ELECTRONIC SURVEYING INSTRUMENTS FOR MINING PRACTICE

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Up-to-date mining operations need accurate, quick and efficient surveying methods. One of the main tasks of the Research Laboratory of the Institute of Geodesy, Surveying and Photogrammetry, Technical University, Budapest is to develop new methods for surveying control of underground works. The research program involves applications of electronic surveying instruments as well as development and checking of new types.

Surveying control in shaft sinking

As far as surveying control is concerned, there are three main problems to be solved: shaft plumbing, measuring the shaft depth, and setting out short directions for the first working.

Experiences show that the shaft depth can be measured like a vertical distance by means of electro-optical distance measuring instruments. For this operation it is required to project the modulated light beam vertically downwards, to determine the refractive index correction as carefully as possible, and to keep clean the optical surfaces of retro-reflectors set up at the shaft foot. First, the AGA Geodimeter Model 6 has been applied; some successful experiments were made with the Zeiss (Jena) EDM Model EOK-2000, combined with a mirror deflecting the modulated IR-beam vertical.

For protecting the retro-reflectors from rain, a centrifugal self-cleaning device was constructed, consisting of a rotating horizontal plastic disc driven by an electro-motor. With this measuring equipment a 900 m range was achieved using AGA Geodimeter Model 6 and a 400 m range using EOK-2000 under unfavourable conditions (almost 100% air humidity). The accuracy of the shaft depth measurement was ± 20 mm root mean square error, caused mainly by extreme meteorological factors.

In order to extend the range and accelerate the measurement, a microwave distance measuring instrument, Tellurometer Model CA-1000 was used. In accordance with our expectations the total depth of 1200 m was easy and quick to measure. The evaluation of results was somewhat difficult because of microwave reflections and effect of air humidity. For this reason, microwave systems are only suggested for preliminary rough measurements with an estimated accuracy of ± 100 mm rms error.

For shaft plumbing a special laser plummet is suggested. It has a biaxial opto-mechanical compensator. According to experience a 1 mW laser can be used up to 400 m range. The estimated vertical laser beam stability is ± 5 mm over this maximum range, using an automatic compensator of medium accuracy. In addition, there are some other sources of error: the path curvature caused by refraction, errors of observation etc. The real accuracy of this laser plummet can be estimated at $\pm 10 \ldots 20$ mm over a range of 400 m. In our experiments a laser light source SIEMENS LG-68 with biaxial compensator and visual observation was used.

For the first working the azimuth of the axis had to be set out with relatively low accuracy. To this aim we used a third-class gyro-theodolite of Hungarian Optical Works Model Gi-Cl. A proper solution of this problem is possible by a small laser-gyroscope. With such an instrument the azimuth can be set out very quickly (within a minute) with the required accuracy.

Surveying control in drift advance

For the first working it is quite enough to set out the axis with a moderate accuracy, but after some hundred meters drift advance the azimuth and the distance between the shaft center and the first bench have to be measured with high accuracy. The above-mentioned Zeiss (Jena) EDM EOK-2000 for measuring distances and the new high-precision digital gyro-theodolite of Hungarian Optical Works Model Gi-B21 have been applied. Our experiences showed that distances could be measured with an accuracy of ± 10 mm, and azimuths of $\pm 5''$. Naturally before and after measurement exact calibration of the gyro-theodolite is required for determining the instrument zero constant.

During the drift advance the location of centre is generally needed. A laser beam can be used for locating the centre or laying out the axis. To this purpose a new model of laser theodolite has been developed by our Laboratory. Fig. 1 shows the principal scheme of this instrument. Its main advantage is the kinetic independence of theodolite and light source. The laser equipment is suspended on the fixed lower part of the theodolite and the laser radiation follows its three main axes (vertical, horizontal and optical). This instrument is as easy to handle as a theodolite, while its field of application is significantly extended.

Another problem in drift advance is that to set out a large number of blast holes on the roadhead before drilling. A significant part of the working time can be saved by using a slide projection equipment. A battery-supplied portable slide projector was constructed by our Laboratory for this purpose. It can project the configuration of blast holes with the desired magnification.

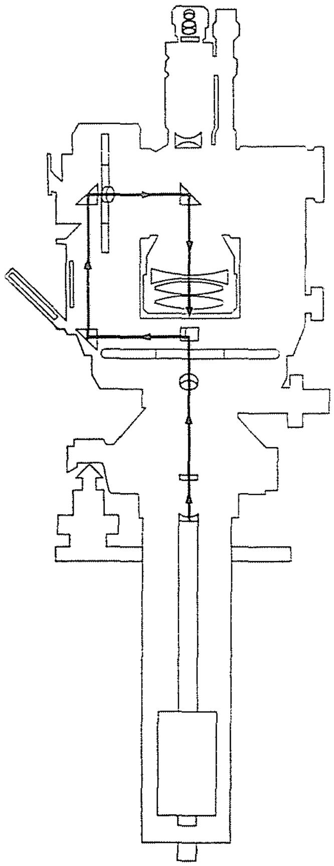

Fig. 1. Scheme of the astatic laser theodolite

This image can be oriented to the main axis which was set out earlier. Fig. 2 shows the schematic arrangement of the instruments. Compared to earlier methods, a considerable (80 to 90%) saving in working time is achieved.

The development of the electronic surveying methods and instruments as well as their application in other fields of mining lead to more accurate results and increase the productivity.

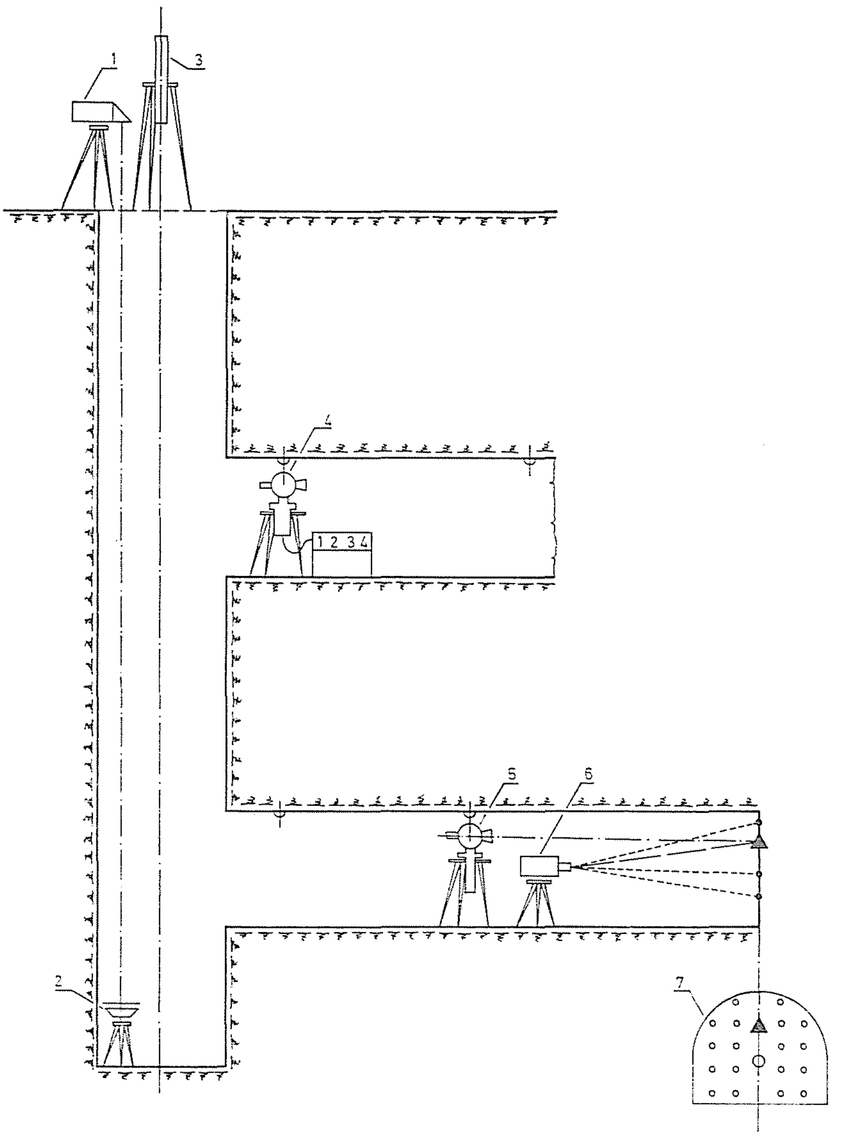

Fig. 2. 1. Zeiss EDM model EOK-2000; 2. Retro-reflector with self-cleaning disc; 3. Laser plummet; 4. Digital gyro-theodolite Gi-B21; 5. Laser-theodolite; 6. Portable slide projector; 7. Configuration of blast holes

Summary

Shaft sinking and drift advance require accurate, quick and efficient surveying methods. The complex application of electronic instruments could solve this problem properly at an up-to-date level.

The paper deals with shaft depth measurement by means of electro-optical and microwave distance measuring instruments; shaft plumbing by means of special laser plummet which has a biaxial opto-mechanical compensator; azimuth measurement by means of a new high precision digital gyro-theodolite HOW Model Gi-B21; setting out works by means of an essentially new astatic laser-theodolite and a blast-hole-configuration slide projector.

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