A frame design of machine tools

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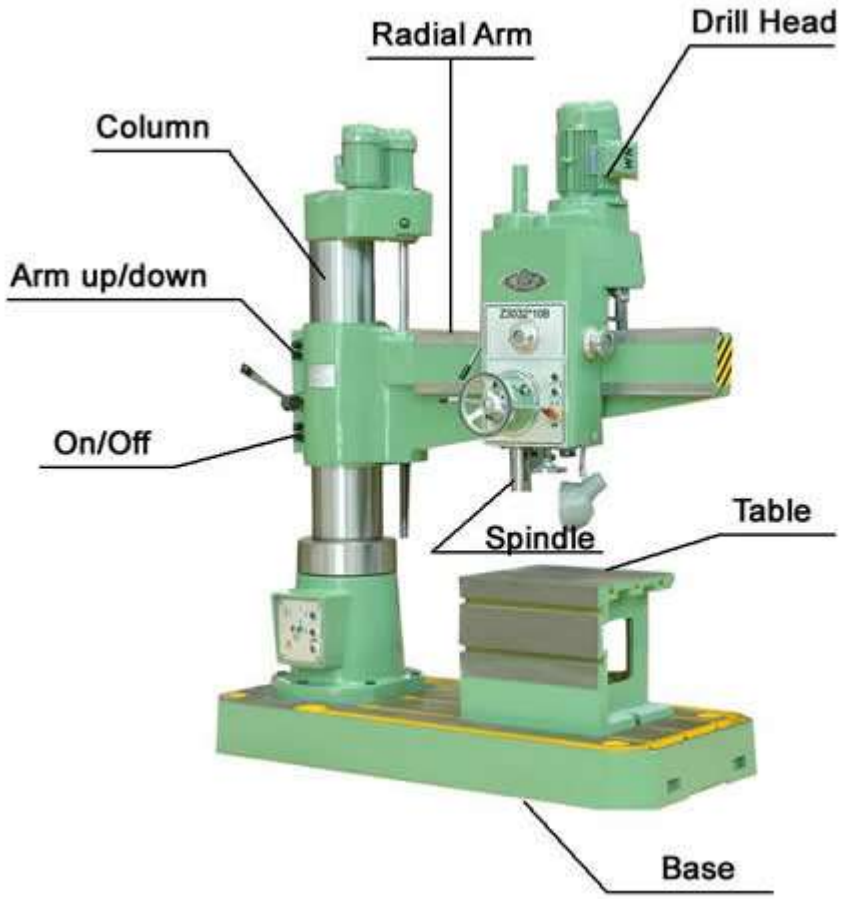
Frames of machine tools

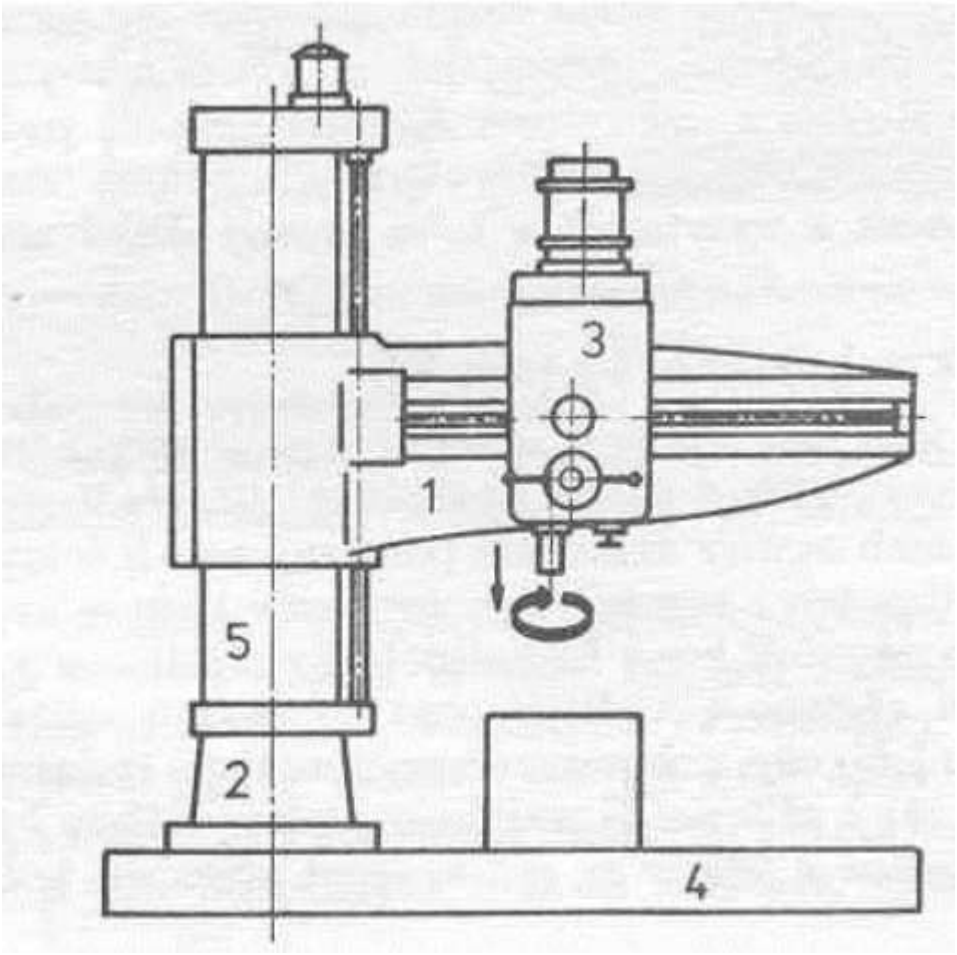
The basic frame part of machine tool :

- **base (bed),**
  - **split,**
  - **solid,**
- **column,**
  - **single column,**
  - **double column,**
- **over arm,**
  - **split,**
  - **solid,**
- **auxiliary elements,**
  - **columns,**
  - **consoles.**



Frames of machine tools

Open frame – type C



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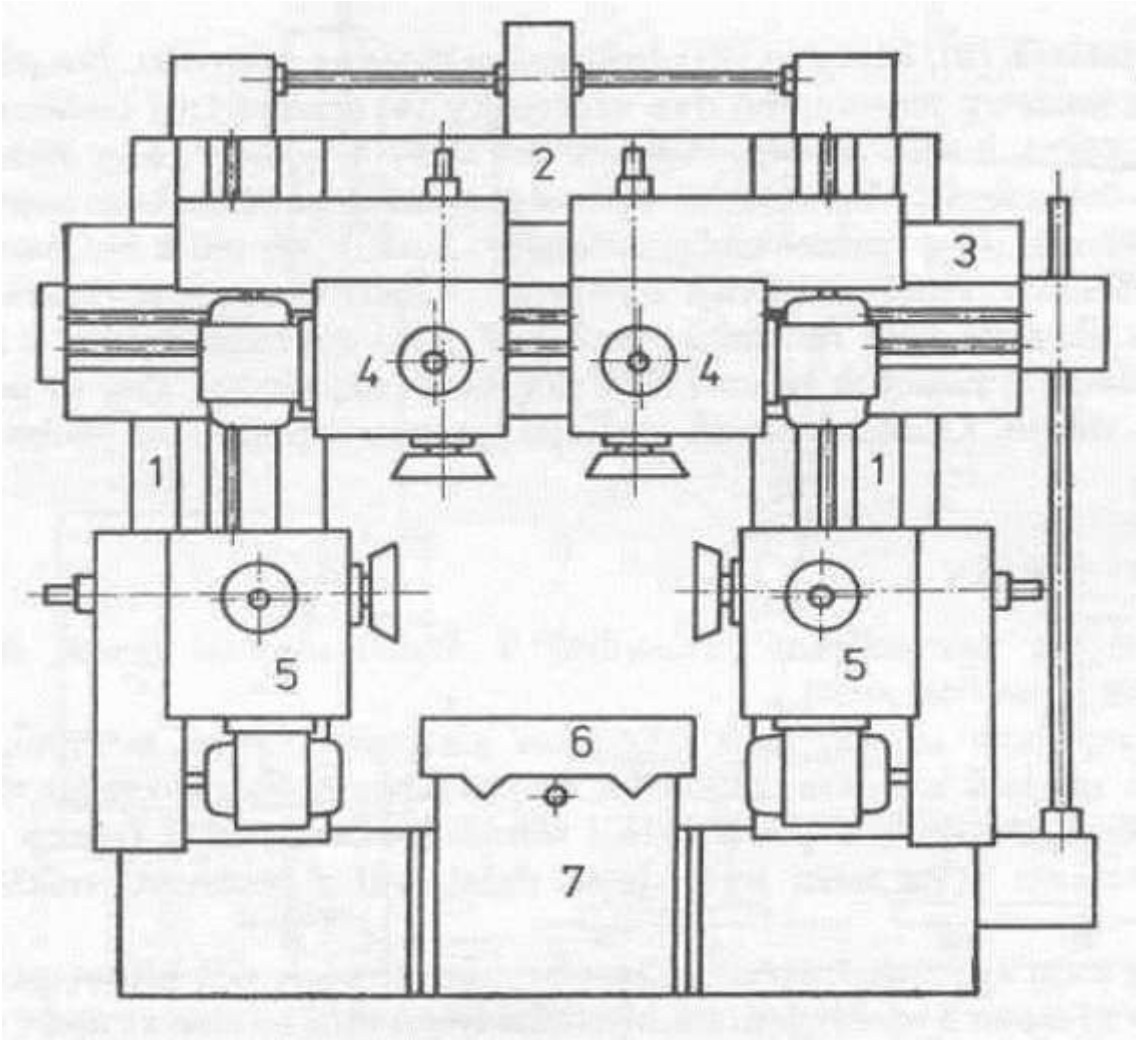
Frames of machine tools

Close frame – type O



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Frames of machine tools

Properties of the basic types of frame

Open :

- less stiffness
- easier handling of the workpiece
- milling machines, lathes, boring machines, drilling machines

Close :

- higher stiffness
- limiting the maximum size of a workpiece
- gantry milling machines,
- carousels, planers

Frames of machine tools

Precision of machining largely depends on stiffness, wear resistance guideways, dynamic stability and stability of shape of frames.

Requirements :

- **quality of frame material,**
- **good static rigidity,**
- **satisfactory dynamic and thermal stability,**
- **allow a good chip evacuation,**
- **simple and efficient production,**
- **low weight,**
- **easy handling,**
- **good mounting on base.**

Frames of machine tools

The properties are primarily intended :

- **by material,**
- **by topology - welding, ribs, wall thickness, proportion of parts,**
- **by connections - the number, location and design of fixed and mobile connections.**

Frames of machine tools

Materials for the construction of frames:

- **metallic,**
  - **cast iron,**
  - **cast steel,**
  - **steel (weldments, castings),**
- **nonmetallic,**
  - **particle composites,**
  - **fiber composites,**
- **combined,**
  - **steel weldment and fill damping material,**
- **natural,**
  - **stone (granite).**

Frames of machine tools

Choice of material influence the basic physical properties that have an impact on technical and operational characteristics of machines:

- **strength (tension, compression, bending, torsion)** ⇒ **safety against permanent deformation and breakage**
- **specific weight** ⇒ **weight, static and dynamic properties**
- **modulus of elasticity (tensile, shear)** ⇒ **static and dynamic stiffness**
- **vibration attenuation** ⇒ **dynamic characteristics**
- **sliding properties, hardness** ⇒ **friction and wear in the sliding zones**
- **internal tensions** ⇒ **permanent precision (long-term)**
- **thermal expansion, conductivity** ⇒ **thermal stability**

Frames of machine tools

Suitable materials for machine tools must display the following characteristics :

- **high rigidity and low weight –** It characterizes the speed of sound in the material.
  - **Suitable materials are based on Be (beryllium), B (boron), C (carbon), Li (lithium), Mg (magnesium), Al (aluminium) and Ti (titanium).**

- **high material damping –** materials composed of multiple macroscopic phases or materials with a large number of internal interfaces between the various components.
  - **fiber and particle composites, foam filling materials containing macroscopic or combinations of these materials with conventional materials based on Fe-C (hybrid structures).**

Frames of machine tools

The most common material used for the frame are metal materials (iron alloy).

Cast iron:

- **with spheroidal graphite ferrite, ferrite-pearlite (422303 = GGG 35)**
- **with lamellar graphite grey cast iron pearlite and ferrite (422415 = GG 15)**
- **malleable iron (422532)**

Cast steel :

- **cast carbon steel (422602 = GS 38)**
- **cast steel ferrite-pearlite (422643 = GS – C25)**
- **manganese steel (422660 = GS 60)**
- **silicon steel (422819 = GRADE 3A)**
- **steel chromium-manganese-vanadium (422830 = GS 50)**

Frames of machine tools

Castings from grey or ductile iron

- Low cost
- Good damping abilities

  X
- Low E and G
- Tension in castings
- Needed model
- Massive frames

Frames of machine tools

Steel

- Castings
- Weldments from metal plates and profiles
- Higher E

  X
- Less damping capability

Frames of machine tools

Light metals

- Using rarely because of high prices
- Aluminium alloys

Frames of machine tools

Mineral cast

- Inorganic substances in resin
- Casting into moulds

- very good damping
- small linear expansion
- eco-friendly material

Frames of machine tools

Hydroconcrete

- Thin steel weldments filled with hydroconcrete
- to increase the damping characteristics

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Frames of machine tools

Granit

- Cut blocks of natural granite mining in Africa

- very good damping
- thermal stability
- homogeneity

Frames of machine tools

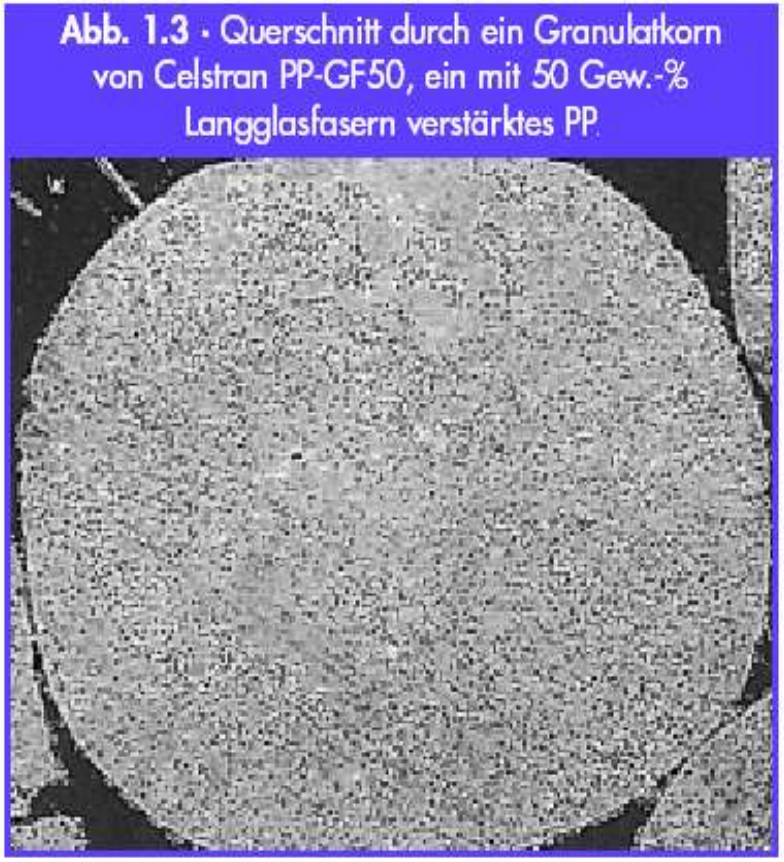
Particulate composites

- Balls or short fibers

metal, ceramic, glass

in a resin matrix

- very good damping
- as weldments filling



Frames of machine tools

Fiber composites

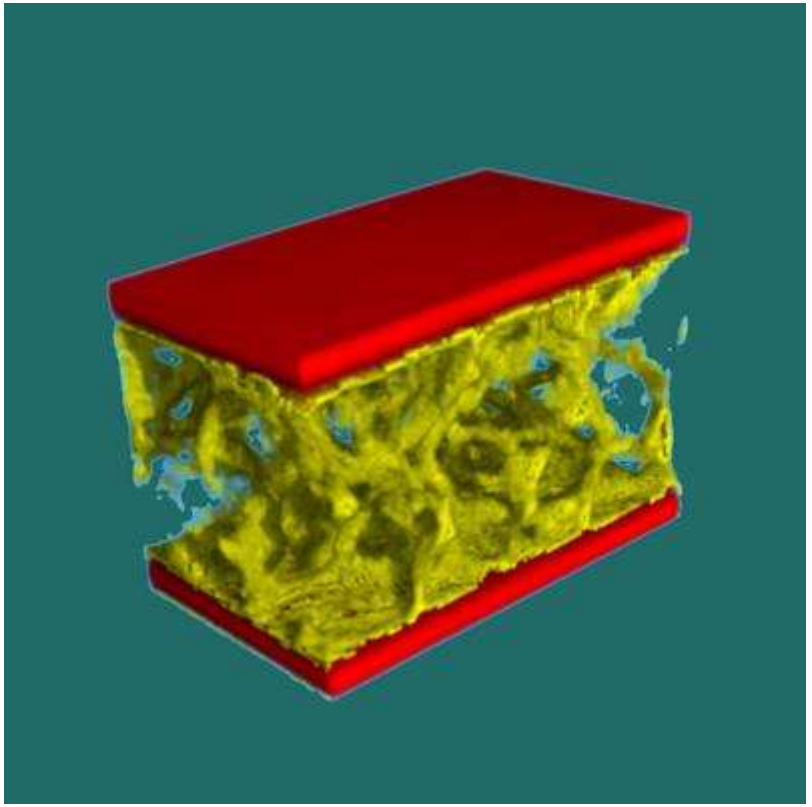
- Oriented fibers, most carbon in a resin matrix
- The laminate material

- high E
- low weight

Frames of machine tools

Sandwich construction

- Basic material:
  - steel weldment
- Filling:
  - Metal foams based on Al
  - Particulate composites
- High damping



Frames of machine tools

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