COMPLEX FOR MEASUREMENT OF DYNAMICAL CHARACTERISTICS OF NUCLEAR-PHYSICAL DEVICES

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The measuring-computer complex with replaceable Hall sensors has been developed. During magnetometric measuring on the screen of the computer display three-dimensional components of a vector of a magnetic field induction are represented depending on time in situ, and then further mathematical processing of the received information is carried out.

Problem

For nuclear-physical investigations various dynamic and quasistatic magnetic fields, low temperatures and other hard conditions of experiment are used. Some devices require a precision angular orientation or a measurement of relative micromovings. In this connection the measuring-computer complex with replaceable Hall sensors has been developed at The State Scientific Institution Joint of Solid State and Semiconductor Physics of the National Academy of Sciences of Belarus. Such a facility allows to make a number of magnetometric and mechanoelectrical measurements.

During magnetometric measuring on the screen of the computer display three-dimensional components of a vector of a magnetic field induction are represented depending on time in situ, and then further mathematical processing of the received information is carried out.

The complex can be used for the determination of quasi-static and single pulse (the arbitrary form) as well as periodic magnetic fields by means of measuring three components of a vector of magnetic induction B_x, B_y, B_z .

The range of registered values of a magnetic field induction is 0,01–100 mT; 0,1–1000 mT;

1mT–10 T; the range of operating temperatures is 4,2–373 K.

The remote measuring block consists of three Hall sensors placed in three mutually perpendicular planes. Amplification of analog signals of primary magnetic converters is realized by three two-cascade amplifiers. Two memory baseplates ADC 10M/12 having two synchronous channels (time of transformation is 100 nanoseconds; the RAM - 64 Kwords on the channel, an input range ± 2B, 4 lines of digital (TTL) input/output; external/internal synchronization, interruption, 14 digits) are built in a computer.

One-dimensional measurements in narrow backlashes up to 0,1 mm and deep apertures in diameter up to 0,75 mm are possible due to special sensors

The tiny special probes functioning on Hall effect which are used in the measuring -computer complex during magnetometric measurements are presented in fig. 1. Small-sized magnetometric probes are intended for measurement of a magnetic induction in a range from 0,001 up to 10000 mT in the narrow backlashes (>100 microns), in the temperature range from 1,5 up to 473K.

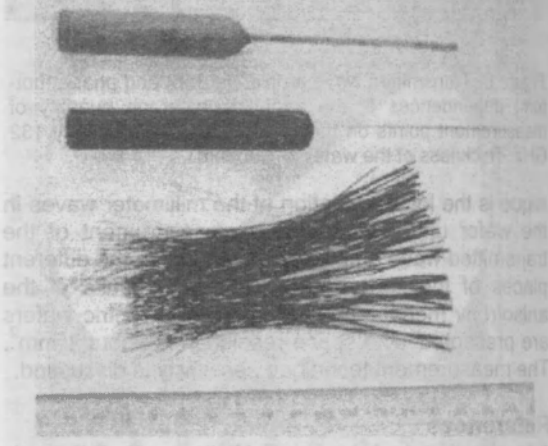

Fig 1.

Probes can be used both for the unique scientific researches and for the creation of the small-sized electronic gauges of transformation of mechanical sizes in an electric signal.

Types of probes

Probes are made in 6 modifications:

1. МПХН - magnetometric probe with a normal arrangement of Hall converter.
2. МПХТ - magnetometric probe with a face arrangement of Hall converter.
3. МПЗНТ - magnetometric probe with a normal arrangement of Hall converter and thermoresistance.
4. МПХНН - magnetometric probe-gradiometer.
5. МПХТН - magnetometric probe with a normal and face arrangement of Hall converter.
6. МПХНТТ - magnetometric probe with a normal and face arrangement of sensitive elements and thermoresistance.

Basic characteristics of sensitive element of probes

1. Crystal sizes, mm	0,5x0,5x0,1
2. Active area sizes, micron	100x100
3. Magnetic sensitivity, μB/mT	80.....500.....80...500 (*)
4. Working temperature range, °C	-60...+100
5. Rated feed current, mA	80...5 (*)

6. Temperature factor of magnetic sensitivity 0,001 % K^{-1}
7. Factor of nonlinearity, %, no more 0,5 (*)
8. Input resistance, Ohm 3±1
9. Voltage nonequipotential, μB <15

(*)-values depend on a degree of impurity incorporation of a semiconductor crystal n-InSb-i-GaAs.

During mechanoelectrical measuring the signals from the precision turning angle transmitter or the linear displacement transducer based on Hall effect are used. So the transformation of a turning angle of a shaft to an electric signal in a transmitter is made by Hall elements during a rotation of two constant magnets around them. The pair of magnets creates a homogeneous magnetic field changing as sine-cosine law relative to inter-perpendicular planes in which Hall elements are located. The sine-cosine converters allows to make angle measuring at quasi-static and static turning angles to within the one tenth of angular second. Temperature correction is easily realized by the processor.

The precision multiturn angle transmitter (ДУПХ) applied in the measuring-computer complex are realized in fig.2.

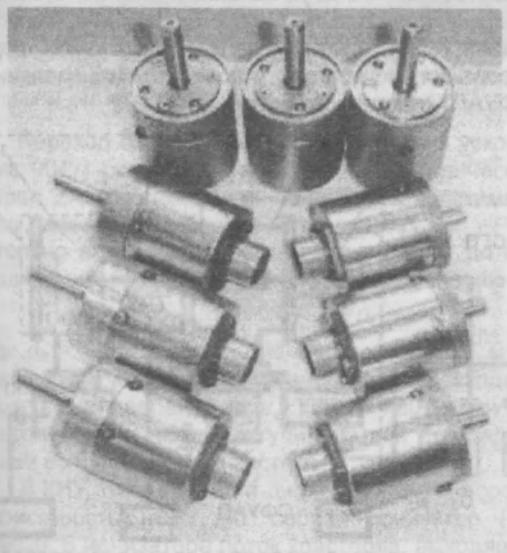

Fig. 2

Here the gauge is executed as the cylindrical case with a flange and a rotating shaft, and for exact fixing it has a spline self-centering holdfast. The gauge is designed for an operation in the conditions of high temperature, aggressive medium (hydrochloric, acid and alkaline exposure, etc.) and it has a fire-explosion-safe version. Unlike the potentiometric and induction gauges it has smaller dimensions, higher degree of reliability, the simplicity of a design, the modern element base

Applying plug-in linear displacement transducer which is used in the developed complex it is possible to measure the displacements by non-contact method with accuracy of 10 nanometers. For that the miniature magnetic system creating approximately constant gradient of magnetic field induction moves relative to Hall element.

The magnetic system providing a high gradient of a magnetic field (a quadrupole magnetic lens) is represented. It consists of four tiny magnets КС-37А. Magnetizations of magnets are oriented in the pairs opposite each other. Backlashes between magnets do not exceed 200 microns. Nonlinearity is completely excluded by computer processing of a signal.

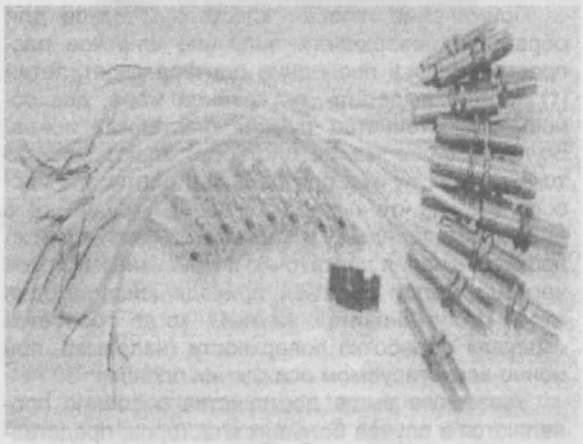

Fig. 3

The complex is supplied with contactless switches based on Hall effect (БКВ). They are intended for the determination of a position of mobile parts of mechanisms accurate within 0,05 mm in backlashes from 1,0 up to 5,0 mm. Depending on size and form of magnetic system the contactless switches БКВ fix a position of object at radial or tangential forms of movings.

The action of gauges is based on measurements of a magnetic field induction in a backlash between the concentrator placed on the end face of a contactless switch and the mobile magnetic system placed on controllable mobile object. Measurements are made with the help of magnetosensitive integrated circuits. When excess of an induction in a backlash the comparator works and the powerful transistor of the output cascade is switched in an open condition. Gauges are structurally executed as the cylinders from non-magnetic material with the built-in concentrator containing Hall element and the micro-baseplate that is submitted in fig. 3.