JOURNAL OF ENGINEERING annals OF FACULTY OF ENGINEERING HUNEDOARA
Tome V (year 2007), Fascicole 3, (ISSN 1584 – 2673)

# MODULAR CLAMPING SYSTEMS

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**ABSTRACT**:
Contribution deals with general requirements, characteristics and basic distribution of modular clamping systems as well as distribution of their components.
Attention is being paid to the new trends and tendencies in the field of clamping jigs construction for automated machining processes.
**KEYWORDS**:
Classification, Jigs, Modular, Clamping, Quickly, Easy, Accurate, Flexible, High quality, New trends

## 1. INTRODUCTION

Modular clamping systems play significant task at rationalizing the processes in industrial production, mainly in single-piece production or small batch production. They actively increase the effectiveness by its universality and ability to react flexibly to changing clamping conditions.

Unforgettable are also the other acquisitions of clamping system, which are expressed in work organization, warehousing, maintenance and technical support of manufacturing. Those also allows decreasing total manufacturing cost as well as time for manufacturing set-up.

Speeding up and specifying of manufacturing process allows to increase the productivity and manufacturability single manufacturing plants, which has to positively show-up in improving of living standard of the operators. Productivity can be increased by manufacturing methods improvement, machines and other manufacturing facilities. One possibility for reaching above mentioned productivity is to implement modular clamping systems into manufacturing process.

Clamping jigs of modular character are being inseparable part of manufacturing processes for being able to clamp the components of different shape, dimensions and size.

## 2. MODULAR CLAMPING SYSTEMS

We can consider modular clamping system as a complex of elements characterized by the structure and common relations, which are expressed in certain conditions as a functional limited entity, having the function of clamping system in relation to the workpiece.

Design of the system uses minimum number of elements with their maximum usage. It shortens time to put together complete clamping system; higher stiffness of clamping is being achieved, which affect the accuracy of the production.

We differ in modular systems:

- **basic systems** (a), which are completed out of number of different components, which are being sequenced only with reference to their geometry,
- **modular systems** (A,B) allocating to the components their quantities as well (figure 1).

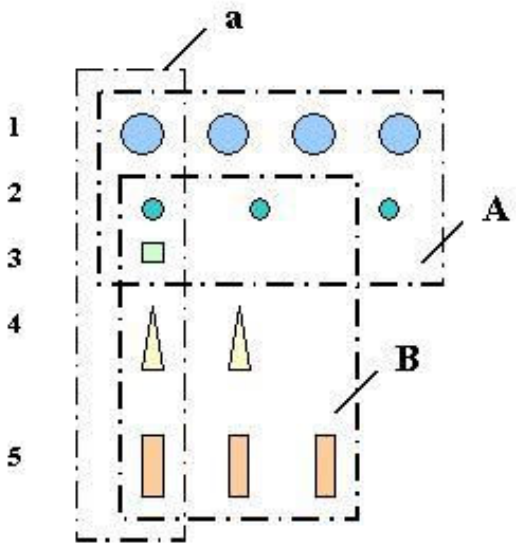


Figure 1. Structure of clamping systems

Further on, we differ following structures within modular systems:

- **opened**, in which the number of possible modular constructions is not really predictable,
- **closed**, which allows construction of final number of possibilities.

Within the components area we talk about:

- **Necessary component**, without the one is not possible to complete the jig (e.g. base plate).
- **Possible component,** this one can be used or can be replaced by the other component with the same function.
- **Functional component** fulfils separate partial task in the function structure.
- **Production component** is limited by manufacturing-technical characteristics.
- **Non-component** is a supplementary and special element, which observes auxiliary function within specific clamping jig.

Modular clamping systems can be divided into following groups:

- **slot systems:**
  - with T- slots,
  - with dovetail furrow,
  - with V- slots,
- **systems with the openings:**
  - threaded,
  - smooth-faced,
  - combined,
- **combined systems**.

With respect to the fact that basic functions of modular clamping systems are not countable by exact mathematical methods, they are being analysed by comparison outgoing from the analysis of single systems according ahead defined criterions. Basic criterions result from give basic functions and are defined by design system, operational and economic criterions.

Within design criterions, the design level of basic, constituent, clamping and supplementary elements being evaluated.

System criterions involve perfection of the system modularity in vertical and horizontal direction as well as completeness of whole system structure.

Operational criterions define the area of usability, conditions of assembling the jig for constituency and clamping together with the handling conditions, storage and maintenance.

Through economic criterions the difficulty of modular system manufacturing is being evaluated, as well as durability and intensive usage conditions.

Evaluation of single modular systems is most affected by basic principles of joining the modular elements among themselves and to the base clamping plate.

For slot system, is characteristic linking of the components by dowel slotting blocks (inserts). Forces transition between the slot and the block is in single coordinates different. Shape and force are fixed in the coordinate **x,** shape is fixed in coordinate **y** and force is fixed in coordinate **z**. Advantage of slot system is in having the components are arbitrary adjustable in direction of the slot, which allows good adaptation to the workpiece shape but their manufacturing cost is pretty high due to very tight tolerances. On figure 2 is a show of fixing the modular elements via T-slots.

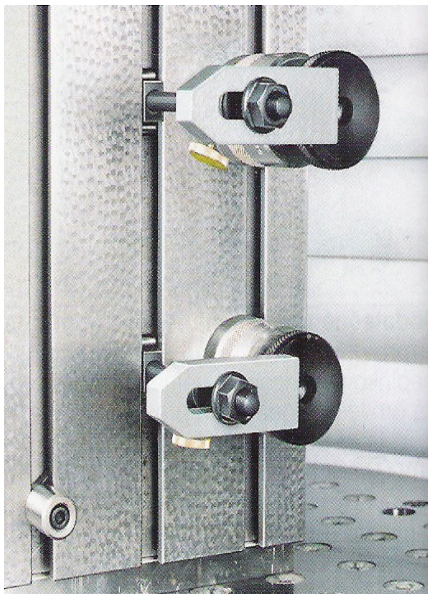

Figure 2. Fixing by the screw and the nut for T-slot

For the system with the openings is characteristic that the assembling of single components by the screws interferencing directly into the other component and their positioning by matching pins. Target of these systems is to avoid expensive production of accurate slots especially for basic components (base plates). Big advantage is in significant reducing of basic element section cut, which has a big meaning at the clamping to the technological pallets. The advantages of the systems with the openings were supported by patented method (system Blüco) of accurate dowel openings manufacturing by embedding of ahead produced

accurate bushings constituting by special sampling plate into ahead prepared openings. Accuracy of openings pitch produced by this method is in tolerance ±0,01 mm. On figure 3 is shown an example of part clamping on the basic plate with the openings.

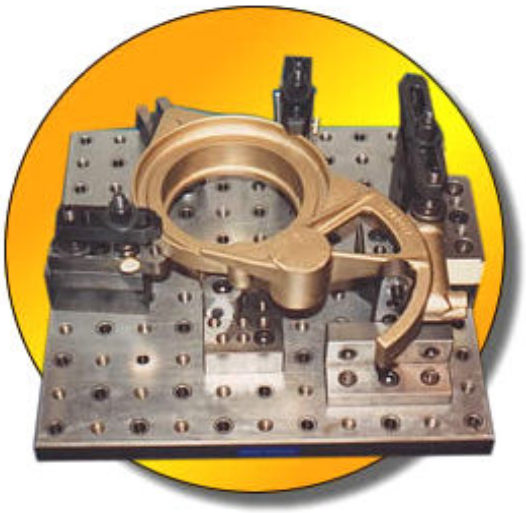

Figure 3. Fixing of the component on the base plate with the openings

Disadvantage of the systems with the openings is the link of the components to the threaded and smooth-faced openings, whereby those modular systems become less flexible. This minus can be partially compensated by the components with the slots.

Combined systems use in preference base clamping plates with the slot system; common assembly of the elements is, however, also by the system with the openings in combination with T-slots, eventually smooth-faced slots.

## 3. PARTS OF MODULAR SYSTEM

Parts of whole modular system can be divided into six basic groups according main purpose of their usage. In each basic group are single parts divided into subgroups based on characteristic design shape. Single groups are:

**Basic parts**

Form bearing part of the jig. There are clamping panels – base plates, pallets, prisms, cubes, desks, angles, etc. Based on part shape the group is being divided into subgroups of plates square-like, rectangle-like, circular, inclinable and base clamping angles. Their clamping surfaces are being equipped by either T-slots system, or threaded openings or by their combination, which allows to fix other elements of the kit b the screw, T-nut or by the screw and T-nut. Clamping plates on their bottom side have the surfaces for their fixing and settlement to the machine platen. At bigger size of the workpiece, more base plates (except circular ones) can be mounted to one entity.

**Relieving parts**

Among the relieving parts belong square and rectangular washers, supporting parts, prisms, ledges, angles, rings, spherical and grooved supports. From these parts the jig frame is being assembled with the using of base parts and they have a function of supporting surface in requested height from the base.

**Constituting/positioning parts**

Here belong the elements, which have to avoid any freedom of workpiece movement in space at exactly defined position of the workpiece as well as the all other parts of modular jig on the base element Design of constituting parts depends on condition of constituting the workpieces, especially on status of their default surfaces. Unmachined default surfaced are being positioned by adjusting elements, those functional surfaces are being produced in spike shape. Machined base surfaces are being constituted on solid flat constituent elements. Those might be constituent pivots, pins, centring bushes, rings, scabs, spacers, direct support, angular supports, prism supports, constituting inserts.

**Leading parts**

To the leading parts belong arms of drilling guides and spindles, arm holders, shafts of drilling guides.

**Clamping parts**

Through the clamping parts the clamping forces stabilize the position of the workpiece against the base parts. Here belong: various clamps, e.g.: flat, bended, extended, curved, jointed. Further on here belong: excenter, clamping centres, joints and springs for the clamps. These clamping elements are assigned for manual tag of clamping forces, however there also exist force-controlled elements, e.g. clamping units – mechanical, hydraulic, pneumatic, (hydraulic nuts, hydroplastic nuts etc.).

**Joining parts**

Assure common join of the clamping system parts. Those are the nuts and the screws, various shape as well as various washers, e.g. T-slots screws, screw with cylindrical head, hexagonal head, etc.

## 4. NEW TRENDS AND TENDENCIES IN THE FIELD OF CLAMPING FIXTURES CONSTRUCTION

Introduction of new technologies, structure of manufacturing systems with flexible automation, development of robotic and no-manned manufacturing machines as well as the effort of realization fully automated manufacturing lines up to level of the plants, significantly affected the place of clamping tools in manufacturing process. Successful implementation of existing tools into condition of higher level manufacturing was always linked with significant effort to adapt to the new conditions.

Modular clamping systems by their adaptability to the new conditions are being more and more implemented into the manufacturing processes. New conditions, however, requires further improvements.

Tendency of workpiece clamping development can divide into three areas:

1. area of own clamping tools,
2. area of design (jigs design),
3. area of usage.

## 5. CONCLUSION

Value of modular clamping system in nowadays is being increased with usage of progressive methods of machining and modern executive automated machining tools. Clamping tools become equivalent partner to the other means of machining process. It is necessary that besides stable clamping of the workpiece, also condition of simply assembly, quick change workpieces, high accuracy of re-clamping as well as number of machinable surface at one clamping was the biggest while keeping the universal function of clamping. Those conditions are being fully supported by

modular clamping system by their universality and possibility of pneumatic or hydraulic control.

**Acknowledgements**
This paper was created thanks to the national grants: VEGA 1/3164/06 - *Using of intelligent fixtures in manufacturing and assembly processes*.

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