INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

PŘEDMLUVA

Učební text vznikl jako specifický cíl projektu z Operačního programu „Vzdělávání pro konkurenceschopnost - oblast podpory 1.1 - Zvyšování kvality ve vzdělávání", který je zaměřený na zkvalitnění a modernizaci systémů počátečního, terciárního a dalšího vzdělávání, jejich propojení do komplexního systému celoživotního učení a ke zlepšení podmínek ve výzkumu a vývoji. OPVK je financován z Evropského sociálního fondu (ESF), z kterého jsou podporovány neinvestiční projekty. Název projektu je „Zavedení výuky moderních technologií průmyslové výroby do oboru strojírenství" (Implementation of progressive technology in machine industry to the education). Jeho hlavním cílem je vytvořit výukový modul, který přispěje k modernizaci výuky v oboru strojírenství zařazením nejnovějších poznatků z oblasti moderních výrobních technologií a manažerských postupů, uplatnitelných ve všech odvětvích průmyslové výroby. Specifickými cíli jsou vytvoření osnov a pomůcek nového předmětu a doplnění osnov stávajících odborných předmětů a cizích jazyků o témata učiva se zaměřením na programování, řízení, obsluhu a údržbu průmyslových robotů a automatů.

V rámci projektu dojde k vytvoření učebních textů a dalších pomůcek výukového modulu se zaměřením na využití špičkových technologií v průmyslové výrobě. Výukový modul bude tvořit nově zavedený předmět se zaměřením na programování, řízení, obsluhu a údržbu průmyslových robotů a automatů ve třetím a čtvrtém ročníku. Učivem moderních technologií budou doplněny některé stávající odborné předměty. Navíc bude vytvořena skupina přednášek s praktickými příklady zaměřenými na komunikační a prezentační dovednosti, řešení otázek úspěšného jednání s lidmi, řízení času a problematiku firemní kultury. Následně dojde k implementaci výukového modulu do výchovně vzdělávacího procesu školy.

Na doporučení výběrové komise a usnesení Zastupitelstva Středočeského kraje č. 6 - 27/2008/ZK ze dne 10.9.2008 byla schválena finanční podpora z veřejných prostředků na výše uvedený grantový projekt. Maximální výše finanční podpory na uvedený projekt byla stanovena na 2 734 093,00 Kč. Veřejné prostředky pro realizaci projektu budou poskytnuty na základě Smlouvy o realizaci grantového projektu ze strany Ministerstva školství, mládeže a tělovýchovy zastoupeným vyhlašovatelem – Středočeským krajem.

Středočeský kraj

Partner projektu: Toyota Peugeot Citroën Automobile Czech, s.r.o. (TPCA)
TPCA Home Page: www.tpca.cz

TOYOTA PEUGEOT CITROËN AUTOMOBILE
Automobilka s budoucností

Poděkování autora Mgr. Vratislava Venzary patří Ing. Vieře Obešlové a Ing. Davidu Balabánovi za nenahraditelnou pomoc a technické rady z oboru strojírenství, nezbytné pro zpracování cizojazyčného učebního textu nestrojařem.

Autor

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

1. TECHNOLOGY

Technology is a line of techniques, which deals with, creating, loading and perfection of manufacturing process.

Expression technology further can stand for:

- summary of productive instruments given company;
- all using substance for given work, concerning production;
- a summary of documents inevitable to a given company, including prospectuses, engineering drawings, schedules, manufacturing process etc.;
- detachment of technical preparations of productions in manufacturing concern. A Designer draws engineering drawing and a technologist designate, which machines, what tools, and under what conditions a product will be will product.

The word technology is of Greek origin. It is teaching about acquirements to produce and to work material in product (tech = skill, logos = teaching).

For region of engineering productions count:

- technology of metal production, metallurgy (metallurgy);
- technology engineering.

Technology of metal production deals with processing of raw materials on material (or even on oven-ready food) and its quality. It is divided into production of iron and nonferrous metal, production of powder-metal and processing made metal on oven-ready foods (harmonica, brass, piping, wire).

Engineering technology deals with production of half-finished or finished products casting, shaping welding, soldering, cutting, heat processing, surface adjustment, production of plastic half-finished products and assembly.

1.1. Technology is divided into

- Technology of metal production
  - Metal ferrous production
  - Nonferrous metal production
  - Powder metal production
  - Metallurgy production of semi-factured product
- Engineering technology
  - casting
  - shaping
  - welding and soldering
  - plastic processing
  - cutting
  - heating processing
  - surface adjustment
  - asssembly

2. ENGINEERING MATERIALS

It is possible to divide engineering materials into two big groups:

- metallic materials
- nonmetallic materials

They are distinguished by different physical, chemical, mechanical and technological qualities which predeterminate their using in engineering.

2.1. Metal materials

2.1.1. Technical ferro-alloys

The most important metal in mechanical engineering is iron. Clean iron (FE) has for its small fort only very limitated. Various metal and nonmetallic elements are added into clean iron wherewith ferro-alloys are created. Ferro-alloys which include cinder greater than 2.14 % belong to inductile and they are crude iron and ferro-alloys Steels include cinder less than 2.14%.

2.1.1.1. Unrefined iron

Unrefined iron is produced from iron ore or from scrap iron (groats) in blast furnace, which are also filled into with slag-forming additives and firing and forced by hot air.

Slag-forming additives (e.g limestone) are necessary to form slag, which swims whereupon smelt crude iron and saves it in face of oxidation. Firing for smelting is coke made of black coal. Air needed for coke firing is forced in into blast furnace by air blast.

Unrefined iron is further worked on and steels or cast iron are made of it.

2.1.1.2. Steel

Steel is produced by fining barbarous steeltrap in steel-making furnaces. Cinder and other elements include in crude iron are burned with oxygen and their content decreases on fit quantity. Steel shapes are casted into metal forms called ingot-mould. Steel shapes get stiff into ingots inside ingot-moulds. Ingots are further worked by mounting and rolling on semi-manfactured products.

Fig. 1. Blast furnace

Shaping steel is divided into steels constructional and steels instrumental. Constructional steel is used to produce sundry expenses piece of machinery (peg, screws, shafting, cog wheels), Instrumental steel is used to produce sundry expenses tools (file, tool, milling cutter, brace, swage, swage, …).

Casting steel is poured into casting forms, in which get stiff on steel casting.

2.1.1.3. Cast iron

Cast iron is produced in shaft furnace called cupola. Chemical process in cupola is anologous like in blast furnace. Leakage grey cast iron, which has laminated plumbago and foundry less effortful piece of machinery are manufactured from it, flows out of cupola. Vaccination of grey cast iron (addition bristly ox-tongue in face of casting) is used for production of spheroidal graphite cast-iron, in which cinder is found in a form of granular plumb ago. Its tensile strength is up to 900 MPa. Foundry made of this cast iron is solid and free-cutting.

Fig. 2. Electric arc furnace

2.1.2. Nonferrous metals and their alloys

Nonferrous metals are all metals excerpt iron and its alloys. They are not only important constructional materials, but also indispensable raw material for production of doped steel and for surface adjustment. Nonferrous metals are divided into heavy nonferrous metals with density over 5000 kg/m^3 and into light nonferrous metals with density below 5000 kg/m^3.

Chief representative heavy nonferrous metal is copper, which is supposed to have very good corrosion resistance. It is red Bronzes and brass belong to copper alloys. Brass is an alloy of copper and zinc. Bronzes are alloys of copper with various metals usually without zinc.

Chief representative of light nonferrous metal is silvery white aluminium. Dural belongs to alloys with very good mechanical qualities alloys and is used especially for construction of planes and in transport. Dural is aluminium, copper and bristly ox-tongue alloy.

2.2. Non-metallic materials

Plastics belong to the most important non-metallic materials in machinery. Wood, glass, ceramics, salamander's hair, earthenware, leather etc. are others.

2.2.1. Plastics

Plastics are organic compounds consists of huge macromolecules which contain thousands of atoms above all cinder and hydrogen. They are produced of monomers through polyreactions. They are very light and noncorrosive. They are split up on two basic groups:

- thermoplastic – by the instrumentality of warmth it grows soft and it is possible repeatedly mold;
- reactoplastic - by the instrumentality of warmth it cures and passages nonreversible into non-fusible state.

Thermoplastics comprise polyvinyl chloride, polyethylene, polypropylene, polystyrene, superpolyamide, etc.

Reactoplastics comprise different sorts of resin, polyester and polyurethan.

2.2.2. Wood

Wood is used for production of constructional portfolio, mock-up, screen and core for foundry industry and so on.

Wood silences beats and vibration. It has the biggest fort along the fibre (perhaps 100 MPa). The disadvantage is unevennes structure, shrinkage, moisture expansion and propensity to decay .It is easy to shape and links.

3. HEAT TREATMENT

Warming –up of material is a substance of every heat processing together with tenacity on this temperatures and resulting fall of material temperature. Structural changes of material proceed inside it during heat processing. They are cause of changing some qualities of material.

Material cools very slowly at annealing. Decreasing of inner tension and hardness of material often happen during this process. At the same time figurability and workability of material can improve sometimes even structure of material can be abstracted.

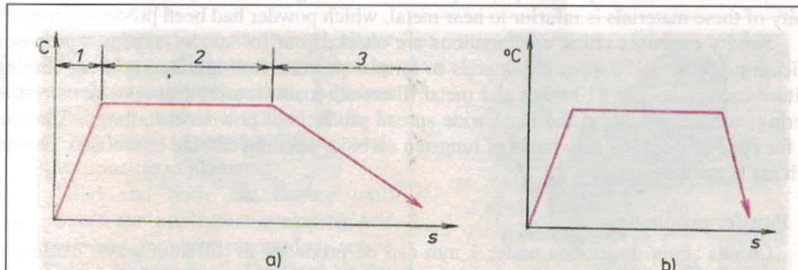

Fig. 3. Process of heat treatment
(1 – warming-up, 2 – tenacity, 3 – refrigeration, a) slow refrigeration, b) quenching)

Material cools quickly at hardening. Turbid material has heavy expenses inner tension, is hard, but also fragile, that is why every hardening is followed by tempering. We can harden steels which include over 0,35 % cinder. Products are hardened and tempered after cutting.

After hardening single parts can be shaped already only by grinding or special cutting method.

Cementation and nitriding belong to chemical-heating process. During this process structure changes and chemical ones are made. Chemical changes appear just on surface. Cementation and nitriding are used to increasing surface hardness with steels that cannot be hardened.

Substance of cementation is saturation of surface strata of single parts with cinder on such a cinder quantity to be able hardening (up to 0,9 % cinder). Cementation is followed by hardening and tempering. Kernel of single parts stays soft and hefty, just a layer contains cinder is hardened.

Nitriding is saturation of surface of work by nitrodgen. Thin nitride film which gives steels big surface hardness rise on a surface. Single part is not hardened after nitriding.

4. POWDERY METALLURGY

Powdery metallurgy makes possible to produce materials from powder mixtures of different metal or from mixtures of metal and nonmetallic chink. Connection of chink rise by the instrumentality of pressure and temperature. This technology helps to raise new materials, which join good qualities of single components.

Technology of part production from powder includes following basic operations:

- chink production;
- chink-compacting (shaping);
- sintering (fritting);
- shanking (coining, calibration) pomace.

Structure of this way made part is porous, because grains have precincts among them. Density of these materials is inferior to near metal, which powder had been produced from.

Sundry expenses chink combinations are checked-out for sundry expenses purposes. Modicum carbonic and copper chink adds to ferrous powder. Self-lubricating shear bearing, garniture friction-coupling , brakes and metal filters are manufactured from powder steeltrap Sintering carbides belong to the most wide spread products of powder metallurgy. They are used for edge-tools. They are chinks of tungsten carbide, titanium carbide or tantalum carbide which are bonded by age.

4.1. Powder production

Chinks about dimension under 1 mm can be produced in different ways. Milling in various mills is one of very often used methods. It often uses atomization as a way of production. Liquid metal leakages out of funnel and is atomizated by current of air, water, oil or other matter. Grain shape is characteristic of way, whereby powder was produced.

Chinks dry and are sorted on sieve. To reduce their inner tension, they are homogenized in warming and slowly revolving diamonds.

4.2. Compacting

Compacting is done on pressing instruments. The biggest concretion of chinks springs below en face punch. Better results in uniformity of concretion are reached by rolling or

pushing-trough. Their disadvantage is, that get past only for fluent production with permanent cross-section. Compacts hold its form just thanks to tenacity of chinks, it is impossible to use them in practice.

4.3. Sintering

Sintering is used to achievement of requisite hardness and strongholds of compacts. The connection of chink happen by the instrumentality of pressure and temperatures at the same time. Sintering temperature is chosen up to 85 % funds of thaw point. Coining and calibration finally ensure accurate dimensions and shapes.

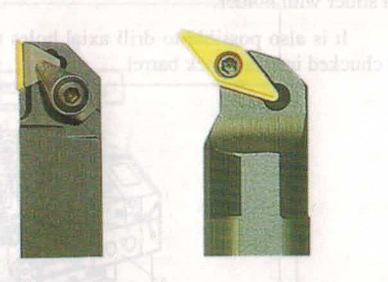

Fig. 4. Cutting plate tips made of sintering carbides

5. CUTTING

Cutting is a technological process, whereat superfluous subassembly is separated away from workpiece like turnings razor-edge by edge-tool. Cutting is done in a following system:

- machine – implement – workpiece.

Cutting can be hand (sawing, drilling, filling…) or mechanical. Fundamental manners of tooling are turning work, boring, paring, planing, slotting, shaving, pushing-trough and grinding.

5.1. Turning work

Rotating surfaces are turned above all. Chief rotational motion is done by workpiece at turning work action. Adjacent straight motion, which is called shift, is done by implement. Tools for turning work is tool. It is one-tip implement.

Head and body are feature tool. Body serves for implement cramping and bringing. Head includes razor-edge, active part of knife. Razor-edge is limitated by flat forehead, on which chip moves away and flat back. Head of knife further includes edge and points.

The machinery for turning work is lathe. The most universal is centre lathe, which consists of lathe bed headstock, grass-hopper, carriage, feed mechanism and facilities.

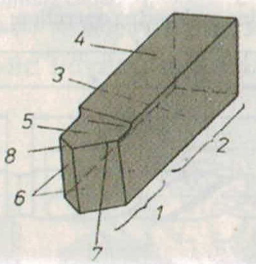

Fig. 5. Cutter

(1 – head with cutting edge, 2 – body, 3 – institute surface, 4 – clamping surface, 5 – forehead, 6 – back, 7 – chief edge, 8 – adjacent edge)

Other parts of lathe are set on bed. Headstock together with hollow spindle ensure chief rotational motion of workpiece. There is a tip for supporting of long workpieces in tailstock barrel. Carriage ensures tool feed and has lengthwise and transverse slider, turn-table and slider with holder.

It is also possible to drill axial holes to roll and to thread. Tools for these operations are chucked into tailstock barrel.

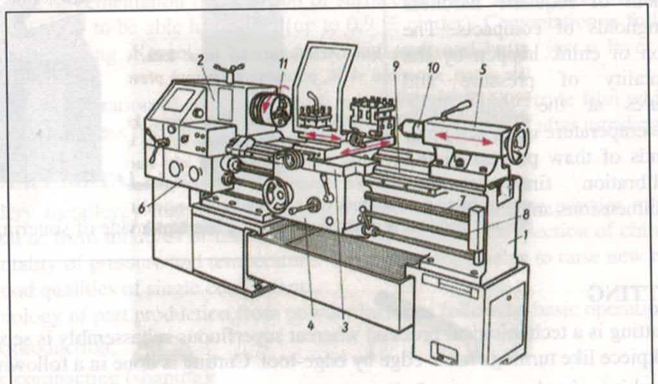

Fig. 6. Centre lathe

(1 – bed, 2 – headstock, 3 – carriage, 4 – apron, 5 – grass-hopper, 6 – feed gear-box, 7 – lead screw, 8 – guide rod, 9 – guides, 10 – tip, 11 – chuck)

5.2. Drilling and boring operation

Drilling is cutting a hole into massive material. Rough-drill holes are enlarged by boring.

Drilling tool is a drill which performs chief rotational motion and adjacent rectilinear shift at the same time. Two-edged twist drill is the most wide spread. Flat drill belongs to the oldest drilling tools.

High accurate holes are rough-drilled with twist drill, then they are roughed out with reamer drill and complete with reamer. Reamer drill has 3 or 4 razor-edge, reamer 8 and even more.

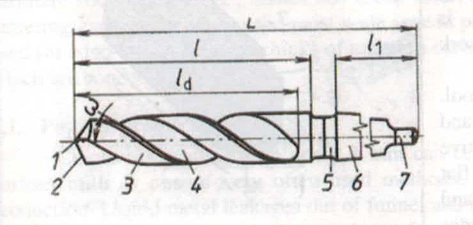

Fig. 7. Twist drill

(1 – point, 2 – chief edge, 3 – tooth, 4 – groove, 5 – neck, 6 – stalk, 7 – ejector)

Countersinking bits are used for enlarging of holes endings to countersinking.

Machinery for boring are called drilling machine. Small dimensions holes are drilled on bench drill, bigger holes on columned and pedestal drilling machine.

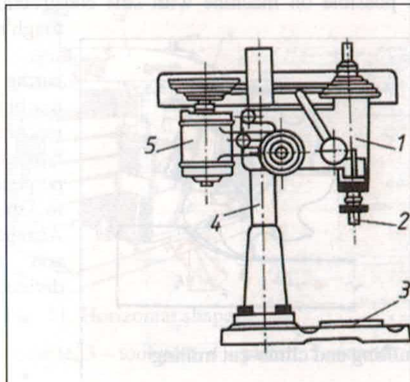

Fig. 8. Bench drill

(1 – headstock, 2 – spindle, 3 – table, 4 – post, 5 – motor)

5.3. Milling

Plane surfaces and shape surfaces are cut with revolving multi-edge tip tool-cutter. Spiral flutes, threads, toothed wheels and shaped cavities are also milled. Chief rotary motion is done by milling cutter. Adjacent movement of workpiece is either rectilinear, or circular.

Plane surfaces with paring cylindrical and face-milling cutter.

We divide milling according to sense of rotation into milling cutter in face of direction of feed dividing paring on:

- conventional milling
- climb-cut milling.

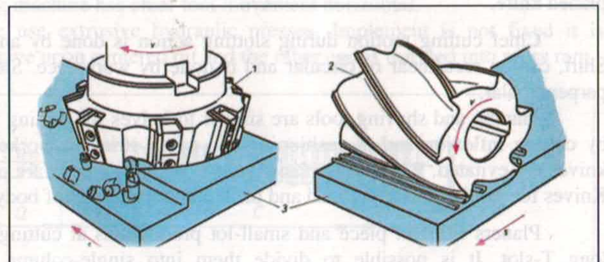

Fig. 9. Paring with frontal and cylindrical milling cutter

Cutter moves in opposite directions of feed during conventional milling. Disadvantage is worse surface finish and direction of cutting force (be pointed at up), which required quality chucking of workpiece. The dimension of warf increases with step by step. Conventional milling fits for cutting forging and foundry, which have unclean and hard surface.

Cutter turns in sense of feed during climb-up milling. Terms cross-section of withdrawed chip decreases, tooled surface is smoother, cutting velocity and productivity overmatch. Disadvantage of climb-cut milling are tonic beats at each tooth engagement into material. Climb-cut milling is possible on machine with stiff construction and softer and tough materials are cut.

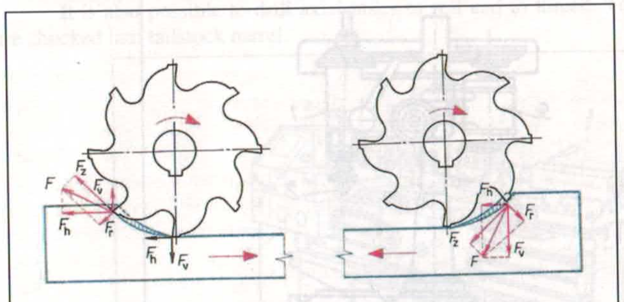

Fig. 10. Conventional milling and climb-cut milling

The machine for paring is a milling machine. Milling machinerycan be either horizontal or perpendicular according to spindle orientation. According to purpose and construction are divided into:

- knee-type miling machinery;
- table milling machinery;
- fix-bed milling machinery;
- special milling machinery.

Knee-type milling machinery are used most often. They have sliding knee up a stand. There is a work bench for chucking a workpiece placed on a sliding knee. The knee makes possible vertical movement of bench.

5.4. Planing and slotting

It is worked by a tool with one cutting edge. Chief motion is linear and reversible. Secondary motion is interrupted and vertical to the direction of chief motion.

Workpiece performs chief motion and adjacent movement is done by an implement – planed knife.

Chief cutting motion during slotting action is done by an implement – shaper tool. Shift, can be rectilinear or circular and is done by workpiece. Slotting can be horizontal or perpendicular.

Planing and shaving tools are similar to knives for turning work. Planing knife stands by cutting inflexion and at cushioning can cause striae in worked flat that is why planing knives are evitated. Burnishing planed knives with long edge are used for finshing operation. Knives for slotting have forehead and back on opposite part of body knife.

Planers exert in piece and small-lot productions at cutting long plane surfaces, e.g . long T-slot. It is possible to divide them into single-column and double-column. The advantage of single-column planers is that plane workpieces transcendenting on one hand of work-table can be planned on them. Double-column planers have stiff construction.

Slotting machinery are possible to divide into horizontal and perpendicular. Horizontal shaving machine is used for cutting short plane surfaces. It is possible to use it for cutting gear

hubs. Perpendicular shaping machinery are used above all for cutting interior surfaces, e.g . square holes, gear hubs….).

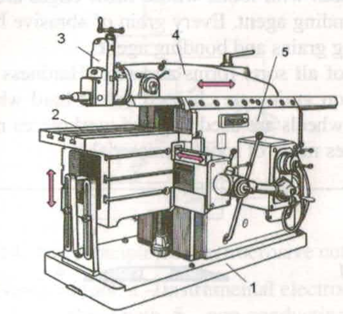

Fig. 11. Horizontal shaper

(1 – base, 2 – work-table, 3 – tool post, 4 – platen, 5 – stand)

5.5. Shaving and pushing-through

Shaving and pushing throught belong to a productive and accurate methods of working holes of various shapes, gear hubs and formative outer surfaces. They are asserted especially in a lot production. Draw-through tools are extravagant, their production is complicated and expensive. Multiedge implement, draw-through or broach, pursuances rectilinear chief movement. Singles razor-edge teeth are made-up so, that following tooth surpass previous about small appreciate, which presents shift on tooth. Every tooth step by step withdrawing material. Last teeth are not graded about shift on tooth. They smooth and peen finish machined surface.

Implement either prolongate,or force through a workpiece. Therefore it is called shaving or pushing-through. Broaches are stressed by traction, that is why they may be longer than push- broaches, that are stressed by pressure. Broaches and push-broaches distinguish except length, that they have not a fixative part.

To broach inner and outer surfaces we are supposed to use two types of broaching machinery:

- perpendicular broaching machine has chief tool movement upright;
- horizontal broaching machine has chief tool movement horizontal.

To push-broach we use extrusive hydraulic presses. Implement is not fixed it is incorporated throught fore give upon centered pit and the other end is inserted into press ram.

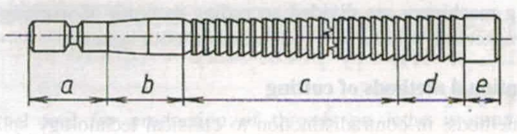

Fig. 12. Broach

(a – fixative part, b – fore lead, c – cutting section, d – calibred part, e – rear lead)

5.6. Grinding

Grinding belongs to the oldest original methods of cutting. It is a complete method of cutting plane, cylindrical or formative surfaces with tools, whose razor-edges are created by grains of hard materials, mutually joined bonding agent. Every grain of abrasive has different geometrical form. There are some pits among grains and bonding agent.

Grinding tools are grinding wheels of all sorts forms and size. Hardness of abrasive reels is identified by bonding agent. Attrition grains are chipped out of hard wheels worse, self-sharpening of reels drags behind. Hard wheels are used to grind workpieces made of soft materials, soft wheels for grinding workpieces made of rougher materials.

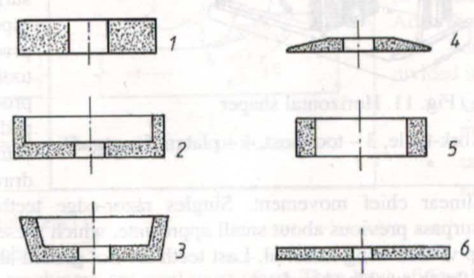

Fig. 13. Shapes of abrasive disks

(1 – surface, 2 – pot, 3 – dish-shaped, 4 – taper, 5 – annular, 6 – cutter)

It is necessary to balance grinding wheel before grinding, not to-throw and shoot, to remove unevenness of reels and attrition grains.

We work with big cutting speed at grinding and withdraw turnings of small cross-section. Basically grinding is equal to cutting. Chief movement is rotary and is done by an implement.

Grinding is also used for sharpening of edge-tools, in order to recover their cutting power.

Grinding machinery are divided according to types of working into point, pointless, pit, plane, toolmaker and special (e.g . on thread or tooth system).

5.7. Unconventional methods of cutting

These methods, in contradistinction to classical technology splintery cutting, unused for stock removal edge-tools. They are found on utilize of other removal ways of material. They are the only possible way, how to produce a part in some cases.

evropský sociální fond v ČR EVROPSKÁ UNIE MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

5.7.1. Electroerosive machinning

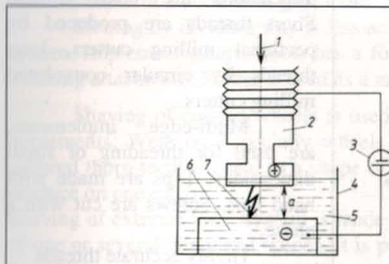

Fig. 14. The principle od electroerosive cutting

(1 – advance of tool, 2 – instrumental electrode, 3 – generator, 4 – working bath, 5 – non-conducting liquid, 6 – workpiece, 7 – electrical discharge)

The substance is an electrical discharge, that happens between the two conductive electrodes placed in an unconductive liquid. One electrode is a workpiece (must have good electric conductivity), another electrode is an implement, which puts near a workpiece. Repeated discharges cause gradual deterioration and drafting of material on workpiece. Implement loses minimum of material, because it is produced from copper or plumbago. Electroerosive low-level cutting is used for production of die cavity, compression moulds and forms for casting. This way is possible after tarnish, it increases accuracy of sinuses.

Electroerosive wire cutting exploitate copper wire as an implement, which unspools from one cop on another and at the same time goes through workpiece. Electrical discharges between wire and workpiece withdraw material from workpiece and cut pertinent form. Cutting is slow but highly accurate. It is possible to cut very hard materials this way.

5.7.2. Cutting scan

It is a way used for cutting hard and fragile materials and materials electrically non-conducting. The removal of material is caused by abrasive effect of abrasives, which is sent in a form of suspension between implement and machined material. Implement oscillates with ultrasonic frequency and grains corrode work surface. It is possible to cut, hollow sinuses and pits of different forms this way.

5.8. Production of threads

The way of thread production depends on their sizes, kind and required accuracy. We especially mean threads of binder screws and common made nuts, but also threads of test gears and leaders with high accuracy.

Threads are manufactured with implements for threads by hand or mechanically.

5.8.1. Threading

The fundamental tool for production of threads on lathe is convoluted tool. A workpiece turns with cutting speed, chaser scrolls in direction of work axis about one lead per a revolution. A feed of tool is derivated from guiding screw. Several catches is needed to produce a thread with a full depth.

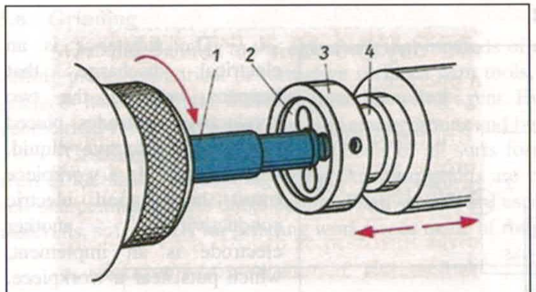

Fig. 15. Tapping convoluted jaw on lathe
(1 – screw, 2 – chaser, 3 – holder, 4 – tailstock sleeve)

Threads of bigger dimensions are often milled. Short threads are produced by pectineal milling cutters, long threads by circular convoluted milling cutters.

Multi-edge implements, are used for threading of small dimensions. Taps are made with hand taps. Screws are cut with a chase.

Highly accurate threads are completed by grinding. The principle of thread grinding is identical threading.

5.8.2. Shaping of threads

Shaping of threads belongs to the most productive manufacturing technology. Comparing it with cutting it has many benefits. Operation time is much shorter, thread is produced with higher speed, cut intacta fibrousness increases fort of thread and pressure at shaping increases smoothness surface of thread.

External threads are shaped by rolling. Short threads are rolled by two disks, long threads are rolled by rolling heads or jaws. Jaw is firm and can roll only definite thread.

Shaping of internal thread uses shaping taps, which have not lengthwise grooves.

5.9. Production of cogged wheels

Cogged wheels are parts of kinetic mechanisms mostly machinery. We require them to be high accurate, durability, operation and noiselessness. Production of cogged wheels belongs to the most difficult lines of engineering production.

Methods of production tooth system are possible to divide according to kinematics of cutting into two chief ways:

- dividing way – is less accurate, suitable for lumpiness and small-lot productions;
- self-generating method – has more accurate form of involute side tooth, is more efficient and fit for serial productions.

5.9.1. Production of spur gearing wheels by divisive way

The easiest way of production spur gearing wheels is milling dividing way. Tools are draught or circular formative milling cutters, whose form is identical to tooth space. Milling cutters create step by step one tooth space behind the other. After finishing one tooth space a workpiece index by the help of divisive apparatus about one space and another tooth space is milled. It is possible to mill spur gearing on universal overhanging milling machine this way. Tooth system is not much exact. We would need to use another milling-cutter so as to be able to mill exact tooth space i.e use another milling cutter for each number of gear teeth, which is

not possible. We use sets of milling cutters. Each milling cutter is used for production of definite extent of a number of gear tooth.

Slotting by dividing way is less accurate and little productive way of production tooth system. Implement (shaper tool) has a form of dentilated space, workpiece is cramped into indexing attachment. Slotter is used as a machine.

Shaving of cogged wheels is used just for a serial production, because of expensive implements. Wear on Especially wheels with internal tooth system are shaved. Profile of calibred thorn teeth is equal to a shape of dentilated spaces. Inner tooth system is possible to produce on one catch.
Shaving of external tooth system is made by a divisive way with a broach, which has profile of one or several dentilated spaces. It is possible to use circular broaches. One tooth space is done by one veer of circular broach.

5.9.2. Production of spur gearing wheels by self-generating method

It is possible to make exact tooth system only by self-generating method, when implement and workpiece practise at work such movements, as if generate one on another. Further benefit is, that for production of tooth system of the same modul with any number of teeth is needed only one implement.

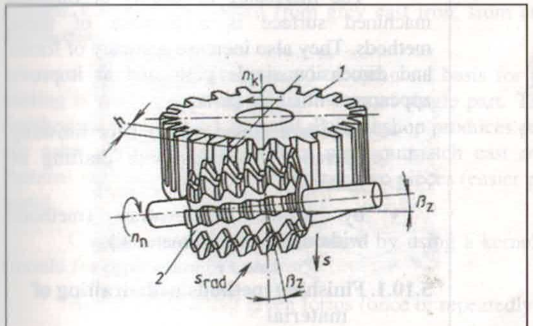

Fig. 16. Paring spur gearing by self-generating method

This process is done on hobbing machine. A workpiece is clamped on a table, which turns. Milling cutter is clamped on an arbor, is turned about spiral angle, rotates and makes also adjacent shift. All depth of dentilated is milled in one.

Milling by self-generating method is the most frequent way of tooth system production. Hobbing machine is used. They are cylindrical formative milling cutter with milled grooves. Profile of cutter teeth are trapezoidal. Involute of tooth side is done by generation.

Slotting by self-generating method is done with two standard types implements:

- circular shaper tool;
- pectineal shaper tool.

Circular shaper tool makes straight-line reciprocating motion and at the same time slowly turns. Machined wheel, clamped on the table of shaping machine, also turns. Wheel is made in 1 and 1/4 of its revolution. During perhaps 1/4 of wheel revolution an implement rolls to a workpiece in order to make full depth of dentilated space.

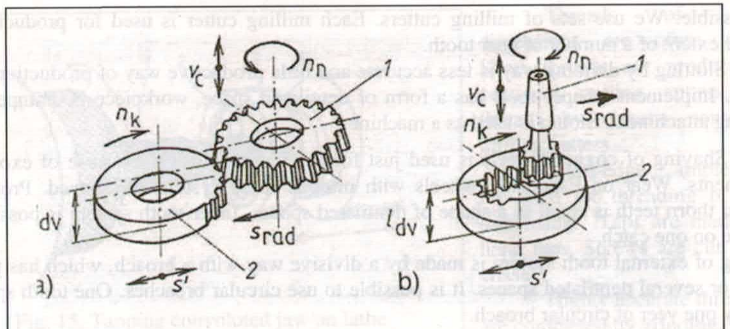

Fig. 17. Slotting spur gearing by self-generating method

5.10. Finshing methods of cutting

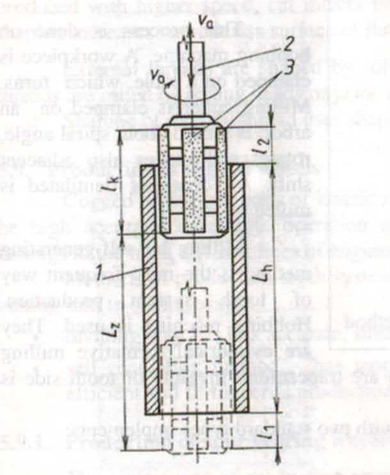

Fig. 18. Tenet honing

(1 – workpiece, 2 – hone, 3 – honer stone)

The increasing of quality of finished machined surface is a purpose of these methods. They also increase accuracy of forms and dimension single parts and to improve appearance of single parts.

- to reduce added material for finishing operation (methods with drafting of material);
- by plastic deformation (methods without drafting of material).

5.10.1. Finishing methods with drafting of material

Finishing (cutting, milling and grinding) is typical for high cutting speed, small feed and small cutting depth. Tools with changable edges plates made from sintered carbide are used for fine cutting.

Honing is used for finishing of inner cylindrical surfaces (war of motors). In principle it is small speed grinding. Hone with honing stone is a tool. Implement slowly rotates and at the same time does straight-line reciprocating motion. Cutting proceeds together with substantial supply of coolant. Pressure of honing stones gradually decreases.

Superfinishing is a slow grinding of outer cylindrical surfaces. Tool is superfinishing head with grinding stones. A workpiece slowly rotates, implement oscillates and at the same time scrolls in direction of workpiece axis. Pegs and the ends of shafts for shear storage are superfinished most often.

Lapping reduces material by free abrasive scattered in liquid or grinding paste. Lapping is used especially to complete plane surfaces (standard gauge). Tools are lapped reels.

5.10.2. Finishing methods without drafting of material

The principle of rolling is holding-down one or more rollers of high hardness on machined surface. During this process surface unevenness are rolled back (rammered) into surface of a part. Rammering of unevenness increases fort of surface of single part. Rollers are rotary seated in a holder. Revolution surfaces– outer and inner are especially rolled. Rolling is most often done on lathes.

6. CASTING

Casting is a way of production of parts made from meltable materials. Liquid alloy is poured into casting moulds with a cavity. Melt in casting mould consolidates and a cast is created. Castings are poured from grey cast iron, from cast steel, copper alloys, aluminum, thermoplast…

A drawing of single part is a technical basis for production of casting. A design of casting is made according to a drawing of single part. The design of casting is bigger than finished part over added material. Pattern shop produces pattern, by the help of which moulds are made. Proportions of pattern must outmatch cast over shrinkage of casting material. Patterns are most often produced from two pieces (easier production of mould) from wood or metal.

Cavity in a cast is manufactured by using a kernel, which is produced in a core box (mould for production of core).

According to using given forms (once or repeatedly) they are divided into:

- non-permanent (sand);
- lasting (metal).

Non-permanent moulds are produced of mixture of sand and bonding agent. They are made either by hand, or mechanical. Drying out made moulds more resistant. A mould is broken during drawing a cast out of it.

It is necessary, to create gatting and air vent system to make perfect cast. Downgates make possible to add melt into all places in a cavity, air vents exhaust fumes out of cavity.

6.1. Progress of formation into two frames

- put a low half-pattern and flask on apattern desk;
- dust a pattern with a chink, so as not to stick sand on a pattern;
- pour sand into a frame and ram down;
- remove superfluous sand;
- turn over a frame about 180 °;
- put the second half-pattern, set up gatting system and exhaust;
- put an upper frame;
- dust with chink;
- pour sand into a frame and ram down;
- unpeg for gate and exhaust;
- lift and turn over about 180 ° upper part of mould;
- take out both halves of pattern;
- mend damage parts of cavity;
- place a kernel (if a cast has a cavity);
- put together a mould and safe against buoyancy force;
- pour.

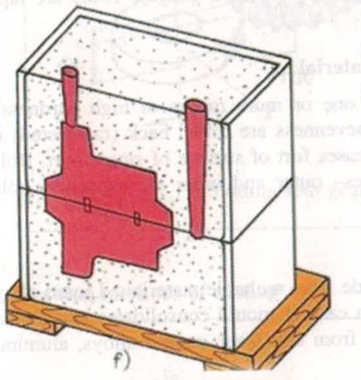

Fig. 19. Formed both halves of mould

6.2. Centrifugal casting

Melt is infused into quickly revolving metal mould during centrifugal casting. Melt is held-down to side of mould by centrifugal force, where gets stiff. Cylindrical foundries with a hole (e.g . war) are created without using a kernel. Centrifugal casting can be perpendicular or horizontal according to a position of axis of rotation.

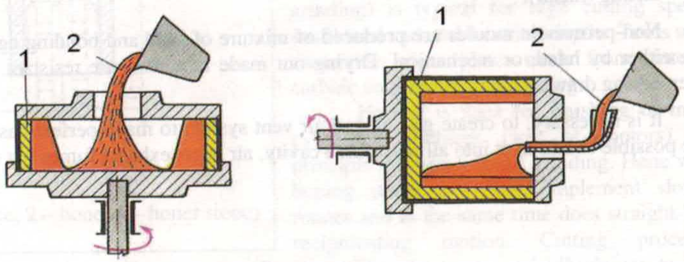

Fig. 20. Centrifugal casting

evropský sociální fond v ČR EVROPSKÁ UNIE MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY OP Vzdělávání pro konkurenceschopnost

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

7. SHAPING

Form is changed by the acting of outer coming forces without breaking of material entirety. Elements are transfered and plastic (lasting) deformations are created.

Forming is divided into two groups: hot forming and cold forming. It depends on temperature. If it is formed at temperature lower than temperature of recrystallization given material, we talk about cold forming. If it is formed at temperature higher than temperature of recrystallization shaping material, we talk about hot working. At cold forming recrystallization does not happen. At hot working recrystallization happens and granulity changes, material is not fortificated.

7.1. Hot working

During hot working steel is warmed to shaping temperature and it is necessary to keep this temperature of steel by repeated warming-up. Hot forming includes forging, which is possible to divide in hand and mechanical. Forging creates forged pieces.

Mechanical forging increases productivity and makes work easier. It can be:

- hammer forging;
- drop forging.

Forging is done on drop hammers or on presses.

use top swages and bottom swages as tools for smith forging. Forge tongs (fort turning forging) and packing piece (to create notches before shouldering).

Basic kinds of working during smith forging:

- upsetting – sectional area of forging is enlarged, its length gets shorter;
- protraction – sectional area of forging is reduced, its length is elongated;
- punching – with using of punching core;
- shouldering –sudden change of cross-section.

A die is a tool for forging. It is a steel binary form with a cavity, which has a form of forging. During forging a cavity is gradually filled. Excessive metal is forced out into sides and forms fin, which is removed by cutting after taking out a forging from a die. Forging made in a die is more accurate.

7.2. Cold forming

According to development of deformation is Cold forming is either surface or voluminous according to development of deformation.

Plates are used for surface forming and radical change of sheet gauge does not happen. Trimming, inflexion and drawing of half-closed vessels.

Voluminous forming includes pushing-trough, with change of cross-section of semi-product.

7.2.1. Triming

Triming is a process of surface forming, when material is separated in all cross-section and various semi-products or products made of plate are created. Triming is done with scissors or shearing implements – shearings.

Main parts of shearing are punch and punching die. Punch is a single part of movable tool part and punching die is a single part of stable tool part. Material is inserted between punch and punching die. There is a clearance between punch and punching die, which is chosen according to thickness of cutted metal plate and works right course cut.

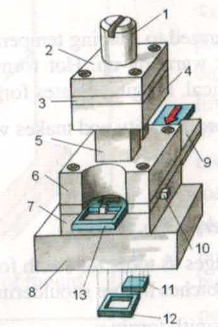

Fig. 21. Shearing

(1 – stalk, 2 – fixative capital, 3 – enclosure, 4 – clamp plate, 5 – punch, 6 – quidance, 7 – punching die, 8 – bedplate, 9 – guide-rail, 10 – backstop, 11 – trash, 12 – cutting)

8. PROCESSING OF PLASTICS

Plastics come up to processing usually in a form of chinks or grains. They are worked with various methods to finished products or semi-products (boards, foils, pipes).

8.1. Processing of thermoplastics

Injection is the most spreas way of processing of thermoplastic to finished products. It is done on injection moulding machine. The principle is injection of melting-down plastic pressurized into enclosure form. The form is metal, usually steel, cooling and has an ejector. Matter is cooled down in a form consolidate and is automatically ejected out. The whole working process takes several seconds. Form can be for one product or several ones made in one injection.

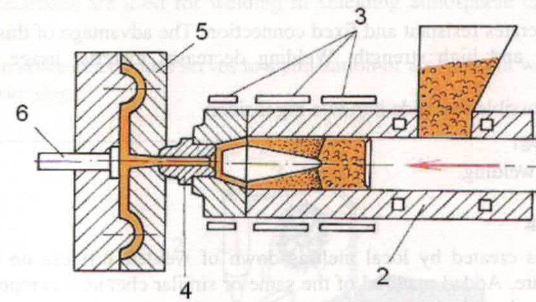

Fig. 22. Injection of plastics

(1 – piston or worm, 2 – heating cylinder, 3 electric heating, 4 – nozzle, 5 – form, 6 – extractor)

Extrusion is continuous way of forming thermoplastics. It is used for manufacturing of tubes, bars, wires or strips. Extruded pipes can be used for production of plastic bottles.

Rolling is used for production of foils.

8.2. Processing of reactoplastics

The oldest way of plastic processing is stamping of reactoplastics. Restrained quantity of moulding material in a form of granule or chink is put into steel heating form Form is shut and matter crosses over by the instrumentality of pressure and temperature into fluid state, fills up a form and cured itself (macromolecules make a net). After curing form is opened, moulding is ejected ,form is cleaned and the whole process is repeated. Working process lasts several minutes (according to size of moulding).

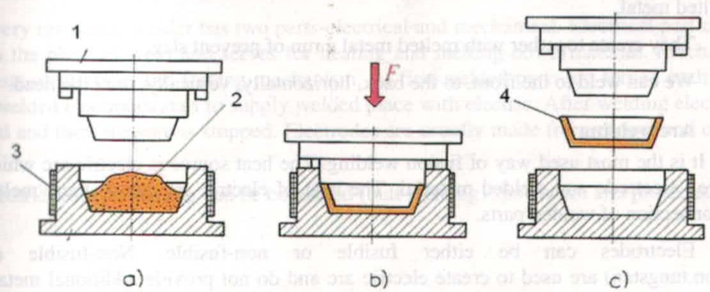

Fig. 23. Moulding of reactoplastics

9. WELDING

Welding generates resistant and fixed connection. The advantage of this connection is tightness, durability and high strength. Welding decreases material usage and increases productivity.

Welding is possible to divide into two big insider:

- fusion welding;
- compressive welding.

9.1. Fusion welding

Connection is created by local melting-down of welded surfaces on basic material without using pressure. Added material of the same or similar chemical composition to basic material is usually used.

9.1.1. Gas welding

The source of heat is a flame, which arises by burning up of mixture of flammable gas (most often acetylene) with oxygen.

Welding set consists of pressure cylinders, cylinder pressure regulators, pressure hoses, torches and facilities.

Gas cylinders are weldless steel containers. Each container must have label with kind of gas and colour mark. Acetylene containers must not be put horizontally and are marked with white stripe. Oxygen containers are marked with blue strip.

Cylinder pressure regulator decreases a pressure of gas which flows out of cylinder to working pressure and keeps it on the same level.

Pressure hoses connect cylinder pressure regulators with torches. Blue pressure hoses are used for oxygen and red pressure hoses are used for flammable gases. Their length must be 5 metres at least.

Welding torches are used to mix flammable gas with oxygen. Fluxes prevent oxidation of melted metal.

They create together with melted metal a run of prevent slag.

We can weld to the front, to the back, horizontally, vertically, over the head.

9.1.2. Arc welding

It is the most used way of fusion welding. The heat source is electric arc which creates between electrode and welded material. The heat of electric arc causes local melting-down and connection of welded parts.

Electrodes can be either fusible or non-fusible. Non-fusible electrodes (carbon,tungsten) are used to create electric arc and do not provide additional metal. Fusible electrodes have the same or similar composition like welded material they are melted and supply weld with additional metal. They can be bare or coated.

evropský sociální fond v ČR EVROPSKÁ UNIE MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY OP Vzdělávání pro konkurenceschopnost

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Bare electrodes are used for welding in shielding atmosphere or for submerged-arc welding.

Coat on coated electrodes serves to stabilization of arc, prevent weld metal against air and help to create slag.

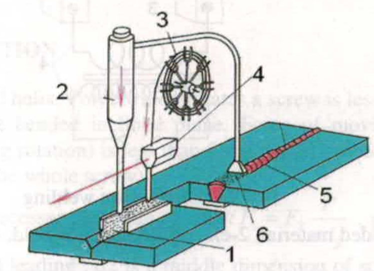

Fig. 24. Submerged-arc welding

(1-flux, 2-flux container, 3-electrode, 4-welding head, 5-weld, 6-sucking off excessive flux)

9.2. Pressure welding

Connection is created by local melting-down of contact surfaces and forcing connected parts each other (pressure welding with melting) or just by forcing of connected parts (pressure welding).

9.2.1. Electric resistor welding

Every resistance welder has two parts-electrical and mechanical. Electrical part carries electric to the place of weld and serves for heating and melting-down material. Mechanical part consists of gripping and forcing mechanism. At first welded parts are forced each other and then welded electrodes start to supply welded place with electric. After welding electric is interrupted and then pressure is stopped. Electrodes are usually made from copper and cooled by water.

Electric resistor welding can be contacted (butt welding) spot, seam and projected.

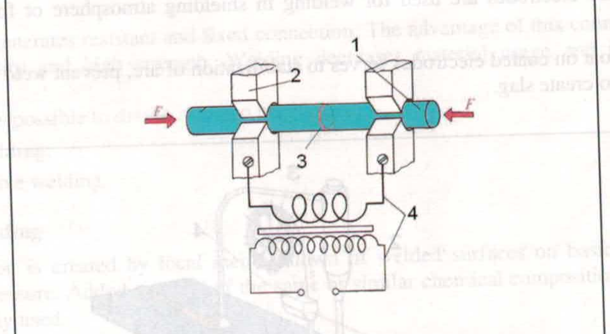

Fig. 25. Electric arc welding

(1-welded material, 2-electrodes, jaws, 3-weld, 4-transformer)

10. CORROSION AND ANTICORROSIVE PROTECTION OF METALS

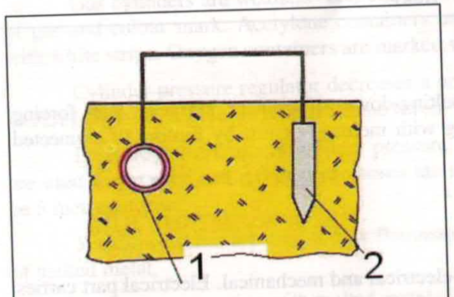

Fig. 26. Electrochemical protection by anode

(1-protective pipe, 2-anode)

Corrosion is destroying metals due to their chemical or electrochemical reaction with their environment. It can runs in atmosphere or other gases, in water or other liquids and soils which have a contact with metal.

Chemical corrosion runs in non-conductive surroundings.It is most often an oxidation of metal. During steel heating layers of oxidatives-scales-are created. Scales make lots of technological problems-loss of material, expanding and forging of scales into surface, hard surface which makes cutting more difficult etc.

10.1. Ways of anticorrosive protection

The speed of corrosion of products and plants can be reduced by a few ways already during their design. They are: choice of material, constructive arrangement, arrangement of environment, electrochemical protection and coatings.

The protection by coats is the most spread way of anticorrosive protection of metal parts.

Coats can be divided into metal and non-metal. Nearly all metals are used for metal coats. Coats made of ceramic enamels, paints and plastics.

Before making surface treatment we must prepare clean and smooth surface of metal part. Scales are removed chemical way-pickling or mechanical way-grinding. Small parts are barrel burnished.

Degreasing with cleaners is also important. Degreasing is followed by rinsing with clear water.

11. BOLTED CONNECTION

Basic curve is called helix. Force which rotates a screw is less than force which moves a screw. Thread is in fact bended inclined plane. Force of moving slony inclined plane (moving along thread during rotation) is less than force which is needed to lift a body without inclined plane (moving of the whole screw).

Force F1 which is necessary to rotate a screw: $F_1 = F_2 \frac{P}{\pi d_2}$, where F2 is a force which loads a screw, P is a thread leading , d2 is a middle dimension of screw. We have to include abrasion. Constant needed to tight (loosen) is mentioned as torsional moment.

Screw belongs to basic connecting material either together with complementary connecting part (nut) or separately.

We recognize basic types of screws according to type of thread: meter, trapezoid, tubular, whitwort and wane.

We can divide screws according to head shape: hexagonal, countersink, oval, cylindrical, button headed and other types (carriage).

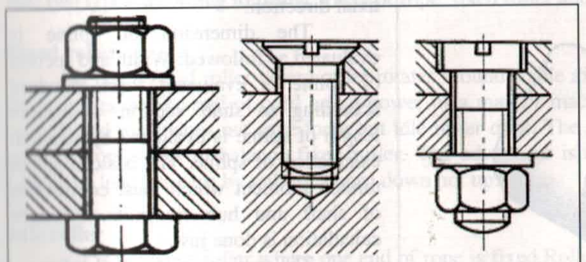

Fig. 27. Screwed joint

Screws are made from various materials in many shapes and dimensions. Screws made from steel are the most spread and produced in various strength ranks. Due to prolongation of durability of connection we use different surface treatments, most often galvanic zincing to prevent them. We design a screw according to condition of tension. We can find a screw with required metre profile according to calculated section of screw core in engineering tables.

12. CONNECTION OF SHAFT WITH HUB

It serves for transmission of torsion moment from shaft to hub or on the contrary. It also transmits axial forces, transversal forces and flexural moments. These connections are mostly standard.

Classification:

a) Force connections (friction contact): The transmission of forces between shaft and hub is done by frictional resistence which is cause due to pressing a hub on shaft with interference, cone self-locking connection or with help of special gripping components as various graduated as well as non-graduated clamp hubs.

b) Shape connection: Torsional moment is transmited by a shape of shaft connection with hub e.i.various types of slots, various shapes of shaft and hub sections(rectangular, triangular,polygonal) or through inserted shaped component (most often spline).

c) Prestressed shaped connections: they are combinations of some above mentioned wals of connections. Special case of this type is a connection with wedge.

d) Material connection: hub with shaft connected by sticking, brazing or welding.

12.1. Connection with the help of tight spline

Spline is a machine component used for connection of shaft and hub. It is a shaped connection and serves for transmission of torsional moment between hub and shaft (for example between shaft and gear).Spline is an elongated metal komponent (most often steel) with rectangular section. I t is inserted into a slot of equal shape milled in shaft. It projects out of shaft thanks to its shape.

Given hub has got a slot of equal shape through and is slipped on a shaft by the help of spline in axial direction. Spline fits its wall with slot walls in a hub as well as in a shaft. A hub on a shaft must be locked some way in axial direction.

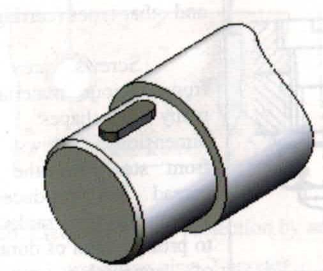

Fig. 28. Connection with the help of tight spline

The dimension of spline is evaluated as followed: Width and section of spline is evaluated from standard according to shaft section. Minimum length of spline is evaluated by strength calculation of spline. The basic is given torsion moment which must connection of shaft and hub transmits. Strenght calculation is done just.

The sections of standard splines are done as followed: if maximum permitted torsion in pressure is not exceeded, it will not exceed maximum permitted torsion in shear.

Dimension standard of splines: ČSN 02 2513, DIN 6885, ISO R 773

Advantages of spline connection:

- low costs;
- easy assembly/dismounting.

Disadvantages of spline connection:

- the influence of notch on shaft;

- necessary additional axial lock of hub.

13. SIMPLE MECHANISMS

13.1. Inclined plane

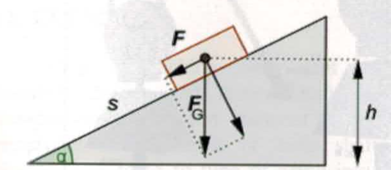

Fig. 29. Inclined plane

Inclined plane is a simple machine the only part of which is a plane inclined to horizontal direction. A body is lifted up and inclined plane saves power needed to lift up a body. The intensity of needed power depends on angle of inclined plane i.e.on length and height of inclined plane.

Balance on inclined plane happens if force F with the intensity

$F = F_G \sin\alpha$, where F_G is weight of a body, α is an angle which forms inclined plane with horizontal direction, acts on a body.

13.2. Roller

It is a single machine. Main parts are wheel and rope. A rope is usually steel. Roller is especially used for lifting bodies and changing direction of force acting. We can divide rollers into two types according to fitting wheel or rope: fixed roller and idle roller.

Fixed roller

It is a type of roller where roller rotates around stable axe. Cord is reeved over roller. Body hangs on one end of cord and a power of a man or machine acts on the other end of cord. Fixed roller does not save force but idle roller does. The same power must act on both ends of cord so as to balance fixed roller. The advantage is a change of force direction. Lifting of load happens by pulling a cord down not up.

Idle roller

It is a type of roller where one end of rope is fixed.Roller moves on a cord and a load is hung on the axe of roller. Power of man or machine acts on the other end of cord. Idle roller saves half of power.Idle roller is balanced during lifting of a load when half of power acts on a rope. Half of power means half of weight of load and roller.

The disadvantage of idle roller during lifting is a necessity to lift a roller itself and to act up, like without roller. It can be eliminated by combination of fixed and idle roller to create a tackle.

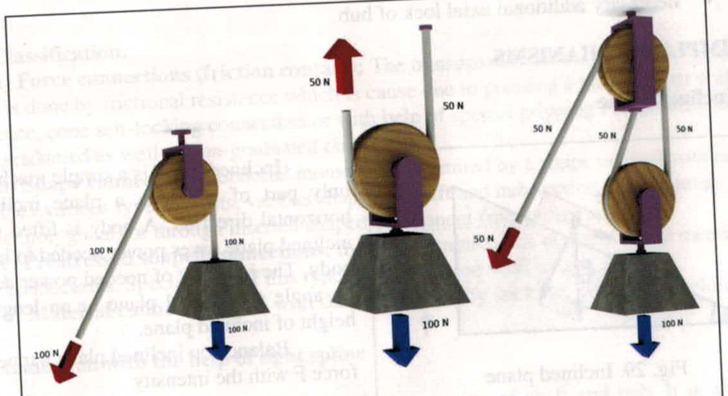

Fig. 30. Rollers

13.3. Tackle

It is a simple machine which arises by combination of fixed and idle roller. Tackle combines advantages of idle roller (saves half of power) and fixed roller (change of force direction) For example a body with gravity G can be lifted by a tackle with one idle and one fixed roller with half of force directed down.

If we use more rollers we can calculate needed force as followed : F=G/n where G is a gravity of a load and n is a number of ropes which idle rollers hang on. Rollers and tackles are used on cranes and lifting devices.

13.4. Lever

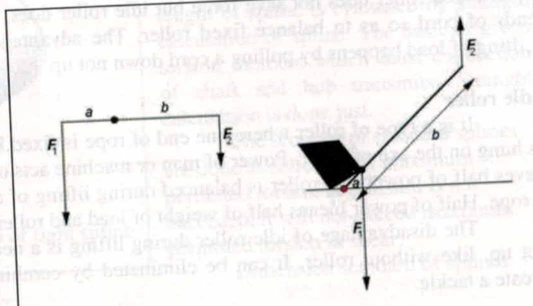

Fig. 31. Levers

It's a simple machine. The most important parts are axis of rotation, arm of load and arm of force. Lever rotates around axis of rotation, arm of load acts on a body and man or machine acts on arm of force. Lever is used for reduction of power because intensity of necessary power is inversely proportional as length of arm. If arm is longer you need lesspower to act. More forces can act on lever in more general case. Lever can have various shapes – straight bar supported in one place (crowbar), two levers connected by joint (tonus), bent shape (handle), circular shape (steering wheel).Lever is also hidden in a wheel on a shaft.

Levers can be divided according to placement of lever arms and axis of rotation into these groups: two armed levers (arms are on opposite sides from axis of rotation), single armed levers (both arms are on the same side from axis of rotation).

Lever is in balance if resultant moment of forces which act on lever is zero. If force F1 acts on arm a and force F2 acts on arm b then condition of lever balance can be expressed by formula $F_1.a = F_2.b$

14. CLUTCH

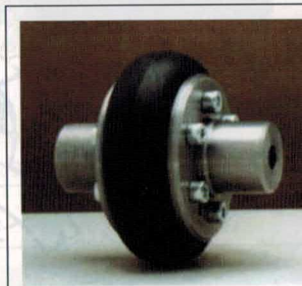

Fig. 32. Clutch PERIFLEX

It's a machine component which usually connects driving and driven shaft and serves for transmission of torsion moment and lining up of reciprocal malalignment of both shafts.We divide clutches according to type of using into solid (sleeve coupling, flance coupling) which transmit permanent torsion moment between shafts and flexible (multiple-disk clutch) which makes possible disconnection between two shafts and breaking up of transmission of torsion moment, overload release clutch (with shear pin), which ensures disconnecting of torsion moment through shearing a pin in case of overloading of torsion moment which is determined for given machine. Many different ways and components are used for transmission of torsion moment in clutches for example-pins, pivots, fitted bolts, rubber (clutch PERIFLEX) or different construction adaptation of clutch disk (claw clutch) and abrasive power is also used-multiple-disk clutch-ordinary type used in cars and motorbikes. Torsion moment is transmited by liquid in hydraulic clutch.

Fig. 33. Clutch

15. GEARS DRIVE

Gear is a disk which has a shape defined teeth around its perimeter. It's a basic construction component of gearboxes and other machinery. Gears are machine components which transmit rotative motion and mechanical energy is transmited from one shaft to the other one. They are used for permanent ratio gear and small axial distance of shafts. They are produced especially from steel but also from other materials. Gears can be made of plastics for light gearings (toys).

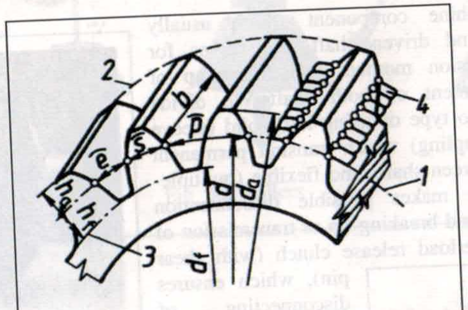

Fig. 34. Dimension of gear

Basic geometric terms:

- **Modul** - basic measure of all tooth system
- **Profile of tooth** - it is created by tooth face and adendum circle
- **Height of tooth** - it consists of adendum and dedendum range between adendum and dedendum is created by circular pitch.
- **Circular pitch** - divides tooth and space into two equal parts
- **Adendum** - (a circumscribed circle) adendum circumscribed circle
- **Dedendum** - limits tooth spaces
- **Distance of axials** - lenght straight connecting line of shafts of two mates

15.1. Spur gears

They are most often used gears. Spur teeth are determined for paralel axials of shafts. Certain gear ratio is required for construction of gearing $i = \frac{n_1}{n_2}$. It's also possible to determine gear ratio by quotient of teeth number on gear perimeter $i = \frac{z_2}{z_1}$.

Fig. 35. Gears

Fig. 36. Spurs gears with helical teeth

15.2. Spurs gears with helical teeth

Their advamtage is longer and more fluent engagement, more silent motion and fewer limiting number of teeth. The disadvantage is resulting of axial power. One gear must have positive angle of inclination and the other must have negative angle of inclination, which is necessary for engagement.

Fig. 37. Bevel gears

15.3. Herringbone gears

They have the same advantage like spur gears with helical teeth but axial force is eliminated by symetrical construction of bevelling teeth.

15.4. Bevel gears

They are used for concurent axials of shafts with common axial penetration.

Bevel gears with helical teeth

They have better operation characteristic similar to spur gears and they are more adaptable on shaft deformations during working.

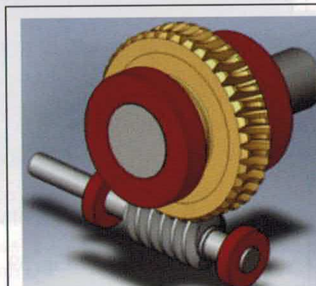

Fig. 38. Spiral gearing

15.5. Spiral gearing

Teeth gearing for extra-axial shafts. Worm gearings are special case but they are the most used. They are determined for gears between extra-axial shafts with angle 90.
Worm gearings are dividend into 3 groups:

- with cylindrical worm and cylindrical wheel (it's seldom used).
- with cylindrical worm and globoid wheel.
- with globoid worm and wheel (they are able to transmit triple output than previou ones.

15.6. One speed gearbox

It consists of driving and driven part of shaft, gear drive and box. Box includes vat and box top. Gear box can be solved either like casting or weldment or thein combination. It's lubricated with oil. It can be forced lubricated (gear pump) or sprayed. One speed gearbox is also gearbox with more gearings between input and output shaft, gear ratio is however constant.

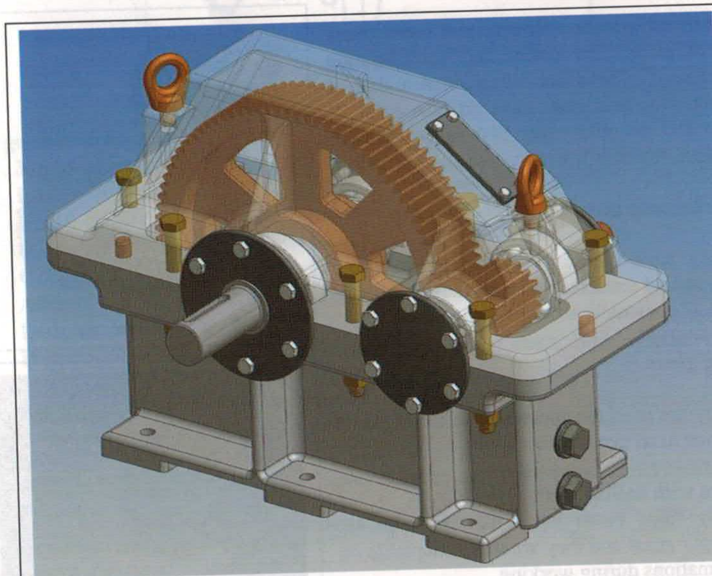

Fig. 39. One speed gearbox

evropský sociální fond v ČR EVROPSKÁ UNIE MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

16. BRAKES

It was necessary to reduce speed by brakes since the beginning of means of transport. The principle of friction force is not the best way of speed reduction but it has been used until this era. Every moving object has its move energy thanks to its gravity and speed. We change it to heat which is not used and it is necessary to carry it away.

The power is carried to friction components if we act on pedal. Breaking moment is resultated and depends on power and arm of action. Better braking effect can be reached either by bigger section or by increasing of power. Coefficient of friction of used material is another fact which affects braking. Coefficient of friction is a relative quantity which determines dependence of friction power on holding-down force.

16.1. Block braker

Brake effect is reached by holding-down of block on motion part of surface. Brake block has shaped working surface equal to break part. Brake block is gradually grinded-off and loses. The oldest block brakes were used at coach vehicles.

16.2. Drum brakes

They are used with cheaper motorbikes where brake qualities are suitable. Drum brake is a hollow cylinder placed in the middle of wheel, which is equiped by brake shoes inside. Cylindrical cam moves round a slight amount, brake shoes expand and act on drum with their out surfaces. There is sticked brake band lining on brake shoes. If power releases brake shoes are turned back to original position by spring. The advantage of drum brakes is closed construction which prevents corrosion. The disadvantage is bad cooling.

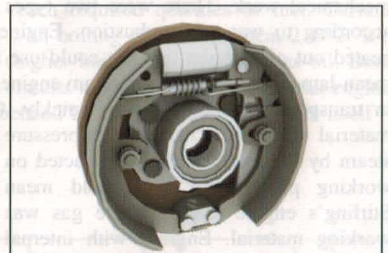

Fig. 40. Drum brakes

16.3. Disk brakes

They are controlled hydraulically most often. It´s a systém of two pistons connected by pressure hose filled with liquid. One smaller piston is controlled by lever or pedal (main cylinder) and the other end of system includes the second piston which acts on brake plates (brake stirrup). The power depends on surface of pistons directly proportional. If piston in stirrup has twice larger diameter than piston in main cylinder (on pedal) then power on plates will be four times bigger than power on pedal. Most brakem are multipistons since to make one big piston on brake valve is disadvantagable. Pistons are either from one side (it's necessary to use a stirrup with

Fig. 41. Disk brakes

axial displacement-floating) or pistons are one against the other (usually 4 pistons). Smaller pistons versus one big piston create better distribution of powers on one plate. Plates act on brake disk diameter of which determines intensity of brake moment.

Hydraulic brakes have a piston in main braking cylinder. During frictional wear off plates liquid from supply vessel fills pressure circuit a brakes adjust themselves unlike mechanical brakes. Packing in brake stirrup ensures reveres of pistons. All hydraulic system must not contain air and therefore there are venting screws on upper parts of stirrups. Gears are dividend into two independent circuits for increasing reliability. Loss of pressure in one circuit does not cause total brake failure. Left front wheel and right back wheel are in one circuit. Right front with left back wheel are in the other circuit.

Bigger trucks and tractors have air compressor as a source of pressure for pneumatic break gears. Vacuum brake booster is used in cars. It utilizes decreasing pressure in suction piping of engine to ease control of brake pedal by driver.

Endeavour to use electronics for controlling of brake process lead to enforcing of ABS systems in equipment of ordinary cars. If ABS electronics do not work brake system should work classical.

17. ENGINES

Heat engine is a machine which changes heat energy obtained from petrol to mechanical work. There were two types of engines in human history. They are divided according to way of combustion. Engines with external combustion where material was heated out of cylinder and we could use anything with good heating value. We especially mean James Watt's invention-steam engine (the end of 18th century) which started being used in transport and industry very quickly. Generally steam engines used water as working material which was changed into pressure steam by indirect heating and it acted on working piston. We also shold mean Stirling's engine (1816) where gas was working material. Engines with internal combustion appeared in the end of 19th century. Fuel burns in combustion space during expansion and regulated pressure acts on piston. It's an ignitive engine which was invented by Mr. Otto and Mr. Diesel. In the end of 19th century Mr. Daimler developed four-stroke ignitive engines. Engines improved but fundament has been the same for 100 years. At the begining of their history engines provided about 5hp from ½ litre capacity, recently it's 150 hp from the same capacity.

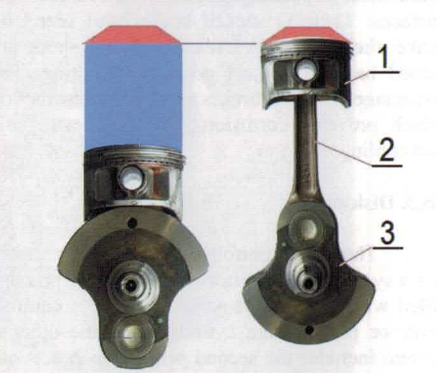

Fig. 42. Crank gear

evropský sociální fond v ČR EVROPSKÁ UNIE MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

17.1. Crank gear

It's a group crankshaft-connecting rod-piston which we find in both types of combustion engines used to drive vehicles nowadays. Piston is exposed to pressure of waste gases and its main function is packing of combustion space and transmission of power to connecting rod. Its motion is sliding between its extreme positions-dead centres. Connecting rod connects piston with crank arm which rotates around crank shaft axial placed in engine block. Connecting- rod big end is fixed by piston pin on piston and motion is sliding in cylinder axe.

Big end is fixed on crank shaft and motion is rotated. It means that rod-connecting motion is not generally very simple from the kinematic point of view. The motion of piston from top dead center (piston is in the furthest place from crank shaft) towards bottom dead centre (piston is in the nearest place from crank shaft) is a stroke of piston. Capacity filled like this (piston surface×stroke) is a stroke capacity. There is a compress space above piston when it is in top dead centre. This space in ratio with the whole space above piston in bottom dead centre is called compress ratio.

17.2. The division according to way of burning of mixture

Explosion engine and compressive ignition engine use fraction of oil, which is produced by distillation and other treatments to reach required qualities of fuel. Current explosion engines use a mixture of hydrocarbons with boiling temperature cca. 210°C. It's called petrol. Diesel engines use heavier fraction (higher boiling point) known as oil. Both engines have a lot of in common however heating circuits are a little different. Diesel engine use higher compress ratio and so injected oil influenced by compression heat ignits itself – there is no need to use ignition spark.

17.3. The division of working process

It's necessary to get fuel into a cylinder (sucking) in every engine. Fuel is compressed (compression) ignited and pressure grows up (expansion). Expansion is followed by exhaust. During exhaust combustion products leave combustion space. This process is repeated and if every phase of the process is equal to one stroke we mean four-stroke engine. Piston is in top dead centre and during motion down underpressure is created and the resultis sucking. Only air is sucked in diesel engines and explosion engines with direct injection. Mixture of fuel and air is sucked into explosion

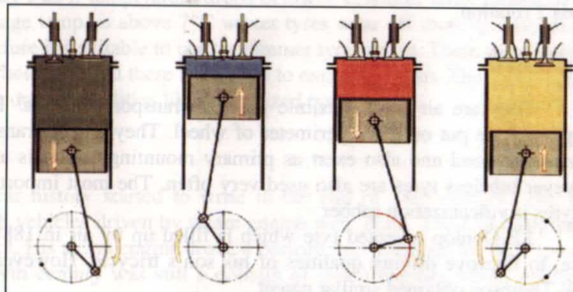
Fig. 43. Four-stroke engine

engines with carburettor or indirect injection. Sucking acts through opened inlet valve. During motion of piston up mixture is compressed, space is closed and the temperature increases to about 410°C. The space is reduced and pressure increases due to compression heat to 1,5 MPa. It's followed by expansion created due to ignition which acts useful work. After ignition of mixture it is necessary for waste gases to leave out through opened exhaust valve. It's done during piston motion up. The process is repeated after every two crank movements.

Two-stroke engine

It has 4 basic phases. Important difference is that we are able to ensure two acts at the same time, therefore the process is finished after one circulation. One circulation is equal to one rotation of crank shaft. During motion of piston towards top dead centre underpressure is created under piston and it is used for sucking of mixture which flows into crank case of engine (under piston). During sucking previous mixture is compressed by piston into combustion space as we know from 4-phases process. During piston motion down expansion of igniting mixture is resultated. In certain moment transfer port is opened and fresh mixture flows from space under piston to space above it and at the same time ejects exhaust. Valves does not ensure gear but transfer ports and piston. Two stroke engine needs just one rotation of crank shaft and four-stroke engine needs 2 rotation.

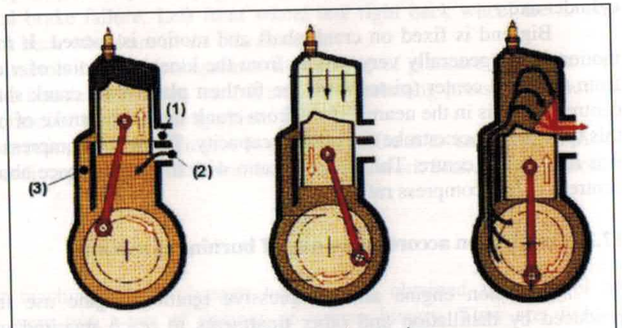

Fig. 44. Two-stroke engine

18. TYRES

They are air filled flexibile parts of transport vehicles. They usually have a toroid shape and are put on outer perimeter of wheel. They ensure transmission of power between wheels and road and also exert as primary mounting. There is an inner tube inside of tyre however tubeless tyres are also used very often. The most important material for production of tyres is vulcanization rubber

J.B.Dunlop invented tyre which is filled up by air in 1888. He made it from garden hose, to improve driving qualities of his son's tricycle. However he was not first. In 1845 R.W.Thomson obtained similar patent.

There were not suitable vehicles to use these primitive tyres in this period so the invention was forgotten. Bicycles were already produced in Dunlop's time and therefore the invention could find its using.

18.1. Labelling

Following picture describes labelling used by producers. Standard size are theoretical values valid for a new tyre.

Fig. 45. Description of tyre

- 205 - nominal width of tyre in mm;
- 55 - ratio of nominal height to nominal width in %;
- R - type of construction (R-radial, D-diagonal, B-bias belted);
- 16 - nominal diameter of relevant disk in inches-inside diameter of tyre;
- 91 - index of loading capacity (nummerical code 91=615kg);
- W - index of speed (code of alphavile W=270 km/h);
- Tyres are also labelled with texts marked specific qualities;
- TUBELESS/TUBETYPE;
- M + S, MUD+SNOW – type for driving in winter;
- RF, XL, C – REINFORCED-reinforced carcass for vans;
- DOT 24 1-week and year of tyre production (24th week, 2001 year);
- OUTSIDE, INSIDE - inside and outside sidewall;
- ROTATION - direction of rotation.

18.2. Exchange of summer and winter tyres

Generally we can say that if temperature drops below 7°C winter tyres should be put on. On the contrary if average temp. is above 7°C winter tyres wear off more quickly due to their composition and therefore it's suitable to put on summer tyres again. There are also tyres which we can use for the whole year and there is no need to exchange them. The disadvantage is that they can't reach such driving qualities like specialized tyres.

19. CARS

The beginning of car history started to write in the end of 18th century. The first successful experiments with vehicles driven by steam engine were done. Their first engineers were J. Watt and N.J.Cugnot. His steam engine drove 4 persons and managed to reach speed 9 kmp/h The beginning of 19th century was still a domain of steam engines which gradually improved and accelerated. Anyway steam engines were cumbrous and exacting. Reversal came in the second half of 19th century. The first combustive engines were invented and putin operation. N. Otto developed four-stroke engine.

The development of current cars began in 1885. K. Benz had his engine bicycle patented. G. Daimler started to build cars separated from K. Benz in 1887. He cooperated on production of engines with W. Maybach. In 1887 austrian R.Diesel constructed first compression ignition engine. President was the first car constructe in te area of current Bohemia in 1897. The first lorry followed in 1898. The first electro-cars appeared in the end of 19th century. The competition among cars with steam, electrical and combustion engines lasted till the end of the first decade of 20th century. Cars with combustive engines started to dominate even if electromobiles are twice more advantagable because of better transmission of energy. Cars driven by petrol or oil became the most important means of transport in 20th century.

The revolution in car production and their mass expansion started in the USA. Henry Ford constructed and produced accessible cars. Famous Ford model T began being sold in 1908 and was in production till 1927.

19.1. Dimensions of car

Fig. 46. Dimensions of car

- Wheel base: the distance of axles of front and rear axle
- Wheel axle: the distance of midpoints of footprint areas of one axle tyres.
- Length: the distance of vertical planes which touch front and rear ends of vehicle.
- Width: doesn't include back mirrors, clearance and blended lights, flexible parts etc.
- Height: is measured at promptness weight of a car.
- Overhang: is front and rear distance from vertical plane which goes through wheel axle to the furthest point on front/rear part of vehicle.
- Raid angle-front and rear is determined at maximum loading. It's an angle between road and plane which is tangential to tyres and any point of car body in front/behind axle isn't placed under it.
- Clearance height: is a distance of middle part of a car from road. It's measured at maximum loading of a car.

19.2. Basic parts of a car

Body, chassis, driving system, facilities, outfit and equipment are basic technical parts of current cars.

Body creates carrying part in most current cars. It provides a space for crew and load and makes fitting other part sof a car possible. Body of historically older car was made as chassis. It was done from carrying frame which was manufactured from steel girders.

Bonnet plates were welded on steel girders. They created closed room of a vehicle.

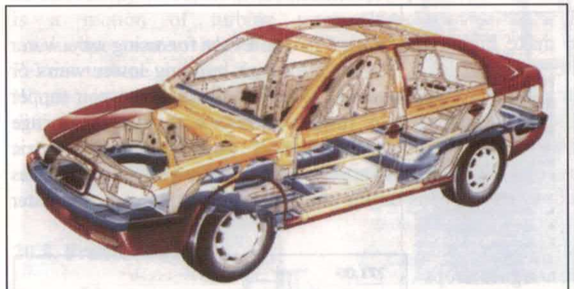

Fig. 47. Body

Body of current cars is self-supporting. It means that it doesn't include carrying frame. Bonnet plates take carrying function. Half-carrying body is an intermediate stage. Body plays very important role. It ensures passive and active safety of vehicle. Therefore it contains deformation zones, the purpose of which, is to absorb as much energy as possible at accident.

Chassis of vehicle consists of front and rear axle, spring mounting, vehicle wheels, brake system and steering. Chassis affects driving qualities of vehicle. Front axle of a car is steering.We divide concept of a car according to driving axle and a place where engine is situated.

Classical concept: Engine, clutch and gearbox are placed in the front, final drive in the back. Driving axle is rear.The transmission of driving moment from gearbox to final drive is by input shaft. BMW cars use this concept.

Front-wheel drive: All parts of drive are placed near front driving axle. Many producers use this concept nowadays. Engine is mostly seated cross, sometimes longitudinally.

Rear-drive: All parts of drive are placed near rear driving axle. If engine is seated cross in front of rear axle the construction is supposed to be marked like concept with engine in the centre.

Axles transmit gravity power of body, driving, brake and inertial forces. They make steering and spring mounting of vehicle possible.

Driving system: It includes engine, clutch, gearbox, final drive and driving shafts. These components create compact unit driving near axle. Final drive in vehicles with driven far axle isn't a part of gearbox and torsion moment is transmited from gearbox to final drive by Karban shaft.

Electrical equipment: Electical facilities of engine vehicles are: sources of energy, electric motors, catchers, ignition, illumination, electroinstallation, board instruments, electronical circuits, interference elimination, wipers, air condition, central locking up, security, electrical control, assistance system of driver and information systems.

20. HYDRO-ELECTRIC POWER PLANT

It's a technological complex which cahges water energy to electrical energy. Ordinary type of river hydro-electric power plant consists of a dame or weir which retains water and an engine room. There are hydraulic turbines and generators in engine room. Turbines and generators create machine unit which is placed on one shaft. Quantity of exploited river energy depends on high difference (relative surpass) of two different water levels and on quantity of flowing water (flow).

It's usually necessary to make high difference of water levels for using any water stream. We reach it by backwater of water level. It's done through building lower weirs or higher dams. Ordinary backwater is usually complemented by higher situated reservoir (upper reservoir) which can be placed somewhere past from original stream with pumped storage power plant. If we build weirs we can reach only from 10 to 20 m. drops. Hydro-electric power plants designed for these drops are called low-pressure through-flow. Kaplan turbines can be used for small drops about 0,6m it means on the smallest weirs. Dam can backwater water to 100m.

These power plants are called middle-pressure. If power plants use even higher drops we call them high-pressure. Most hydro-electric power plants are built on dams. In the past small plants used to be nearly on every small weir.

Dam is usually made of poured concrete. We can also find smaller earth dams. There are revise room, ventilate and drain corridors (for outlet of infiltrate water). Water flows through steel piping to water turbines. The inlet of water into piping is equiped by clearance device called racks and high pressure valve which closes water inlet in case of breaking-down.

Power plant is usually situated under dam sometimes it is built inside it.

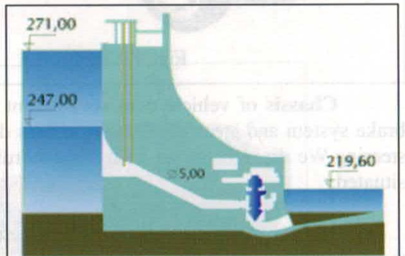

Fig. 48. Hydraulic power plant

20.1. Advantages and disadvantages of hydro-electric power plants

The advantaage is that energy of streams and revers belongs to restore sources-it can't be exhausted. At the same time its running doesn't pollute enviroment. These plants require minimum service and can be controlled long-distance.

They can start running during a few seconds and can be used to covering sudden pretension to production of electric energy.

The disadvantage is enormous prize, time of building and necessity to flood large area. We can't forget about dependence on stable flow of water.

Dam manages to prevent little flood, but it can't influence flood disaster.Dams and weirs limit shipping operation on the river and it's necessary to build a system of locks Dam lakes can serve other purposes. They can serve as recreational areas or sources of drinking and service water or fishing.

20.2. Pelton water wheel

It's an impulse turbine with partial tangential admission. Water flows tangentially to perimeter of rotor by jets. Jet on penstock is a switchboard. Water ascends from jet in a shape of circle jet impinges on runner blades of spoon shape. Each of blade runners stand up against

direction of water flow and water rotates its direction. The result of created forces is a motion of turbine rotor. If conductive water has high pressure Pelton turbine is the most effective. Water is compressible with great difficulties and nearly all its energy is transfered into turbine. Therefore just one moving wheel is enough to transmit water energy on rotor energy.


Fig. 49. Pelton water wheel

20.3. Francis turbine

It's overpressure turbine it means that working water changes its pressure on its way through machine and at the same time transfer its energy. Turbine rotor is placed between high pressure supply and low pressure suction pipe usually inside a heel of the dam. Inlet piping has got a shape of spiral casing. Water is tangentially pointed at turbine rotor by the help of stay ring of guide wheel. Blades of guide wheel are constructed as adjustable so that turbine can adapt on various water flows. Water gets out of turbine rotor in the direction of axe rotation. Water goes through turbine rotor its rotative speed decreases and at the same time water transfers its energy to moving wheel. Francis turbine has got two versions according to position of shaft-vertical and horizontal

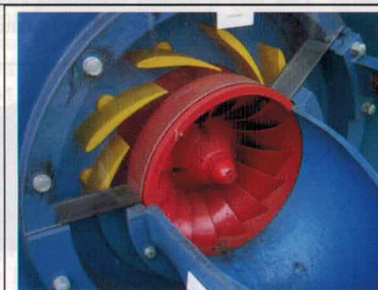
Fig. 50. Francis turbine

Francis turbines belong to the most use ones nowadays.

20.4. Kaplan turbine

It's overpressure axial turbine with a very good possibility of regulation. This fact is utilized especially in places where it isn't possible to ensure permanent flow or drop. V. Kaplan professor of technical college in Brno invented this turbine. It differs from Francis turbine by less number of blades, shape of moving wheel and especially possibility of regulation of blade inclination on moving and guide wheel. It has got higher efficiency than Francis


Fig. 51. Kaplan turbine

turbine but it is more complicated and expensive. It is used for drops from 1 to 70,5 m (which is the drop in plant in Orlík) and flows 0,15 to some tens m3/s. The biggest absorption capacity in the world have Kaplan turbines in hydro-electric plant Gabčíkovo on the river Danube i.e.636 m3/s with drop 12,88-24,20m. Generally we can say that Kaplan turbine is used especially in small drops at big flows which aren't constant.

20.5. Pumped-storage power plant

Electric energy can't be stored any way and there fore we use potentional water energy for changing to electric energy and on the contrary. If power consumption is minimal machine unit works in opposite role. Turbines as pumps and alternators as synchronous electric motors.

Machine unit fills upper reservoir of plant with water from bottom reservoir, system consumes electric energy from electrical distribution network. It behaves as big cosument of el. energy. This way it usually consumes electric energy produced in other sources, energy obtained from operation of thermal power stations or atomic power plants. If there is a lack of electrical energy in distribution network turbines work in normal mode. In this case water from upper reservoir is drained-off to lower reservoir across power plant turbines. Accumulated water energy is transformed back on electrical energy which is returned to distribution electric network.

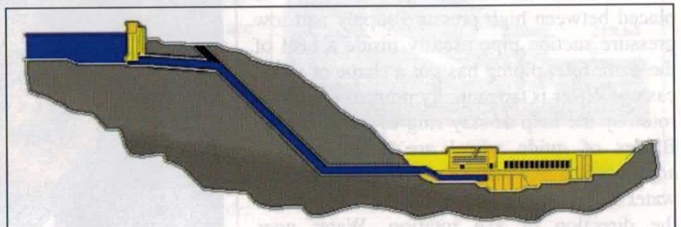

Fig. 52. Pumped-storage power plant

The biggest installed capacity has got the plant on the dam in China (Tři Soutěsky)- 18 200 MW. The biggest installed capacity in our country has got pumped-storage power plant Dlouhé Stráně – capacity 2x 325 MW, the biggest drop 510,7 m and the biggest Francis reverse turbines in Europe.

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

LITERATURE AND INFORMATION

1. Mádl J. Kafka J., Vrabec M., Dvořák R.: Technologie obrábění – 1. díl, ČVUT Praha 2000
2. Mádl J. Kafka J., Vrabec M., Dvořák R.: Technologie obrábění – 2. díl, ČVUT Praha 2001
3. Mádl J. Kafka J., Vrabec M., Dvořák R.: Technologie obrábění – 3. díl, ČVUT Praha 2002
4. Řasa J., Gabriel V.: Strojírenská technologie 3, Scientia, s.r.o., Praha 2000
5. Hluchý M., Beneš J.: Strojírenská technologie pro SPŠ nestrojnické, SNTL, Praha 1981
6. Hluchý M.: Strojírenská technologie I, SNTL, Praha 198
7. Němec D. a kol.: Strojírenská technologie II, SNTL, Praha 1985
8. Hluchý M. a kol.: Strojírenská technologie 2, SNTL, Praha 1979
9. Němec D. a kol.: Strojírenská technologie 3, SNTL, Praha 1979
10. Macek K., Zuna. P., Bartoš J.: Nauka o materiálu II, SNTL, Praha 1986
11. Chaloupecký V. a kol.: Netřísková technologie – 1. díl, VŠST Liberec 1981
12. Zapotil M., Zeman K., Flaška M.: Základy strojírenské technologie, ČVUT, Praha 1981
13. Řasa J., Kerečaninová Z.: Nekonvenční metody obrábění, MM Průmyslové spektrum 5/2008
14. Řasa J., Kerečaninová Z.: Nekonvenční metody obrábění, MM Průmyslové spektrum 11/2008
15. Kříž. R a kol. :Strojní součásti 1 pro SPŠ strojnické, SNTL Praha 1988
16. Jan Z. , Ždánský B. : Automobily 1. Podvozky, Avid Brno 2001
17. Jan Z. , Ždánský B. : Automobily 3. Motory, Avid Brno 2000
18. http://www.mmspektrum.com/clanek/nekonvencni-metody-obrabeni
19. http:/www.wikipedia.org
20. http:/www.motorkari.cz

SOME SPECIAL TECHNICAL TERMS USED IN THE TEXT

according to	podle
alloy	slitina
welding	svařování elektrickým obloukem
assembly	montáž
belong to	patřit k něčemu
blast furnace	vysoká pec
block brakes	špalíkové brzdy
body	karosérie
bottom dead center	dolní úvrať
braking moment	brzdný moment
casting	odlévání
centrifugal casting	odstředivé odlévání
clutch	spojka
connect	spojit
connection	spojení
conventional milling	nesouladné frézování
cord	lano
create	vytvořit, tvořit
cylinder	válec
dimension	velikost
direct injection	přímé vstřikování
disk brakes	kotoučové brzdy
drilling	vrtání
drum brakes	bubnové brzdy
edge	hrana, ostří
eject	vytlačit, vyhodit
fixed roller	pevná kladka
flow	téct
force	síla
four-stroke engine	čtyřdobý motor
front wheel drive	přední pohon
fusion welding	tavné svařování
gas welding	svařování plamenem
gear box	převodovka
grinding	broušení
heat treatment	tepelné zpracování
hub	náboj (kola)
hydro-eledtric power plant	vodní elektrárna

idle roller	volná kladka
ignition	zapalování
inclined plane	nakloněná rovina
lever	páka
load	náklad
manufacture	vyrobit
metal	kov
milling	frézování
nitriding	nitridování
nonferrous	neželezný
nonferrous metal	neželezný kov
piston	píst
plane	rovina
planing	hoblování
plastics	plasty
pour	lít
powder metal	práškový kov
pressure welding	svařování tlakové
ratio gear	převodový poměr
roller	kladka
screw	šroub
shaft	hřídel
shaping	tváření
single armed lever	1 ramenná páka
sintering	slinování
slotting	obrážení
spline	pero (v hřídeli)
spur gear	kolo s čelním ozubením
submerged-arc welding	svařování pod tavidlem
sucking	sání
surface	povrch
tackle	kladkostroj
thread	závit
tool	nástroj
top dead center	horní úvrať
torsion moment	kroutící moment
transmission	přenos
two armed lever	2 ramenná páka
welding	sváření