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MEASURING SUBSYSTEM WITH PHOTOELECTRIC DISPLACEMENT SENSORS FOR CNC MACHINES

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Annotation: The article discusses the use of control and measuring systems of CNC machines in technological operations of machining parts. The issues of express diagnostics of the geometric accuracy of CNC machines to ensure guaranteed measurement accuracy are considered. The characteristics of measuring systems of the world's leading manufacturers are considered. Conclusions and practical recommendations on the use of these systems in production are given.Linear motion sensors for CNC systems are widely used. They are intended for use on machines and installations with adjustable feed axes, such as, for example, milling, turning and grinding machines, machining centers and horizontal boring machines. The good dynamic properties of linear motion sensors, their high speeds of movement and acceleration allow them to be used both on conventional highly dynamic axes and with direct drives.

Keywords: Sensor, CNC, Machine tools, circuits, modulation, Photodetector, Links, Rectangular, Signals.

To control the movement of the working bodies of CNC machines, a measuring subsystem with photoelectric sensors operating in phase-pulse mode has been developed and is widely used. The offset of the input link of the sensor by one step of its scale corresponds to a shift of the output signal of the subsystem for a period of 2 hours.

Figure 1 shows the diagrams of the devices of circular and linear motion sensors. The operation of the sensors is based on the modulation of the luminous flux emitted by the source 4 and passing through the optical system 3. The modulation is created by shifting the measuring raster 2 relative to the indicator 1. The modulated luminous flux is perceived by four flat silicon photodetectors F1—F4, located with a shift of i/2 (for circular sensors). The use of flat photodetectors with a large photosensitive area (75 m2) made it possible to simplify the sensor circuit by eliminating collecting lenses, which are usually located in front of photodetectors [1].

The scale parameters of the measuring raster [2] are selected in such a way that when the input link moves, the photodetector currents change according to a triangular law (Fig. 2). Using a triangular signal, in contrast to

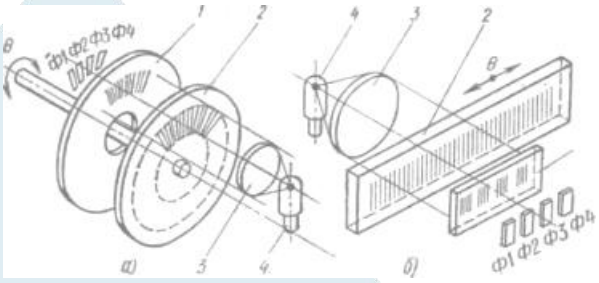

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Fig. 1. The scheme of circular (a) and linear (b) displacement sensors

The commonly used sinusoidal one makes it possible to simplify the design of sensors and the structure of the measuring subsystem (Fig. 3). The block diagram of the subsystem operating in CNC machines is shown in Fig. 3, a and b.

In the FDN circuit, rectangular signals K (t) and K (t + i/2) are formed. In the FS circuit, these signals are modulated in amplitude by the currents of photodetectors F1—F4 and summed to form an intermediate step signal. To convert a stepwise signal into a phase-modulated one, it is integrated in time and then formed at the zero points of the INT and NI circuits. Integration is necessary in order to obtain a signal L (t) of the same shape as the signal L (0), which is a necessary condition for establishing a linear relationship between the displacement of the input link of the sensor and the phase shift of the output signal of the subsystem. Due to the use of the INT integrator, the measurement error of the subsystem within certain limits does not depend on the absolute value of the signal frequency K (t).

Based on the scheme of the measuring subsystem, digital counting devices (DCS) [3] are built (Fig.3, c), in which the displacement is converted into the number of pulses. At rest, the phases of the signals at the FD inputs coincide and the control circuit is locked. When moving the input link of the sensor, the phase of the signal from the NI output shifts relative to the phase of the signal from the CD output; the control circuit opens, and additional generator pulses arrive at the CD input. As a result,,

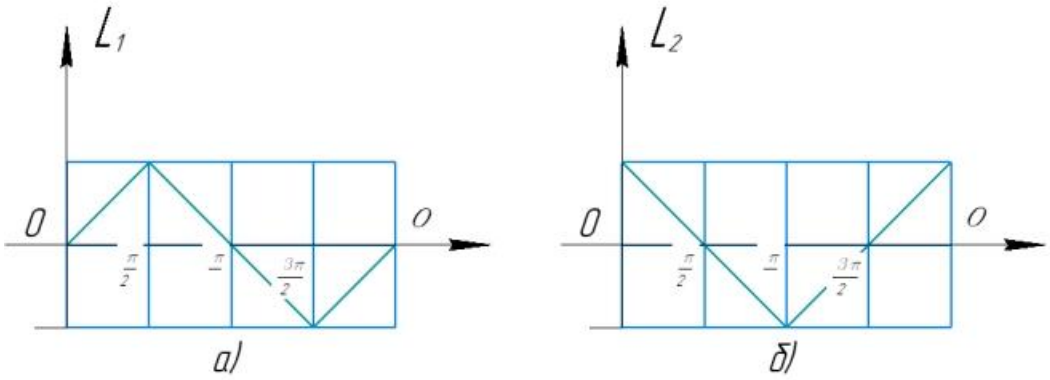

Fig. 2. The nature of the change in the currents of photodetectors F1, FZ (a) and F2, F4 (b)

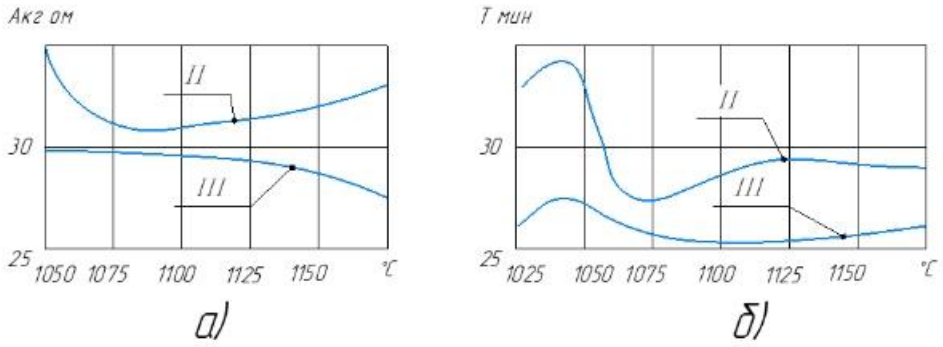

Fig. 4. Dependence of strength A (a) and durability T (b) of drills on the temperature of their rolling and subsequent heat treatment according to modes II and III

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