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ACTIVE PARTS OF CLAMPING DEVICES

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ABSTRACT: Clamping systems used for workpiece clamping in the production must be designed to reliably absorb all workpiece affecting forces generated by the technological machining (cutting force, centrifugal force, force and moments of inertia). To induce a clamping force, various mutually different clamping mechanism types are used. This article deals with active parts of clamping devices and principle of reaching a necessary size of clamping force via pneumatic-hydraulic multipliers.
KEYWORDS: clamping, fixture, force, manufacturing, mechanism

1. INTRODUCTION

In the course of the technological machining process it is necessary to keep the determinateness (stability) of a part location what is conditioned by contact constancy of workpiece loading area with supporting and setting elements of the fixture. This is reached by action of external loading forces *P* induced by active parts of clamping devices. To induce those forces we make use of:

- elastic properties of clamping components' material
- frictional forces,
- self-weight of the workpiece,
- magnetic and electromagnetic forces,
- compression forces: hydraulic and pneumatic,
- combined methods.

The clamping mechanism is able to increase the inducing force P and in case of need to change its direction. The clamped workpiece is affected by the active part of the device applying the clamping force Q in desired places and direction of action.

2. ACTIVE PARTS OF CLAMPING DEVICES

Considering the application way of force necessary, the clamping devices can be divided into manual ones where the operating force is induced by attendants of the manufacturing equipment and the mechanized or automated ones working unattended. Clamping of workpiece can be: direct, or indirect. Indirect clamping devices consist of an element inducing the clamping force, a clamping element and a mechanism for increase or direction change of the acting force. In case of a direct clamping all these functions are taken over by one element. Active parts of clamping devices consist of a great number of structural solutions working on various principles.

Mechanical Clamping Elements

The group of mechanical clamping elements includes a lot of systems. Screws, nuts, V-shaped mechanism, cams and eccentrics, expanding mandrels and spring collets, self-clamping tapered mandrels and cavities, lever systems, ball and roller clamps, etc. are the most frequent elements.

Clamping Elements Working by means of Pressure Medium

Pressure medium inducing clamping force divides clamping devices into: pneumatic, hydraulic, pneumatic – hydraulic, and hydro-plastic.

Electromagnetic and Magnetic Clamping Elements

Electromagnetic and magnetic clamping elements take advantage of magnetic properties of the workpiece material. Following types are used: permanent magnets, electromagnetic clamps, and electro-permanent magnetic clamps.

In case mechanic clamping elements are used for clamping the size of the clamping force Q can become lower during the main operating times namely due to deformation and damage of the contact areas. By using clamping elements working via pressure medium or utilizing magnetic properties of the workpiece the clamping force Q is constant.

3. PNEUMATIC - HYDRAULIC MULTIPLIERS

Pneumatic – hydraulic multipliers belong to clamping elements that work via pressure medium and use compressed air and liquid for development of pressure.

These work as amplifiers or multipliers of pressure. In this way they enable decrease of dimensions in compare to pneumatic clamping elements. Multipliers are separate devices consisting of low-pressure pneumatic part and high-pressure hydraulic part (Figure.1). Their design combines advantages of pneumatic and hydraulic clamping. Constructional arrangement of a hydraulic roller in one unit with a pneumatic roller which is supplied by compressed air enables to make use of advantages of a hydraulic clamping despite a source of pressure liquid not being available. For equilibrium between the low-pressure part and high-pressure part the following formula is valid (1):

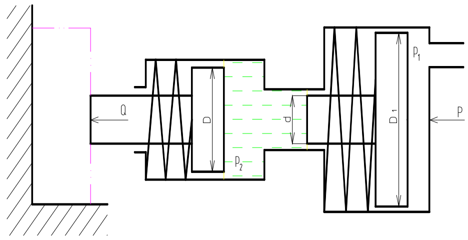

Figure 1: Diagram of a pneumatic-hydraulic multiplier

$$p_1 \frac{\pi D_1^2}{4} = p_2 \frac{\pi d^2}{4} \quad (1)$$

where: p_1 is the compressed air pressure, p_2 is the pressure in liquid, D_1 is the diameter of the pneumatic roller piston, d is the small diameter of the hydraulic roller piston.

The pressure applied on the clamping element can be expressed by the relation (2):

$$p_2 = p_1 \left(\frac{D_1}{d}\right)^2 \quad (2)$$

The pressure liquid will affect the working hydraulic roller piston by force Q (3):

$$Q = p_2 \frac{\pi D^2}{4} = p_1 \left(\frac{D_1}{d}\right)^2 \frac{\pi D^2}{4} \eta \quad (3)$$

This results in the relation (4):

$$Q = \left(\frac{D}{d}\right)^2 P.\eta \quad (4)$$

where: Q is the clamping force in the piston rod of the working hydraulic roller, P is the force affecting the pneumatic roller piston, D is the big diameter of the hydraulic roller piston, η is the efficiency.

The above mentioned relations indicate that with a relatively low pressure in the pneumatic roller a high pressure can be reached in the hydraulic clamping part, the increase of which is directly proportional to square number of the proportion of big and small diameter of hydraulic roller pistons. That also means that the ratio size of inducing force to the clamping force is the result of a suitably designed difference of roller diameters in the multiplier hydraulic part.

4. CONCLUSION

Nowadays, when to be competitive it is necessary to increase continuously the economic effectiveness of the production process, the emphasis is laid also on peripheral manufacturing devices that affect length of secondary times. These devices include also clamping systems. Pneumatic-hydraulic multipliers are one of devices enabling automation of workpiece clamping. Based on a simple principle, they multiply and amplify the relatively small inducing force to reach a desired value of clamping force what allows minimization of dimensions compared to pneumatic clamps.

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