

## With precision to noble design

### High precision displacement measuring system for processing gemstones

The processing of gemstones is a highly skilled craft, but one that does not dispense with precise machine production, as Herbert Stephan KG impressively assigns. The gemstone manufacturer has been developing its own machines for a long time and relies on sensor technology from ipf electronic, among others, for some special solutions. "Gemstone processing is now an industry in its own right, which requires highly specialized machinery," says André Jakoby, who is responsible for the maintenance of electrical systems at Herbert Stephan KG. The company, based in Frauenberg not far from Idar-Oberstein, employs 230 people and is one of the largest companies in the region for processing precious and semi-precious stones as well as synthetic stones (see Symbiosis of high-tech and tradition).

#### High-tech manufacture with in-house development

The company, which has its own technology center and a production facility that extends via seven halls with a total area of around 4,400 square meters, describes itself as a high-tech manufactory. And rightly so, as André Jakoby knows: "There are basically no standard solutions for mechanical gemstone processing." This is why Herbert Stephan KG develops its own machines, including the in-house software programming for the control (units). The company now has via 130 special machines. "Thanks to these consistent in-house developments, we certainly have a unique selling point in our segment, and in some areas of gemstone processing we are even the market leader. Our production is also constantly being expanded with modern CNC machines."

#### Beautiful shapes, motifs and patterns using ultrasonic technology

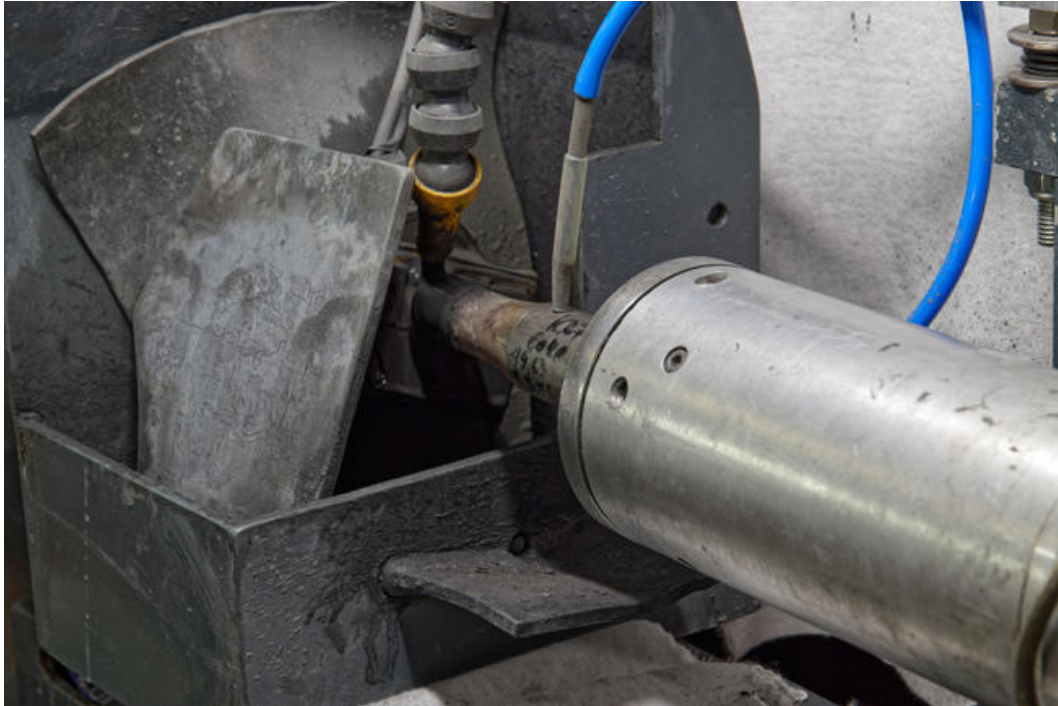
One of Herbert Stepan KG's core competencies is the engraving of shapes, motifs or patterns using ultrasonic technology and negative matrices in synthetic and genuine gemstones. "The solution we have developed enables us to produce large quantities by machine at competitive prices, with one employee being able to operate several machines at once. We now have around 50 of these ultrasonic machines in use," explains Jakoby, describing the production process: "A negative die is soldered onto an ultrasonic head and then the corresponding shape is worked into a stone using high oscillations and boron carbide as an abrasive emulsion. In this way, we can produce motifs that cannot normally be ground, for example. We also use the process to press recesses into stones for gold inlays, among other things."



The special machine enables extremely intricate patterns and shapes, as shown in this and the following image: a rose made of opal (Image: Herbert Stephan KG)



... a turtle made of jade. (Picture: Herbert Stephan KG)



The corresponding shape is worked into the stone using a negative die soldered onto an ultrasonic head. The addition of boron carbide during the process can also be clearly seen. (Image: ipf electronic)

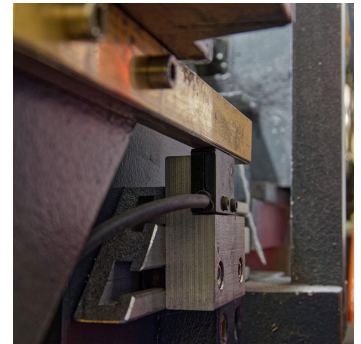
### **Cable pull system too imprecise and vulnerable**

A decisive parameter during machining is the most precise and accurate positioning of the tool to the workpiece. Previously, a cable pull system was used for this purpose, but it repeatedly caused problems due to the process-related oscillations in the 22 kHz range as well as the boron carbide used in the machining process. "The system was not only susceptible to wear and soiling, but also inaccurate, as the predefined parameters, e.g. the zero position of the tool feed, kept changing. We therefore had to recalibrate the cable pull system frequently, sometimes even during the manufacture of a production batch. When we were looking for an alternative, we turned to ipf electronic because we have been working with this company in some areas for a long time," reports André Jakoby. With an incremental magnetic displacement measuring system, the sensor specialist from Sauerland finally had a solution that met the decisive requirements, especially in terms of precision and reliability.

**From rectangular pulse to exact distance**

The displacement measuring system essentially consists of a sensor **MW110430** in degree of protection IP67 as a sensing head with a very high resolution of 10µm and the pulse monitor **WY050100**. In magnetic measuring systems, the sensor usually moves contactless via a magnetic tape. André Jakoby explains: "On our special machine, however, the sensor is permanently mounted on the machine, while the magnetic tape, which is attached to the tool drive and protected by an additional stainless steel band, moves via the sensor.

This solution ensures that the connection cable for the sensor is not subject to wear due to the movements of the tool slide. "Similar to the rotor of a motor, there are alternating north and south poles on the magnetic tape with a precisely arranged pole width of 5 mm, which generate a sine/cosine oscillation when scanned in the sensor. The sensor converts these oscillations into two square-wave pulses offset by 90 degrees. The resulting four switching edges can be used via the pulse monitor to determine and visualize the distance covered by the tool advance or the desired depth of the negative die and its movement direction.



The sensor **MW110430** is mounted on the machine so that the connection cable is not subject to wear. The magnetic tape, which is attached to the drive and protected from soiling by an additional stainless steel tape, is located above the sensor. (Image: ipf electronic)

**High resolution and sampling rate requirements**

"As the stones are sometimes only two to three millimetres thick and the depths are sometimes in the hundredths of a millimetre range, the propulsion system has to be extremely precise. The sensor's high resolution of 0.01 mm provides us with this precision," says Jakoby. Because the advance is also very slow and the process generates strong vibrations at the same time, it is also necessary to record the square-wave pulses at the highest possible sampling rate. Here, too, the input frequency or sampling rate of the pulse monitor of 250 kHz compared to the ultrasonic frequency of the tool of 22 kHz means that the system is always on the safe side, especially as the system processes the pulses very cleanly due to the high resolution, even when the tool slide is retracted manually.

André Jakoby explains: "Before machining begins, the tool advance must be in exactly the zero position in order to maintain the exact presettings for engraving. After machining, but also partly for checking during initial machining, the tool slide with the die is retracted by hand. The high-precision position measuring system now ensures that the die is exactly in the zero or start position again when it is subsequently restarted or at the start of a new production run. With the cable pull system, this position could be lost when the die carriage was retracted quickly, so we had to readjust it again."

**Colored display visualizes operational states**

The pulse monitor, which is designed as a front panel device, is parameterized via the integrated touch panel, whereby a total of four dimensions are currently stored. The pulse monitor is preset so that the display visualizes the current dimensions in green while the machine is in operation. Once the set-point is reached, the machine switches off and the display changes to red. "The employee responsible for the machine can therefore see instantaneously when the processing of a stone has been completed."



The pulse monitor currently has four press-in dimensions (C1 to C4) for the negative matrices that can be selected at the touch of a button. The front panel device visualizes the current dimension for the advance with green digits. The display changes to red when the set-point for the depth of the die is reached. (Image: ipf electronic)

**Established standard**

According to André Jakoby, the solution from ipf electronic's solution is superior to conventional position measuring systems, as it not only meets the required high accuracy, but also works contactless and is therefore insensitive to mechanical loads and vibrations. Even soiling from the boron carbide no longer affects the production process, as the machine employees only have to remove the emulsion residue from the stainless steel belt once a week using a cloth. "In the meantime, the incremental distance measuring system from ipf electronic has established itself as a standard for our ultrasonic machines that is both precise and reliable. Ten machines have already been equipped with the solution and a further 20 are to follow gradually," concludes André Jakoby.



André Jakoby, responsible for the maintenance of electrical systems at Herbert Stephan KG: "The incremental distance measuring system from ipf electronic has established itself as a standard solution for our ultrasonic machines." (Image: ipf electronic)

**Symbiosis of high-tech and tradition**

Herbert Stephan KG has been supplying the jewelry industry around the globe for more than 75 years. Based in Frauenberg (Rhineland-Palatinate), the company combines traditional craftsmanship with state-of-the-art technology. The company's own technology center with highly specialized machines and automatic machines, which are continuously and consistently developed further, is considered unique in the industry. Herbert Stephan KG is the market leader in the production of machine-engraved gemstones, with hundreds of thousands of engravings of high quality and precision being realized annually via 60 processing centers. Along with ultrasonic and CNC engraving using machines developed in-house, the company also offers the production of sample stones as "models on the fly" using rapid prototyping.



The company headquarters of Herbert Stephan KG in Frauenberg near Idar-Oberstein. (Picture: Herbert Stephan KG)