Precision Workholding for Gear Production

Custom clamping for challenging requirements

Emuge-Franken USA

A range of gear manufacturing applications such as planetary carriers and gear wheels with strict tolerances demand comprehensive, reliable clamping solutions. Whether the objective is to reduce vibrations or ensure concentricity of only a few microns, the clamping must meet challenging requirements.

Planetary Gear Wheel Clamping Device—designed, engineered, and manufactured by Emuge-Franken.

A first example is a planetary gear carrier—an essential component of an automatic transmission because it carries the planetary gears, which are needed to couple the sun and ring gears. It is interesting to know that its name "planetary gear" is based on the solar system. The central point of an automatic gearbox is the sun wheel, which is orbited by several shafts. These shafts have gear wheels, the so-called planetary gears, and the movement which is similar to that of planets orbiting a central sun. This structure is surrounded by a ring gear. As the name suggests, the planetary gear carrier carries the planetary gears.

By changing gears in the gearbox, the interaction of the various gears previously mentioned changes so that the drive operates at the optimal speed and load range.

Precise Clamping for Planetary Gear Carriers

There are significant and demanding technical clamping challenges on a "bulky" planetary gear carrier being used in milling operations with high machining forces. Requirements include clamping with low distortion and fixed with low vibration by means of enormously high torques.

Collaborating as a "team," Emuge-Franken worked closely with its customer and machine manufacturer to design, engineer, and manufacture a planetary gear carrier clamping solution. The goal was not to achieve the highest possible accuracy but to be able to run a demanding machining operation with great forces that have to be absorbed by a massive clamping device and high levels of torque. This also has an impact on the machine, which had to be considered during the project process.

To meet the requirements, the best of two worlds were combined in a clamping concept. First, primary clamping featured a diaphragm chuck with clamping jaws. Second, a traditional concept of a collet chuck and hydraulically actuated clamping piston was incorporated for the additional internal clamping. Emuge chose this design to best accommodate a relatively short clamping surface on the workpiece and a large working space required for the tools.

We know the diaphragm has high inherent tension and provides good holding torque. Add in hydraulic back pressure and the holding torque is greatly increased, which theoretically might have been suitable for the machining process. However, a collet chuck was a necessary addition to achieve vibration-free clamping and withstand the high holding forces. This was especially key to offset the high cutting forces, which can cause significant vibration and possibly reduce machining quality.

An alignment unit was another important design element of this clamping device. The first function is the insertion lock, ensuring the workpiece is inserted correctly during manual loading. The alignment sleeve has pins that can be extended and retracted, giving the workpiece the correct angular alignment for machining.

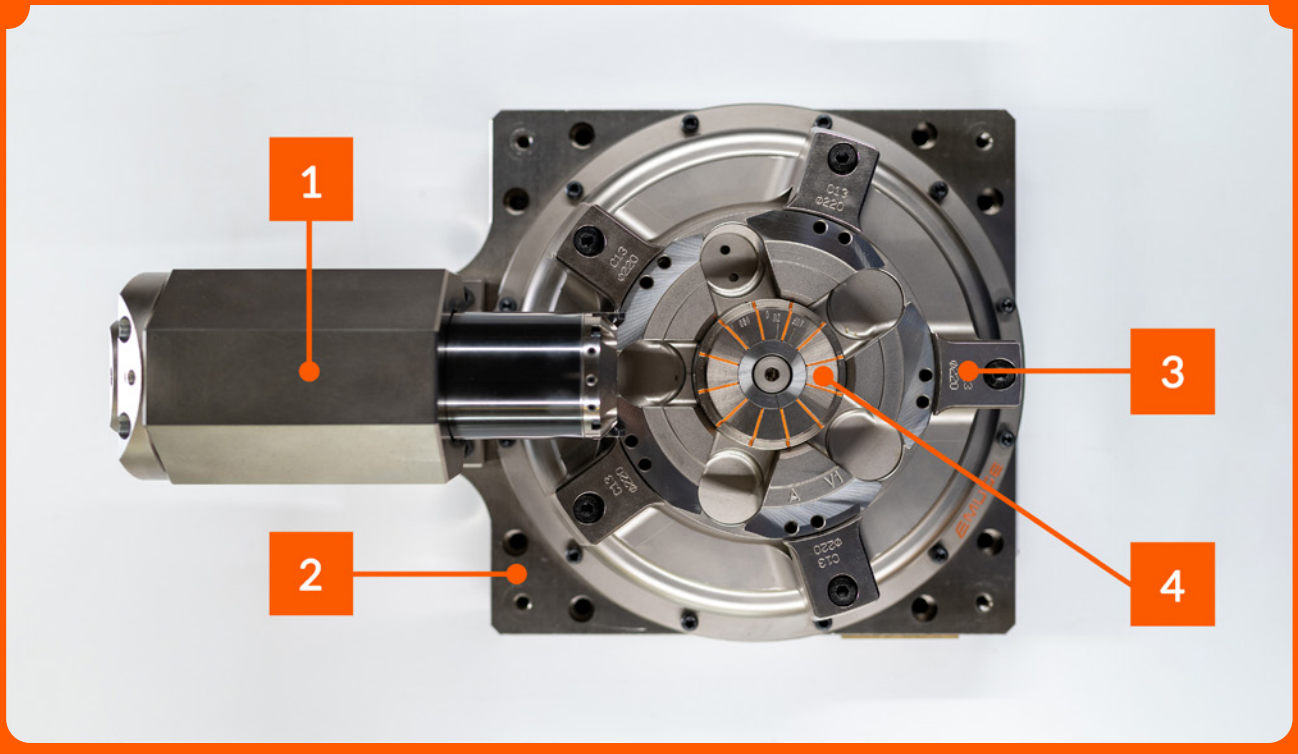
A movable sleeve also sets the final position during alignment, freeing up enough space for the added tools by retracting away from the workpiece. The clamping device is actuated hydraulically with a maximum of 200 bar. Precisely controlled clamping sequences were matched to the workpiece, precisely defined by a complex hydraulic circuit. The hydraulic circuit was limited by the number of hydraulic channels available on the machine side.

The completed clamping solution was about more than just clamping and unclamping. It was about the coordination of many movement sequences, a complex control system and finally the huge size of the clamping device which has a base plate of 23 x 14 inches (580 x 360 mm) and weighs in at over 353 lbs. (160 kg).

It is interesting to note that the required holding torque could not be easily checked. A 6.5-ft. (two-meter) long torque wrench had to be used. Once the holding torque was verified, the customer setup the six clamping devices on the machine. The configuration had three devices inside the machine and three devices outside the machine -- all on palletized tables. This setup allowed the three clamping devices in the machine to be operated simultaneously, which significantly increased the volume of machined workpieces. The other three clamping devices, which are located outside the machine, can be unloaded/ loaded concurrently, which also increases production volume.

Emuge-Franken's Planetary Gear Wheel Clamping Device was designed to meet demanding clamping technical challenges.

The planetary gear carrier clamping device has a solid foundation that is a specially designed plate (2) on which the other components are installed. All hydraulic and pneumatic lines, including the external connections, are connected to this plate. There are distinctive hydraulic connections and mounts for the load bars which are necessary due to the total weight of over 353 lbs. (160 kg).



The external clamping concept forms a diaphragm. The five clamping jaws (3) are screwed to the diaphragm and rest against the workpiece due to its inherent tension. This torque is massively reinforced by hydraulic pressure. The orange slots of the collet (4) are clearly visible through the clamping jaws. The alignment unit (1) is located in an outboard position above two of the clamping jaws.

High Accuracy Hollow Wheel-Clamping Technology

Diaphragm clamping devices are also an excellent choice for the demanding holding requirements when power skiving to produce external and internal gears, as well as spur and helical gears when modern power skiving. The machining process is highly productive, but only if the machine, the tool, and the workpiece are perfectly matched.

These clamping devices are subject to enormous demands regarding design, clamping force, and accuracy. In addition to the sophisticated design, the complex production of the clamping diaphragm also plays an essential role.

Diaphragm clamping devices are used in the gearing of ring gears for use in commercial vehicle transmissions. High-precision production of gears is an important factor in these transmissions, and Emuge-Franken diaphragm clamping devices are ideally suited for these applications. The repeatable concentricity on the workpiece is often in the range of less than 10 µm, depending on the clamping diameter, as is the axial run-out.

The design also makes diaphragm clamping devices low-maintenance and resistant to contamination in addition to the guaranteed clearance and run-down for the machining tool.

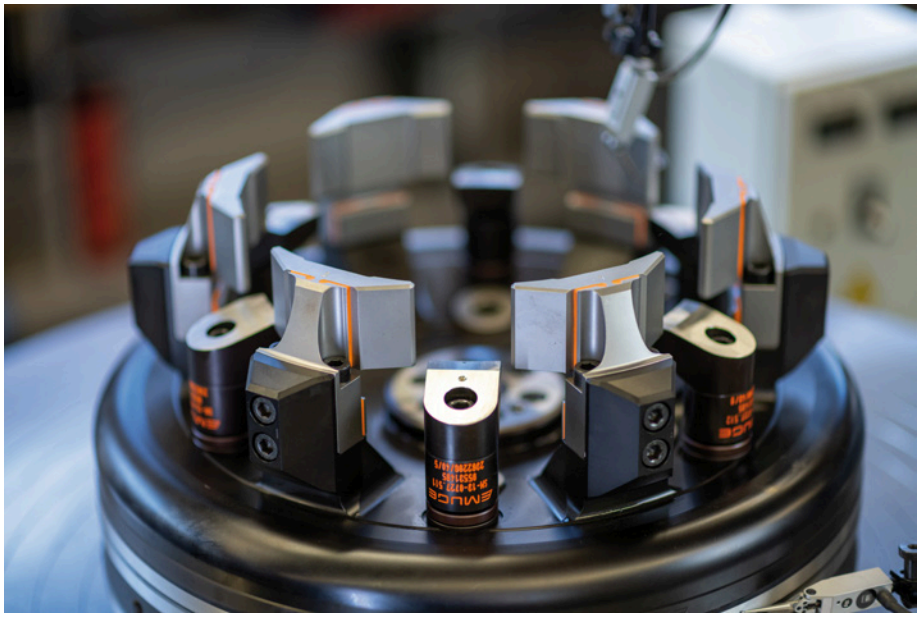
Diaphragm clamping devices are able to achieve excellent concentricity or roundness in machining, even with finely detailed workpieces with strict tolerances. Accuracies in concentricity or roundness of 10 to 30 µm can be obtained, depending on how large and how thin-walled the workpiece is. And even though many diaphragm clamping devices are suitable for workpieces with a diameter of 5 to 20 in. (130 to 510 mm), a compact design is possible.

A clamping diaphragm has a high internal tension due to its design, so the forces adapt perfectly to the contour of the workpiece. For thin-walled workpieces, the clamping diaphragm is designed accordingly. The clamping force can be increased by the tractive force of the machine for robust workpieces.

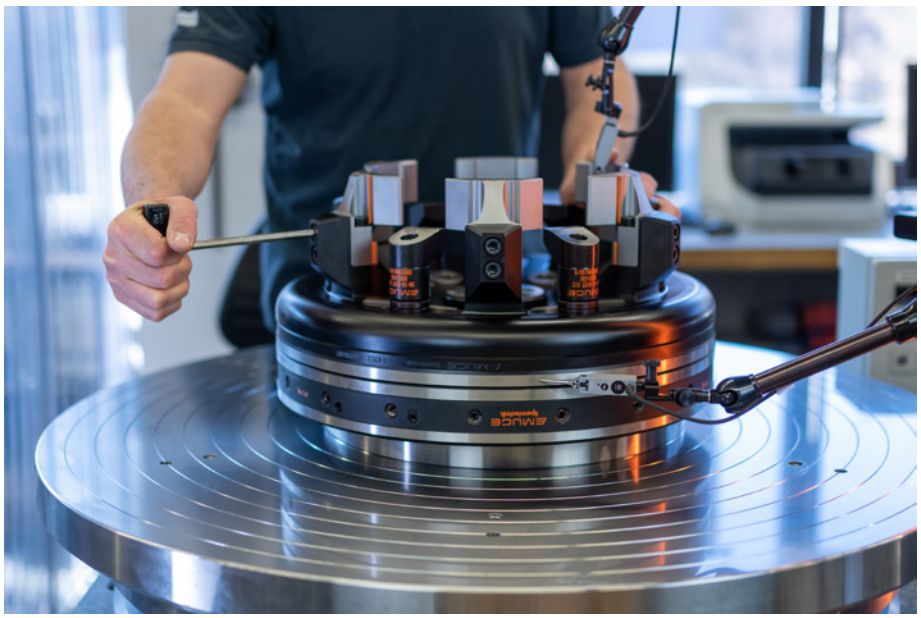
Clamping jaws, which are a typical element of diaphragm devices, ensure that the workpiece is clamped securely, without deformation, and at defined points. An optional face clamping additionally clamps the workpiece. Six or eight clamping jaws are used depending on the clamping diameter. Also, the clamping force is independent of the rotational speed due to centrifugal force compensation.

emuge.com

For Related Articles Search
workholding
at geartechnology.com



Emuge-Franken's Diaphragm Clamping Device provides excellent concentricity or roundness in machining, including parts with fine details.



Designed with indicating in the base and jaws on a diaphragm for perfect runout correlation between the two.