

# THE PRINCIPLES OF WORKHOLDING: PART I



This article is the first in a multi-part series on workholding presented by Toolink Engineering and König-mtm, with this installment devoted to the fundamentals of hydraulic workholding devices.

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This article is the first of a multi-part series intended to inform, guide, and assist the gear manufacturing industry in selecting or identifying the most efficient and practical workholding solution to fit their gear manufacturing needs. In this installment we touch on the principles, fundamentals, advantages, and limitations of hydraulic workholding. Next we will introduce mechanical devices and their strengths/limitations, as well as discuss both hydraulic and mechanical devices used in inspection applications. Future discussions will encompass special applications for both hydraulic and mechanical workholding devices and the various application-specific additions that are available to truly customize your workholding to best fit your individual needs. The intent of the information that found in these articles is to encourage the review of your current workholding and potentially identify operations that could be improved upon with a newer generation of workholding.

Gear manufacturing is no different than any other industry—or hobby, for that matter—in that having and using the right tools for the task at hand is key to achieving quality results/products in an efficient manner. Much like selecting the proper lure for the fish that you are angling for, or choosing the right golf club to get you nearest the green in the fewest strokes, choosing the proper workholding will reduce change-over time, increase productivity and part quality and, ultimately, increase profits.

## Hydraulic Expansion

Hydraulic expansion arbors (mandrels) and chucks offer excellent radial and axial runout accuracy and transfer incredibly high clamping forces to the workpiece. The hydraulic medium is pressurized by means of a clamping/actuation piston that can be actuated either manually by hand or over the machine utilizing pneumatics, hydraulics, or a draw-bar. The hydraulically actuated clamping sleeve expands into the bore or contracts onto a shaft, making contact over the entire clamping surface despite any imperfections of the form such as a taper, belly, etc. Workpieces can be held with either direct contact on the clamping sleeve or through a slotted collet that is fitted to the device, allowing for a range of workpieces to be held using the same device. Runout accuracies of 3 microns are quite common, while in special cases 1 micron of runout is attainable.

Hydraulic devices—both arbors and chucks—can be made to adapt to all common gear manufacturing machines/methods such as hobbing, shaping, shaving honing/coroning and, of course, gear grinding. Given that the clamping system operates hydraulically within a closed



Figure 1: A selection of Koenig workholding devices, available from Toolink Engineering.

# QUICK-CHANGE CHUCKS

For today's machine tools the complexity of machining tasks, variety of workpieces, and number of available clamping tools are constantly increasing. In response König-mtm has developed a new generation of quick-change chucks that minimize tooling expense as well as changeover times. This yields reduced costs and higher productivity, meeting the basic requirement of more-efficient machining operations.

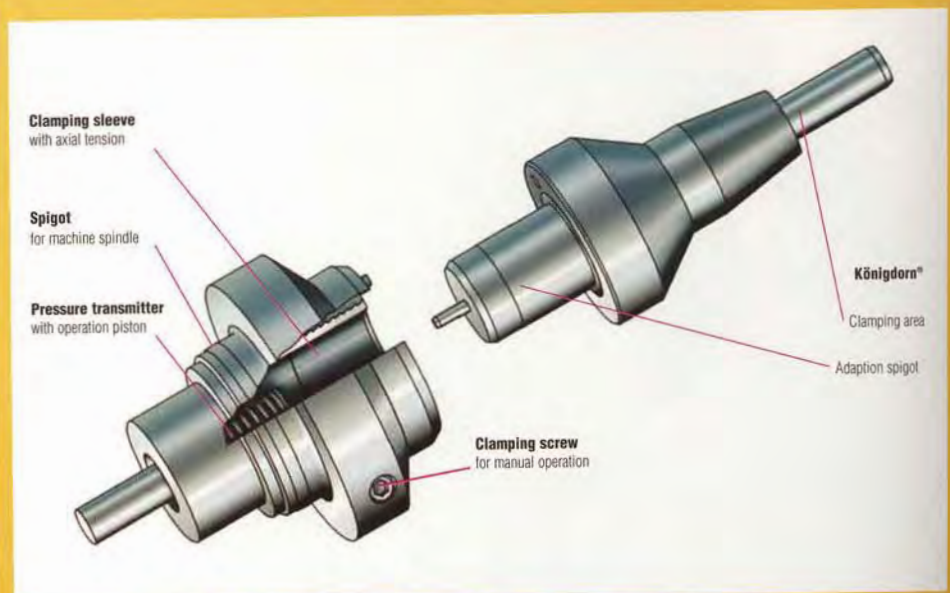


Figure 2: Hydro-mechanical quick-change chuck

Machine tools equipped with König-rtm's quick-change chucks allow faster change of clamping tools versus machines with conventional chucks. Accordingly, as lot sizes decrease, the number of machine tools operating in frequent changeover environments is increasing. By harmonizing the adaption configuration, a simple effortless change of the clamping device is possible. The quick-change chuck is operated manually by a hexagonal key. By means of the pressure being built up within the clamping sleeve, the mandrel or chuck is centered, clamped, and axially located against the flange with positive force. This results in solid, full-contact clamping which assures a deflection-resistant connection between the quick-change chuck and workpiece clamping tool. Usually, the clamping mandrels and chucks are operated directly by the hydraulic system of the machine or by a pressure transmitter which is integrated in the quick-change chuck. On relaxing, integrated springs push the piston back to the starting position.

Technological advantages include easy changeover of the clamping tools (no screws, no bolt-on); good radial and axial run-out accuracy, and excellent wear resistance. Economic advantages are reduced expenditure of tooling; reduced retooling times; reduction of tooling costs; high workpiece flexibility; and increased productivity

The type—either the hydraulic (see fig. 3) or hydro-mechanical version (fig. 2)—as well as the specific design of the quick-change chuck is individually tailored to the construction of the machine tool, the machining tasks, and the shape of the workpieces. The hydro-mechanical type is always used when a very compact shape is required, i.e. to reduce interference collisions; under particularly cramped installation conditions; and if larger shapes are requested.



Figure 3: Hydraulic quick-change chuck

system, there are no mechanical wear parts that are susceptible to the dirt/swarf, etc., that frequently incapacitate a mechanical/taper-type clamping device. While the expansion sleeve of a hydraulic clamping device can wear over time, it is not uncommon for said devices to last upwards of 80-100,000 clamping cycles before needing to be serviced. At that time, if necessary, that service might entail either replacing the seals on the actuation/adjusting

pistons or replacing the worn expansion sleeve. Considering that the clamping of a hydraulic arbor or chuck involves the deformation (expansion/contraction) of a solid metal sleeve, there are some limitations to the clamping range of such devices. In most cases the solid bushing can be expanded up to 0.3 percent of the clamping area without the use of a collet or other special design characteristics such as a plastic expansion sleeve or a higher expansion steel.

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Given this expansion tolerance limit, only workpieces with a machined/qualified surface can be clamped.

## Configuration is Key

To accommodate for the limitations of clamping range on the expansion sleeve itself, there are several arbor configurations that can be employed. First, the arbor or chuck of nominal diameter can be fitted with a range of collets with varying clamping diameters while still maintaining runout accuracies of 5-7 microns. The clamping range for a collet-type device will vary depending on the nominal clamping diameter of the arbor or chuck. However, with a relatively few number of nominal diameter arbors and/or chucks, customers can quickly and inexpensively manufacture their own collets to fit their current workpiece. This arrangement allows for a cost-effective, accurate, repeatable, and flexible clamping solution. As a general guideline, with four nominal diameter arbors/chucks and a series of collets, a clamping range of 100mm can be covered.

To address lengthy changeover procedures it is becoming increasingly common to pair a hydraulic base chuck to your workpiece clamping tool. First the quick-change base chuck is mounted and "dialed in" on

the machine spindle. Next you load the workpiece clamping tool (arbor or chuck) into the base chuck. The base chuck is then clamped/actuated manually using a T-handled Allen wrench. Through the contraction of the base chuck your workpiece clamping tool is centered, clamped, and axially located against the flange with positive force. The workpiece clamping tool is then actuated over the machine pressure or drawbar. Implementation of the quick-change base chuck allows workpiece clamping tools to be interchanged without the need to dial them in. Additionally, if workpieces are manually loaded, a second arbor or chuck can be outside of the machine for loading during the machine cycle. When the cycle is finished, a few quick turns of the base chuck actuation screw allows an operator to make the swap in a matter of seconds. Hydraulic workholding is an excellent choice for a variety of gear manufacturing applications. They are extremely accurate, repeatable, tolerant to dirty environments, easy to use, and they are attainable. It doesn't matter if you are a small job shop with low-volume, high-mix products; an automotive gear manufacturer with high volume low mix; or an aerospace component manufacturer with the highest quality demands, you will not be disappointed with the consistency and precision of a hydraulic workholding device. 

### ABOUT THE AUTHORS:

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