
Who needs a hair to be drilled?

Micro drilling 30 µm - Attempt on a record?

Recently 50 µm was thought to be the smallest diameter to be drilled. Considering the thickness of a human hair at 60 µm diameter, the task of drilling such a small hole becomes more obvious. Usually 50 µm is the smallest unit to be visible to a human eye and it is quite difficult to discern a drill 30 µm diameter with only the naked eye. Of course, such a small drill is not very solid and therefore can only be operated successfully with very smooth running High Precision Machines.

One of the few machines that is capable of doing this job, is the KERN CNC high precision micro milling and drilling machine. This machine is designed for such an extreme operation. The smooth movements of all axes are guaranteed, i.e. the spindle travels vertically in its own precision carrier with a minimum of loading. The high precision NC-table is a separate basic unit with positioning accuracy of the workpiece $\pm 1\mu\text{m}$. All three axes of the machine (X, Y, Z -axis) are fitted with HEIDENHAIN glass scales with a resolution of 0,1 µm. The basic mechanical units for the X/Y/Z-axes are produced in-house at KERN to ensure the extreme close tolerances required are achieved.

Of course there are more features which guarantee the success of the KERN machine in such demanding manufacturing environments. All the parts from external suppliers such as spindles, tool holders, collets etc. have to pass strict quality control procedures, and are rigorously tested, in some cases for several days, to ensure full working integration into the KERN machines. In order to avoid breakage of the 50 µm drill the concentric running of the spindle, collet and drill was absolutely necessary.

What types of industries require such critical standards? Electronics is one good example, for the manufacturing of test membranes for microchips. Additionally the watch industry is a main focus point, as almost all the high value mechanical parts of watch manufacturers in Switzerland and Germany are produced on KERN machines. For example, an M 0.35 thread, was tapped on the periphery of a pendulum wheel using a rigid tapping technique!

Following an inquiry from the Far East, KERN was considering the idea of drilling smaller holes but was limited by the availability of cutting tools. During the EMO exhibition in Paris a drill manufacturer was found who could supply drills as small as 30 µm. The first delivery of drills were critically examined under a microscope and, thereafter, all existing doubts were destroyed.

In order to visualise the capability of KERN machines optically and to enable the operator to control tool wear and breakage, a Macro-Video-Camera was developed together with a Research Institute in Jena, Germany. This Macro- Video- Microscope consists of a high-resolution camera with different lenses for magnification of up to 100x, 200x and 500x-times. This splash-proofed camera was mounted on the spindle housing and the machining of the workpiece was watched precisely via a 14" colour monitor outside the machine.

KERN
Micro- und Feinwerktechnik
GmbH & Co.KG
Ammergauer Str. 11
DE-82418 Murnau-Westried

Phone +49 8841 6130-0
Fax +49 8841 6130-40
Email:
kern@microtechnic.com
Website:
www.kern-microtechnic.com

But how can minute machining operations be demonstrated? For our test, a hair was cut from an employee's head. It was positioned and glued onto a small aluminium block. The first test run using a 30 µm drill was very successful and five holes, one after the other were drilled in the hair without breaking the hair or the drill!

As there is no obvious need for a drilled hole in a hair, appropriate applications for such small tools have to be exposed. The increasing importance of Microsystems Engineering covers a wide range of applications that the KERN team will be dealing with now more intensively.

KERN
Micro- und Feinwerktechnik
GmbH & Co.KG
Ammergauer Str. 11
DE-82418 Murnau-Westried

Phone +49 8841 6130-0
Fax +49 8841 6130-40
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