позволяют эффективнее осваивать новую иноязычную информацию по специальности, быстро извлекать нужную информацию из текста и ее фиксировать.

Аннотирование – процесс составления кратких сведений о печатном произведении (книге, статье, докладе и т.д.), позволяющих судить о целесообразности его более детального изучения. При этом учитывается содержание произведения, его назначение, ценность и направленность.

Аннотация (a synopsis) – краткая характеристика текста с точки зрения содержания, формы, читательского назначения и других особенностей, дополняющих библиографическое описание. Язык аннотации должен быть простым, без использования ненужных и малопонятных терминов. Она должна в сжатой форме сообщать, о чём говорится в тексте и какие теоретические и / или практические знания дает это произведение. Аннотации по содержанию бывают нескольких типов, самым популярным из которых является описательный.

Описательная аннотация – описание содержания текста с помощью безличных конструкций в форме краткой справки; может быть составлена на любой вид печатного произведения. Её обычный объем 300-500 знаков, т.е. в среднем аннотация содержит 3-4 предложения на любую печатную статью вне зависимости от ее размера.

Текст описательной аннотации должен состоять из трех частей:

1. Вводная часть с выходными данными: название текста, фамилия автора, год издания, место издания, номер, объем (количество страниц, иллюстраций, таблиц).
2. Описательная часть - два-три основных положения, наиболее характерных для данного текста, которые должны содержать в себе тематику (если она не раскрыта в названии), цель данной работы и область применения, а также способы, с помощью которых достигаются поставленные автором цели.
3. Заключительная часть, где рассматриваются отдельные особенности изложения материала, иногда приводятся выводы.

Аннотация не имеет абзацев и начинается с сути вопроса или с вводных фраз.

Реферирование – одна из самых широко распространенных письменных форм извлечения информации. Если в аннотации приводится лишь краткий перечень рассматриваемых вопросов, то в реферате излагается суть вопросов и приводятся важнейшие выводы.

Реферат (a summary) - это сокращенное содержание печатного текста с основными фактическими данными и выводами. Реферат представляет собой объективное, лишенное эмоций сообщение информации первоисточника на основе ее смысловой переработки. Он акцентирует внимание на новых сведениях и определяет целесообразность обращения к первоисточнику.

Существует много видов рефератов, наиболее интересным является информативный реферат, т.е. конспективное изложение существенных положений оригинала. Изложение содержания статьи в реферате ведется по степени важности отобранных сведений. Сначала кратко излагается существо вопроса, далее сжато приводятся необходимые фактические данные. План составления реферата может не совпадать с планом статьи.

Реферат, как правило, не имеет разделов или рубрик. Текст реферата начинается с изложения существа реферируемого текста. Следует избегать вводных фраз (в отличие от аннотации). В реферат не включаются исторические справки, введения (если они не составляют основного содержания статьи), описание раннее опубликованных работ и общеизвестные положения. План реферата:

1. Тема, предмет (объект), характер и цель работы. Здесь нужно показать особенности темы, которые необходимы для раскрытия цели и содержания работы.
2. Метод проведения работы (если этот метод или методы новые, то нужно дать их описание).
3. Конкретные результаты работы (теоретические или экспериментальные).
4. Выводы, рекомендации, оценка, предложения, описанные в первоисточнике.
5. Область применения.

Если в статье отсутствует какая-либо из перечисленных выше частей (например, в статье ничего не говорится о применении), то ее в реферате опускают, сохраняя последовательность изложения.

В конце реферата могут даваться примечания референта (при наличии в нем противоречий или ошибок), но интерпретация или критика первоисточника в самом реферате не допускается. Текст реферата заканчивается сведениями о количестве иллюстраций, таблиц, библиографии, за которыми идут ф.и.о. референта.

Основные требования языку реферата:

1. Краткое, точное и объективное изложение материала.
2. Применение стандартной терминологии. Следует избегать непривычных терминов и символов и разъяснять их при первом упоминании в тексте.
3. Термины, применяемые в реферате более трех раз и смысл которых ясен из контекста, рекомендуется после первого употребления полностью заменить аббревиатурами (сокращениями) в виде начальных заглавных букв этих терминов. При первом упоминании такая аббревиатура дается в скобках непосредственно за термином, при последующем употреблении - без скобок. В реферате не следует применять более трех различных аббревиатур.

Как правило, при написании реферата сложные предложения преобразуются в простые, широко используются неопределенно-личные предложения. Формулы в реферате приводятся в следующих случаях: а) без формул невозможно построение реферата; б) формулы выражают итоги работы; в) формулы существенно облегчают понимание работы.

Допускается включать в реферат иллюстрации и таблицы, если они помогают раскрытию основного содержания работы.

Объем реферата не зависит от объема реферируемого текста, а определяется ее содержанием, количеством сведений и их научной ценностью, Средний объем для журнальных статей ~ 1000 печатных знаков.

Основные отличия аннотации от реферата:

Аннотация	Реферат
Аннотация лишь перечисляет вопросы, которые освещены в первоисточнике, не раскрывая самого содержания этих вопросов. Аннотация отвечает на вопрос: «О чем говорится в первичном тексте?» В аннотации основное содержание передается своими словами, которые представляют высокую степень абстрагирования и обобщения	Реферат представляет собой объективное, лишенное эмоций сообщение информации первоисточника на основе ее смысловой переработки. Он обращает внимание на новые сведения и сообщает существенное содержание основных вопросов. В реферате формулировки и обобщения заимствуются из самого текста оригинала

Лексические модели для использования при составлении аннотаций и рефератов на английском языке:

The article is headlined…	Статья называется...
The headline of the article I have read is...	Название статьи, которую я прочитал...
The author of the article is...	Автор статьи...
The article is written by... .	Статья написана...
It's published in...	Она опубликована..
It’s printed in...	Она напечатана...
The main idea of the article is...	Основная мысль этой статьи…
The article is about...	Статья о...

The article is devoted to...	Статья посвящена...
The article deals with....	Статья связана с...
The article touches upon....	Статья затрагивает...
The purpose of the article is to give the reader some information on...	Цель статьи – ознакомить читателя с информацией о...
The aim of the article is to provide the reader with some material (data) on....	Цель статьи ознакомить читателя с материалами/данными о...
The author starts by telling the reader that..	В начале статьи автор пишет ...
The author writes (states, stresses, thinks, points out) that...	Автор пишет / утверждает / подчеркивает / полагает / выделяет, что...
The article describes ...	Статья описывает...
According to the text...	Согласно тексту...
Further the author reports (says)...	Далее автор сообщает...
It is important to note (stress, underline)...	Важно отметить / подчеркнуть...
In conclusion....	В заключение...
The author comes to the conclusion that...	Автор приходит к заключению, что...
I found the article interesting (important, dull, of no value, too hard to understand) because...	Статья показалась мне интересной (важной, скучной, не представляющей интереса, слишком трудной для понимания), так как...
Логические коннекторы	
Beforehand	Прежде всего
Firstly	Во-первых
Secondly	Во-вторых
Nevertheless	Тем не менее
Then	Затем
Further	Далее
Besides	Кроме того
Finally, In general	Наконец, в целом
As mentioned above	Как указывается выше

In other words	Иными словами
But	Однако
On the one hand	С одной стороны
On the other hand	С другой стороны

RUSSIAN-ENGLISH TERMINOLOGICAL VOCABULARY ON ART METALWORK

алюминий aluminium (*US*: aluminum)
áмбус [массивные стойки с выпуклой поверхностью для выколотки и проковки выпуклых изделий] anvil bed / stake
басма = тиснение
бородóк [*кузнечный инструмент*] driftpin
бронза bronze
выколотка [=дифовка] raising (*изделие выколачивается на оправке с наружной стороны*); dishing (*изделие выколачивается на оправке изнутри*)
высадка [кузнечная операция] upset(ting)
гибка [кузнечная операция] bending
горн (*кузнечный*) smith's hearth / forge
грабштихель [резец гравёра] burin
гравировать (*режущим инструмен-том*) to engrave; to cut (*гранение, тесание*); to chase (*только по металлу*); (*травлением*) to etch
гравировка (*режущим инструментом*) engraving; cutting (*гранение, тесание*); chasing (*только по металлу*); (*травлением*) etching; ▪ гальваническая ~ galvanocautery
дифовка = выколотка
заготовка blank; (*литая*) casting; (*круглого, квадратного или прямоугольного сечения*) billet; (*плоская или прокатанная*) slab; ▪ кованная ~ forged blank; кузнечная ~ forged piece / stock; листовая ~ sheet billet
золото gold
зубило (*кузнечное*) anvil chisel
клещи (*кузнечные*) smith's tongs
ковать to forge; (*под молотом*) to hammer; (*в штампах*) to press; ▪ ~ в горячем / холодном состоянии to forge hot / cold
ковка forging; (*под молотом*) hammering; ▪ горячая / холодная ~ hot / cold forging; ~ в штампах (под прессом) press forging, pressing; ~ в открытом штампе open-die forging; ~ молотом hammer forging; ~ под падающим молотом drop forging; ручная ~ hand forging, blacksmithing; свободная ~ smith forging
ковкость (*технологич. св-во*) forgeability, malleability; (*пластич. св-во*) ductility
кувалда sledge (hammer)
литьё 1. (*действие*) casting; 2. (*изделия*) casting(s); ▪ ~ в оболочковые формы shell (mould) casting; ~ песчаные формы sand (mould) casting; ~ в постоянные формы permanent-mould casting; ~ по выплавляемым моделям investment casting; ~ по выплавляемым восковым моделям lost-wax process;~ под давлением die casting; точное ~ precision casting; центробежное ~ centrifugal casting; художественное ~ art / ornamental casting
медь copper
мессерштихель [резец гравёра] knife-shaped graver, knife tool
металл metal; ▪ вязкий ~ tough metal; драгоценный ~ precious metal; ковкий ~ ductile metal; листовой ~ sheet metal; литейный ~ cast(ing) metal; хрупкий ~ brittle metal; цветной ~ non-ferrous metal; чёрный ~ ferrous metal
металлопластика [изготовление изображения, выдавливанием его на поверхности тонкого металла] repoussage
молот(**ок**) hammer; ▪ ~ кузнеца smith's hammer
наковальня anvil
напильник file
обжимка [*кузнечный инструмент*] swage
обработка металлов metalworking; ▪ горячая / холодная ~ hot / cold metalworking; художественная ~ art metalwork
обрабатывать металл свободной ковкой (*под молотом*) to work / shape a metal by hammering; (*под кузнечным прессом*) to work / shape a metal by press forging
олово tin
опока [в литейном деле приспособление, служащее для удержания формовочной смеси при её уплотнении] mould(ing) box, flask
отливать (*в форму*) to mould, to cast
отливка casting; ▪ извлекать ~у из формы to strip a casting;
подбойка [*кузнечный инструмент*] set hammer
припаивать to solder (*мягким припоем* on / to); to braze (*твёрдым припоем* on / to)
прокатка rolling
протяжка [кузнечная операция] drawing
пуансон [инструмент, напоминающий по форме гвоздь, используется при гравировании пунктирной линией из точек различной величины и глубины] punch
резец engraver's tool, (en)graver
рифление [обработка поверхности для придания ей шероховатости] fluting, grooving
резьба (*зубилом, чеканом и т.п.*) chiselling
серебро silver
скань [вид ювелирной техники] filigree
скребóк scraper
скручивание [кузнечная операция] twisting
соединение (*деталей болтами, сваркой, клёпкой и т.п.*) joint
сплав alloy
сталь steel
тиснение stamping
травление etching
филигрань [ювелирное узорчатое изделие из тонкой кручёной проволоки] filigree
форма shape; (*литейная*) (casting) mould

фреза cutter
чекан embossing die; raising hammer (*разновидность молотка для выколотки*)
чеканить to emboss
чеканка 1. [изготовление изображения, выдавливанием его на поверхности] embossing; stamping (*листовая*), chasing (*тиснение орнамента на тонкой металлической пластинке*) 2. [изображение, выбитое на металлическом изделии] repoussé work
чернь [гравировка на серебре, золоте, штрихи которой заполняют чёрным металлическим сплавом] niello /*pl*.: -li, -los/
чугун (*первичный продукт доменного производства*) pig iron; (*продукт вторичной плавки*) cast iron
ша́бер [инструмент, служащий для точной обработки поверхностей металлических изделий, нанесения рисунков и надписей в гравировальном деле] scraper
шперак [*небольшая наковальня*] beak iron
штамп ковочный forging die
штихель [резец гравёра] burin

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alloy *n* сплав
aluminium (*US*: aluminum) *n* алюминий
annealing *n* отжиг
anvil *n* наковальня
anvil bed / **stake** а́мбус (*стойки для выколотки и проковки выпуклых изделий*)
anvil chisel *n* зубило (*кузнечное*)
art / **ornamental casting** *n* художественное литьё
art metalwork *n* художественная обработка металлов
beak iron шперак (*небольшая наковальня*)
bending *n* изгиб
billet *n* заготовка(*круглого, квадратного или прямоугольного сечения*)
binder *n* связывающее вещество
black-smithing *n* ручная ковка
blank *n* заготовка
brass *n* латунь
braze (on / to) *v* припаивать (*твёрдым припоем*)
brazing *n* пайка (*твёрдым припоем*)
breaking *n* разрушение; излом
brittle *adj* хрупкий
bronze *n* бронза
burin *n* (граб)штихель (*резец гравёра*)
capacity *n* способность: **heat** / **thermal capacity** теплоёмкость
cast 1) *тж*. **casting** *n* литьё, отливка (*процесс*); *мн*.: литьё (*изделия*); 2) *v* отливать (*в форму*)
cast iron *n* чугун (*продукт вторичной плавки*)
cavity *n* полость; впадина
centrifugal casting *n* центробежное литьё
chase 1) *n* гравировка (*по металлу*); чеканка (*на тонкой металлической пластинке*); 2) *v* гравировать (*орнамент*)
chasing *n* гравировка (*по металлу*)
chiselling *n* резьба (*зубилом, чеканом и т.п.*)
chromium *n* хром
coating *n* покрытие (*процесс*), грунтовка; слой, покрытие
compression *n* сжатие; уплотнение
composite 1) *adj* составной, сложный; 2) *n* композит, композиционный материал
conduction *n* (электрическая) проводимость; теплопроводность
conductivity *n* удельная проводимость
conductor *n* проводник
constituent *adj* составляющий часть целого, составной
copper *n* медь
corrosion *n* коррозия
crack *n* трещина
creep resistance *n* сопротивление ползучести
cupric *adj* содержащий двухвалентную медь
cuprous *adj* содержащий одновалентную медь
cutter *n* фреза
cutting *n* гравировка (*тесание*)
damascene *v* насекать (*металл*) золотом / серебром
deformation *n* деформация
density *n* плотность
die-casting *n* литьё под давлением
dies *npl* кузнечная оснастка
dishing *n* выколотка, дифовка (*изделие выколачивается на оправке изнутри*)
drawing *n* протяжка
driftpin бородо́к (*кузнечный инструмент*)
drop forging *n* ковка под падающим молотом
ductile *adj* вязкий (*металла*), ковкий
ductility *n* вязкость (*металла*), ковкость; пластичность

elastic *adj* упругий: **elastic force** сила упругости
elasticity *n* эластичность, упругость
electric current *n* электрический ток
electricity *n* электричество
emboss *v* чеканить; выдавливать рельеф
embossing *n* чеканка; выдавливание рельефа
embossing die *n* чекан
embossment *n* чеканка; резьба; тиснение; рельефное изображение
enamel work *n* глазуровка; покрытие эмалью
(**en**)**graver** / **engraver's tool** *n* резец
engraving *n* гравирование, гравиров-ка (*режущим инструментом*)
etching *n* гравирование (*кислотой*), травление
ferrous *adj* железистый
file *n* напильник
filigree *n* филигрань
flask *n* опока (*приспособление в литейном деле*)
flowability *n* текучесть
fluidity *n* текучесть; подвижность
fluting *n* рифление
force *n* сила
forge 1) *n* кузнечный горн; кузнечный цех; 2) *v* ковать; штамповать (*в горячем состоянии*)
forgeability *n* ковкость
forged blank *n* кованная заготовка
forged piece / **stock** *n* кузнечная заготовка
forging *n* ковка; горячая штамповка
forging die ковочный штамп
found *v* отливать в форму
foundry *n* литьё (*процесс и изделия*); литейный цех;
fracture *n* разрушение
fracture strength *n* сопротивление излому / разрыву
furnace 1) *n* печь; 2) *v* нагревать в печи; плавить (*в печи*)
fusible *adj* легкоплавкий
galvanocautery *n* гальваническая гравировка
gold *n* золото
gray / **grey iron** *n* серый литейный чугун
grinding *n* шлифование
grooving *n* рифление
hammer 1) *n* молот, кувалда; 2) *v* ковать (*молотом*)
hammering *n* ковка (*под молотом*)
hand forging *n* ручная ковка
hardness *n* жёсткость (*напр. воды, бумаги и т.п.*)
impact strength *n* ударная вязкость; ударопрочность
impurity *n* примесь
ingot *n* слиток
investment casting *n* литьё по выплавляемым моделям
iron *n* железо
ironwork *n* изделия из железа, чугуна
joint *n* соединение (*деталей болтами, сваркой, клёпкой и т.п.*)
knife-shaped graver *n* мессершти-хель (*резец гравёра*)
load *n* нагрузка
lost-wax process *n* литьё по выплавляемым восковым моделям
lustre (*US*: luster) *n* блеск (*металла*)
malleability *n* ковкость (*способность деформироваться в холодном состоянии*)
malleable *adj* ковкий
melting *n* плавка; (рас)плавление
melting point *n* температура (точка) плавления
metal *n* металл
metalware *n* металлоизделия
metalwork *n* художественная работа по металлу
metalworking *n* металлообработка
milling *n* прокатка
mould 1) *n* литейная форма; отлитая деталь 2) *v* отливать (*в форму*)
moulding *n* формовка; отливка, отлитая деталь
mould(**ing**) **box** *n* опока (*приспособление в литейном деле*)
nickel *n* никель
niello /*pl.*: -li, -los/ *n* чернь (гравировка на серебре, золоте, штрихи которой заполняют чёрным металлическим сплавом)
nonmetals *n* неметаллы
opaque *n* непрозрачный
pig iron (*первичный продукт доменного производства*) чугун
porosity *n* пористость
pressing *n* ковка в штампах / под прессом
punch *n* пуансон (*инструмент для гравировки*)
raising *n* выколотка, дифовка (*изделие выколачивается на оправке с наружной стороны*)
rapture *n* разрушение; разлом; трещина
repoussage *n* металлопластика
repoussé 1) *adj* рельефный; 2) *n* барельеф на металле

repoussé work *n* чеканка (*изделие; техника чеканки и выколотки по металлу с использованием деревянной формы*)
resistance *n* сопротивление
rigidity *n* жесткость; устойчивость (*конструкции*)
rivet *n* заклёпка; *v* клепать, заклёпывать
rolling *n* прокатка
roulette *n* гранильник; цинкографская рулетка
sand casting *n* литьё в песок
scraper *n* ша́бер (*инструмент для гравировки*); скребо́к
set hammer *n* подбойка (*кузнечный инструмент*)
sheet billet *n* листовая заготовка
shell *n* оболочковая литейная форма
shell (**mould**) **casting** *n* литьё в оболочковые формы
shrinkage *n* усадка (*при сварке*); степень обжатия (*при прокатке*)
silver *n* серебро
silverware / **silver-work** *n* изделия из серебра
slab *n* заготовка (*плоская или прокатанная*)
sledge (hammer) *n* кувалда
smith forging *n* свободная ковка
smith's tongs *n* клещи (*кузнечные*)
solder (on / to) *v* припаивать (*мягким припоем*)
soldering *n* пайка (*мягким припоем*)
specific gravity *n* относительная плотность
specific weight *n* удельный вес
spin 1) *n* скручивание; свивка; 2) *v* скручивать; свивать; вытягивать нить
stamping *n* (*листовая*) штамповка; тиснение
steel *n* сталь
stiffness *n* жесткость; коэффициент упругости
strain *n* (*механическое*) напряжение; деформированное состояние, деформация
strength *n* прочность; предел прочности, временное сопротивление (материала)
stress *n* (*механическое*) напряжение; напряжённое состояние
stretching *n* растяжение
swage *n* обжимка; ковочный обжимной штамп
tenacity *n* прочность на разрыв
tensile strength *n* сопротивление растяжению, предел прочности при растяжении
tension *n* 1) натяжение; растяжение; 2) напряжение, напряжённое состояние
thermal conduction *n* теплопровод-ность
thermal expansion *n* тепловое расширение
tin *n* олово
tolerance(**s**) *n* допуск(и)
toughness *n* ударная вязкость; жёсткость
treatment *n* (*технологическая*) обработка
twisting *n* скручивание
volume *n* объём
weight *n* вес
weldability *n* свариваемость
work / **shape** *v* (a metal) обрабатывать (металл)
workability *n* обрабатываемость, способность обрабатываться холодной обработке
wrought iron *n* сварочное железо
yield strength *n* предел текучести
Young's modulus *n* модуль Юнга, модуль упругости
zinc *n* цинк

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