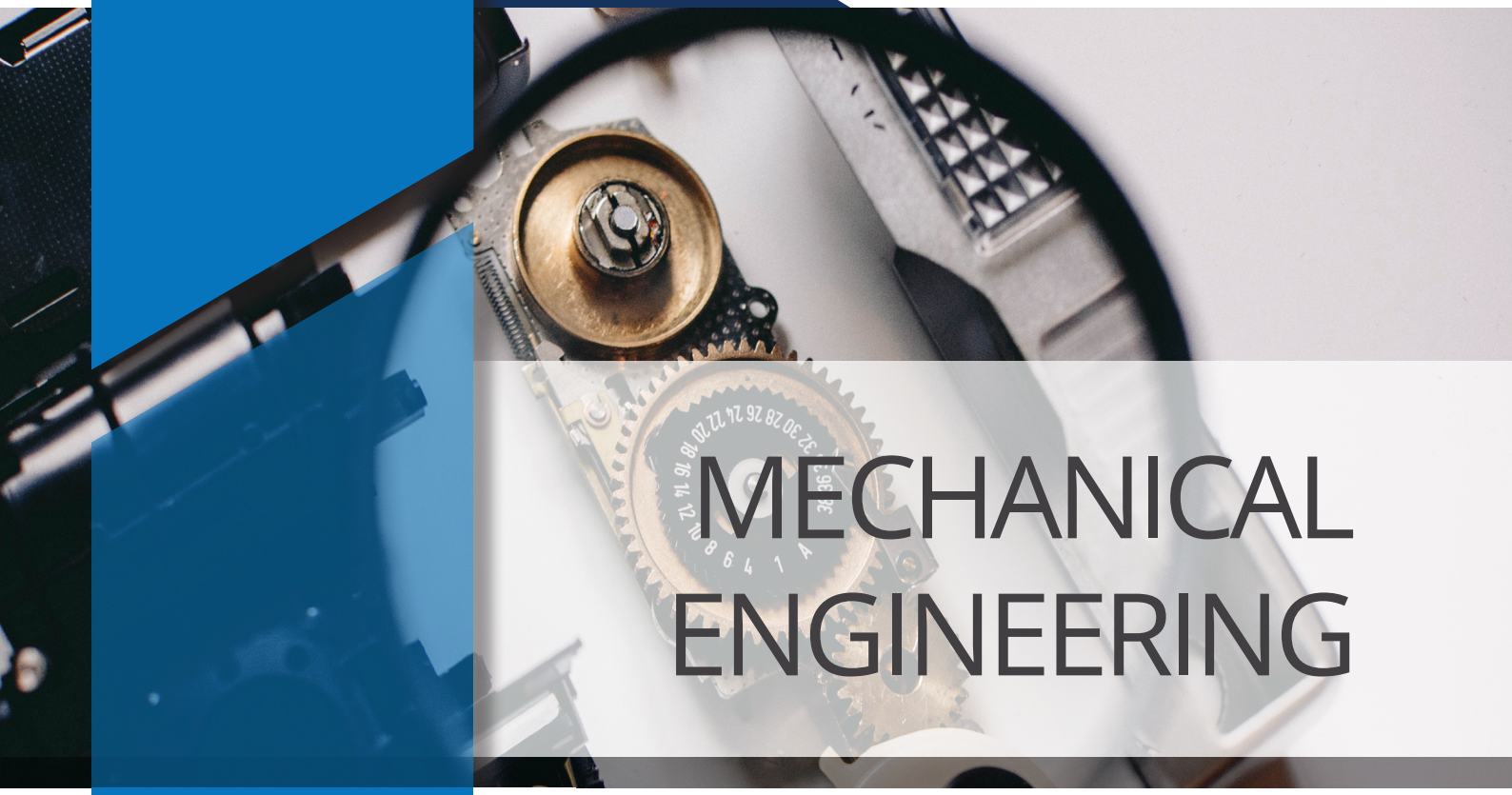
Interreg
EUROPEAN UNION
Austria-Czech Republic
European Regional Development Fund



MECHANICAL ENGINEERING

Introduction to mechanical engineering technologies

UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA

VŠTE

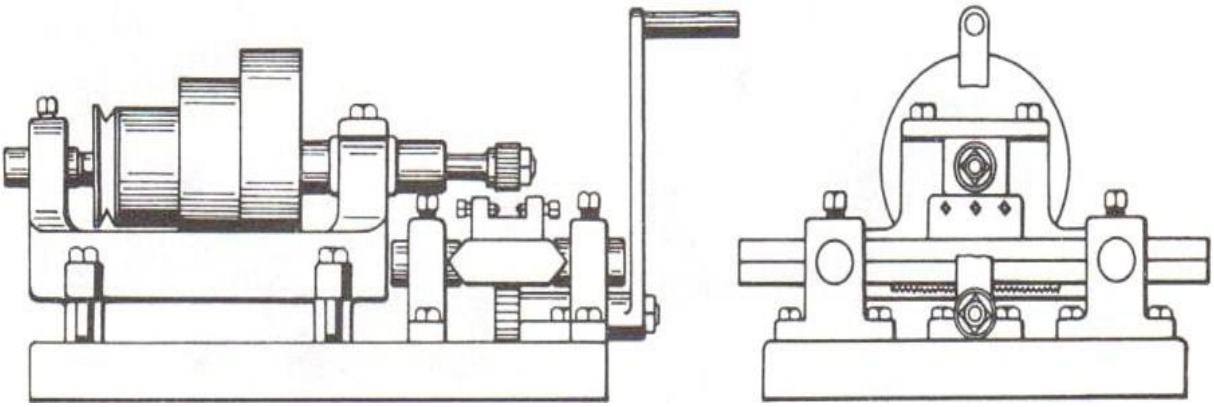
EUROPEAN UNION

CONTENTS

1. INTRODUCTION TO ENGINEERING TECHNOLOGY

- A simple grinder appeared in 1480. Its drive was with a pedal and a crank with a connecting rod.
- In 1565, the first ironing machine appeared, followed by a water-drill (1684).
- Individual machines have improved, for example, a metal lathe with a support, which allowed to cut threads, appeared after 1800.

In 1818, the first milling machine was drawn by S. Mortha



1.1. Engineering Technology I

- Is an introductory subject which provides an introductory explanation of the technology used in engineering. A more detailed introduction to engineering technologies will be provided in other specialized courses provided by the Department of Mechanical Engineering.

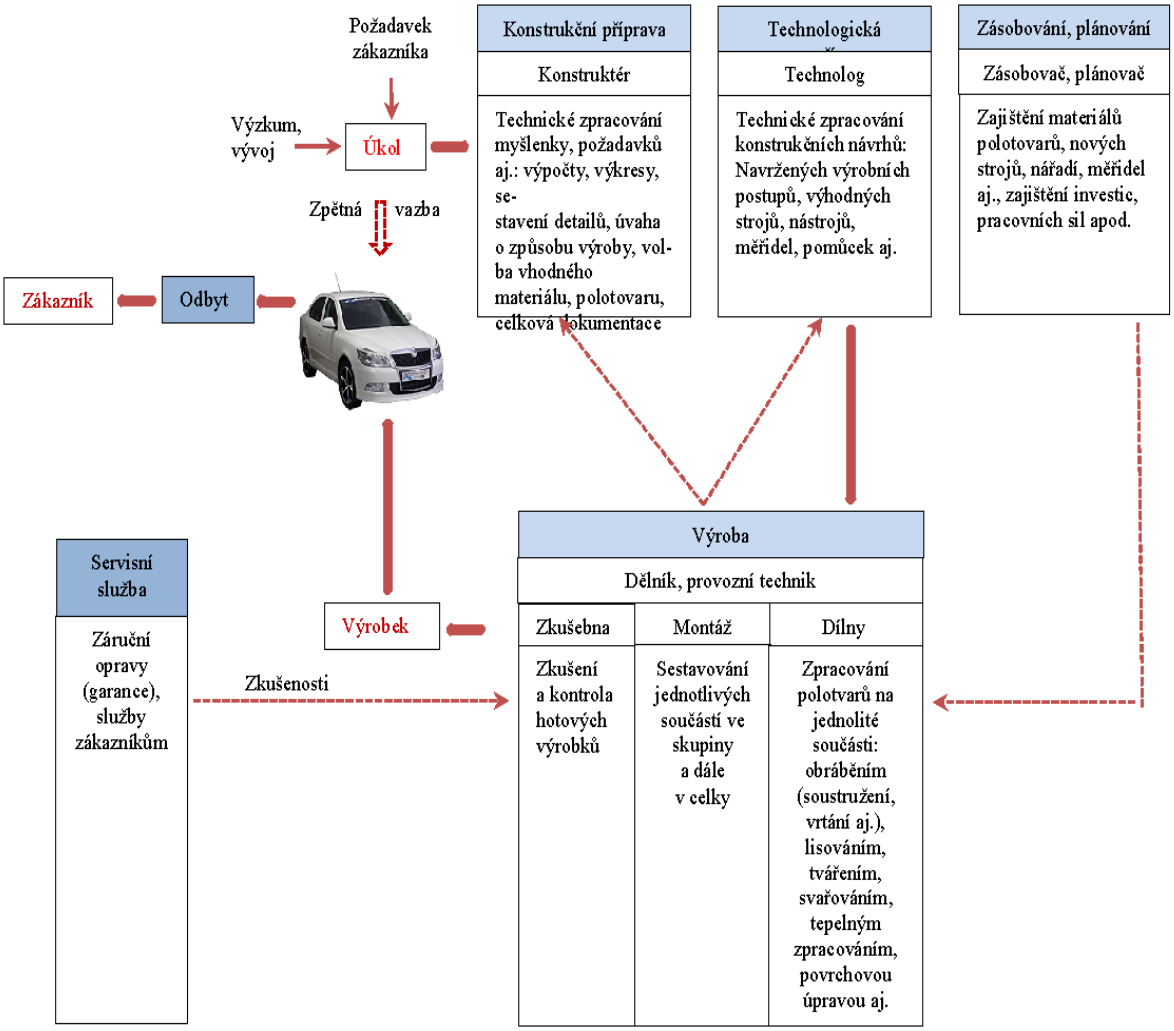
- **Metallurgy** deals with the management of raw materials on the material and its properties. This part of the technology is divided into heavy metallurgy and engineering metallurgy. Heavy metallurgy deals with the production of ferrous and non-ferrous metals from ores, powdered metals and the management of manufactured metals on semi finished products (sheets, rod, wire, etc.).

- **Machine-building metallurgy** is characterized by the production of semi finished products by casting, molding, heat treatment (changes in the internal structure of the material such as hardening, brining, tempering) and non-releasable joining of materials (welding, soldering).

- **Machining technology** addresses machining, assembly and surface treatment technologies.

- **Surface treatment technology** is achieved by changing the look of the product or surface properties.

1.2. Preparation and organization of production



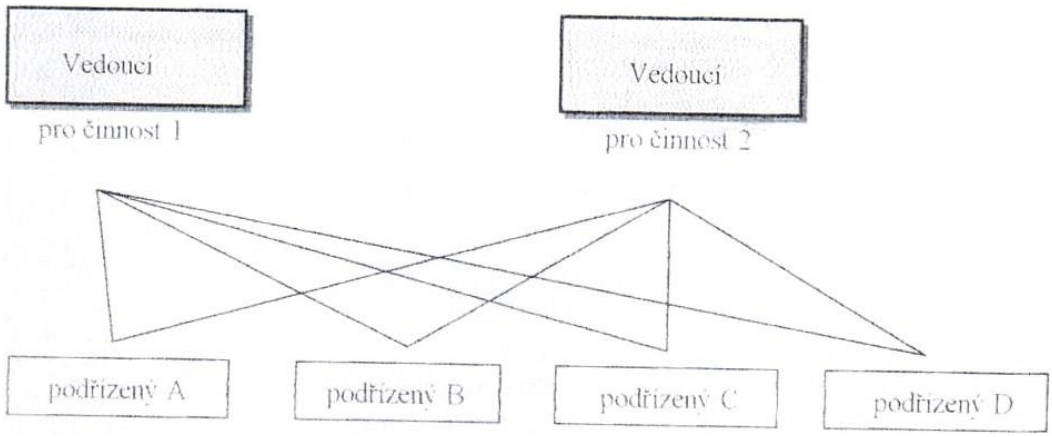
Legend: požadavek zákazníka - customer´s requirement, výzkum, vývoj - research, development, zpětná vazba - feedback, úkol - task,
konstrukční příprava - preparation of construction, konstruktér - designer, Technické zpracování myšlenky, požadavků (výpočty, výkresy, sestavení detailů, úvaha o způsobu výroby, volba vhodného materiálu, polotovaru, celková dokumentace) - technical processing of the idea, requirements (calculations, drawing, details, production method, choosing suitable material, semi-finished material, documentation),
Technologická příprava - technology, technolog - technologist, Technické zpracování konstrukčních návrhů (nav-

výrobních postupů, výhodných strojů, nástrojů, měřidel, pomůcek, aj.) - technical processing of designs (production methods, suitable machines, devices, measuring tools, aids, etc.)
Zásobování, plánování - supply, planning, zásobovač, plánovač - stock provider, planner, zajištění materiálů, polotovarů, nových strojů, nářadí, měřidel aj., zajištění investic, pracovních sil apod. - ensuring materials, semi-finished products, new machines, tools, measuring tools, etc. , insuring finance, workforce, etc.
zákazník - customer, client, odbyt - sale
servisní služba - service, záruční opravy (garance), služby zákazníkům - repairs under guarantee, customer service
výrobek - product
zkušenosti - experience
výroba - production, dělník, provozní technik - operations technician, zkušebna - testing room, zkoušení a kontrola hotových výrobků - testing and checking finished products, montáž - assembly, sestavování jednotlivých součástí ve skupině v celky - mounting individual parts into sets, dílny - workshops, zpracování polotovarů na jednotlivé součásti: obráběním (soustružení, vrtání), lisováním, tvářením, svařováním, tepelným zpracováním, povrchovou úpravou - machining (turning, drilling), pressing, forming, welding, heat processing, surface treatment

1.3. Organizational structure of the enterprise

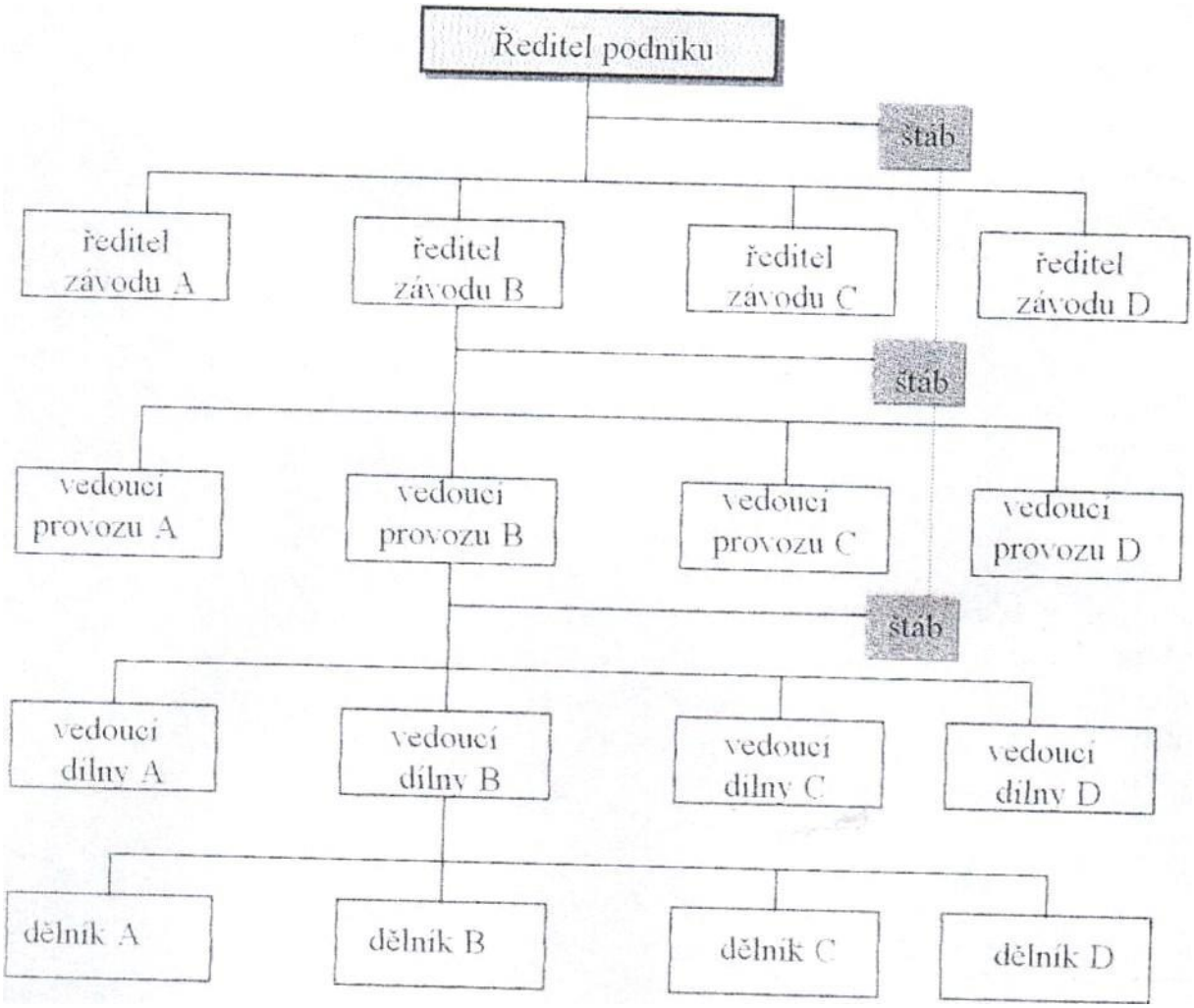
- Functional with multiple subordination
- Staff
- Divisional
- Combined

Functional with multiple subordination



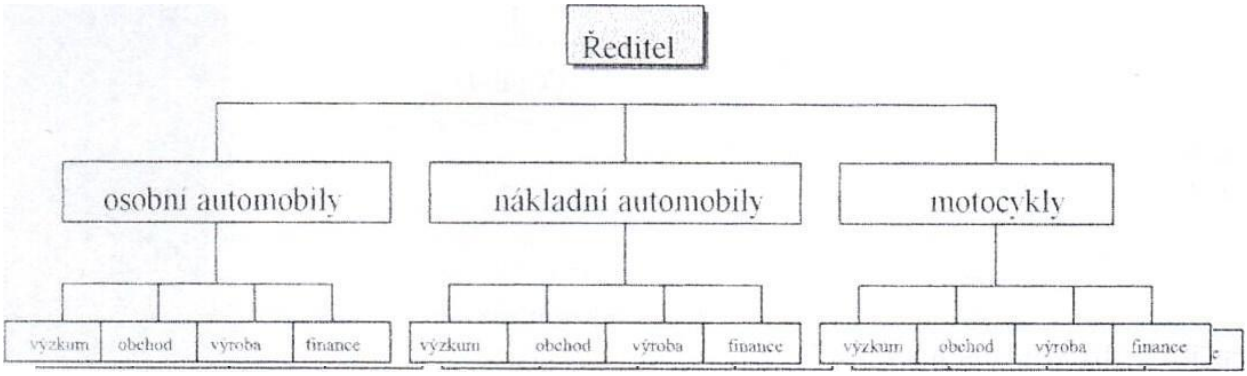
Legend: vedoucí - head (superordinate, boss), pro činnost 1 - for activity 1, podřízený - subordinate

Staff structure



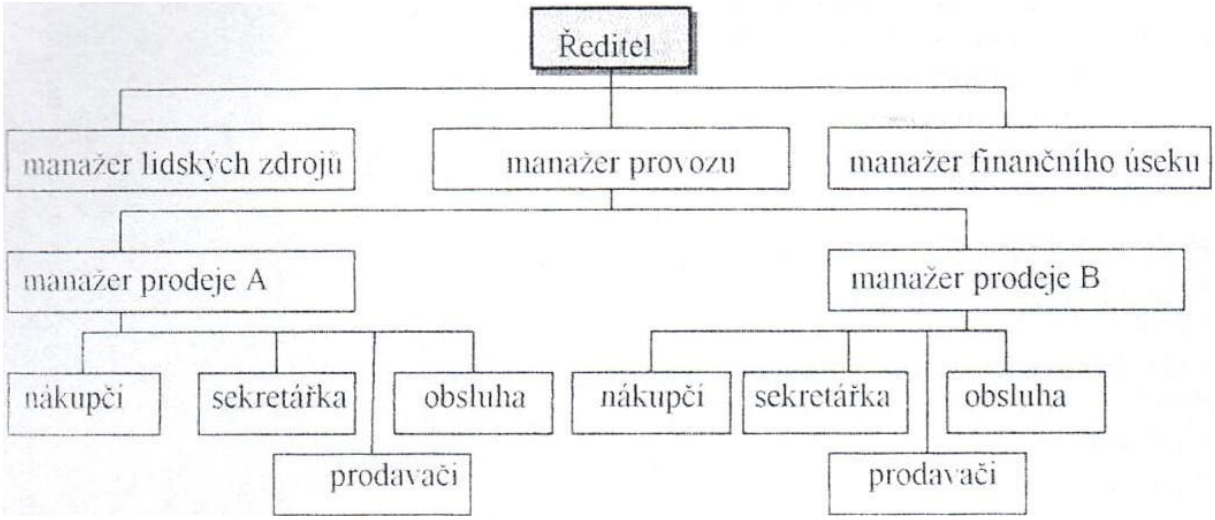
Legend: ředitel podniku - company director, štáb - team, ředitel závodu - director, vedoucí provozu - operation head, vedoucí dílky - head of workshop, dělník - worker

Divisional arrangement



Legend: ředitel - director, osobní automobily - passenger cars, nákladní automobily - trucks, motocykly - motorbikes, výzkum - research, obchod - trade, sales, výroba - production, finance - finance

Combined structure

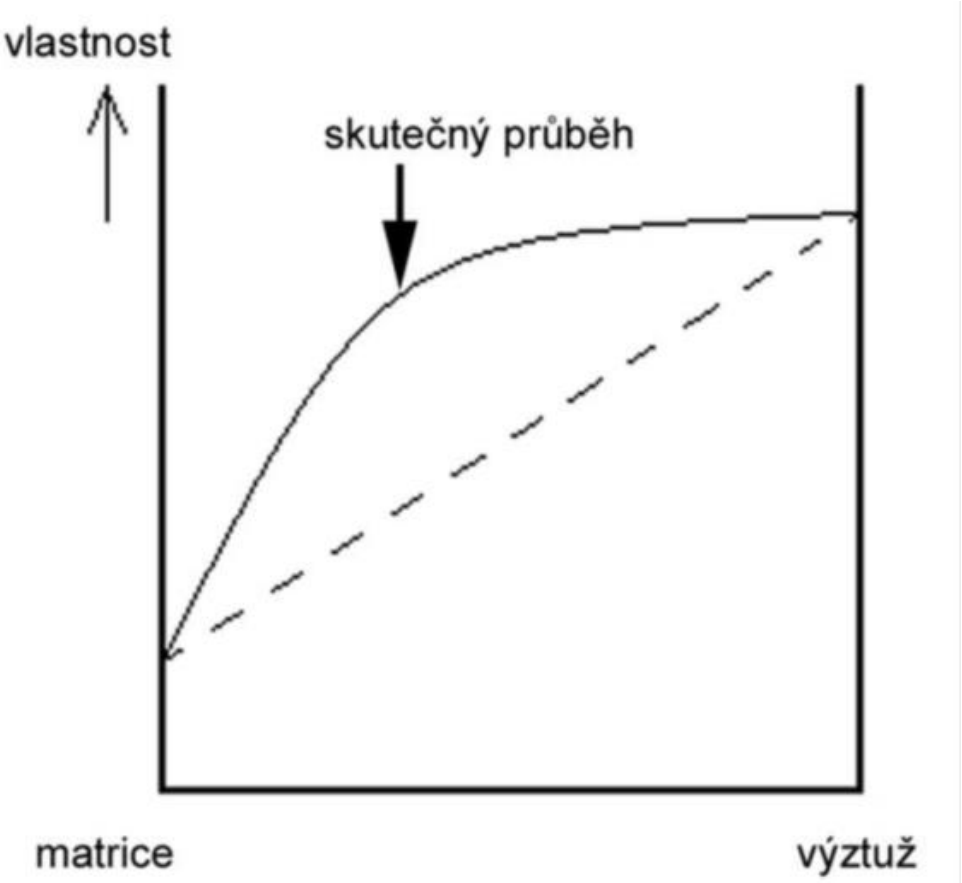


Legend: ředitel - director, manažer lidských zdrojů - human resources management, manažer provozu - operations manager, manažer finančního úseku - finance department manager, manažer prodeje - sales manager, nákupčí - purchaser, sekretářka - assistant, obsluha - service, prodavači - sales assistants

2. COMPOSITE MATERIALS

A composite can be defined as a material consisting of two or more heterogeneous constituents. These components differ in their mechanical, physical and chemical properties. In general, the composite material consists of a continuous and discontinuous phase. The continuous phase is called a matrix, and in the composite structure its main task is to act as a binder. The discontinuous phase is called reinforcement and has a reinforcing function in the composite.

2.1. Synergism



Legend: vlastnost - property, matrice - matrix, výztuž - reinforcement, skutečný průběh - actual course

2.2. Polymer composite materials

The properties of composite materials point to the perspective of these materials not only for engineering but also for other industries. The basic feature of composite material is the low weight of composite components while maintaining high mechanical properties. Composites can be matched with steel in terms of mechanical properties.

Advantages of polymer composite materials

- High flexibility in deformation
- High strength and stiffness that can be adapted to the direction and type of load
- High adaptability to every shape
- High resistance to dynamic stress at high mechanical damping
- Low coefficient of linear thermal expansion
- Resistance to aging and corrosion
- A great possibility to combine different types of matrix and reinforcement, creating a "tailor-made"
- Great weight loss against steel products.

(Carguideblog, 2013)

Disadvantages of polymer composite materials

- There is no standardized composite because of the many possibilities of combining the matrix and the reinforcement
- It is not possible to accurately estimate the behavior of the composite material (it is not possible to easily read the properties of the individual components)
- Complex material testing (if non-destructive testing is a condition)
- Low tensile strength in the direction perpendicular to the orientation of the fibers (cracks, weak connection of the fiber and the matrix)
- Complex repairs and machining of composite materials after manufacture

(Evaulationengineering, 2006)

2.3. Possibilities of application in the transport industry

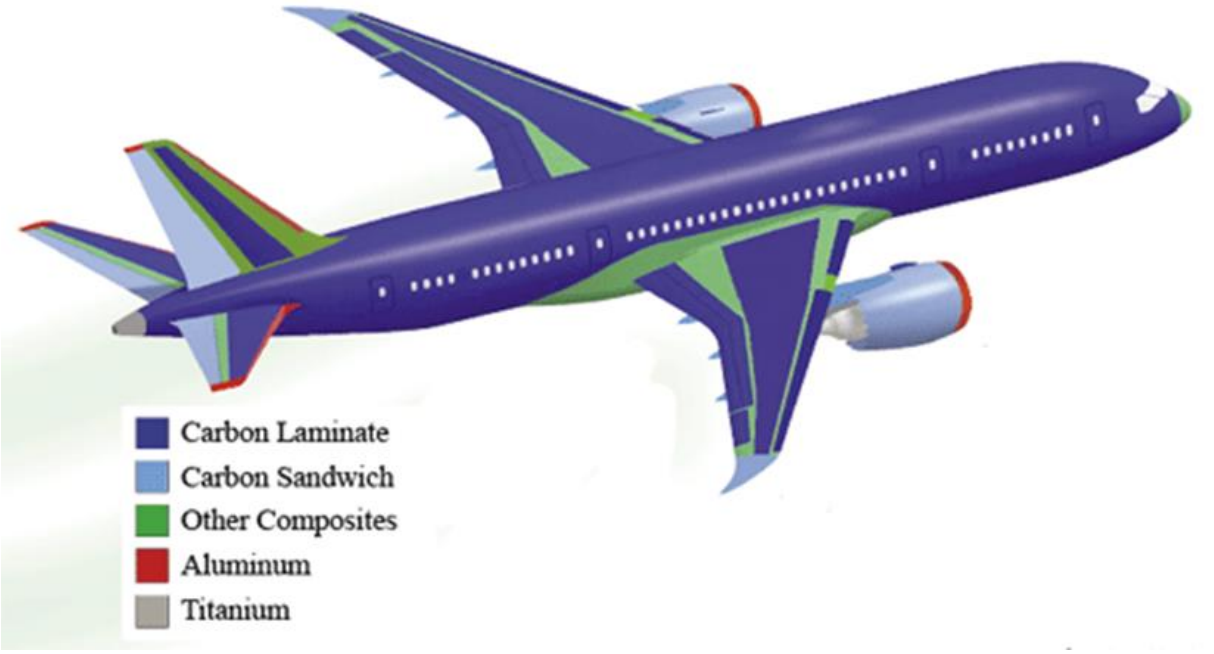
Composite materials nowadays find use in almost every industry. In the transport industry, this applies to all modes of transport, ie automobile, rail, air and shipping. The space industry is also ranked here, although it is only marginal to the transport industry.

Automotive
In this transport sector, composite materials are produced for example, dashboards, axles, body parts, bumpers, headlamp covers, drive shafts, seats, cockpits, ...

In the automotive industry, composites are used due to their mechanical properties and to reduce the weights of the individual components and thus the whole car

Aerospace and aerospace industry
Even today, a large percentage of innovations in the field of composite materials are used in the aerospace and space industries. This is again because of weight reduction, which results in a reduction in fuel consumption. The latest developed composites are used in the military, that is, most of the aviation. An example of use in the military industry is the fact that composite material can partly absorb radar waves.
In transport aviation composite materials are applied to propellers, wings, radar technology, hulls of aircraft, but also to the interior.

Material composition of Boeing 787 Dreamliner



Rail transport

The main aspect is weight reduction (not only weight but also easier handling) and excellent mechanical properties (high stiffness and strength, fire resistance, etc.). Another great advantage and feature is the low maintenance requirement. The use is very wide on both locomotives and wagons. Specifically, it is a rough construction, front and rear front, front, rear panel, ceiling and wall paneling, interior composites, dashboard, etc.

Use of composite hoods on the train set

2.4. Forms

Mold production is based on several of the following criteria:

- form size, complexity and geometry,
- accuracy and surface quality, maximum cost limit
- required durability: number of pieces produced

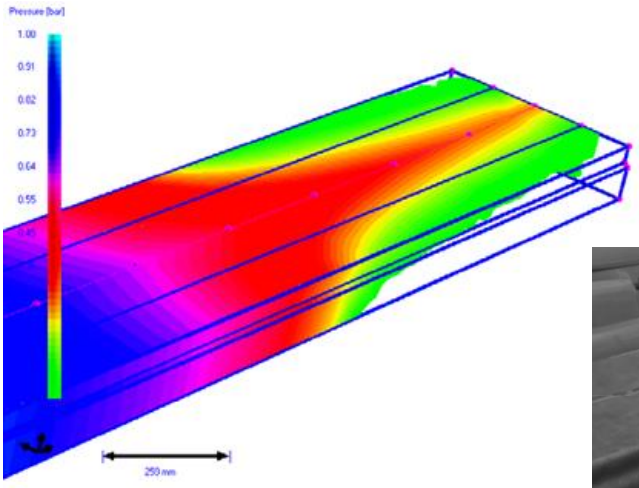
Formal Claims especially for manual layout and vacuum infusion:

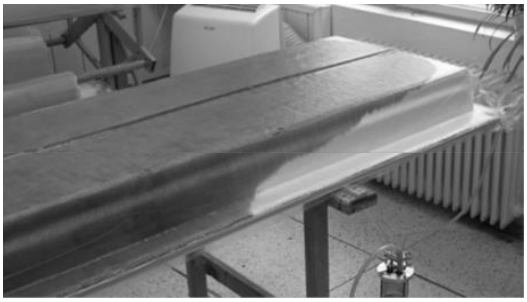
- low weight due to form manipulation
- dimensional stability at temperatures around 80 ° C, mobile execution

2.4.1. Process and realization of mold production

The entered future product is first modeled in 3D and 2D software. According to the requirements, a model is then created, which is then used for production. Subsequently, the finite element method (FEM) is used to optimize production. It is a verification method that verifies mechanical properties, deformation, internal tension, stability, binder bonding (speed, time, etc.)

Production of thick-walled composite components





2.5. Forms materials

- Composite (laminate)
- Metal molds
- Other materials

Form for the production of composite components

2.6. Models

The model is an integral part of the manufacturing technology that makes both the mold and the finished part. The model has the shape of a negative geometry of the resulting form. Design dimensions require dimensional allowances. This is the case if the mold surface is machined. For composite models, the surface of the model is lacquered and a separating agent applied for ease of deformation.

Model (prototype) of the future product

Darcy's law on composite materials

$$\frac{Q}{A} = -\frac{K \cdot \Delta p}{\eta \cdot L}$$

Veličina	Jednotka	Popis	Veličina	Jednotka	Popis
Q	$m^3.s^{-1}$	Objemový průtok	Δp	1	Tlakový gradient
A	m^2	Plocha průtoku	η	Pa.s	Viskozita pojivého systému
K	m^2	Permeabilita výstuže	L	m	Penetrovaná délka

Legend: veličina - quantity, jednotka - unit, popis - description, objemový průtok - volumetric flow, plocha průtoku - flow area, permeabilita výztuže - permeability of reinforcement, tlakový gradient - pressure gradient, viskozita pojivového systému - viscosity of binder system, penetrovaná délka - penetrated length

Requirements for materials for the railway industry

At present, composite materials are becoming an increasingly important element in the construction. Composites have greatly penetrated into the aviation, shipping and automotive industries, but in the rail industry the use rate of composites is still the smallest. But we can say that they will find and find their place in this industry over time. The main obstacle to mass expansion is the initial high cost of design, calculation and control in simulation programs, but also raw materials and the production of composite components.

Material requirements

At present, there are 8 major requirements for materials in the railway industry:

- Weight
- Mechanical properties
- Safety
- Lifetime
- Maintenance
- Ecology
- Shape properties
- Costs

3.PLASTICS

Výroba předmětů (výrobků) z polymerních materiálů má některé specifika, které je potřebné zohlednit při navrhovaní jednotlivých technologických postupů. Rozmanitost vlastností polymerů v závislosti od chemické povahy polymeru a jeho fyzikálního stavu vyžaduje poměrně velkou variabilitu i ve výrobních postupech, v podmínkách zpracovaní polymerů.

3.1. Polymers

Polymers can be divided into three basic groups:

- Thermoplastics
- Elastomers (rubbers)
- Reactoplasts (formerly called thermosets)

Thermoplastics

Thermoplastics behave like solids at normal temperatures, but at elevated temperatures, highly viscous liquids (in all cases of pseudo plastic), which can be shaped and re-cooled, fix their shape. This process is repeatable, that is, the polymer can be re-heated to re-melt and re-mold.

Elastomers

Elastomers exhibit high elastic deformation at normal temperatures but are capable of flowing at high shear stresses. After cross-linking between macromolecules, the plastic flow of material is suppressed, the polymer becomes highly elastic, very resistant to plastic deformation. The material is generally referred to as rubber.

Reactoplast

Reactoplasts behave like thermoplastics, have very little or no component of elastic deformation, they are usually lightly molded at normal temperatures or at slightly elevated temperatures, and chemical structure changes occur during shaping. In order to stabilize the shape of the article, a chemical crosslinking reaction occurs which can be induced by mixing two reacting components, or only by the influence of an elevated temperature. After the chemical reaction has taken place, a solid material is obtained which exhibits practically no elastic deformation and can not be re-introduced into the plastic state.

3.2. Extrusion

The extrusion of the mixture is an adiabatic process - this process converts mechanical energy into heat. In practice, we are talking about the sub-adiabatic (polytropic) and super adiabatic process of extruding the rubber compound. In the sub-adiabatic process, part of the heat is fed from the external source to heat the mixture to the desired temperature required for good processing of the rubber mixture, and part of the heat is formed by the conversion of mechanical energy.

The extrusion machines are mainly divided according to the type of material to be processed and the different design of the extrusion units. When we know the characteristics of the material and its properties, we can select an extruder with a suitable pressure of the extruded material. [Jahelka, 1969].

According to the method of forming the pressure on the mixture, the extruders are divided into:

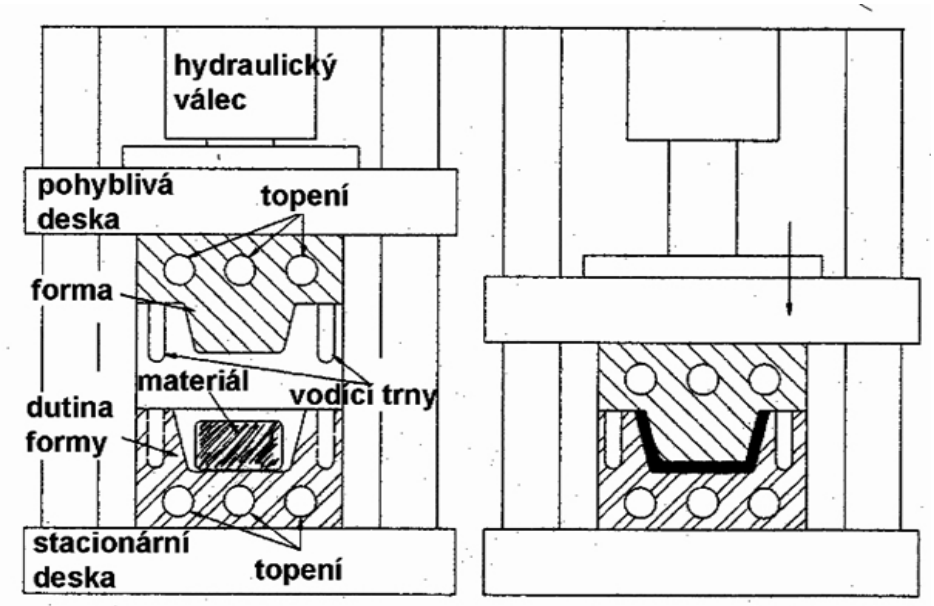
- Disks
- Piston
- Cylinders
- Threaded screws: - One screwdriver
- Two or more screws

3.3. Pressing and overpressing

Pressing is one of the simplest and economically less demanding polymer processing technologies. The principle of molding consists in forming the molten polymer in the cavity of the die and subsequently fixing the shape of the article. The shape fixation depends on the type of polymer being processed. Thermoplastics must be cooled before molding; in the case of thermoplastics and rubber mixtures, chemical reactions - crosslinking, vulcanization must be carried out.

Horizontal injection press

Overpressure is very pressed by its technological layout and process characteristics. The difference between compression and overpressure lies in the design of the mold and the resulting different dosing of the mixture into the mold cavity. The material is dispensed into an auxiliary pressure chamber which is separate from the mold cavity. By pressing the press the piston develops pressure on the mixture, which is then pressed through the nozzles into the mold cavity. The pressure required to fill the mold cavity is lower, which allows the use of vertical openable molds and hence the production of more sophisticated products.



Legend: hydraulický válec - hydraulic cylinder, pohyblivá deska - movable plate, topení - heating, forma - mould, dutina formy - mould cavity, materiál - material, vodící trny - guide pins, stacionární deska - stationary plate

3.4. Injection

The principle of thermoplastic insertion lies in their plasticization, i.e., placing the polymer in a viscous liquid (melt) state and subsequently injecting it into the cooled closed mold cavity. There, the material under cooling cools down and becomes stiff. The principle of molding is identical to the molding except that the melting of the polymer does not take place directly in the mold, and the flow rate of the polymer upon tapping into the mold cavity is substantially higher than that of the molding or overpressure.

Injection machine

An injection machine is a device which allows the molten plastic to be homogenized, and further to inject the melt under pressure into a closed mold. Closed forms must be secured against openings by a force that is greater than the force induced by pressure in the mold cavity.

The basic parts of the injection molding machines are:

- Injection unit - a hopper, dispensing device, plastication and injection chamber with piston or roll, nozzle, heating and control.
- The closing unit comprises: a locking mechanism (joint or piston), a holding mechanism
- Form 3 - Shows product shape.
- Accessories of the injection molding machine - it is made up of an energy source, a molding device and control and control elements.

Horizontal injection presses

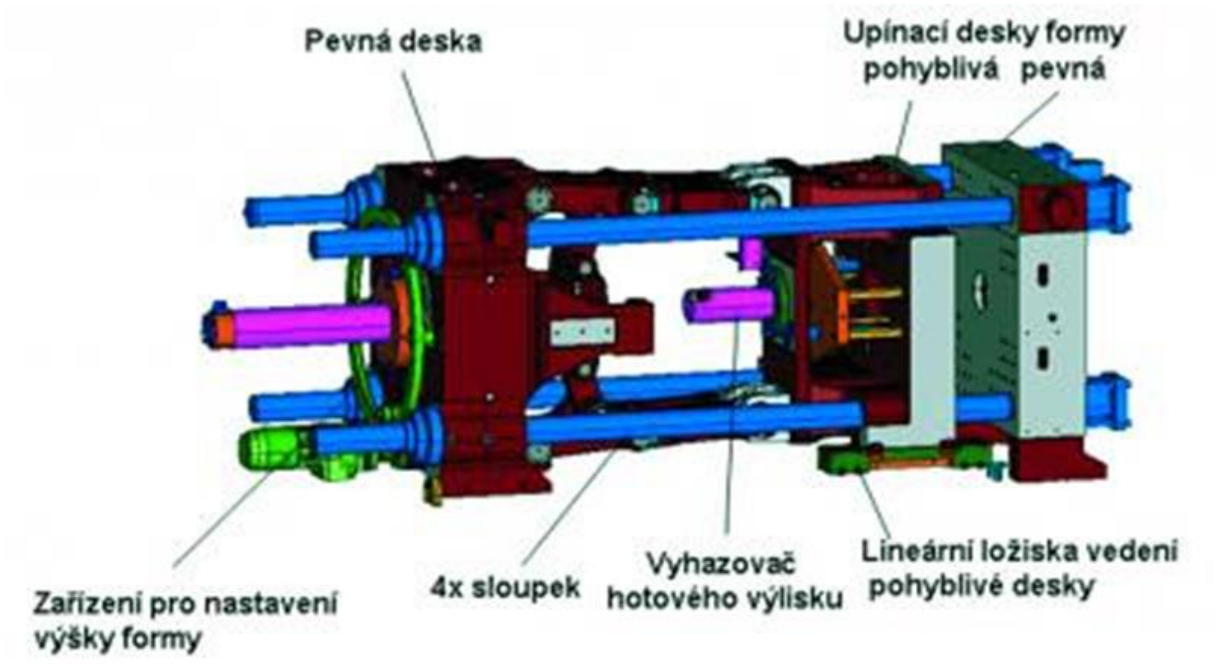
The most common design of the injection molding machines is a horizontal one-chamber injection molding, That the axis of the injection unit is in a horizontal position perpendicular to the molding plane of the mold.

Vertical Injection Presses

For special applications, vertical injection molding presses are used in many cases. Clamping plates have horizontal molding surfaces. The top plate is movable in the vertical direction, the lower plate is movable in the horizontal direction. The movement of the bottom plate is made possible either by rotating the rotary table or by sliding the sliding table moving. In both cases, the form then has one half of the mold on the top table and two identical lower halves on the lower table.

Legend: Vertikální vstřikovací lis s otočným stolem a vertikální vstřikovací jednotkou - Vertical injection press with rotary table and vertical injection unit

3.5. Hydraulic machines

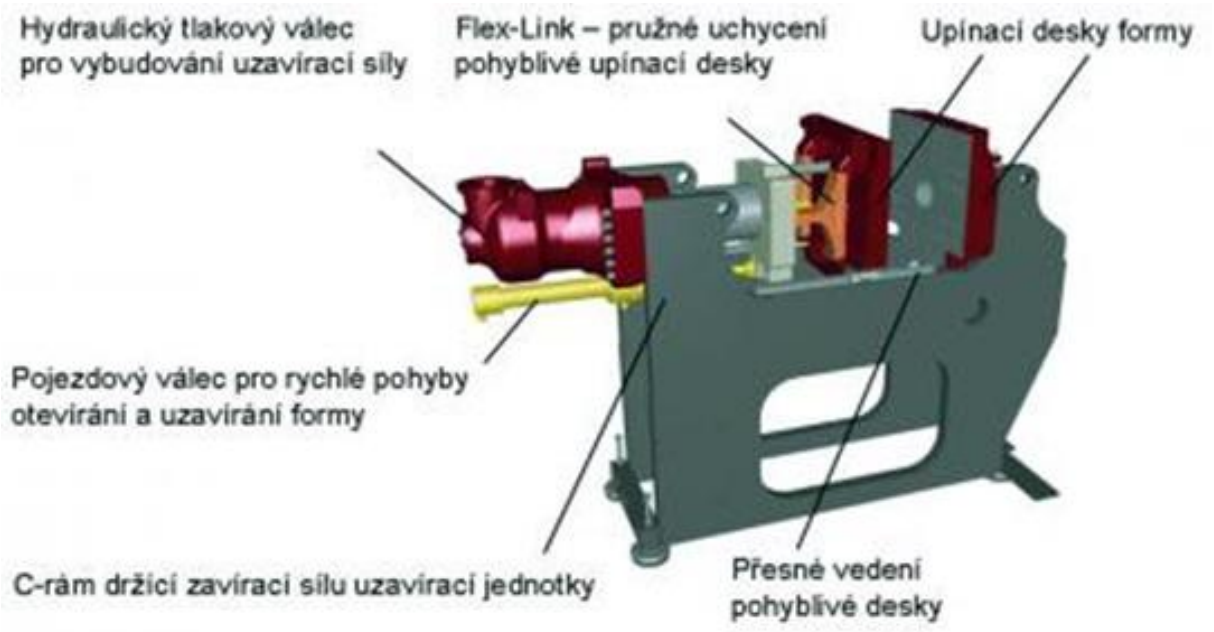


Legend: pevná deska - stationary plate, upínací desky formy, pohyblivá, pevná - mould clamping plates, movable, fixed, zařízení pro nastavení výšky formy - device for setting the mould height, 4x sloupek - 4 columns, vyhazovač hotového výlisku - ejector of finished pressing, lineární ložiska vedení pohyblivé desky - linear bearing guide plate

Two plate machine with one fixed and one movable plate

Frequent is the construction of "no column" machines. The locking force transmits the so-called C frame instead of the columns. The mild elasticity of the C frame is compensated by the flexible attachment of the movable plate called flexline. This patent construction allows precise closing of the mold without the risk of shear forces. More space is available for clamping mold than for columnar machines.

Without a pillar machine



Legend: hydraulický tlakový válec pro vybudování uzavírací síly - hydraulic pressure cylinder for closing force creation, pružné uchycení pohyblivé upínací desky - flexible clamping of movable plate, upínací desky formy - mould clamping plates, pojezdový válec pro rychlé pohyby - running cylinder for fast movement, otevírání a uzavírání formy - opening and closing of the mould, C-rám držící zavírací sílu uzavírací jednotky - C-frame holding closing force of closing unit, přesné vedení pohyblivé desky - precise guiding of movable plate

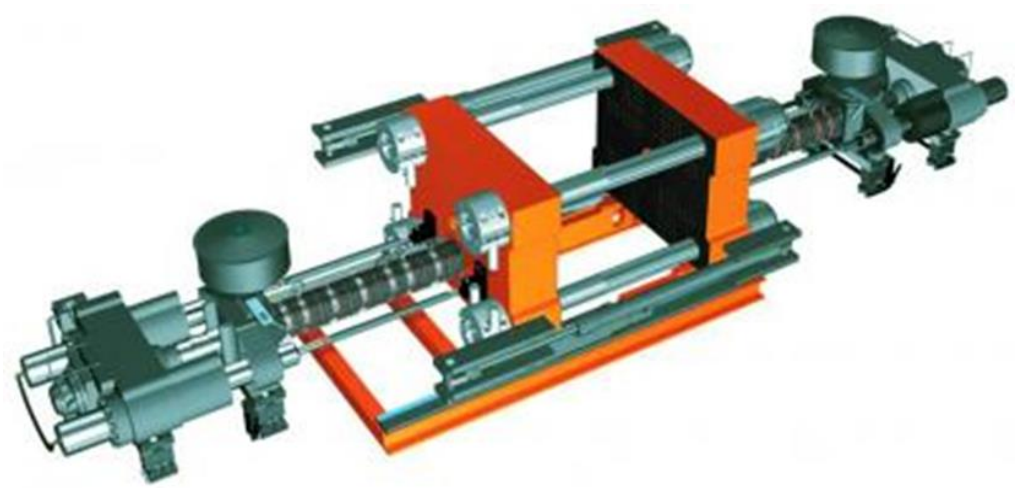
Electric Injection Presses

Machine movements are driven by electric servo motors controlled by frequency converters. The price of a larger number of drive motors and their steering is compensated for by more precise production and better reproducibility compared to hydraulic machines. The cycle time of the machine is shorter, and it is also interesting to save energy resulting from higher drive efficiency compared to hydraulics. Also, there is no need to cool the hydraulic motor.

Hybrid machines

Hybrid machines with electrically driven injections are currently most widely used in multi-component injection molding, where injection precision is the most important parameter for successfully assuring the quality of molding of multiple materials.

Two injection machine



Automation of injection presses

The use of robots and manipulators greatly accelerates and improves the production of injection molded parts. Particularly for larger machines with closing forces above 1 500 KN, the use of robots is now common in almost all machines. Most linear manipulators are used.

Linear manipulator with molding conveyor

3.6. Rolling

Rolling is a technology that molds the polymer mass into the shape of foils and belts in a slot between two counter-rotating rollers. Rolling, or also calendering, is the basis of several technological operations applied mainly to the production of rubber products:

- manufacture of rubber belts themselves, which are also used in the manufacture of finished products (eg tires, rubber footwear, conveyor belts etc.)
- impregnation and rubber coating of fabric, friction coating

3.7. Blowing

The blowing technology is used to produce hollow articles, particularly bottles and other closable containers. This technology is suitable for the production of hollow articles where too high accuracy in wall thickness is not required. Typical examples are PET beverage bottles, PET bottles and detergent containers, household chemistry, agrochemicals, etc. This method currently manufactures about 90% of hollow bodies of plastics (bottles, cans, tanks, etc.), with the largest containers having a volume of 10,000 Liter and weight up to 180 kg.

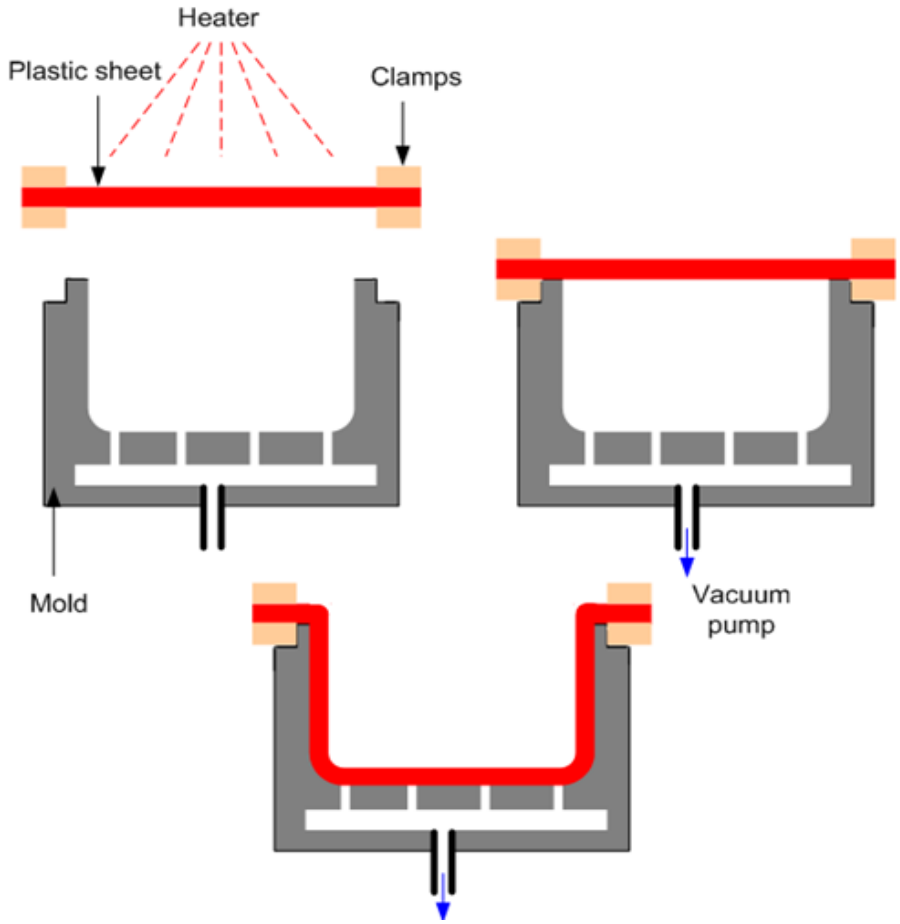
Blow mold and product

3.8. Shaping

Shaping takes place in cold form. It must run out in the shortest possible time so that the plastic temperature is constant during the molding phase. Therefore, the maximum speed of the molding allowed by the plastic is chosen.

After molding, the product must not be molded earlier if its temperature does not drop below the lower of the glass transition temperature. The result is that the shape memory is not reflected. Plates and materials with a thickness of 0.4 mm to 10 mm are usually processed and have the dimensions of 100 x 100 mm or 800 x 1500 mm, made of materials hPS, ABS, PMMA, PVC, PC.

Vacuum molding principle



3.9. Casting, soaking, heat and fluid application

Casting is a technology that can be processed by both thermoplastics and thermoplastics. Depending on the forces acting on the polymer for its shaping in form, we recognize casting gravity, centrifugal and rotary.

The principle of rotary casting



Soaked

By soaking, the polymers are processed in liquid form, paste, and dispersion. The most commonly used polymeric materials are PVC pastes but also latex rubbers. In the case of PVC paste, gelling of the product is done in the case of solutions or latexes by evaporation of solvents. When soaking latex rubber products, the vulcanization is usually required after drying the latex.

The principle of soaking latex gloves




Warm application

Polymers which have a decomposition temperature sufficiently higher than the melting temperature, respectively, can be processed. softening. The principle of hot melt is to melt the polymer in a special gun and then spray the polymer melt onto the surface of the selected material. The design of a spray gun is derived from a gun for hot metal application. By means of a central tube of the gun, a powder polymer is fed and an acetylene-oxygen burning mixture flows through the outer ring.

Fluid coating

Is used as the technology of applying a polymeric coating to the surface of articles for the purpose of surface treatment. Provides a more uniform and superior coating such as hot spray. The principle of fluid deposition is that the heated article is immersed in the fluidized bed of the powdered polymer. The polymer particles are melted on the surface of a sufficiently heated article and poured into a compact layer.

4. SEMI-FINISHED PRODUCTS AND SEMI-FINISHED PRODUCTS

By its principle, the different methods of metallurgy are different and are often divided into:

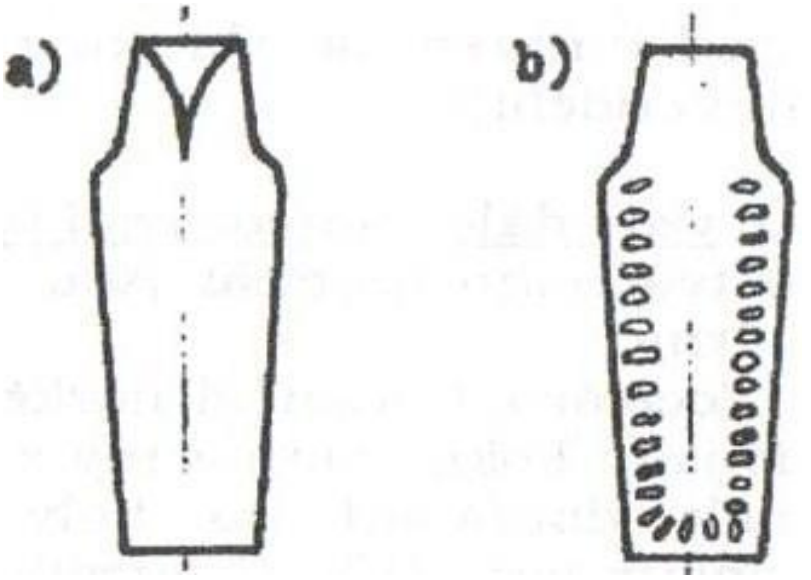
- Farming
- Molding
- Welding, soldering, heat separation, gluing, etc.
- Thermal management

4.1. Discounts

From a wider metallurgical point of view, we distinguish:

- Casting of metallurgical castings
- Casting of shaped castings

Casting of metallurgical castings



(a) calms steel; *(b) steel does not settle*

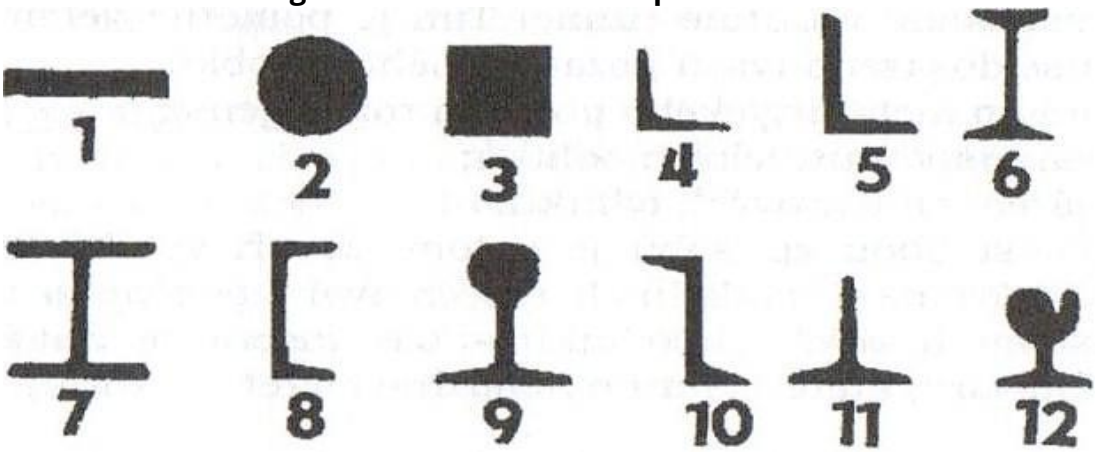
Scheme of ingot

Rolled steel rolled steel can be divided into (New, I. et al., 2006):

- Profiles of simple geometric shapes
    - circular, square, rectangular, I-profiles, U-profiles, etc .;

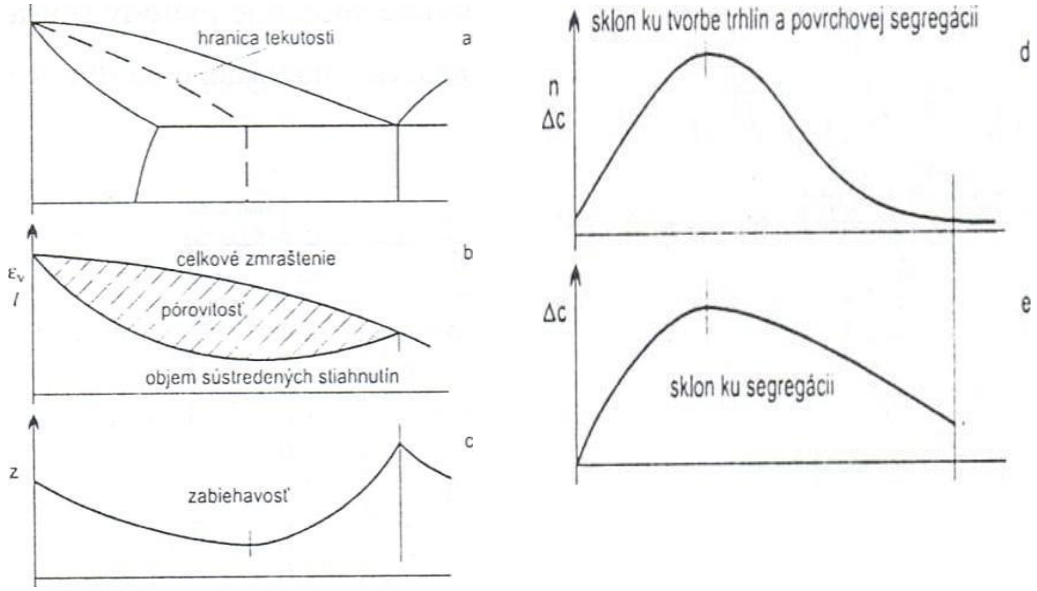
- Sheet thickness 0,15-4 mm - depth 3000 mm, thickness 4-60 mm - depth 3500 mm; Thickness 60 - 250 mm - Depth 4500 mm;
- Tubes - circular, rectangular, oval cross section ;,
- Rolling a profile obtained in a particular manner by rolling.

Scheme of metallurgical rolled semifinished products



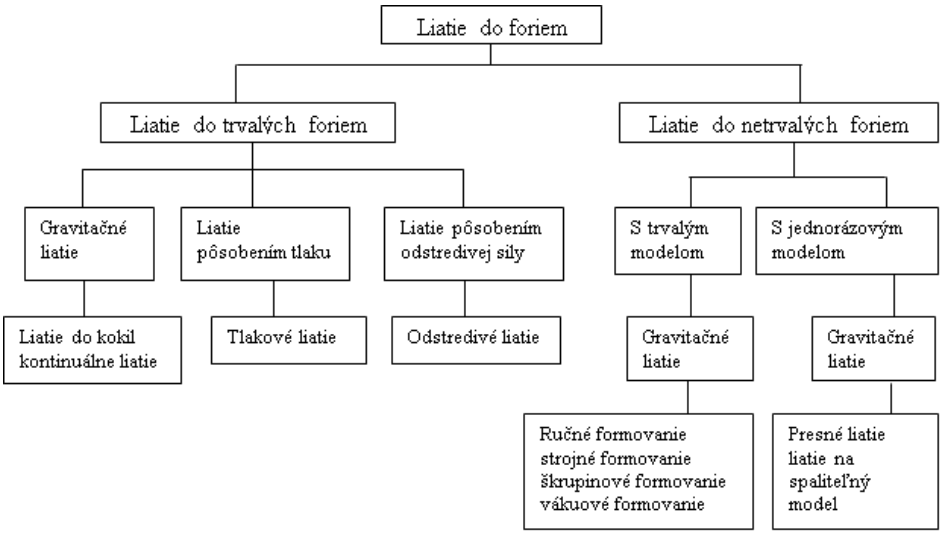
1-strip steel, 2-ring steel, 3-square steel, 4-isosceles angular, 5-angled isosceles, 6,7-I profile, 8-U profile, 9- Profile, 12-tram rail

Dependence of the technological properties of the alloy from the composition



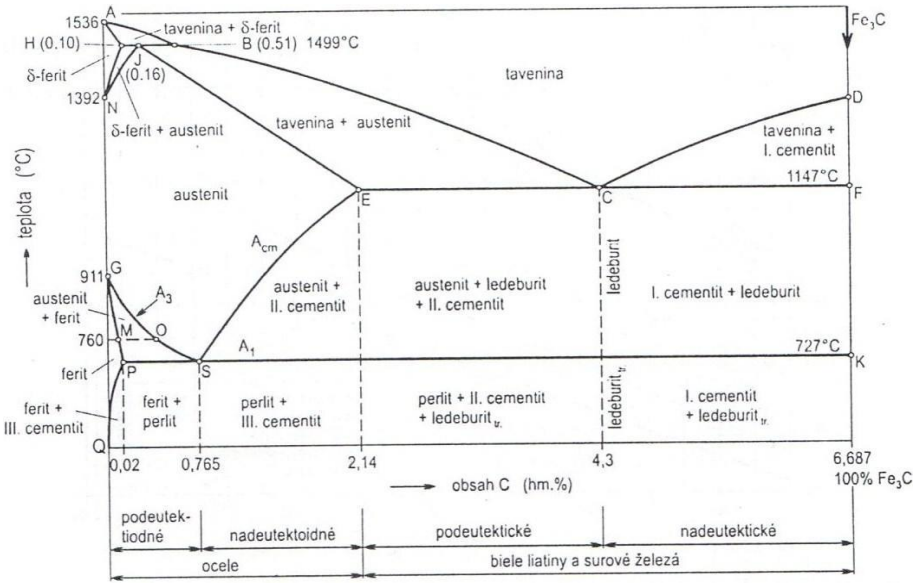
Legend: hranica tekutosti - fluidity limit, celkové zmraštenie - overall shrinkage, pórovitost - porosity, objem sústredených stiahnutin - volume of concentric shrinkage, zabiehavosť - convergence, sklon ku tvorbe trhlin a povrchovej segregácii - tendency to cracking and surface segregation, sklon ku segregácii - tendency to segregation

Forms and models



Legend: liatie do foriem - mold casting, liatie do trvalých foriem - permanent mould casting, gravitačné liatie - gravity casting, liatie posobením tlaku - die casting, liatie posobením odstredivej sily - rotational casting, liatie do kokil - chill casting, kontinuálne liatie - strand casting, liatie do netrvalých foriem - casting in expendable mould, s trvalým modelom - permanent mould casting, s jednorázovým modelom - expendable mould casting, ručné formovanie - hand moulding, strojné formovanie - machine moulding, škrupinové formovanie - shell moulding, vákuové formovanie - vacuum moulding, presné liatie - precision casting, liatie na spalitelný model - investment casting

Iron - carbon alloy diagram



Legend: tavenina - melt, ferit - ferrite, austenit - austenite, cementit - cementite, teplota - temperature, perlit - perlite, ledeburit - ledeburite, obsah C - C content, podeutektoidné - hypoeutectoid, nadeutektoidné - hypereutectoid, ocele - steels, biele liatiny a surové železá - white cast and pig **iron**

Depending on the chemical composition we divide the casting steel into the following basic groups:

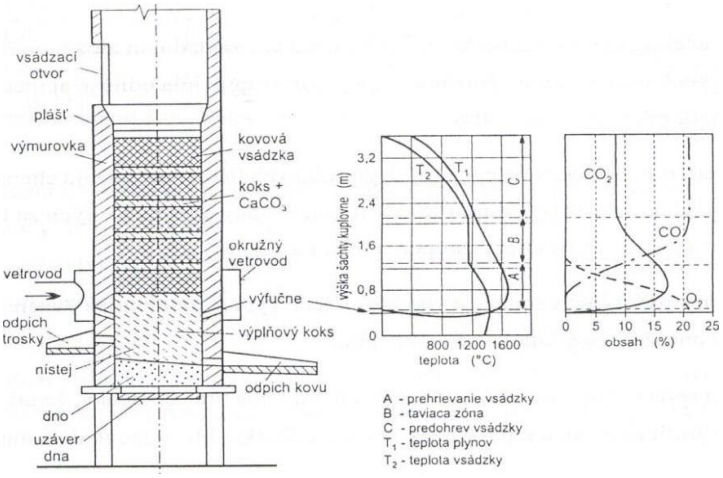
- **Alloy steels** - contain alloying elements (one or more alloying elements).
    - Depending on the content of alloying elements, we divide them into:
    - Low alloy (content of alloying elements below 5%)
    - Medium alloyed (alloying content 5% - 10%)
    - High alloy (content of alloying elements above 10%)

- **Unalloyed - carbon steels** - contain a small amount (0, 06 - 0, 5%) of the accompanying elements (S + P, P, S, Mn, Si,). We can roughly divide these steels into three groups:
    - Low carbon (carbon content below 0, 25%),
    - Medium carbon (carbon content 0, 25% - 0.6%),
    - High carbon (carbon content above 0, 6%).

We refer to casting steels according to the ČSN standard as follows: 42 XX YY. Z1Z2.

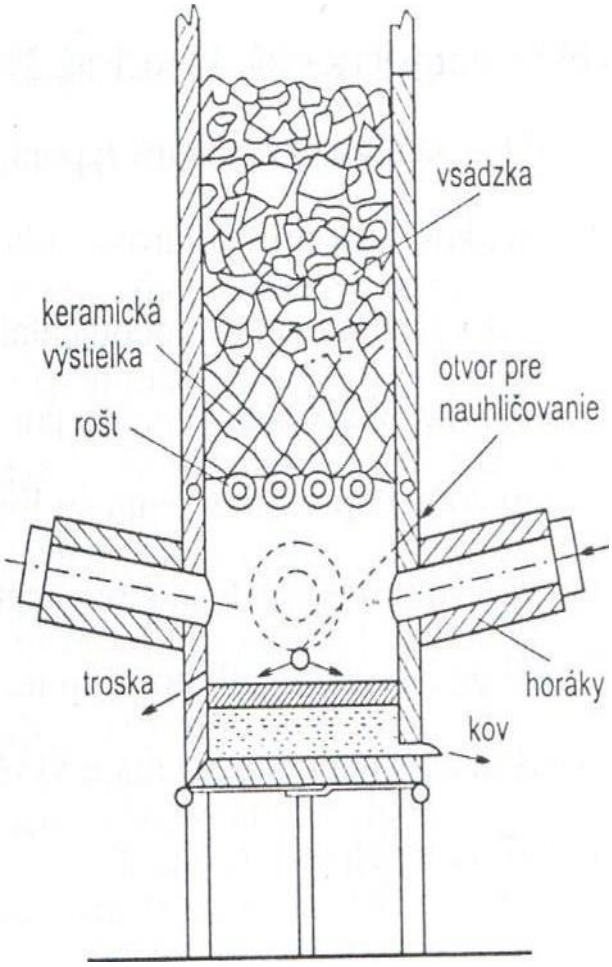
- First two digits
    - 42 - a class of standards for metallurgy
- The second two digits
    - XX - type of casting material, eg casting method
- The third twin - XX
    - 00-29 describes that castings cast in a different manner to sand molds,
    - 30 - 99 indicates the lowest tensile strength at 10 MPa (e.g., 42 2636 - tensile strength 360 - 460 MPa).
    - For high-alloy casting steels (42 29 YY), the third two-digit group of alloying elements is used.
- Fourth double - Y1Y2 (additional digits)
    - Y1 - denotes the final state of the casting material depending on its heat treatment,
    - Y2 - indicates the casting process of iron alloys.
    - For alloy steels, four-piece castings have the same meaning as carbon steel

4.2. Arrangement of the furnace with the temperature and composition of flue gases



Legend: A - batch heating, B - melting zone, C - bach pre-heating, T1 gas temperature, T2 batch temperature vsádzací otvor - charging opening, plášť - wall, výmurovka - liner, vetrovod - wind pipe, odpich trosky - slag tap, nistej - furnace hearth, dno - bottom, uzáver dna - closing, odpich kovu - metal tap, výplňový koks - filler coke, výfučne - exhaust pipe, okružný vetrovod - round wind pipe, koks - coke, kovová vsádzka - metal charge, výška šachty kuplovne - cupola furnace shaft height, teplota - temperature, obsah - Content

Without a coke oven



Legend: vsádzka - charge, keramická výstielka - ceramic lining, rošt grate, troska - slag, kov - metal, horáky - burners, otvor pre nauhličovanie - opening for carburizing

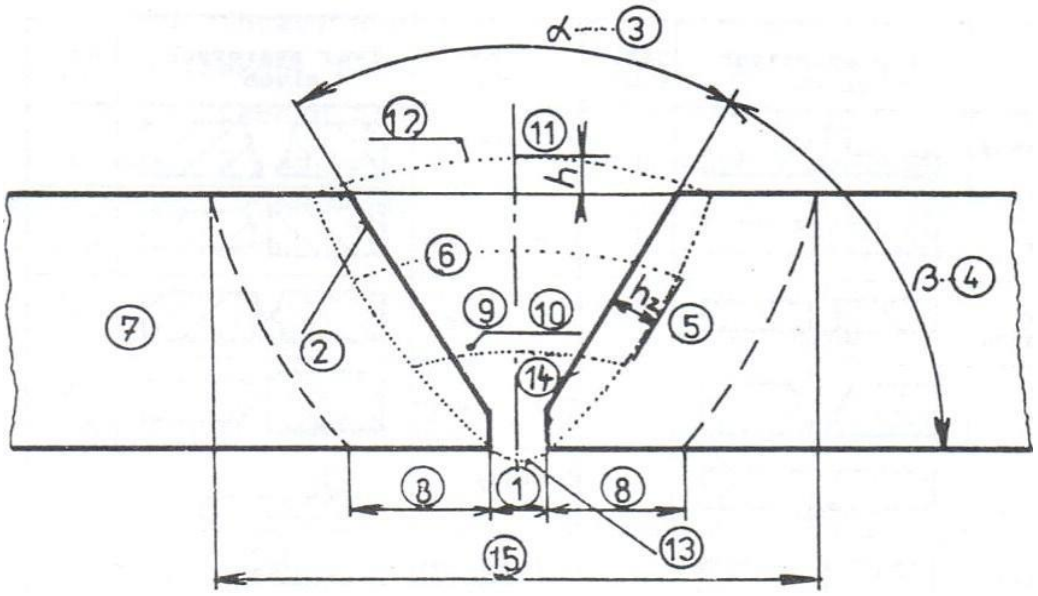
Foundry molding materials

Foundry molding materials are raw materials (sands - bristles, binders and auxiliaries) from which molding compounds are produced. These are used to make semi-permanent and non-permanent cores and molds.

Sharpener and binder

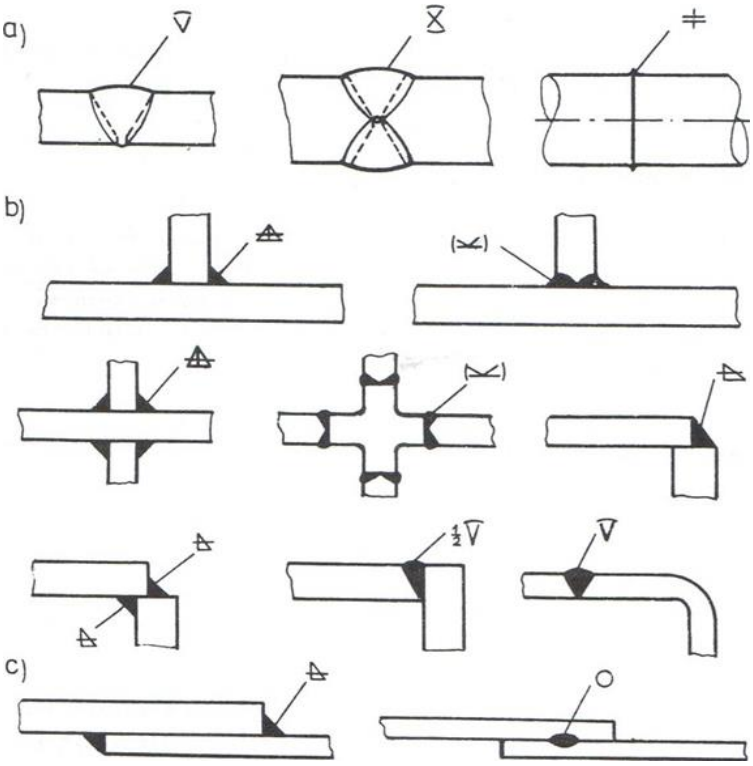
- Sharpness of molding mixtures (sand) is a refractory material comprising 86-96% by weight and by volume in the molding mixture
- The binder connects the brightener and the molding mixture gives the necessary ductility and strength.

4.3. Welding



Basic ways of welding

Fusion welding	Pressure welding
Flame welding	
Arc welding: **-coated electrode welding** **-in protecting atmosphere with consumable electrode, wire or cored electrode (MIG, MAG)** **-in protecting atmosphere with non-consumable electrode (WIG, TIG)** **-automatic with various types of electrodes (carbon)** **-submerged arc welding** **-rotary arc welding**	Electric resistance welding: -spot welding -seam welding -resistance projection welding -contact welding – forge welding - flash welding
Exothermic welding (aluminothermy)	Friction welding
Electroslag welding	Induction welding
Laser beam welding	Ultrasonic welding
Plasma arc welding	Svařování tlakem za studena
foundry welding	Explosion welding
Svařování elektronové	Svařování kováním



Names and shapes of weld surfaces

Název svaru	Tvar svarových ploch	Zákl. znak	Název svaru	Tvar svarových ploch	Zák. znak
Lemový svar			U - svar		
I - svar			½ U - svar		½
I - svar na podložce			UU - svar		
V - svar			½ UU - svar		½
V - svar na podložce			Koutový svar		
½ V - svar		½	Koutový svar oboustranný		
X - svar			Rohový svar		
X - svar nesymetrický			Svar děrový a žlábkový		
K - svar			Svar děrový a žlábkový skosený		

Legend: svar - weld, název svaru - weld type, tvar svarových ploch - shape, základní znak - basic symbol, lemový svar - flange weld, I-svar - square butt weld, I-svar na podložce - square butt backing weld, V-svar -V-butt weld, X-svar - X-butt weld, X-nesymetrický - X-butt weld asymmetrical, K-svar - K-butt weld, U-svar - U-butt weld, UU-svar - UU-butt weld, koutový svar oboustranný - T-fillet weld , rohový svar - fillet (corner) weld , svar děrový - plug weld, žlábkový - groove weld, svar děrový a žlábkový skosený - bevel plug and groove weld

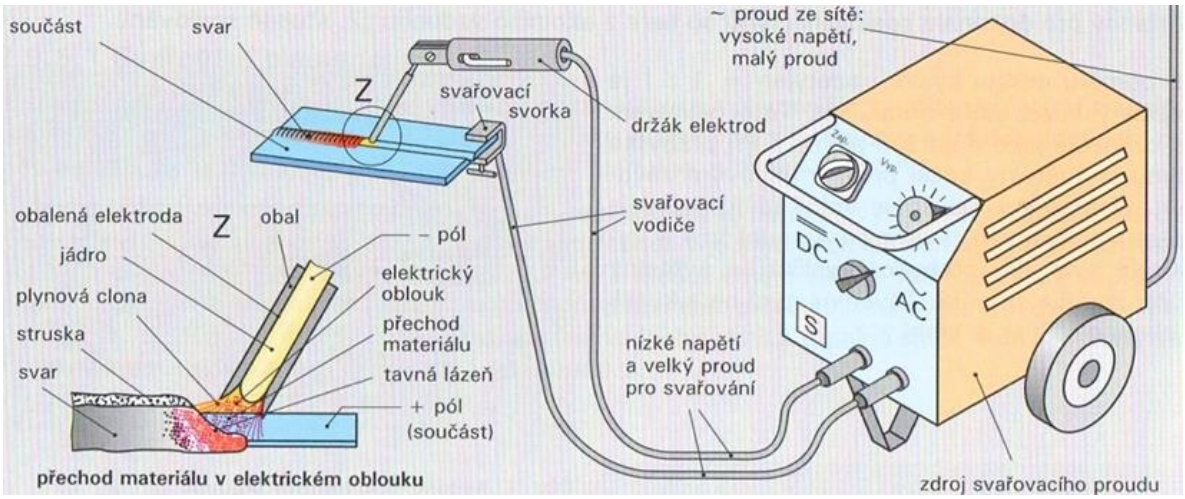
4.4. Arc welding

The arc has several characteristic areas (Blaščík, F. et al., 1988):

- On the surface of the electrode which has a minus pole (cathode), a cathode spot is formed over which the current passes. In the vicinity of the cathode, a cathode region is formed in the gaseous column,
- On the surface of the electrode with the positive pole (anode) there is an anode patch and an anode region connected thereto,
- The central part of the column is a positive column that forms almost the entire length of the arc.

Manual arc welding scheme

(Fischer, U. a kol., 2004)

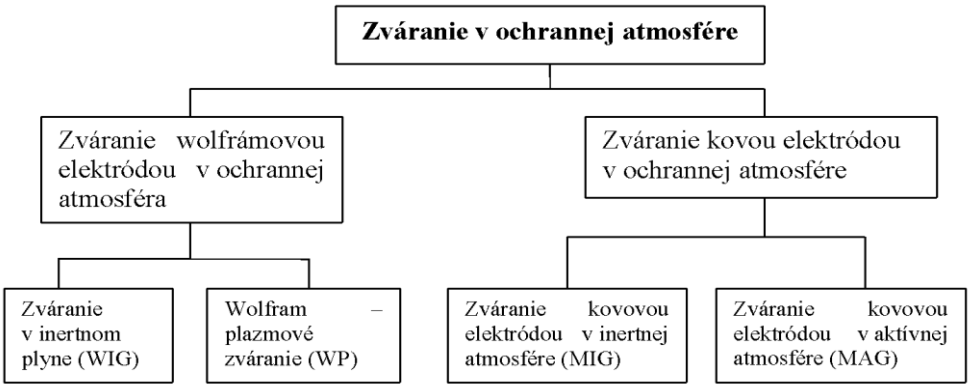


Legend: součást - part, svar - weld, obalená elektroda - coated electrode, jádro - core, plynová clona - gas curtain, struska - slag, pól - pole, elektrický oblouk - electric arc, přechod materiálu - material transition, tavná lázeň - molten bath, přechod materiálu v elektrickém oblouku - material transition in electric arc, proud ze sítě: vysoké napětí, malý proud - power from power grid: high voltage, low current, držák elektrod - electrode holder, svařovací svorka - welding clamp, svařovací vodiče - welding conductors, nízké napětí a velký proud pro svařování - low voltage and high current for welding

Arc welding in protective atmospheres

When welding in protective atmospheres, we distinguish WIG welding and welding with a molten metal electrode (MAG, MIG). The advantage is simple automation of welding process and suitability for use in robotized workplaces.

Separation of welding in a protective atmosphere

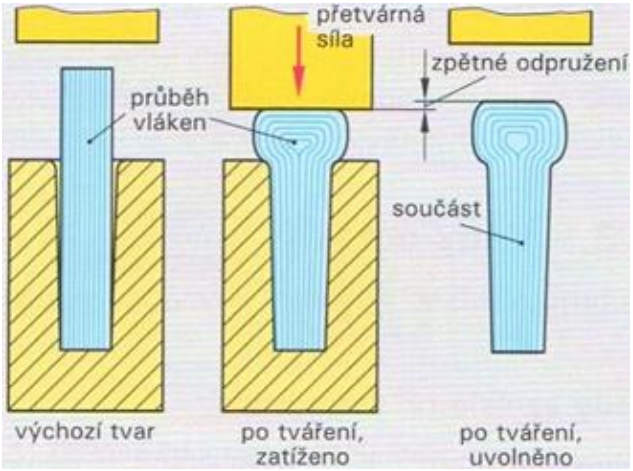


Legend: zváranie v ochrannej atmosfére -shielded arc welding, zváranie wolfrámovou elektródou v ochrannej atmosfére - shielded tungsten electrode welding, zváranie kovovou elektródou v ochrannej atmosfére - shielded metal electrode welding, zváranie v inertnom plyne (WIG) - wolfram inert gas welding (WIG), wolfram plazmové zváranie - wolfram plasma welding (WP), zváranie kovovou elektródou v inertnej atmosfére - Metal inert gas welding (MIG), zváranie kovovou elektródou v aktívnej atmosfére - metal active gas welding (MAG)

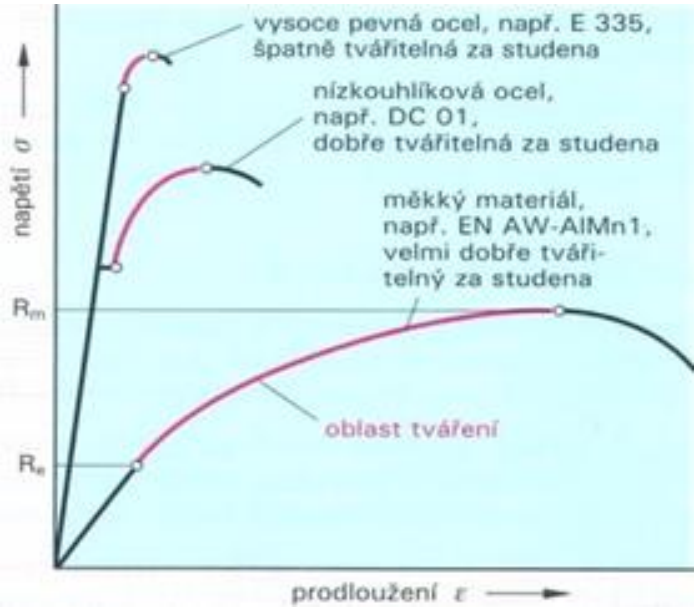
4.5. Molding

Deforming a portion of machining technology, which changes the characteristics, dimensions and shape by external forces. The change of shape occurs by the transfer of metal particles based on plasticity. It is the most important property of metals and strength and flexibility. It is a permanent change in shape and dimension of the molded material (components). This is caused by the external forces of the forming machine and the tool.

The part has been transformed, has a different shape.



Plastic deformation during molding



Areas of molding in the stress / elongation diagram
(Fischer, U. a kol, 2004)

Legend: průběh vláken - filament flow, výchozí tvar - initial shape, přetvárná síla - deformation force, po tváření zatíženo - loaded after forming, zpětné odpružení - back suspension, součást - component, po tváření uvolněno - released after forming
napětí - tension, prodloužení - extension, oblast tváření - forming zone, vysoce pevná ocel (např. E 335, špatně tvářitelná za studena) - high-strength steel (e.g. E 335, not suitable for cold forming) , nízkouhlíková ocel (e.g. DC 01, dobře tvářitelná za studena) - low-carbon steel (e.g. DC 01, suitable for cold forming), měkký materiál (např. EN AW-AlMn1. velmi dobře tvářitelný za studena) - soft material (e.g. EN AW-AlMn1, suitable for cold forming)

Laws of molding

- Law of stability (constant)
- The law of residual and complementary tensions
- The law of the least resistance
- The law of constant (constant) potential energy of shape change
- The law of similarity
- Law of non-compliances of elastic stresses (deformations)
- The law of consolidation
- Law frightened

Hot process molding processes

- ironwork - free and dump
- Rolling - for the mass production of simple shapes
- Extrusion - for the production of various profiles, rods, tubes

Processes of cold forming

- Rolling
- Pulling
- Pressing - cutting, bending, spreading, twisting, pulling containers, bulk molding - overpressing

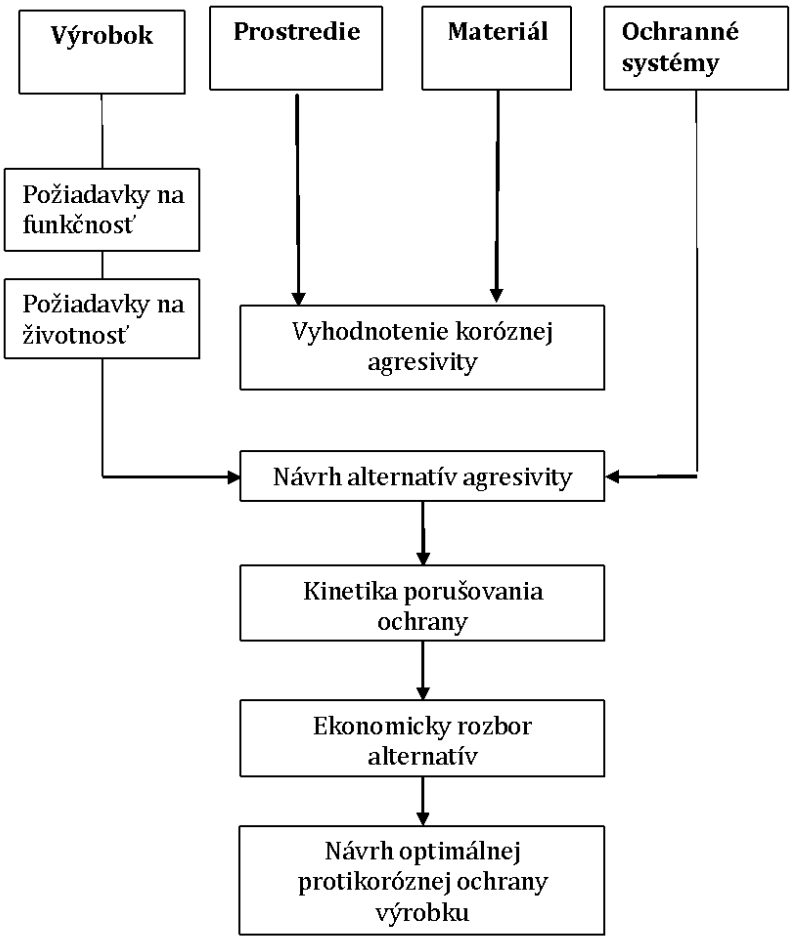
Types of semi-finished products used

- rolling
- ingots
- Sheets

5.SURFACE TREATMENT

Workpiece surface treatment has previously served mostly for decorative purposes. It gave the products a nice look, which was created with color, smoothness, gloss, etc., thus increasing the product salesability. Today, this requirement is secondarily secondarily because the surface treatments are intended for functional purposes (eg corrosion resistance, wear resistance). Surface treatments include all physical, chemical, electrochemical and mechanical processes that will give the surface the desired properties without the use of a cutting tool.

Scheme of the procedure for choosing anti-corrosion protection

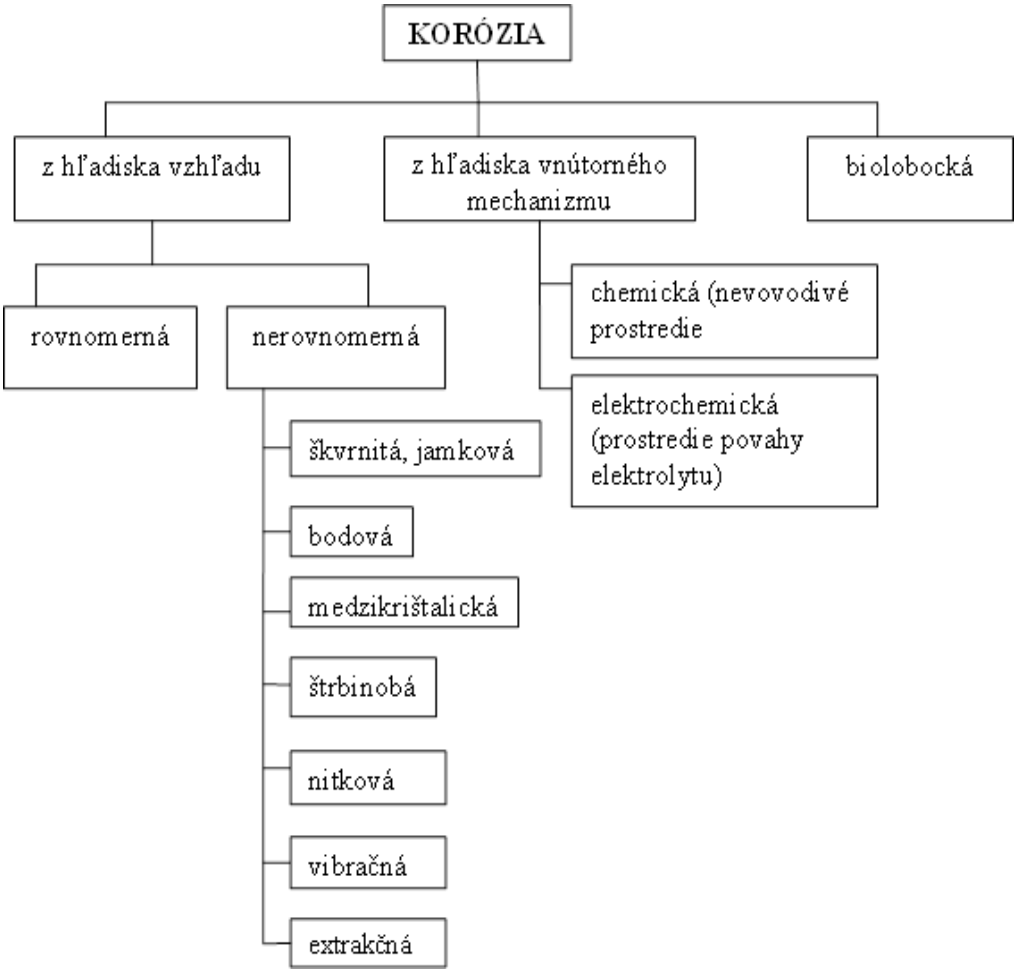


Legend: výrobok - product, prostredie - environment, materiál - material, ochranné systémy - protective systems, požiadavky na funkčnosť - requirements for functionality, požiadavky na životnosť - durability requirements, vyhodnotenie koróznej agresivity - evaluation of corrosion aggressiveness, návrh alternativ agresivity - proposal of aggressiveness alternatives, kinetika porušovanie ochrany - protection kinetics, ekonomický rozbor alternativ - economic alternatives analysis, návrh optimálnej protikoróznej ochrany výrobku - proposal of optimal anti-corrosion protection

Corrosion data acquisition scheme

The degradation of metallic materials by the chemical or physico-chemical effect of the surrounding environment, ie metal corrosion, is an increasingly serious national economic problem around the world. The natural corrosive environment is polluted by industrial activity and thus increases its aggressiveness.
In the chemical industry, power engineering, electrical engineering, engineering and other industries, the demands for metal resistance against corrosion increase.

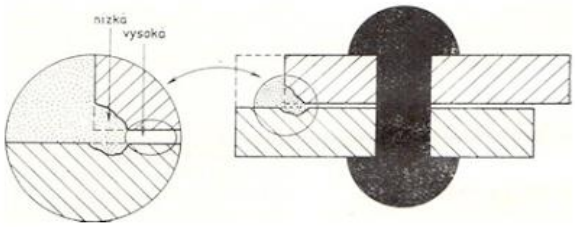
Diagram of the division of corrosion



Legend: korózia - corrosion, z hladiska vzhladu - in terms of appearance, z hladiska vnútorného mechanizmu - in terms of internal mechanism, biolobocká (biologická) - biological, rovnomerná x nerovnomerná - uniform x non-uniform corrosion , škvrnitá /jamková - pitting corrosion, bodová - spot corrosion, medzikryštalická - intercrystalline corrosion, štrbinová - crevice corrosion, nitková - reticulated corrosion, vibračná - vibration-enhanced corrosion, extrakčná - extraction, chemická - chemical (nevodivé prostredie - non-conductive environment), elektrochemická (prostredie povahy elektrolytu) - electrolytic corrosion

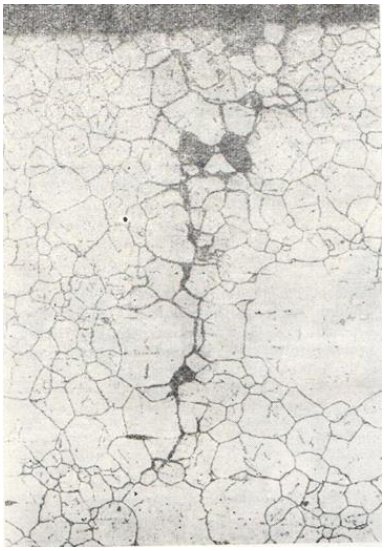
Even corrosion

Point Corset



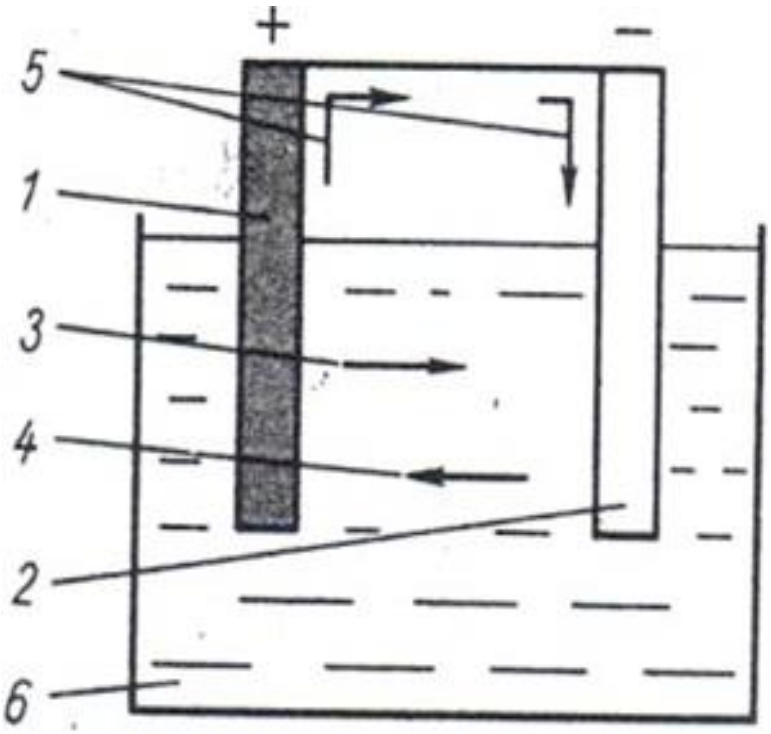
Concentration cell with varying concentrations of metal ions

Crystal corrosion



5.1. Types of corrosion in terms of internal mechanism

- chemical corrosion
- electrochemical corrosion



Biological corrosion

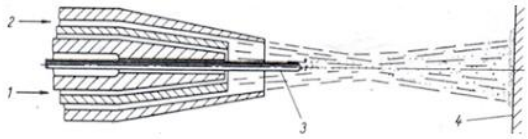
Metal technical material can be disturbed by a living organism. For example, the Dermestes beetle eats Zn, Ag, Au and the most soft Pb. A beetle was observed which overcrossed in Pb plate in 4 hours t = 0.2 mm and a diameter of 3 mm. Bacteria are also involved in the disruption of the metal, which in their presence makes the formation of chemical compounds increasing the aggressiveness of the corrosive environment.

5.2. Corrosion protection of metallic technical materials

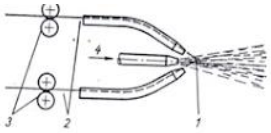
Anticorrosive protection is carried out:

- By appropriate material choice
- Structural modification
- Corrosion treatment
- Electrical protection
- Surface treatments
- Plating by immersion in a molten metal bath - is one of the oldest methods of corrosion protection. Immersion is mainly made of Zn, Sn, Pb. After heating and soaking the surface, the baths are removed and cooled.
- Plate - When plated, the layer of protective metal on the components is formed by bending, casting, soldering, or making a tough metal, protective metal, explosion.

Gun for hot metal spraying

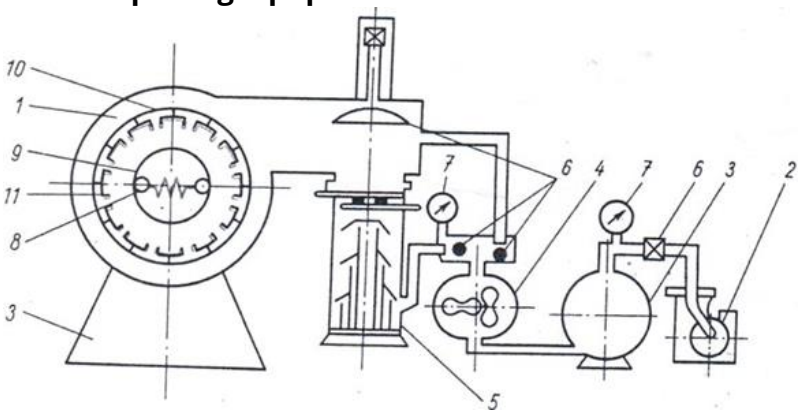


A-wire gas gun: 1-mixture of C2H2 and A2, 2-compressed air, 3-flame wire, 4-sprayed item



B-wire arc gun: 1-arc arc, 2-wound wire, 3-feed rollers, 4-compressed air

Vacuum plating equipment



1-working vacuum chamber, 2-rotary vacuum pump, 3-feed vacuum flask, 4-Root vacuum pump, 5-pipe vacuum pump, 6-valves, 7-vacuum metering, 8-vaporized metal, 9- Holder with plated parts, 11-plated components

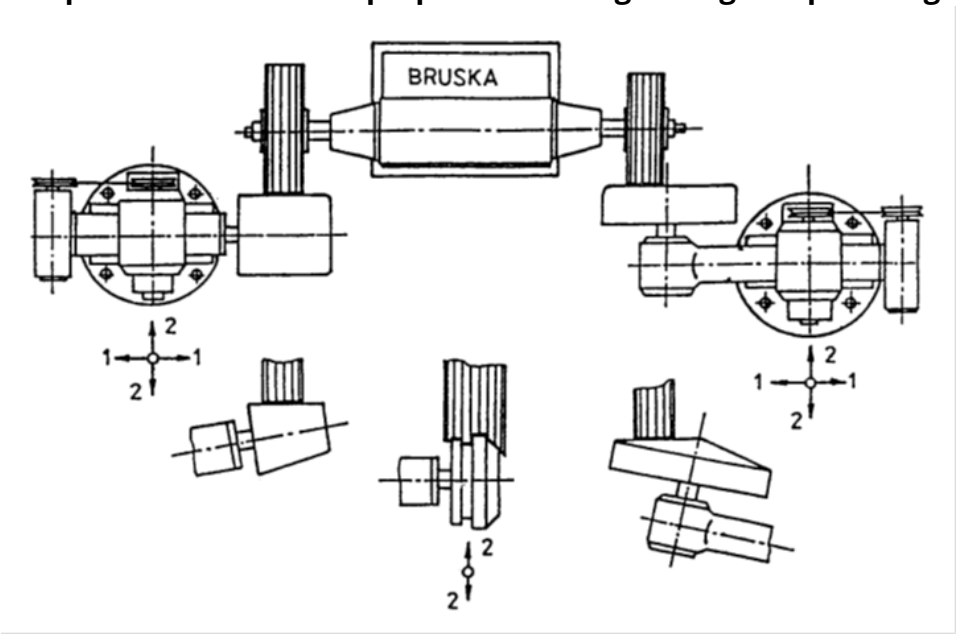
Protective coatings and non-metallic layers

- Chemical surface treatment
- Oxidation
- Chromium plating
- Phosphating
- Diffuse sulfur and sulfanitriding

Protective coatings and non-metallic layers

- Enamelling
- Coatings of paints
- Mechanical surface treatment
- Plastic coatings

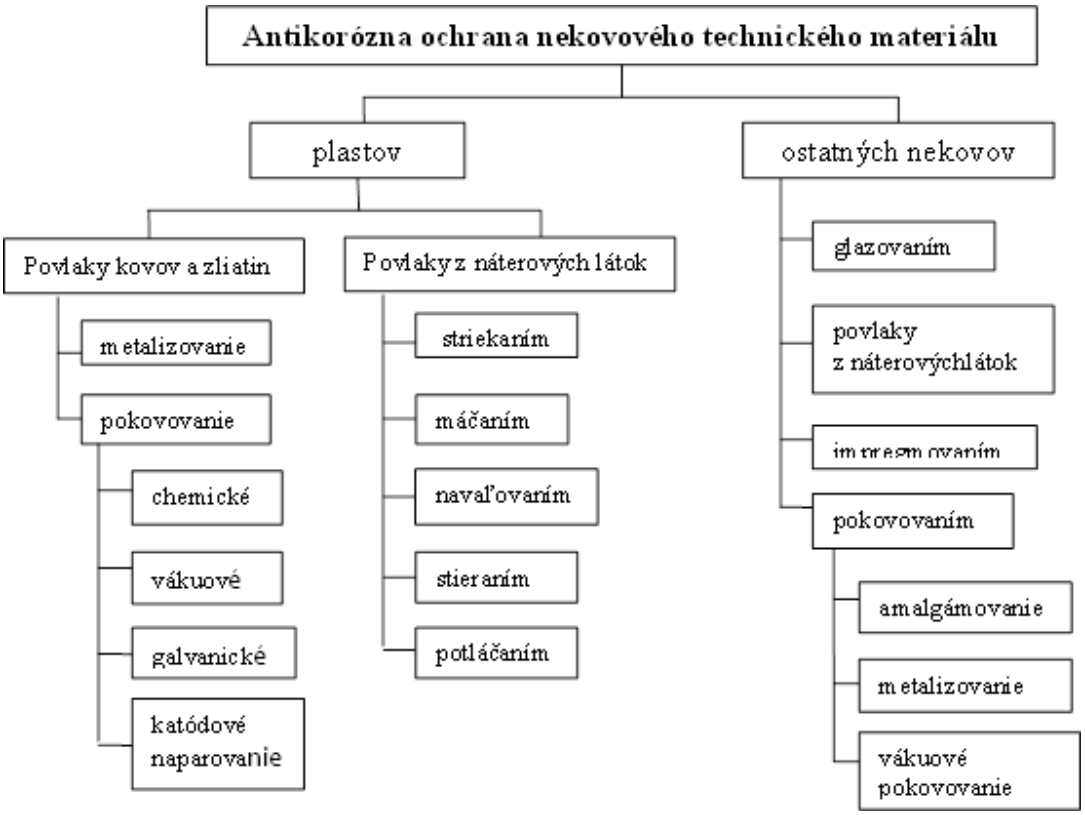
Sample of machines and preparations for grinding and polishing



Legend: bruska - grinder

Corrosion protection of non-metallic technical materials

Legend: Antikorózna ochrana nekovového technického materiálu - anti-corrosion protection of non-metallic technical material, plastov - plastics, povlaky kovov a zliatin - coatings of metals and alloys, metalizovanie - metallization, pokovovanie - metal plating, chemické - chemical, vakuové - vacuum, galvanické - galvanic, katódové naparovanie cathodic vapor

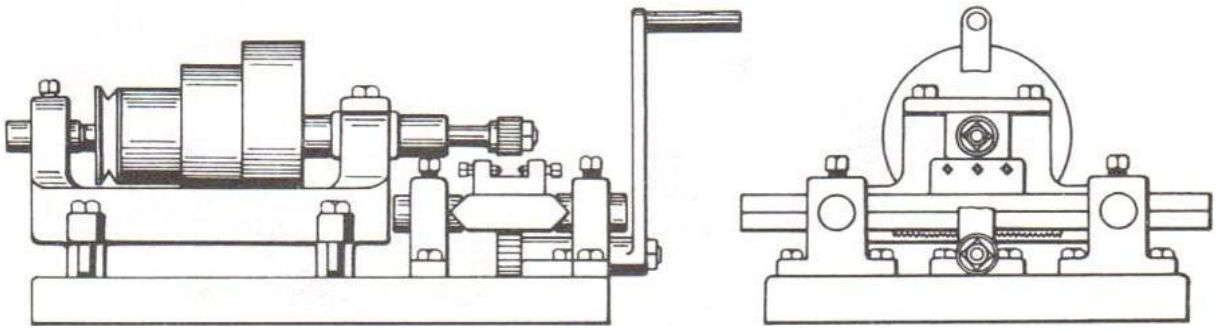


treatment, povlaky z náterových látok - paint coatings, striekaním - spraying, máčaním - dipping, navaľovaním - coating, stieraním - wiping, glazovaním - glazing, impregnovaním - impregnation, amalgamovanie - amalgamation

6.CHIP MACHINING

The history of working tools began to write about two million years ago. One started Modify used items according to your needs.

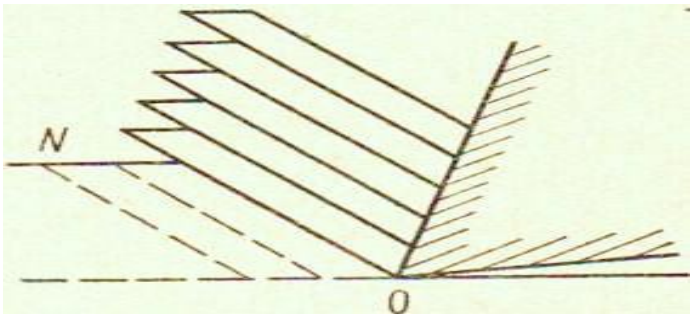
In 1818, Morton was first designed by a milling machine

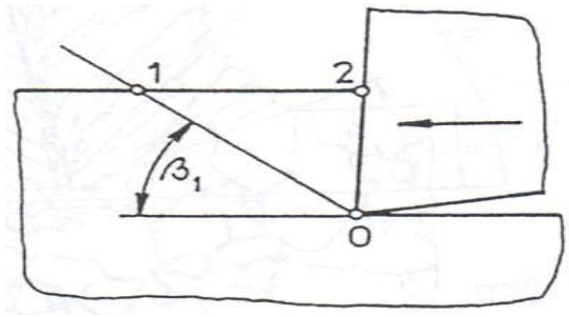


6.1. Theory of chip formation

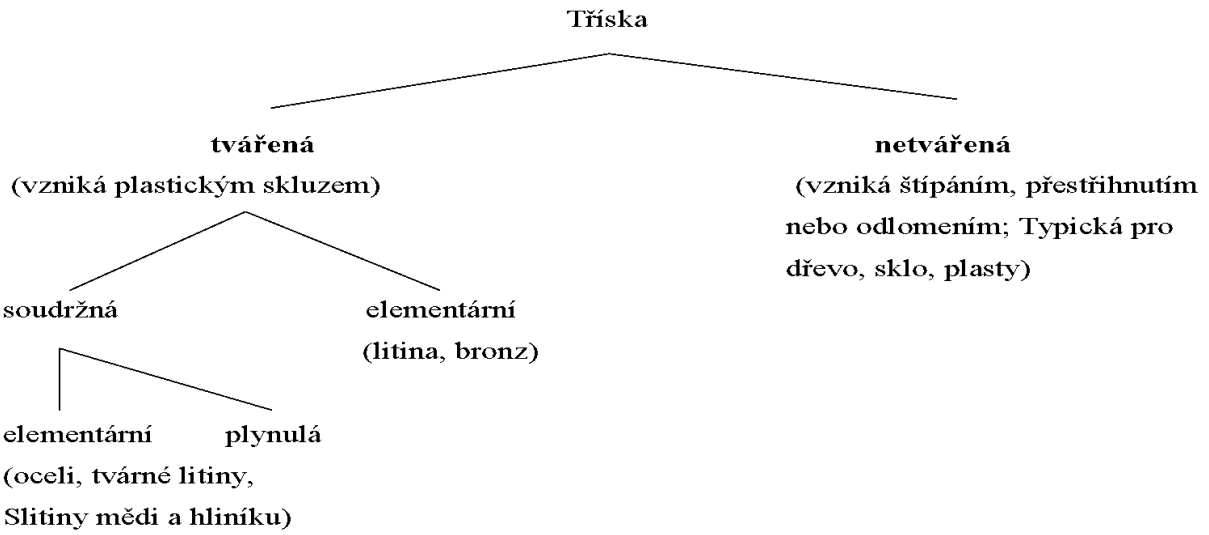
When machining the material, a cutting wedge is formed and part of the material is separated from the blank. We call this part a splinter. Before the chips are created, an intensive plastic zone is created.

At the pressure of a harder tool and a softer blank, the bonding of its elementary parts is broken. At initial contact with the tool with the machined metal (Fig.), The pressure of the tool face causes the elastic first and then the plastic deformation O12.





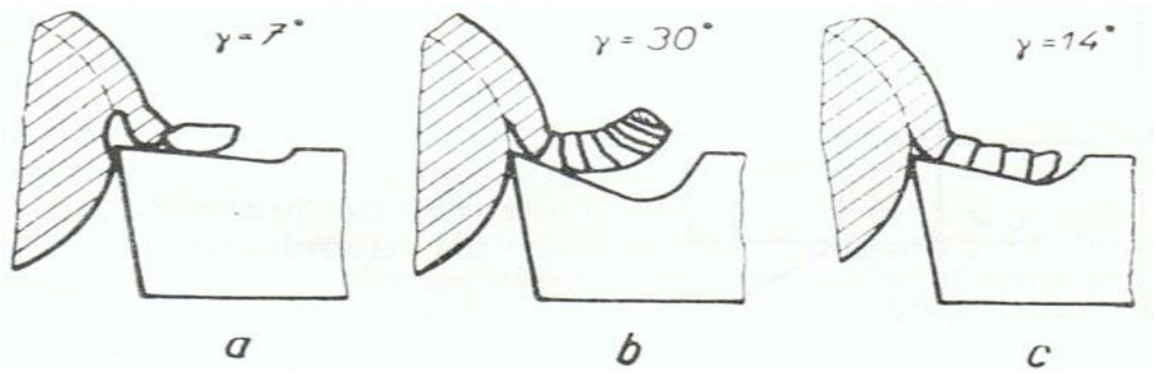
Types of chips and their division



Legend: tříska - chip, tvářená (vzniká plastickým skluzem) - formed (created by plastic chute), soudržná - compact, elementární (litina, bronz) - elementary (cast, bronze), plynulá (oceli, tvárné litiny, slitiny mědi a hliníku) - continuous (steels, malleable cast, copper and aluminium alloys), netvářená (vzniká štípáním, přestřihnutím nebo odlomením, typická pro dřevo, sklo, plasty) - not formed (created by splitting, cutting or breaking off, typical for wood, glass, plastics)

6.2. Basic chip shapes

For materials with higher plasticity, the cut-off material remains intact at the deformation displacements of the individual parts of the chips and creates a continuous chip (Figure b). When the material does not withstand the deformation displacement, particles of the shear layer are formed to form a broken chip. It is either divided (Fig. C) or friable (Fig. A).



Using lines on machine drawings

The shape of the chip depends mainly on the angle of the front and the cutting speed. The larger the angle of the forehead, the less

The chip is compressed and broken. Then the chip develops smooth. When the angle of the knife edge decreases,

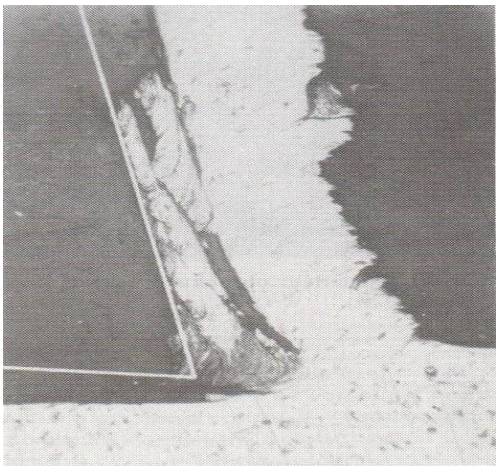
The compression of the chips increases, the chip breaks and splits into smaller pieces. Then a chip develops

The figure shows an example of a zone with an increase in the cutting wedge, where the increase

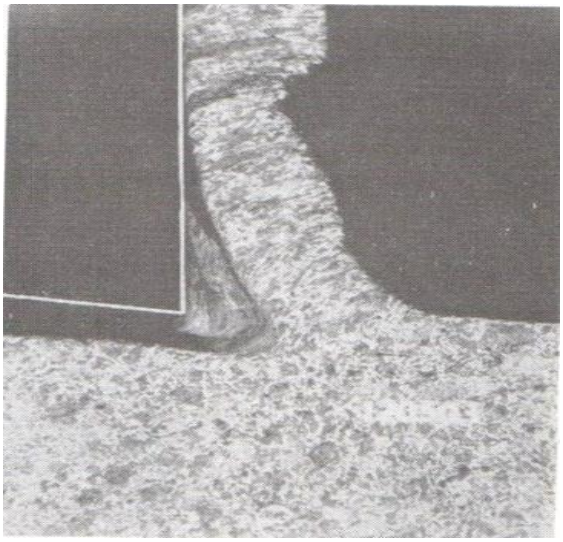
Modifies the original geometry of the cutting wedge. Here, the angle of both the forehead and the back increases.

The material is steel 12050.1, tool SK, v = 40 mm.min-1, s = 0.2 mm.

Metallography of the materiál Of the workpiece in the formation of the chips with an increase



Metallography of the material of the workpiece during chip formation an extreme increase



6.3. Cutting materials

The basic condition for the required technological operation, the reliable and good work of the tool is the correct choice of cutting material. The most important feature of cutting tools is their cutting ability. From a tooling point of view, this term includes the ability, under sufficient toughness, to maintain strength characteristics at high temperatures and to withstand wear at the point of contact of the tool edge with the workpiece and the leaving chips.

The tool material is chosen with respect to its stress. A cutting wedge enters the workpiece material at high pressure. The material is separated in the shape of a chip.

Basic properties of the material:

- Ø sufficient rigidity, strength, toughness
- Ø stability of mechanical properties even at elevated temperatures
- Ø low vulnerability to thermal fatigue
- Ø resistance to wear
- Ø thermal conductivity
- Ø technological production and processing

The most used cutting tools for metal machining:

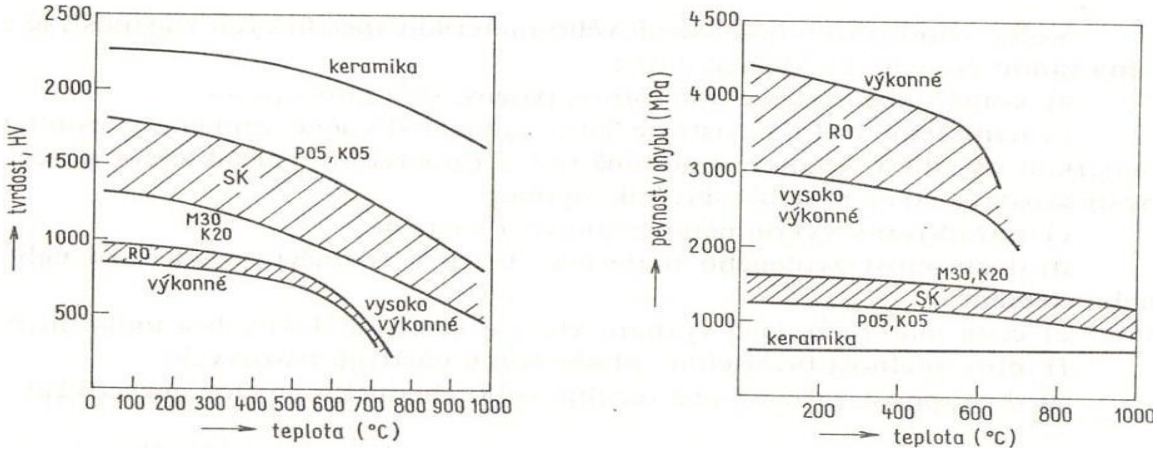
- Ø sintered carbides
- Ø tool steels
- Ø cutting ceramics
- Ø very hard materials

The use of a suitable type of material for a tool is influenced by some factors including:

- Ø Blade stress
- Ø Requirements for durability or performance of the tool
- Ø tool design
- Ø Tooling and cutting edge as a whole
- Ø Required tool life
- Ø required performance
- Ø availability of required material
- Ø the price of the material
- Ø grinding machining especially for shaped tools

Cutting properties of cutting edge and tooling of tooling

To design a cutting edge, we should consider a comprehensive assessment of available data on machined material and selected cutting material. The best solution is to rely on the results of rigorous tests. These tests are the most reliable performance indicator.



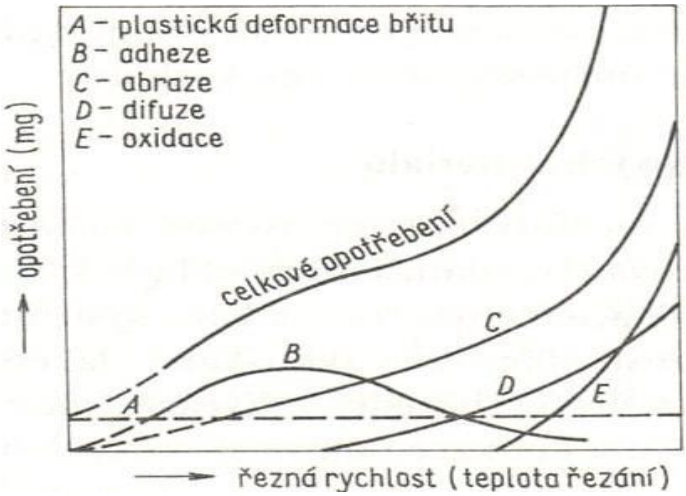
a b

Legend: tvrdost - hardness, keramika - ceramics, výkonné - efficient, vysoko výkonné - highly efficient, teplota - temperature, pevnost v ohybu - bend strength

The temperature dependence of the strength characteristics of the steel tools is summed up under the term tempering resistance. These dependencies are a decisive criterion for the performance of the tool when machining metal materials with high melting temperature. The most common method of assessment is to determine the hardness of the material at 20 ° C or the so-called hot hardness (a). Fig. B shows the effect of temperature on bending strength.

Wear mechanisms depending on cutting speed

Another significant feature of chemical shrinkage is chemical resistance at high temperatures and resistance to wear. Wearing mechanisms occur at the point of contact of the cutting edge with the machined surface and chip. The most important wear mechanisms include oxidation, diffusion, adhesion and abrasion. Their occurrence is linked to the tool-work interaction, cutting conditions (Fig.) And other factors (eg cutting environment).



Legend: opotřebení - wear, celkové opotřebení - overall wear, plastická deformace břitu - plastic deformation of cutting edge , adheze - adhesion, abraze - abrasion, difuze - diffusion, oxidace - oxidation, řezná rychlost (teplota řezání) - cutting speed (cutting temperature)

The working abilities of the cutting material, which comprehensively determine the rate of its performance, express the notion of rigidity. The control is determined by the sum of the physical, chemical and technological properties of tool materials that influence the choice of cutting materials. We must take into account the quality of the machining operation.

Control of tooling

The control of the tooling material is expressed by an index:

$$I = \frac{v_{cT}}{v_{ceT}}$$

Where:

v_{cT} *- the cutting speed is reached on the evaluation of the cutting materials during the life of the cutting wedge T,*
v_{ceT} *- cutting speed is reached by the reference material at the same durability of the cutting wedge T with the same dulling criterion under the same test conditions as with the rated cutting material.*

6.4. Materials

Sintered carbides

They are pulverized metallurgy products. Their discovery meant an increase in labor productivity,
It meant an increase in cutting speeds. The basic component is the tungsten carbide, it can also
Containing chromium oxide, cobalt, tantalum carbide, molybdenum carbide, titanium carbide, and
Niobium carbide. Depending on the number of components we obtain cutting material with different
Mechanical, chemical and physical properties. The respective type of sintered carbide

The manufacturer assigns to a particular use group according to ISO 513.

According to this standard, sintered carbides are divided into groups P, M, K and another two-digit number.
P - suitable for fluent materials,
M - universal,
K - for materials with a short, crumbly chip.

- **Advantages:** maintaining high hardness, wear resistance, cutting edge durability At temperatures of 900 ° C - 1000 ° C.
- **Disadvantages:** fragility, do not tolerate bending stress, sensitivity to temperature shocks

Tool steels

Tool steels are divided into:

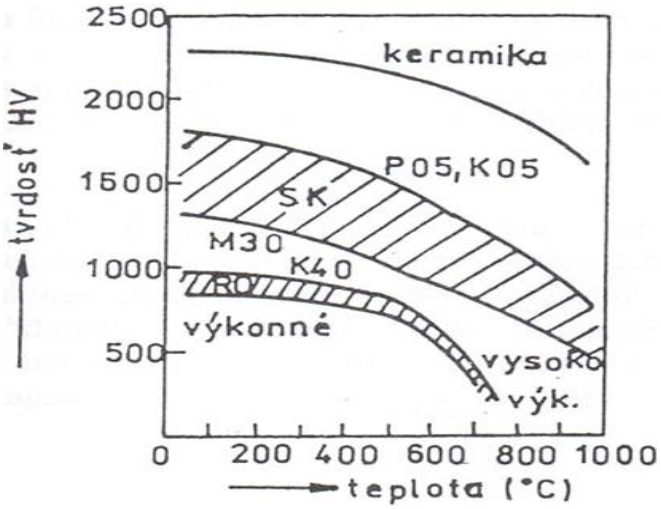
- Ø carbon steel
- Ø alloy steels
- Ø high-speed steels
- Ø Casting steel

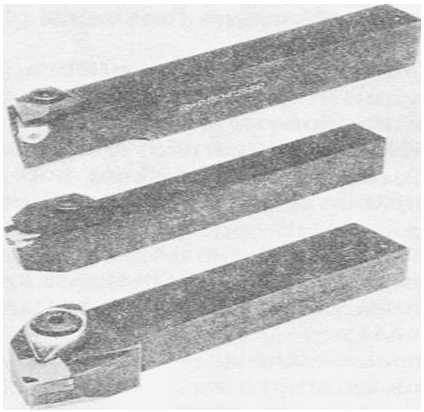
Cutting ceramics and metal ceramics

Cutting ceramics and metal ceramics, especially strength and pressure. Further good chemical resistance and resistance to wear.

Legend: řezná keramika - cutting ceramics, oxidová - oxide, čistá oxidová - pure oxide, polosměsová - semi-mixture, směsná - mixture, bezoxidová - oxygen-free, kubický nitrid boru - cubic boron nitride, polokristalický diamant - semi-crystalline diamond

Dependence of hardness of cutting materials - from cutting temperature





Examples of cutting elements

Basic distribution of cutting materials and their area of use in relation to the cutting speed and the permitted cutting temperature

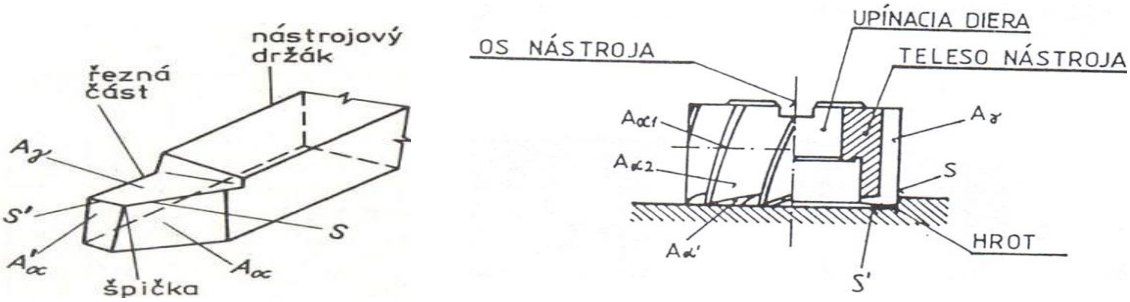
Type	Cutting speed [m/s]	Temperature[°C]
TOOL STEEL a/ carbon b/ alloyed	 0,16 – 0,2 0,2 – 0,3	 220 280

high speed steel	1	600
CEMENTED CARBIDE	4.16 /10/	1000
CERAMIC MATERIALS	16.6 /25/	1400
ABRASIVES	15 - 30	1500

Cutting edge geometry

In general terms, a machining tool is an instrument that consists of:

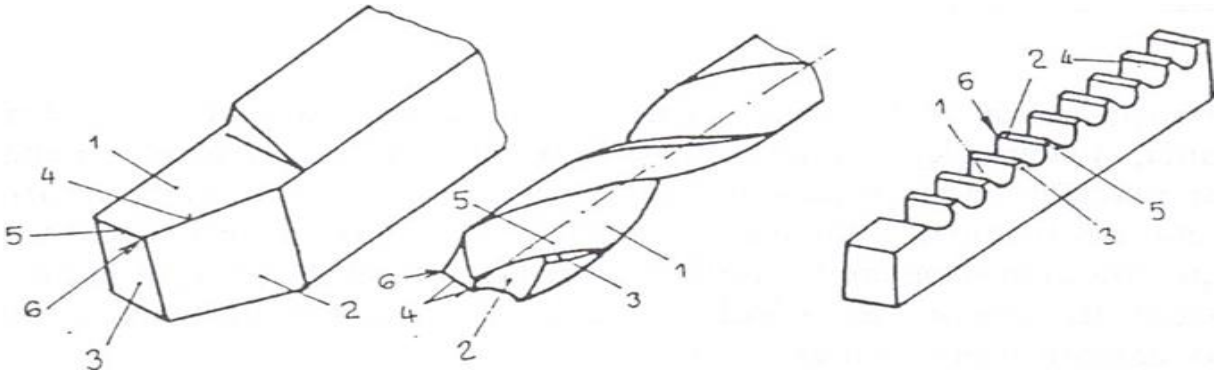
- Cutting wedge - formed by the front and back
- Tool body - part of the tool that serves to secure the cutting tool
- Tool holder - a part of the tool that serves to secure the outer surface
- Clamping hole - The part of the tool that serves to fasten the inner surface
- Tool axes base Forehead Ag Main spine Aa Minor back



Legend: špička - tip, řezná část - cutting part, nástrojový držák - clamp, os nástroja - tool axis, upínacia diera - clamping hole, teleso nástroja - tool body, hrot - tip

Cutting wedge

The cutting wedge is the part of the tool that has the ability to penetrate the machined material. The cutting wedge forms differently the surfaces of the back and the faces, respectively. The sides of the back ridge. The fore and aft intersection forms the main cutting edge, and the intersection of the forehead and the back ridge forms a minor cutting edge. Intersection of the face and ridge surfaces are cutting edges (ČSN 22 00 11 Cutting tools). In general, the surfaces can be screw, planar, cylindrical, tapered, etc. Surfaces on different types of tools: 1-face, 2-main spine, 3-spine, 4- cutting edge, 6th peak



Machine machining

The machine tool processes the blank in the desired size, shape and surface quality. In order to secure machined parts of the parts, the machine tool ensures reciprocal movements of the workpiece and tools.

Machining is one of the criteria for cutting machine tools. Machine tools are divided into types:

- Lathes
- Milling machines
- Grinders
- Drills
- Boring machines
- shavings
- Slides
- Protractors
- Honing machines
- Lakoping machines
- Superfinishing machines

6.5. Basic movements, machining areas and cutting conditions

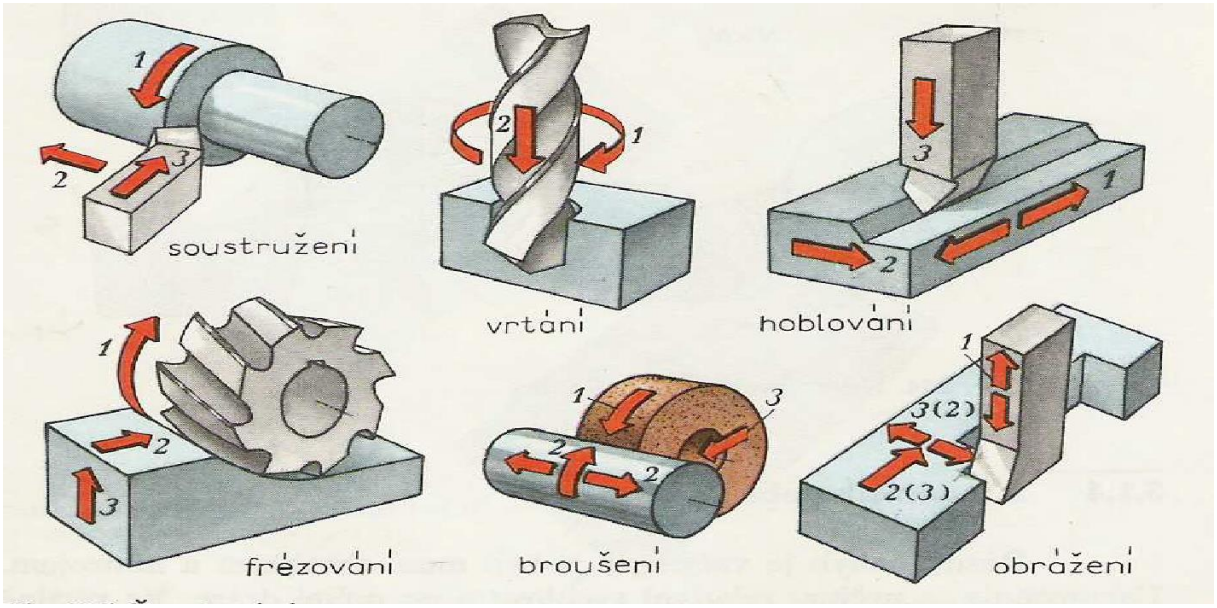
The following two movements are required for machining cutting chips:

- the main cutting movement
- More cutting movement

Cutting according to the main cutting motion:

- Rotational movement performs workpiece - turning
- rotary movement is performed by the tool - drilling, drilling, reaming, countersinking, milling, grinding, sawing

- linear rectilinear motion performs work-planing
- linear reciprocating movement is performed by the tool - reaming, extrusion, stretching, frame sawing, sawing, sawing

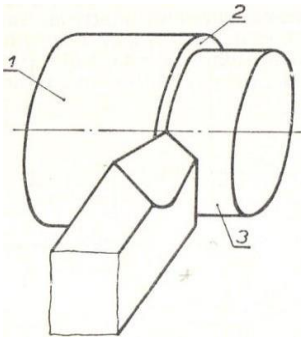


Legend: soustružení - turning, vrtání - drilling, hoblování - planing, frézování - milling, broušení - grinding, obrážení - slotting

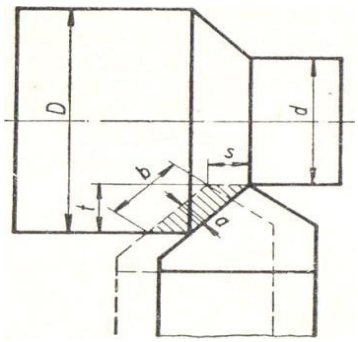
6.6. Base areas

When the cutting wedge enters the workpiece and the feed, three base surfaces are formed (Figure 7.26):

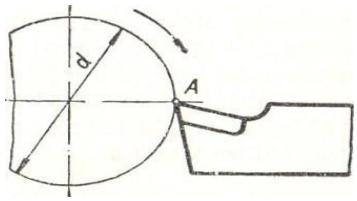
- Machined surface 1 - is machined
- Cutting surface 2 - Becomes just beyond the cutting edge on the component
- Machined surface 3 - is machined



Base areas movement



Chip cross-section dimensions



Main machining

6.7. Turning

Turning is the most widespread technological operation. By turning it is possible to machine the inner and outer cylindrical surfaces, spherical and general rotary surfaces. The lathes can drill, drill, ream, produce external and internal threads with turning knives or taps.

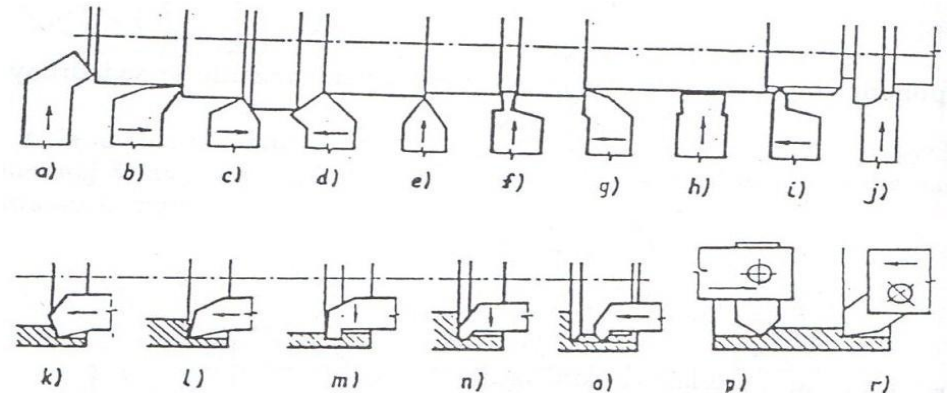
The lathe and its main parts

Division of turning machines

There are many types of lathes. In general, we categorize them according to ČSN 200200 to:

- Center point
- Revolver
- Frontal
- vertical
- Semi-automatic
- automatically
- Special lathes

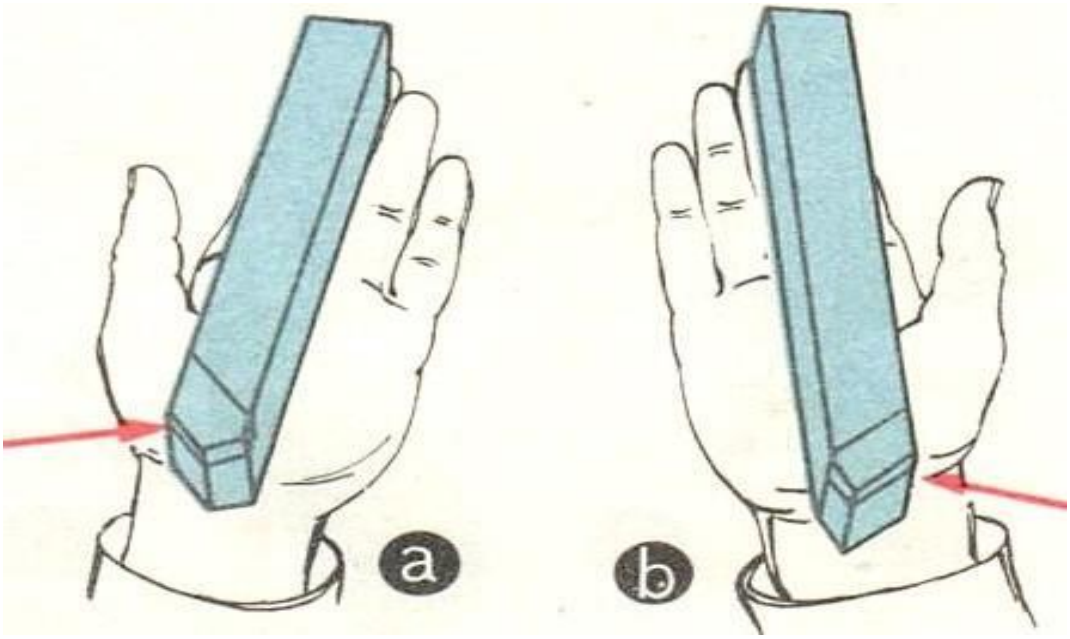
Basic types of turning knives and the surfaces with which they can be produced



A) bent left-hand, b) corner left, c) straight, left-handed, d) bent right,
E) narrow, smoothing, f) grooving, g) side scrolling right, h)
J) radius right, k) inner right, l) inner corner, m, n) internal grooving, o) internal threaded, p) inner straight, r)

Determination of right and left knives

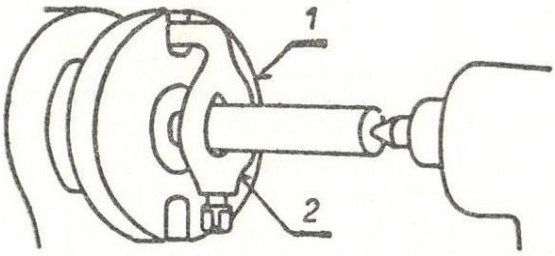
When working, the lathe uses a right or left knife. The right knife turns the longitudinal
The feed from the tailstock to the headstock and the left knife away from the headstock to the tailstock. Direction of knife with Determines where the main edge of the blade lies on the palm
Hand, with its tip pointing to the body of the turner

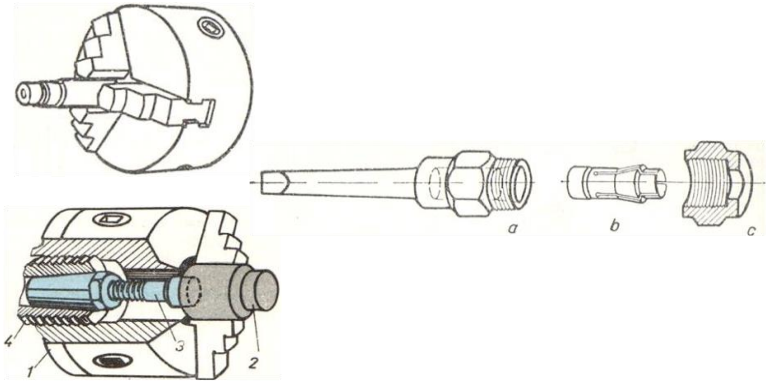


Clamping of workpieces during turning

We generally recognize two basic ways clamping:

- Gentle - without support
- With the support of a tailstock (chuck and tip, between spikes)





6.8. Milling

The main cutting movement is rotary and is executed by a milling cutter. The secondary movement is sliding and is

Carried out by the workpiece. The tool used is a milling cutter. It is a more wedge rotating tool.

The resulting cutting movement of the tool teeth is cycloid shortened along the path. Speed of main
Cutting motion - the cutting speed (vc) is calculated according to the formula

$$v_c = \frac{\pi . D . n}{1000} \qquad [m/min]$$

Where:

D - the diameter of the cutter
N - rotor speed per min
Vc - Cutting speed

The feed rate for milling is calculated according to the relationship

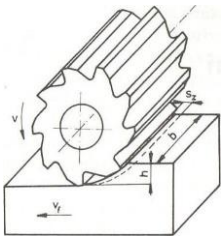
$$v_c = f_z \,.\, z \,.\, n = f \,.\, n \qquad [mm/min]$$

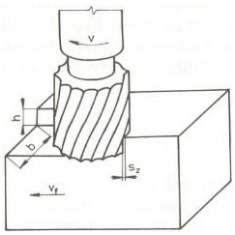
Where:

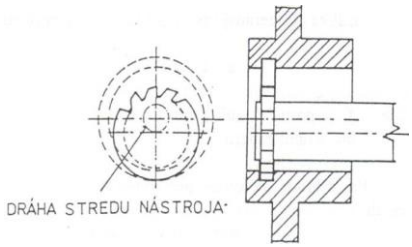
Fz - tooth movement
F - feed rate per revolution
Z - number of teeth
N - speed

Depending on the position of the tool axis on the work surface, we distinguish milling

- **Cylindrical milling** - whose axis is parallel to the machined surface and the depth of the cut is set in a plane perpendicular to the axis of the cutter
- **Front milling** - whose axis is perpendicular to the machined surface, the depth of cut is adjusted in the direction of the tool axis
- **Circular milling** - The tool axis and the workpiece are usually tilted a the depth of cut is set in a direction perpendicular to the workpiece axis
- **Planar milling** - fig. 7.5





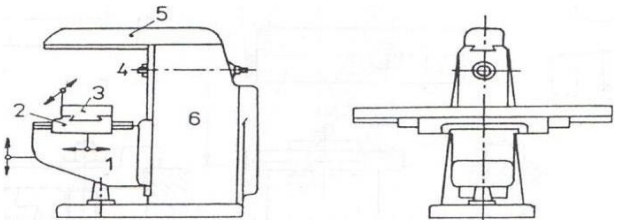


Cylindrical *Frontal* *Planets*

Milling machines

Milling machines are produced in a large number of models and
Sizes with different maximum capacities. It can be
Divided into four basic groups: console,
Table, planar and special. Special category

Are tooth milling machines and milling machines.



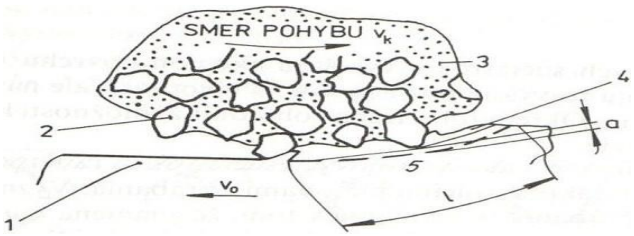
Console horizontal milling machine
Console vertical milling machine1-console, 2-transverse slide, 3-way table, 4-spindle, 5-arm, 6-stand

6.9. Grinding

Grinding is a chip cutting of material with multiple cutting wedges created
Abrasive grains. Abrasive grains are fastened in the tool with a binder so that
The tool has a porous structure. Characteristic is irregular
Layout of cutting wedges (grinding grains), which are additionally random
Orientation and random geometry. The peculiarity of grinding is that the process is
It happens with the participation of a large number of relatively small grains in short sections.
The chip is cut off in a relatively short time period of about 0, 001
seconds. As a rule, most of this time period is needed on
Plastic deformation (by compression and recording of material before cutting
Wedge. Due to high cutting speeds and significant deformation
The material layer creates a temperature at the cutting point 1200 - 1500°C.

Operation of grinding wheel grains during the process

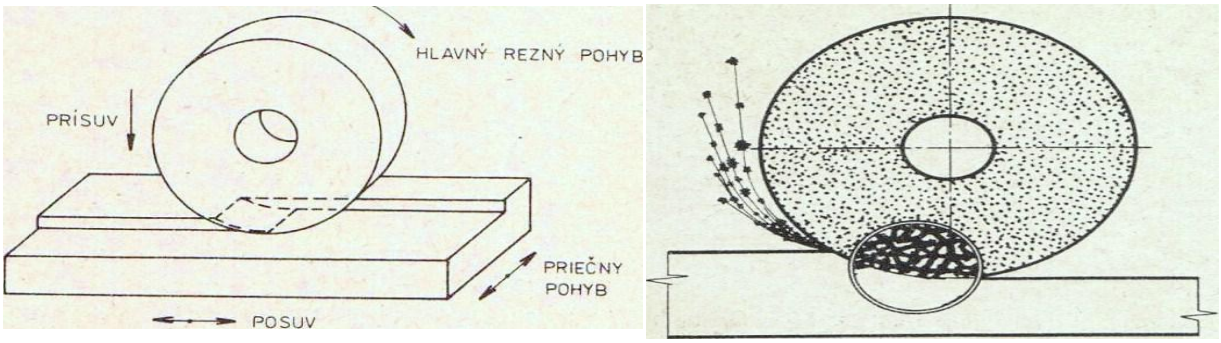
The essence of each grinding method is abrasion grain removal as the effect of grinding grain effects
For machined material. This is the bonding of the grain and the material of the workpiece.



1-workpiece, 2-grain grain, 3-binder, 4-cut material, 5-chip chip,
směr pohybu - movement direction

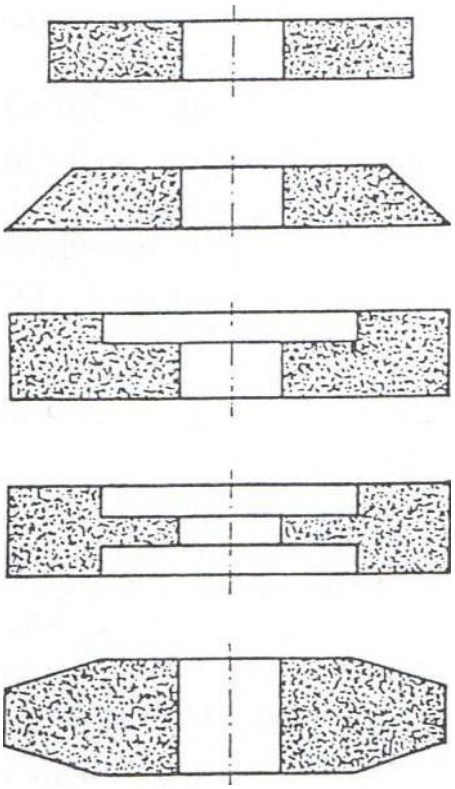
Vk-peripheral disk velocity, a-depth, cut-off layers, V-peripheral disk velocity

Main and minor movements and grinding operation of the blade



Legend: hlavný rezný pohyb - main cutting movement , prísuv - infeed, priečny pohyb - transverse movement

Shape of grinding wheels



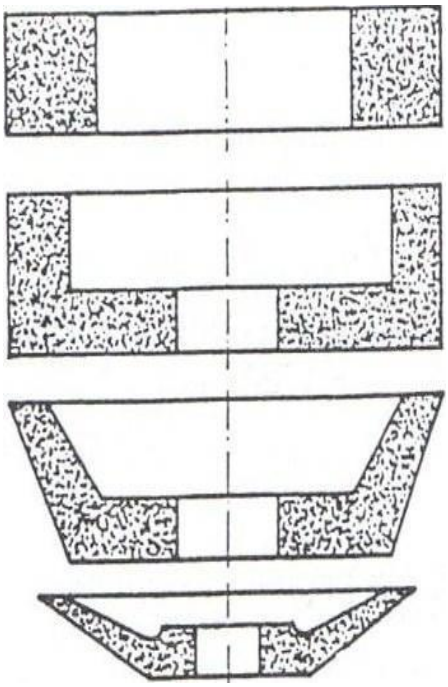
A) flat grinding wheel

B) the sanding wheel is one-sided

C) a single-sided grinding wheel

D) a double-sided grinding wheel

E) the sanding disc is tapered on both sides



F) ring grinding wheel

G) a cup grinding wheel,

H) a cup grinding wheel,

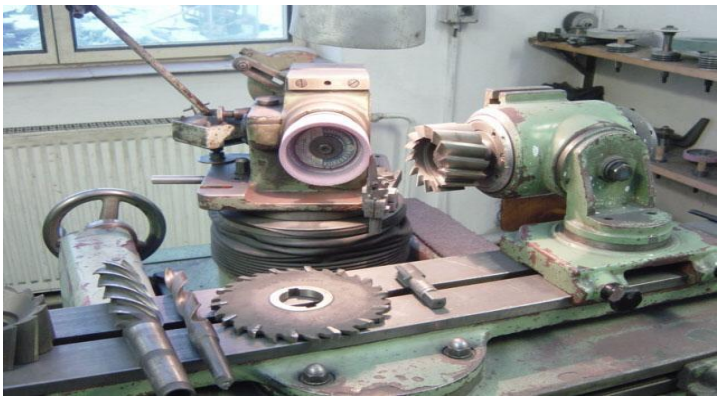
I) a disc grinding wheel

Classification of grinding machines

Depending on the purpose and the way we work, we sort the grinding Machines for:

- Studs
- Without need
- On holes (holes)
- Planar
- Tooling
- Parallel plan

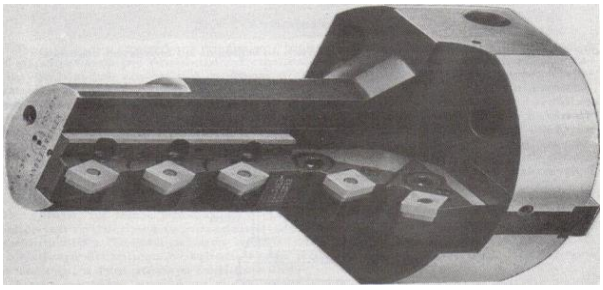
Tool grinder



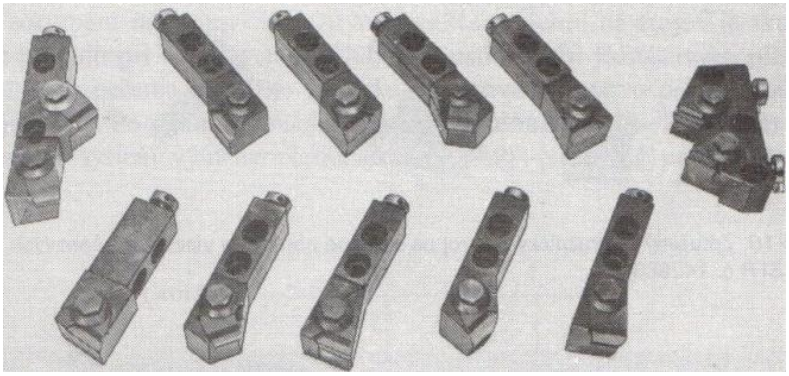
Instrumentation of an automated manufacturing system

The tooling system is one of the factors that it makes conditional Operational reliability of automated manufacturing systems. Reliably And high performance cutting tools are a prerequisite for efficient i Stable operation of an automated manufacturing system. Cutting tools on Analysis of existing systems can be divided into:

- Normalized,
- Combined,
- Tool heads
- Multi spindle heads
- Special cutting tools.



Combined block tool



Set of knife holders with coated cutting inserts intended for warehouse blocks

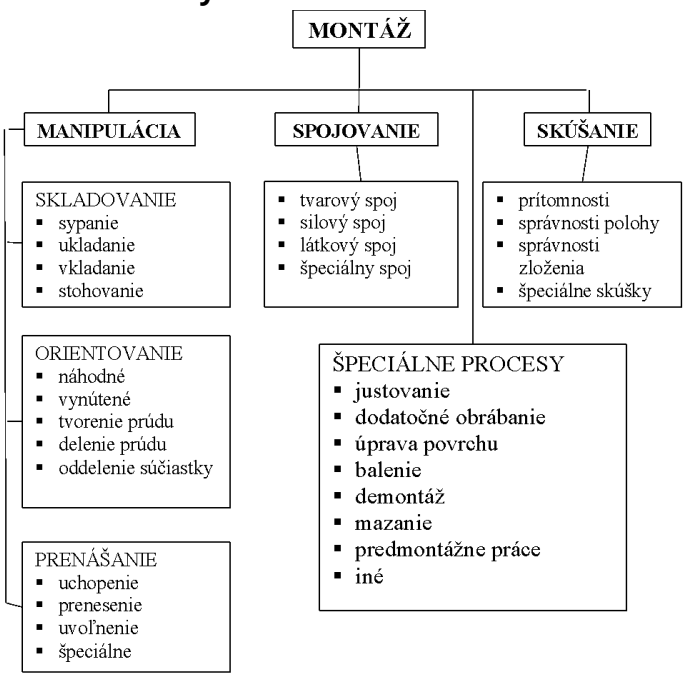
7. ASSEMBLY AND REPAIR TECHNOLOGY

Mounting is the creation of fixed or movable joints between rigid components, but also between liquids and gases. The assembly creates the final process of the production system. The production system can be understood as a manufacturing enterprise. Then the assembly system is just one subsystem of the production system.

The decisive elements of the assembly subsystem

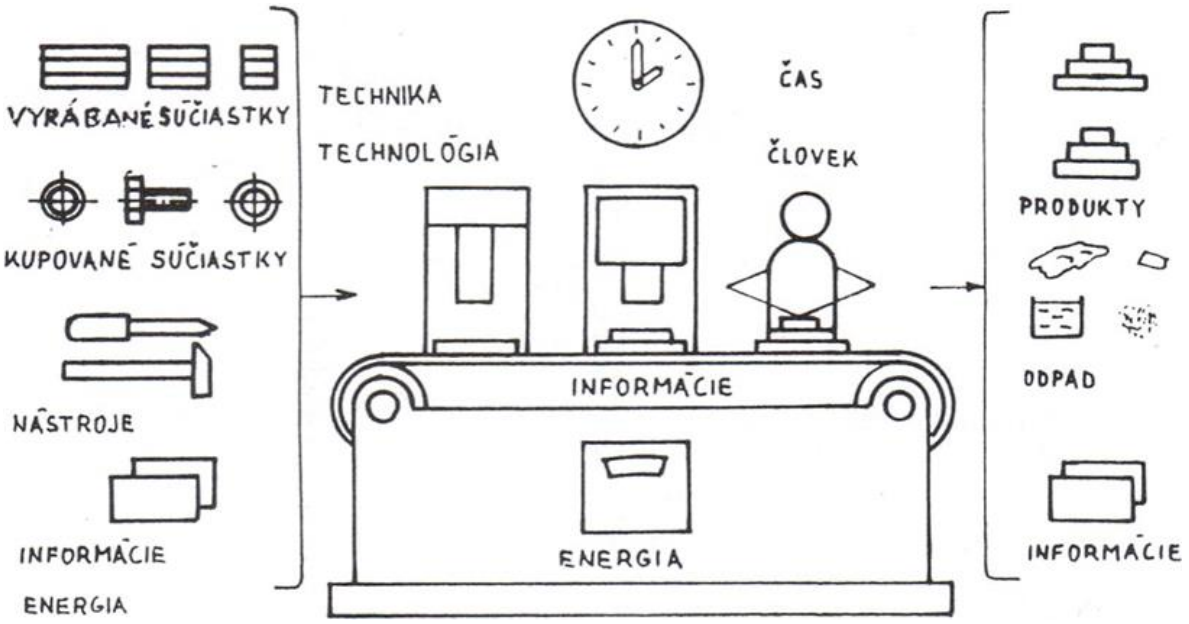
- Assembly product
- Assembly technique
- Assembly technology (ways of creating the connections of the required function)
- Man in assembly
- Information System
- Energy system

Basic assembly activities



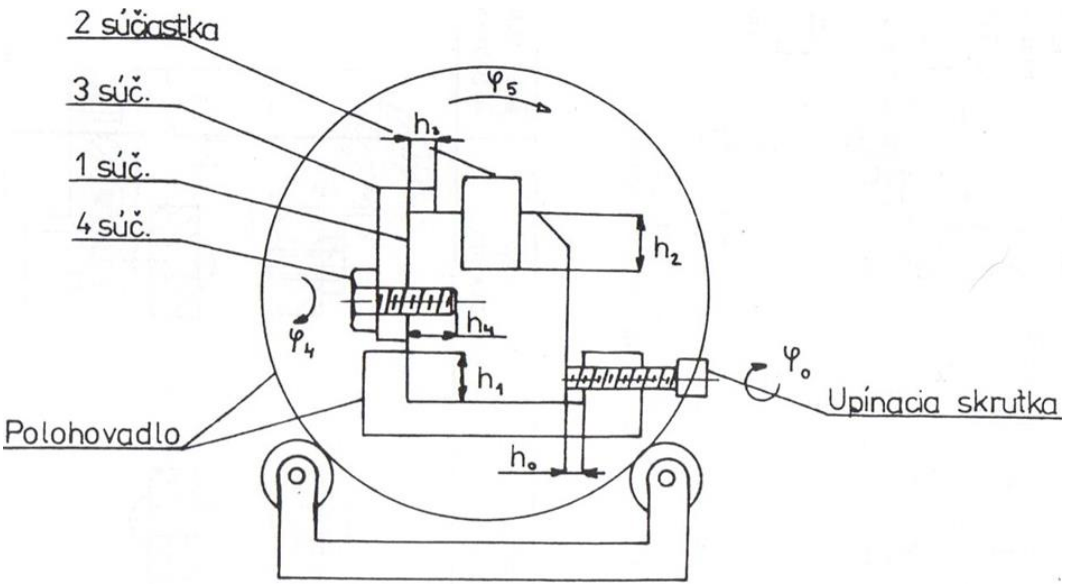
Legend: montáž - assembly, manipulácia - manipulation, skladovanie - storage, sypanie - loose-filling, ukladanie - stowing, vkladanie - insertion , stohovanie - stacking, orientovanie - orientation, náhodné - random, vynútené - imposed, tvorenie prúdu - current generation, delenie prúdu - current separation, oddelenie súčiastky - component separation, prenášanie - transmission, uchopenie - grip, prenesenie - transfer, uvoľnenie - release, špeciálne - special, spojovanie - joining, tvarový spoj - form joint , silový spoj - joint by forces, látkový spoj - fabric joint, špeciálný spoj - special joint, skúšanie - testing, prítomnosti - testing presence, správnosti polohy - testing of positioning, správnosti zloženia - testing of composition, špeciálne skúšky - special tests, špeciálne procesy - special processes, justovanie - adjustment, dodatočné obrábanie - additional machining, úprava povrchu - surface treatment, balenie - packaging, demontáž - dismantling, mazanie - lubrication, predmontážne práce - pre assembly work, others

Diagram of general assembly system



Legend: vyrábané súčiastky - components produced, kupované súčiastky - components purchased, nástroje - tools, informácie - information, energia - energy, technika - technics, technológia - technology, čas - time, človek - human, informácie - information, produkty - products, odpad - waste

The notion of assembly Process for assessing the technology of the construction in terms of assembly



Legend: súčiastka - component, positioner, upínacia skrutka - clamping screw

Fundamentals of assembly work

- Shape and position control
- Screw connections
- Connecting collars, wedges and pens
- Sliding bearings
- Roller bearings
- Rotary motion transmission components
- Mechanisms for movement change

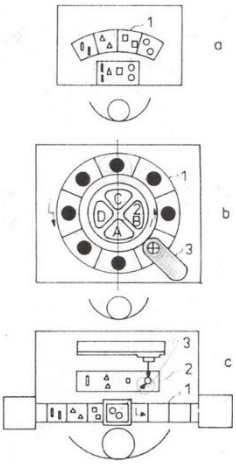
7.1. Assembly workplace

The assembly workplace is a defined space with the appropriate technical equipment. Workplace equipment is designed for manual, mechanized or partially automated assembly provided by one or more persons.

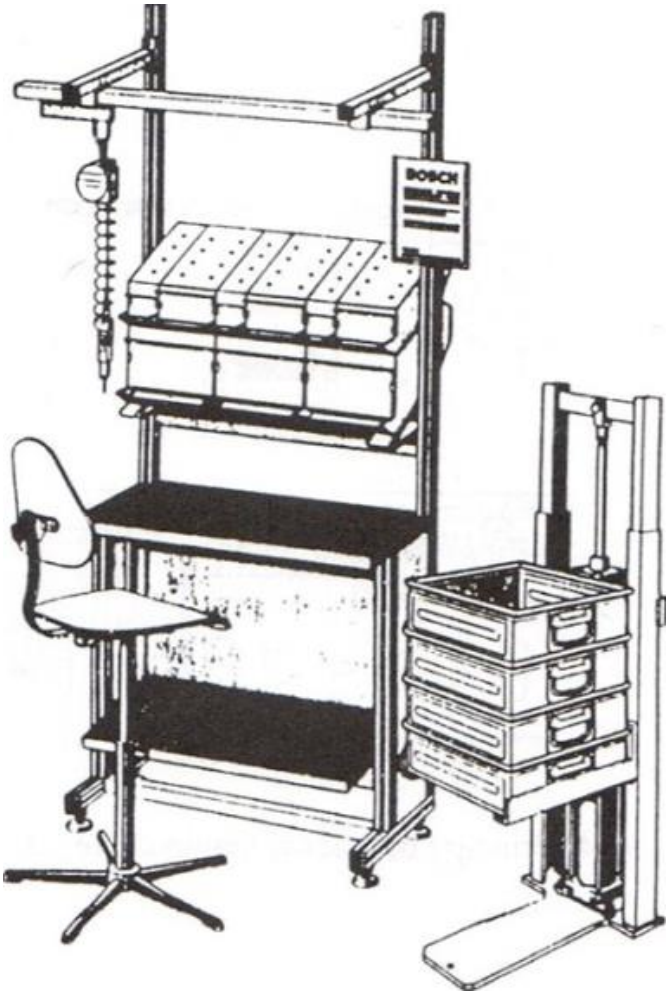
Typical parts of the assembly workplace

- Montage table
- Stool
- Footrest - it's adjustable footrest
- Motorized tools mounted on brackets using balancers
- Box trays
- Local lighting
- Shoulder and forearm support

Mounting workplace



Light desktop assembly workplace by BOSCH



Mounting equipment is also installed on the assembly workplaces

- Basic units of dismantling equipment,
- Base units of mounting devices,
- Basic units for individual workplaces,
- Basic units for assembly machines and lines,
- Assembly equipment is an assembly technique
- Manually operated (transmitted) equipment,
- Manual assembly,
- Machine assembly equipment,
- Assembly lines,
- Stationary building units

7.2. Robotic assembly

Robots are generally considered as free programmable devices. He has three or more degrees of freedom. These are designed in one device.

- The portal robot works in three Cartesian coordinates.
- Robot with rectangular workspace

- The arguments about which of these structures are more advantageous for mounting are the following (Valentovič, 2001):

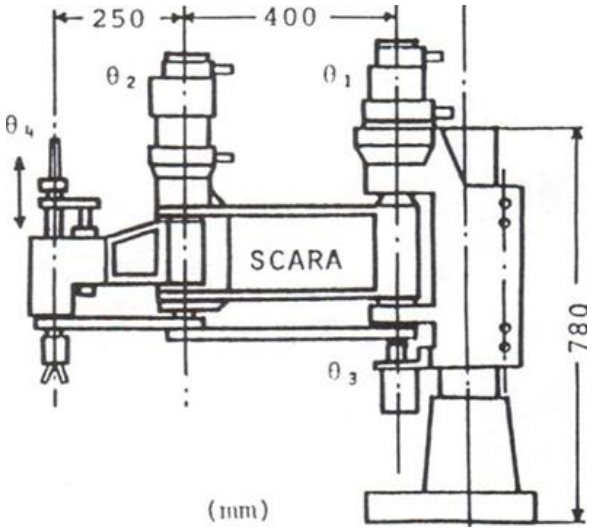
- The SCARA column prevents access to the mounted product by the column

- The pallet with the components and the assembled product are listed in the Cartesian system, programming the Cartesian robot does not require recalculation.

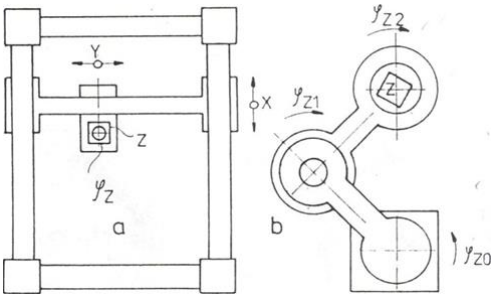
- The positioning accuracy of the scarified SCARA robot is smaller than the packed, the accuracy of the Cartesian robot is roughly the same across the work field.

- Generally, the rotation pairs of the SCARA robots are simpler, more rigid and less tangible than a linear pair of Cartesian robots, in which the portal support at its higher span represents a considerable problem in terms of weight minimization and precision errors.

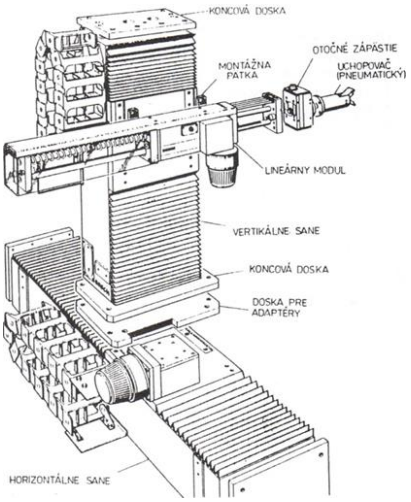
The first prototype of the SCARA robot



Mounting robots

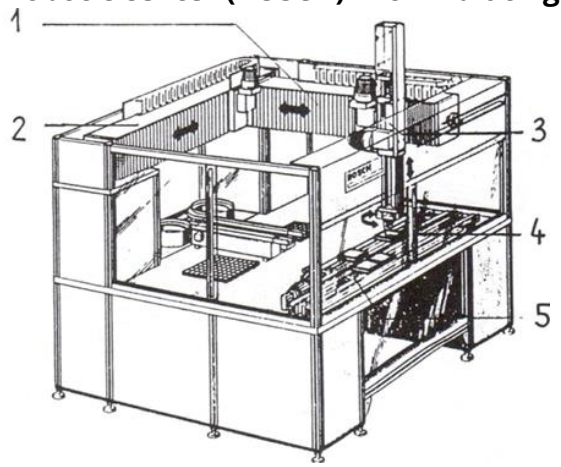


Robot with rectangular space (BOSCH)



Legend: koncová doska - end plate, montážna patka - mounting foot, otočné zápästie - swivel, lineárny modul - linear module, vertikálne sane - vertical slide, doska pre adaptér - adapter plate, horizontálne sane - horizontal slide

Robotic center (BOSCH) with vibrating component feeder and carrier conveyor



7.3. Architecture of robotic assembly techniques

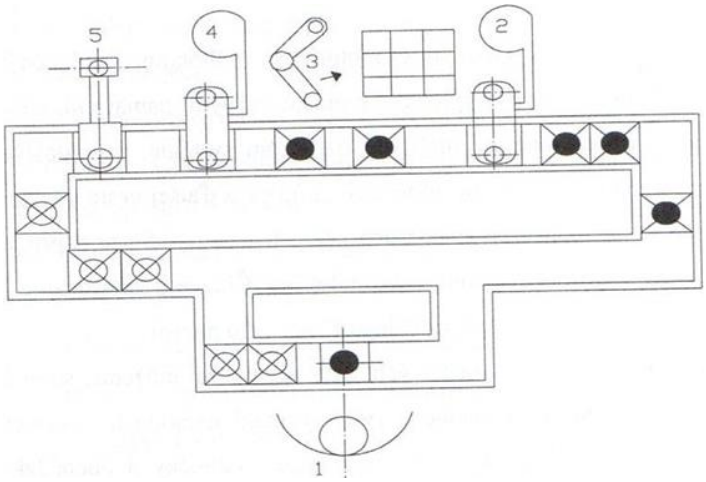
- Assembly workplace with one universal robot
- The robot as a synchronous station or asynchronous lines
- Workplace as a mini line with two robots
- Flexible assembly line with circulating supports
- Assembly line SMASH
- One technological robotic systems

Automatic mounting systems

- Asynchronous machines composed of automatic assembly lines are created where we can automate operations.

- Asynchronous lines - products can be moved in a line without a carrier, i.e., having a flat base for entrainment. The base part also functions as a driver.

Line diagram of asynchronous mounting systems



Alternative (1), robots (3), assembly stations (2), unloading manipulators (5)

Synchronous mounting machines are built as multi-station machines, ordinary automata for which they are valid

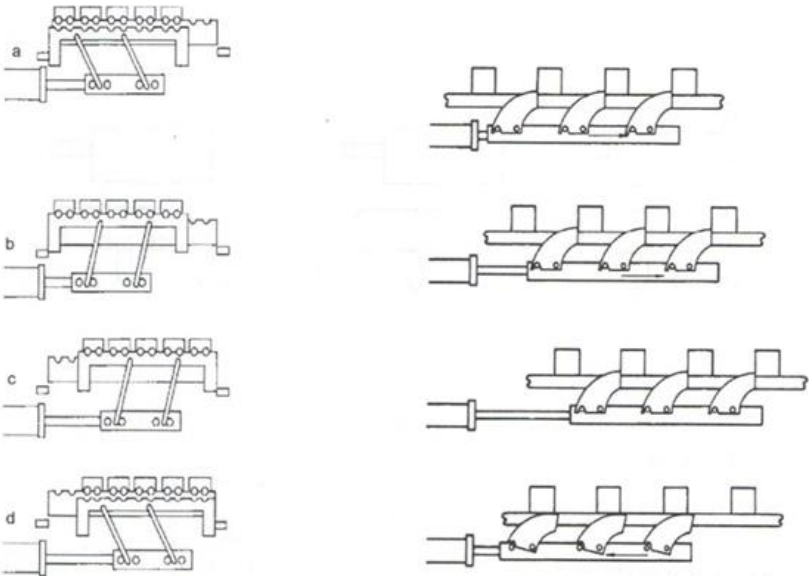
- There is a fixed connection between the transport medium and the technological carrier, the carrier with the clamp of the partially assembled product moves simultaneously with the medium,
- All carriers prepared on the transport medium move synchronously. Synchronicity is parallelism in time, present,

- All workstations work synchronously. The working cycle starts at the same time and returns to its starting point after its end. The cycle time of the individual workstations is the same, but the partial cycles within the overall cycle may not be the same, the return of the working organs to the starting position may no longer be simultaneous,
- In synchronous machines, the current work on all workstations with the simultaneous displacement of assembled products from each of the previous workstations is alternated.

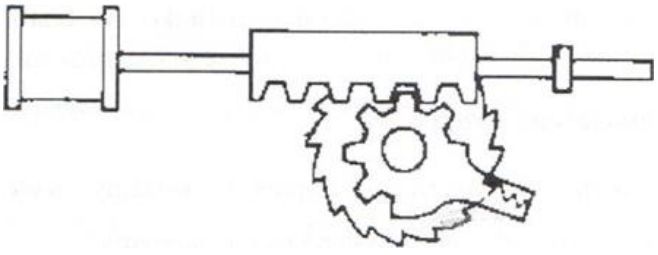
Classification of synchronous machines to:

- Rectilinear, drilled linear parts of closed circuits, rectilinear parts of tree-like circuits,
- Circular, drilled closed circuits, not only circular but also any, eg, oval, polygonal, most often quadrangular shape

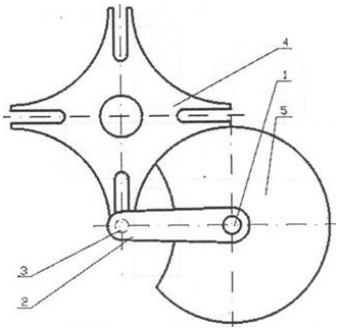
Connecting drives to mechanisms



Toothed rack bar



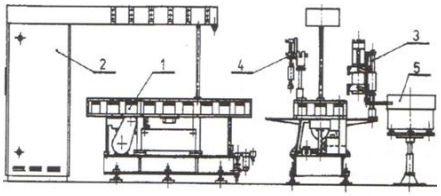
Classic Maltese Mechanism

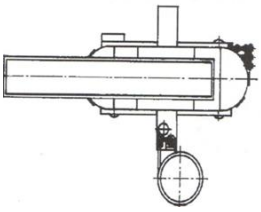


Technological systems of synchronous machines are generally divided into:

- Machines with central drive units
- Machines with individual drive units

Linear synchronous automaton



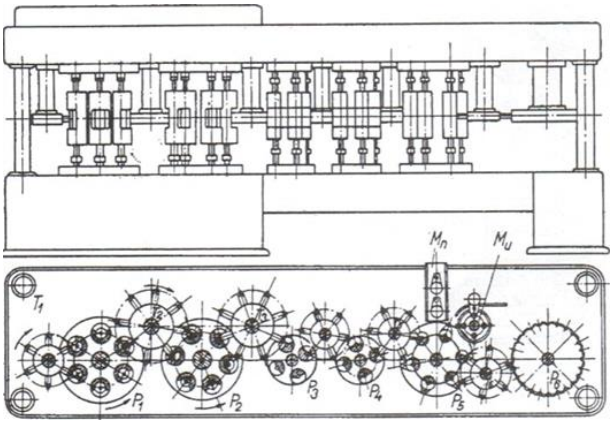


1-way transport unit for MPAX 10, 2-control unit, 3-technology units, 4 control units, 5-tanks

Continuous machines

- Assembly equipment for final assembly of cars
- Rotor assembly machines

Basic unit of the rotor machine with working P and conveyor D rotors

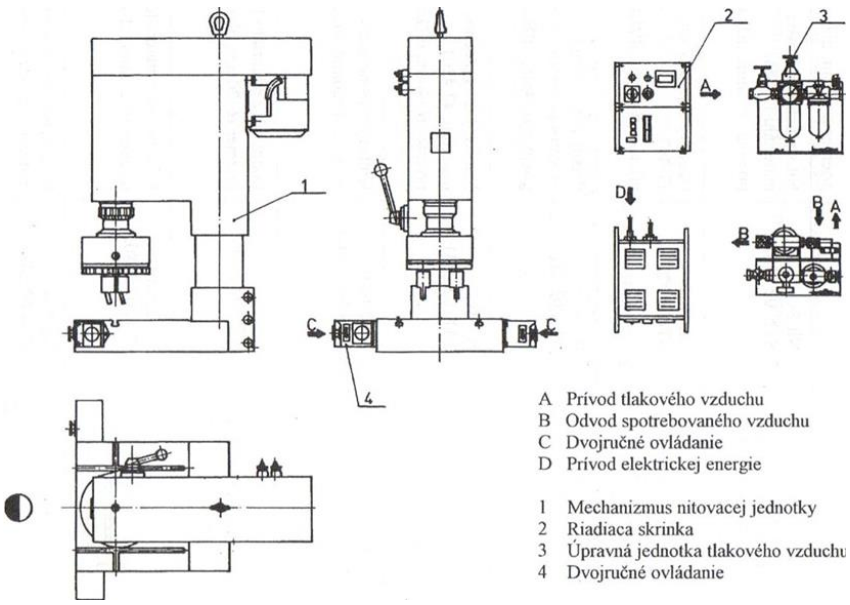


7.4. Coupling device

Assembly presses - we use for making molded and pressed joints and general molding and molding. The most common mechanisms used in mounting presses are hydraulic, pneumatic, pneumatic-hydraulic, pneumatic-mechanical and mechanical with rolling tools.

Pneumatic assembly sheet

- Riveting device - Used to form a non-detachable rivet joint. We can divide rivets:
- According to the mutual position on one and on two sides
- Depending on the type of hollow shaft rivet, full shaft and special
- According to design, direct and indirect

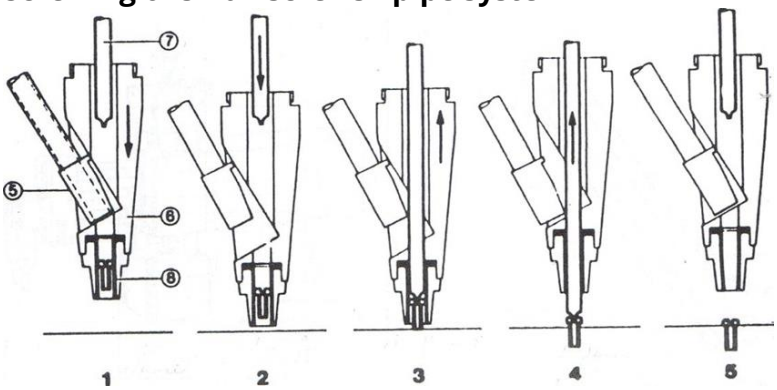


Screwdriving devices - screw connections are detachable mounting joints. The base is a bolt and also a matrix of washers of various types.

Screws and nuts are classified into special attachment, coupling, drive, movement and screws (adjusting, spacing, etc.). The threads are right and left. The most common are true threads.

Screw devices are used during assembly, among which we include technical tools for manual screwdriving, screwdrivers, torque screwdrivers, mounting wrenches, torque wrenches and motorized handwheels.

Screwing of small screws - pipe system - WEBER



The following procedure is maintained when screwing:
1 - Product Head - Screw Fits Head 2 - Product Tool
3 - Screwdriver 4 - Head up - Screw not screwed out of the head
5 - Up Tool

7.5. Screw drive unit

Repairs of equipment, machinery and equipment
Current quality new technology, machinery and equipment enable us to diagnose a problem quickly and securely with the use of diagnostic tools. The failure can be remedied by repairing existing components, replacing these components, or replacing whole groups or subgroups exhibiting a malfunction.

The causes of the malfunctions can be divided into internal and external

- Internal causes of failure are caused by inappropriate shapes, properties and resilience of material, technology, machinery and equipment.
- Internal malfunctions:
    - construction material (composition, properties), working mode (cooling, lubrication), surface protection, control points (diagnostics)
    - aging

- technological - material change, material quality (defects), unattended technology, unattended working mode

External faults occurring

- wear - Abrasive, Adhesive, Erosion, Cavitation, Fatigue, Vibration, Burning
- excessive load - ignorance of technical conditions, negligence in meeting the manufacturer's technical conditions
- mechanical damage - impacts, falls, accidents, failure to observe the conditions of installation, maintenance and repair
- electric shock - electric sweep, lightning strike, improper handling
- fires - the result of some faults (excessive braking, shocks, crashes, traffic accidents)
- corrosion - atmospheric, biological, chemical, electrochemical