WITH PRECISION TO NOBLE DESIGN

HIGH-PRECISION LINEAR MEASUREMENT SYSTEM FOR PROCESSING GEMSTONES

The processing of gemstones is a high level of craftsmanship, which, however, does not do without precise mechanical manufacturing, as Herbert Stephan KG impressively demonstrates. The gemstone manufactory has been developing its own machines for a long time and relies on sensor technology from ipf electronic for some special solutions, among others. „Gemstone processing has become a branch of industry in its own right, which requires highly specialized machinery“, says Andrè Jakoby, responsible for the maintenance of electrical systems at Herbert Stephan KG. The company, which is based in Frauenberg not far from Idar-Oberstein and employs 230 people, is one of the largest companies in the region for the processing of precious and semi-precious stones as well as synthetic stones (see symbiosis of high-tech and tradition).

HIGH-TECH-MANUFACTURER WITH OWN DEVELOPMENT DEPARTMENT

The company, which has its own technology center and a production facility that extends over seven halls with a total area of around 4,400 square meters, describes itself as a high-tech manufacturer. Rightly so, as Andrè Jakoby knows: "There are basically no standard solutions for mechanical gemstone processing". Therefore, Herbert Stephan KG develops its own machines, including in-house software programming for the controls. In the meantime, there are more than 130 special machines. "Due 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 BY ULTRASOUND

One of the core competences of Herbert Stepan KG is the engraving of forms, motifs or patterns using ultrasonic technology and negative matrices in synthetic and genuine gemstones. "The solution we have developed in-house enables us to produce large quantities of engravings by machine at competitive prices, whereby one employee can operate several machines at once. We now have around 50 such ultrasonic machines in use," explains Jakoby, describing the production process: "A negative matrix is soldered onto an ultrasonic head and then the corresponding shape is worked into a stone using this tool by means of high vibrations and boron carbide as an abrasive emulsion. In this way, we can, for example, produce motifs that normally cannot be ground. In addition, we also use the process to press depressions into stones for gold inlays, among other things."

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

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

A negative matrix soldered onto an ultrasonic head is used to work the corresponding shape into the stone. The addition of boron carbide during the process is also clearly visible. (Picture: ipf electronic)

ROPE PULL SYSTEM TOO IMPRECISE AND SUSCEPTIBLE

A decisive parameter during machining is the most precise and positionally accurate advance of the tool to the workpiece. Up to now, a cable pull system has been used for this purpose, but this has repeatedly caused problems due to process-related vibrations in the 22kHz range as well as the boron carbide used during machining. „The system was not only susceptible to wear and contamination, but was also inaccurate, as the predefined parameters, e.g. the zero position of the tool drive, were repeatedly adjusted. As a result, we had to recalibrate the wire rope hoist system more often, sometimes even during the production of a production batch. When we were looking for an alternative, we turned to ipf electronic because we had been working with this company for some time in some areas," reports Andrè Jakoby. With an incrementally operating magnetic linear measurement system, the sensor specialist from the Sauerland region finally had a solution at hand that met the decisive requirements, particularly in terms of precision and reliability.

FROM RECTANGULAR PULSE TO EXACT DISTANCE

Essentially, the lienar measurement system consists of a sensor **MW110430** in protection class IP67 as probe with a very high resolution of 10µm and the pulse monitor **WY050100**. With magnetic measuring systems the sensor usually travels contactless over a magnetic tape. As Andrè Jakoby explains: „On our special machine, however, the sensor is permanently mounted on the machine, while the magnetic tape attached to the tool drive and protected by an additional stainless steel band moves over 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, north and south poles are alternately located on the magnetic tape with a precisely arranged pole width of 5mm, which generate a sine/cosine oscillation when scanning in the sensor. The sensor converts these oscillations into two rectangular pulses offset by 90 degrees. With the four switching edges resulting from this, the pulse monitor can be used to determine and visualize the distance covered by the tool drive or the desired depth of the negative die as well as its direction of movement.

The sensor **MW110430** is mounted on the machine so that the connection cable is not subject to wear. Above the sensor is the magnetic tape attached to the tunnel drive and protected from dirt by an additional stainless steel band.
(Picture: ipf electronic)

HIGH DEMANDS ON RESOLUTION AND SAMPLING RATE

"Since the stones are sometimes only two to three millimeters thick and the depths are sometimes in the hundredths of a millimeter range, tunnelling must be extremely precise. The sensor‘s high resolution of 0.01 mm gives us this precision," says Jakoby. In addition, because the advance is very slow and the process generates strong vibrations at the same time, it is also necessary to record the rectangular pulses at the highest possible sampling rate. Here, too, the input frequency or sampling rate of the pulse monitor of 250kHz compared to the ultrasonic frequency of the tool of 22kHz means that one is on the safe side in any case, especially since the system processes the pulses very cleanly due to the high resolution even when the tool slide is retracted manually.

Andrè Jakoby explains more precisely: "Before starting the machining process, the tool advance must be exactly in the zero position in order to comply exactly with the presettings for engraving. After machining, but also to some extent as a check during the initial machining, the tool slide with the die is retracted by hand. The high-precision linera measurement system now ensures that the die is exactly in the zero or start position again when the machine is subsequently restarted or at the start of a new production run. With the cable pull system, this position could already be lost once during rapid retraction of the tool slide, so we had to readjust it again."

COLOR DISPLAY VISUALIZES OPERATING STATES

The impulse monitor, which is designed as a front panel unit, 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 shows the current dimensions in green while the machine is running. After reaching the target value, the machine switches off and the display changes to red. "The employee responsible for the machine can thus immediately see when the processing of a stone is completed."

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

ESTABLISHED STANDARD

According to Andrè Jakoby, the solution of ipf electronic are superior to conventional linear measurement systems, since they not only meet the required high accuracies, but also operate without contact and are therefore insensitive to mechanical loads and vibrations. Even contamination by boron carbite no longer affects the production process, as the machine operators only have to clean the stainless steel strip with a cloth once a week to remove the emulsion residues. "In the meantime, the linear measurement system from ipf electronic has established itself as a precise and reliable standard for our ultrasonic machines. Ten machines have already been equipped with the solution and another 20 are to follow step by step," is the positive conclusion of Andrè Jakoby.

Andrè Jakoby, responsible for the maintenance of electrical systems at Herbert Stepan KG: „The linear measurement system from ipf electronic has established itself as the standard solution for our ultrasonic machines“. (Picture: ipf electronic)

SYMBIOSIS OF HIGH TECH AND TRADITION

For more than 75 years Herbert Stephan KG has been supplying the jewelry industry around the globe. The company, based in Frauenberg (Rhineland-Palatinate), combines traditional craftsmanship with the latest technology. The company‘s own technology center with highly specialized machines and automats, which are continuously and consistently developed, is considered unique in the industry. In the production of machine-engraved gemstones, Herbert Stephan KG is the market leader. With over 60 machining centers, hundreds of thousands of engravings are realized annually in high quality and precision. In addition to ultrasonic and CNC engraving with specially developed machines, the company offers, among other things, 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)