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DEVICE FOR MEASURING THE TEMPERATURE OF ROTATING OBJECTS

Abstract. The bench is proposed and studied using crystal-optical converters for the temperature of rotating objects.

Key words: crystal-optical method, temperature measurement, rotating object

Introduction. Due to the development of automated control and control systems, as well as the transition to flexible automated production, the need for reliable means of measuring various physical quantities, in particular, the temperature and speed of rotation of moving objects with a wide range of measurements, is growing rapidly. In addition to high metrological characteristics, measuring instruments must have high stability and reliability.

These requirements maximally satisfy the crystal-optical and fiber-optical measurements using anisotropic crystals [1], the main node of which is a thermosensitive element and a measurement method that determines the operational and metrological characteristics of these devices.

To measure the temperature and frequency, we have proposed the device shown in Fig. 1.

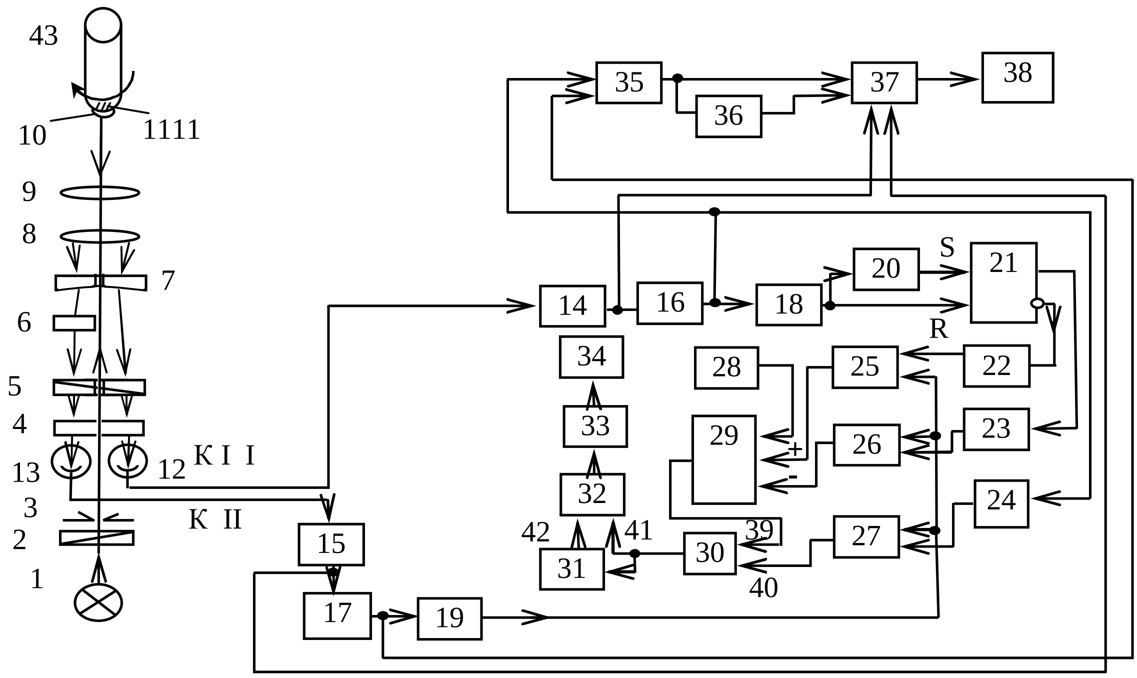

Fig. 1. Schematic diagram of the device for measuring the parameters of rotating objects, mainly temperature and speed of rotation

In Fig. 1: 1 – source of monochromatic radiation, 2 – polarizer, 3 – diaphragm, 4 – filter, 5 – analyzer, 6 – phase plate, 7 – third scattering lens, 8 – second focal lens, 9 – first focusing lens, 10 – thermocouple, 11 – a mirror gasket sprayed on the side of the bifurcation crystal; 12 – the first photodetector; 13 – the second photodetector; 14 – the first operating amplifier; 15 the second operating amplifier; 16 the first smoothing filter; 17- the second smoothing filter; 18- the first waveform rectangular pulse in, 19 – the second former of rectangular pulses, 20 – the first inverter, 21 – RS trigger, 22 – the first differentiating link, 23 – the second differentiating link, 24 – ADC, 25 – the first key circuit, 26 – the second key circuit, 27 – the first block of memory, 28 – installation unit, 29 – reversing pulse counter, 30 – first adder, 31 – second memory block, 32 – second adder, 33 – code code converter, 34 – display unit, 35 – comparator, 36 – second inverter, 37 – multiplexer, 38 – frequency meter, 39 – first input of the first adder, 40 – second input of the first adder, 41 – first and the input of the second adder, 42 – second input of the second adder, 43 – a rotating shaft, and C – the first channel K II – the second channel

In this device, the monochromatic polarized beam from the light source 1 (Laser type ЛГН-207Б) passes through the polarizer 2, the filter 4, the opening of the analyzer 5, the opening of the third disperse lens 7, the second focusing lens 8, the first focusing lens 9, the thermosensitive birefringent crystal 10 and reflects from the mirror gasket 11 sprayed on the back side of the thermosensitive bifurcating crystal 10, passes through the heat-sensitive birefringing crystal 10, passes through the first focusing lens 9, the second focal lens 8, a third scattering lens 7, and ambient light creates two beams. The 1st ray passes through the analyzer 5 and the narrowband light filter 4 and falls on the first photodetector 14, and the second after passing through the phase plate 6, the analyzer 5 and the filter 4 receives a constant phase shift – $\pi/2$ and enters the second photodetector 15.

The electrical signals $U_{ф12}$ and $U_{ф13}$ at the output of the photodetectors 12 and 13, which are determined by the square of the amplitude of the corresponding optical signals at their input and the sensitivity (steepness of the transformation) S1 and S2, are amplified by operational amplifiers 14, 15 and pass through the smoothing filters 16, 17, that is, we obtain the relation :

$$U_{16} = S_1 I_o \sin^2 \pi k t/\lambda , \qquad (2)$$

$$U_{17} = S_2 I_o \sin^2 \pi k (t - T/4)/\lambda, \qquad (3)$$

where Io – intensity of light at the input of the thermocouple (birefringent crystal) 10; ; λ = 632.8 nm – wavelength of source 1 of monochromatic polarized light; k – can be a function of temperature t; T is a characteristic temperature interval for a given thermocouple 10 corresponding to a phase multiplied by $\pi/2$.

Then the value of the measured temperature can be given as follows:

$$t = t_o + mT + \Delta t ,$$

where to – known initial temperature; m – the number of photocurrent minima registered at the temperature change of the thermosensitive birefringent crystal from the known initial (to = 0) to the measured t; Δt, $\Delta t<T$ – temperature corresponding to the fractional part of the temperature interval.

Conclusion. The device for measuring the parameters of rotating objects allows to make measurements of temperature and frequency together, to increase the accuracy and reliability of the measurement by removing intermediate elements that create additional influence and noise on the polarized beam, the source of monochromatic light 1 and complicate the process of adjustment of the device.

The device makes it possible to measure the frequency and temperature for cases of its rapid and cyclic change and provide remote measurements with the minimum heat transfer in the conditions of the electromagnetic field, as well as in the presence of high electrical potential with a digital reference.

Література

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