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LASER STRAINMETERS FOR SMALL DISPLACEMENT MEASUREMENTS

The new prototypes of laser strainmeter have been recently developed. The instruments are based on unequal-arm laser interferometer schemes. The measuring optical path is protected by an air-filled pipe that can be extended up to 50 m.

The two versions of laser strainmeter: jamproof LID-M and precise LID-MP instruments have been created. They distinguish by applied schemes and electronic equipment.

The LID-M version is based on three-mirror laser feedback interferometer [1]. The light scattering from remote object retroreflector is used for accurate discrimination of it's displasements. The instrument consists of two displasement sensitive optical units and distant electronic controle one (fig. 1). The heterodyne recording system operates on single-side band modulation of the laser beam and keeps 1/300 interference period resolution under turbulent signal fluctuations or another jamming effects. There is especial detecting device that makes is possible to prove the measurement result.

The precise laser strainmeter LID-MP is based on unequal-arm Michelson interferometer. In addition to the previous version (fig. 1) this instrument includes the precise interferometer unit with the compensative type optical servo system [2].

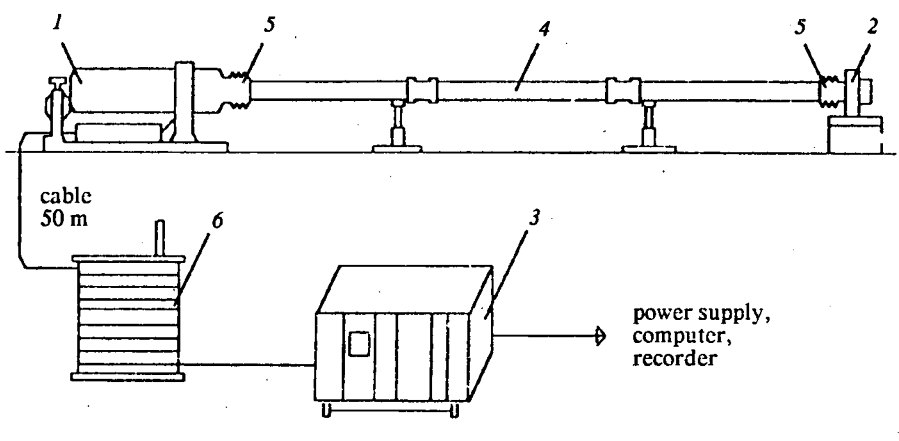

Fig. 1. Jamproof laser interferometer LID-M.
1 — laser and modulator unit, *2* — retroreflektor, *3* — control electronics and data storage, *4* — air-filled sectional pipe, *5* — rubber crimped hoses, *6* — cable.

Appendix

INSTRUMENT PERFORMANCE

Parameter, characteristic	Laser strainmeter version: Jamproof LID-M	Precise LID-MP
Measured base lenght *L, m*	10...50	1...30
Instrument sensitivity to:		
retroreflector displacement ΔL, *nm*	1,0	0,1
base strain $\Delta L/L$	10^{-10}	10^{-11}
Range of full scale continuoues record, *nm*	±320;...±160,000	±2;±20;±320
Measurement range under automatic storage of record discontinuities	Unlimited	±30 nm; unlimited
Frequency banddwidth	10^{-3} Hz...3 kHz	10^{-6} Hz...1 kHz
Maximum displacement velosity, *mm/s*	1,0	0,3
Antijamming capability (permissible interference signal attenuation), *dB*	30	10
Laser wavelenght, *nm*	633	633
Typical plasma tube lifetime, *hours*	20,000	10,000
Model of device controller, *A*	8080	8080
Capacity of power supply independent memory for data saving, *kBytes*	16	16
External computer interface	IRPS	IRPS
Power consumption (~ 220 V, 50 Hz or battery = 24...27 V dc), *Watts*	60	50
Dimensions, *mm*		
laser and modulator unit	∅170×740	∅170×740
precise interferometr	—	∅170×300
electronics control unit	330×160×330	330×160×330
Total weight (without pipe), kg	50	60

The photoelectric discriminator-grating and fast mirror galvanometer are applied to record the slightest interference fringe movements. There are 3 ranges of continuous displacement measurement: ± 2, ± 20, ± 320nm with 1,5 % r.m.s. nonlinearity of the upper margin (fig. 2). The signal is digitized by 10-bit converter and stored in controller unit.

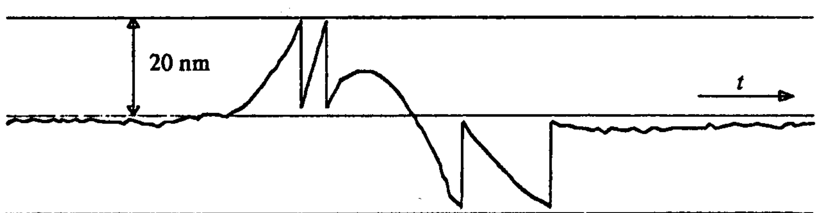

Fig. 2. The precise LID-MP instrument records the strain event in ±20 nm full-scale range.

The specifications of the both instrument versions are given in the Appendix.

The strainmeter control electronics permits the laser interferometer be installed 50 m apart. The measuring data output can saved on any analog recorder or power supply independent digital memory containing in the controller unit. The connection with an external personal computer being up to 0,2 km apart have been realized.

The LID-M and LID-MP instruments can operate in high humidity or dusty environment including adits, underground galleries, pits etc. The strainmeter are suitable to such application as geophysics, accurate surveying, industrial engineering, and high technology control.

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