TOMSK POLYTECHNIC UNIVERSITY

METAL-WORKING EQUIPMENT

LECTURE 5

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CLUTCHES OF MACHINE TOOLS

Clutch is a device for connecting the ends of coaxial shafts between themselves and with the different parts and aggregates, and also the rotating parts together.

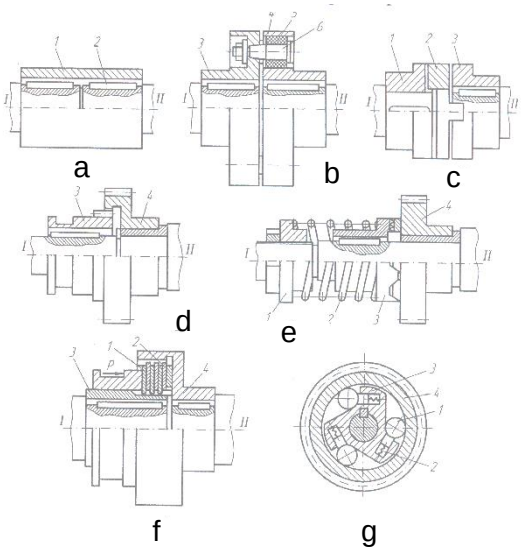
In addition to the transmission of torque from one shaft to another, the coupling performing the functions of the safety devices protecting the components of the drive against overload, as well as functions of speed control.

By appointment clutches are divided:

- **Constant** – used to connect shafts that are in the process of work remain together. Divided into rigid and elastic.
- **Coupling** – used for periodic connection of shafts of mechanisms and machines in between. Divided into frictional and toothed.
- **Safety** – used in machine tools to prevent accidents in case of overload. Also are permanent.
- **Overrunning** – used to transmit torque only in one direction of rotation.

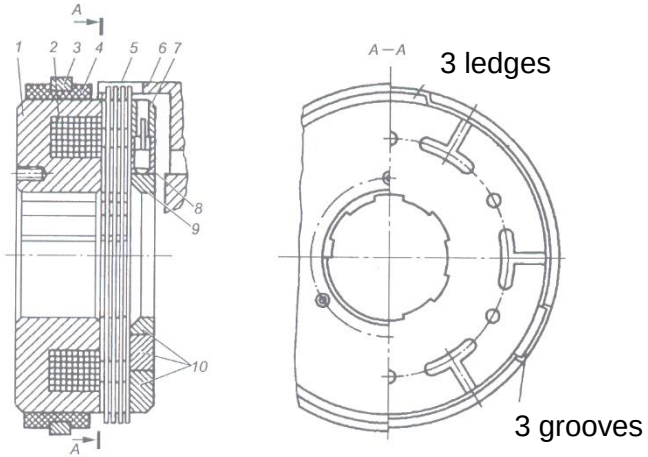
Ways of connecting shafts or parts couplings depend on the requirements of each connection. The most commonly used in machine tools clutches: cam, gear, friction, electromagnetic, overrunning and safety.

Clutches



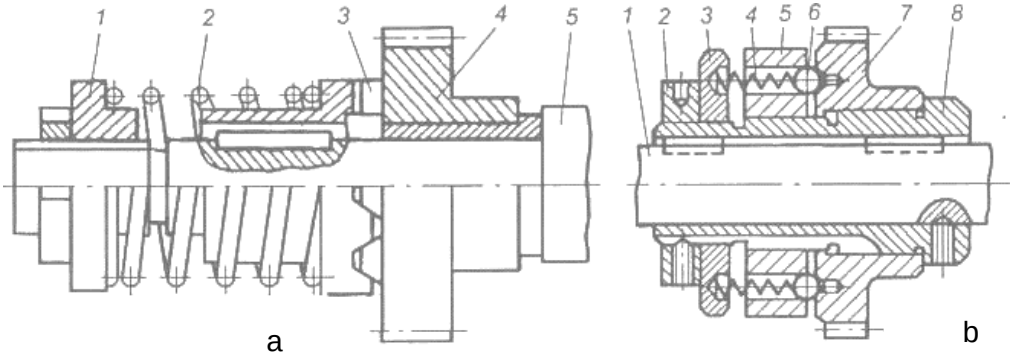
Schematic representation of the clutch: a – rigid; b, c – flexible; d – the coupling gear; e – cam safety; f – friction clutch; g – overrunning roller.

Clutches



Schematic diagram of the electromagnetic clutch friction:
1 – case; 2 – coil; 3 – ring; 4 – friction ring; 5 – friction disks; 6 – holder; 7, 8 – outer and inner ring of the anchor; 9 – plug; 10 – anchor.

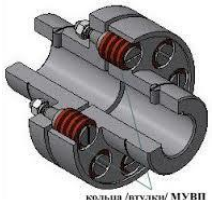
Clutches

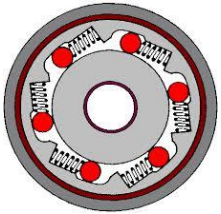


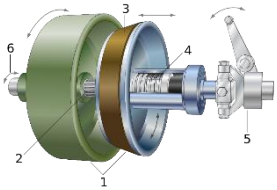
Safety couplings: a – cam coupling (1 – nut; 2 – spring; 3 – cams; 4 – gear; 5 – shaft); b – ball coupling (1 – shaft; 2, 3 – ring; 4 – spring; 5 – half-coupling; 6 – balls; 7 – gear; 8 – bushing)

CLUTCHES OF MACHINE TOOLS

Clutches







BRAKING DEVICES

For a quick stop of the executive bodies of the machine tools are used shoe brake, drum brake, belt brake, cone brake, multi-disc friction brake and other devices.

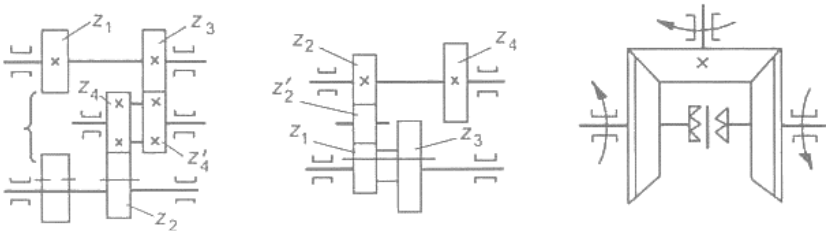
Cast iron in a pair of pressed asbestos or fiber most commonly are used for brakes of the machine tools.

The most widely are used shoe brakes, disc brakes and tape because of their constructive simplicity. Band brake has one drawback - the unilateral pressure on the shaft, which causes it to bend. Drum brakes inferior to a braking force of tape and disc brakes at the same dimensions.

Disc brakes have two opposing cylinders do not require any floating suspension for brackets or disc. The main advantage – reliable operation over a long period of continuous use. Pistons of disk brakes provides an even distribution of load on the pressure, and the quick-pad can be replaced quickly without the need to remove or move the other parts brakes.

REVERSING MECHANISMS

Reversing mechanisms provide the ability to change the direction of rotation of the drive.



a b c

Reversing mechanism shows in fig. ***a*** and changes the direction of rotation of the bottom shaft by moving the sliding wheel z2, which is connected with the wheel z1 or z4. On fig. ***b*** shows the kinematic scheme of the reversing mechanism, in which the direction of rotation of the bottom shaft can be effected by connecting of the sliding block gears z1 and z3 with gears z4 or with "parasitic" gear z2 '. On fig. ***c*** shown with reversible mechanism, shown with reversible mechanism consisting of bevel gears and toothed gear mechanism. The direction of rotation of the horizontal shaft is changed by switching coupling.

GEARBOXES

Mechanism for stepwise changing the frequency of rotation of the driven shaft at a constant rotational speed of a drive shaft by changing the gear ratio is called a **gearbox**. This change is achieved by rotation of the various gear kinematic pairs between the shafts. Gear boxes provide a standard range of frequencies of rotation of the spindle.

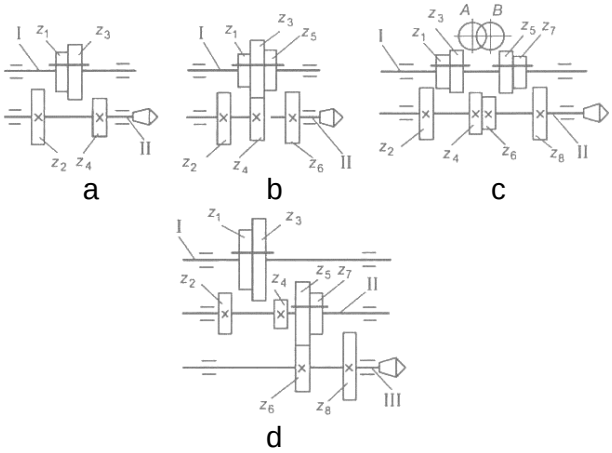
Gearbox are compact, easy to operate and reliable in operation. Their disadvantages include the difficulty or impossibility of infinitely variable speeds, vibration and noise at certain frequencies.

Gearboxes divided into gearboxes with cogwheels fitted in the spindle stock and gearboxes with a separate motor. For the latter, the spindle stock and the gears are in the form of separate units connected by a belt.

Gearboxes are classified by way of switch:

– With changeable cogwheels between the shafts and a fixed center distance;
– With movable cogwheels or blocks of cogwheels;
– With fixed cogwheels along the shafts and cam couplings, friction couplings, magnetic couplings combined with switches.

GEARBOXES



Schemes of gearboxes: a – at two speeds; b – at three speeds; c, d – at four speeds.

FEED GEARBOXES

Feed gearbox is designed to transmit rotation from spindle or motor to feed shaft or feed screw of machine tool.

Mechanisms of feed gearboxes receive movement from the spindle of the machine tool or by a separate motor. Feed options should provide the required surface roughness of processed, high tool life and nominal capacity of the machine tool.

Feed gearboxes constructively manufactured with: gears; removable cogwheels at a constant distance between the axes of the shafts; with sliding cogwheels and blocks of cogwheels; with built-in step-cones (sets), cogwheels and movable keys; with the mechanisms of the "meander“ and other.

Guitar – a unit of the machine tool for changing the feed rate. By replacement cogwheels the guitar can be adjusted with any degree of accuracy. Guitar allow you to change the gear ratio to 1/8. Guitars come in two-pair and three-pair . They are provided with a certain set of changeable gears.

FEED GEARBOXES

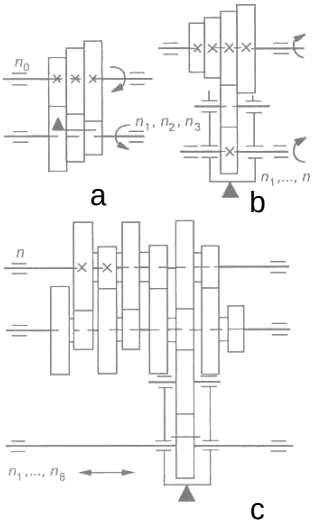
Feed gearboxes with integrated cones of cogwheels and movable keys are very compact, they allow to arrange in one group of up to 10 gear, including helical gears.

Feed gearbox with movable keys used gearboxes in small machine tools.

Feed gearbox with clamping cogwheel is widely used in high-precision machine tools. The disadvantages of these gearboxes is the low rigidity of clamping wheel, the possibility of clogging of transmission in the presence the cutout in the gearbox body.

Mechanism "meander" consists of a series of identical blocks of pair of cogwheels and a movable carriage with clamping cogwheels on the third shaft. The advantage of such feed gearboxes consists in a large range of regulation; Disadvantages – the rotation of all blocks of cogwheels, including cogwheels which not used in the transfer of rotation at the moment.

FEED GEARBOXES



Scheme designs of feed gearboxes: ***a*** – with built-in cones of cogwheels and movable key; ***b*** - with clamping wheel; ***c*** – meander.

SPINDLE UNIT

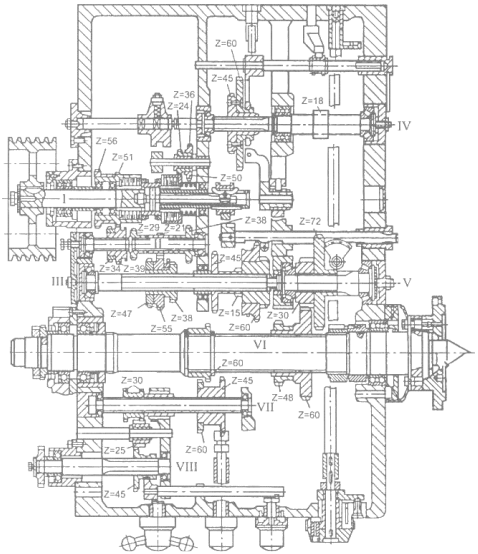
The shaft of the machine tool, transmitting the rotation to the cutting tool attached in it or the workpiece is called spindle.

To ensure the accuracy of processing for a specified lifetime spindles must have rigidity, stability axis position during the rotation, wear resistance of base surfaces, vibration resistance.

To ensure these requirements spindles are usually made of alloy steels subjected to heat treatment (carburizing, nitriding, bulk and surface hardening, tempering).

In some cases, large diameter spindles are made of cast iron and made hollow.

SPINDLE UNIT



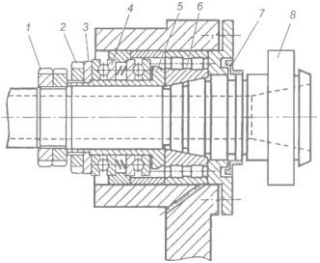
Spindle unit of machine tool 16K20

SPINDLE UNIT

For fixing cutting tools and accessories front ends of the spindles are standardized. As the supports used bearings and roller bearings.

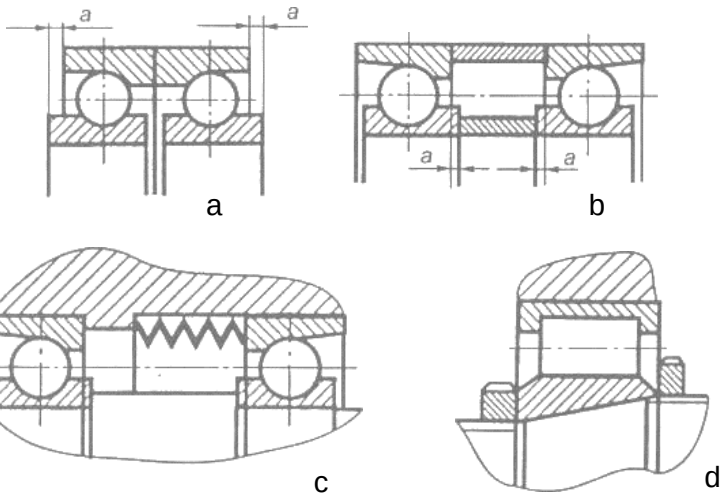
Rolling bearings used in spindle units must have high accuracy. Accuracy class determined bearing runout for the executive surfaces spindle, which depends on the desired accuracy.

Typically, the front support bearings are used more accurate than in the back end of spindle.



The design of the front end of the lathe spindle: 1, 2 – a nut; 3 – unit preload thrust bearings; 4 – trust bearings; 5 – bushing; 6 – inner ring of the bearing; 7 – labyrinth seals; 8 – spindle.

SPINDLE UNIT



Constructive ways to create the preload of rolling bearings: ***a*** – grinding end faces of the inner rings; ***b*** – the installation of spacers; ***c*** – preload; ***d*** – the deformation of the inner ring.