

## Roof Monitoring Safety System for Underground Stone Mines

### Objective

The Roof Monitoring Safety System (RMSS) provides a first step in roof behavior awareness. By understanding and measuring roof movement in an underground mine, the potential for injuries or fatalities to mine workers from fall of ground can be lessened. Also, officials at an underground mine with a history of data on roof movement are better prepared to make a decision on remedial actions if falls of ground become a problem. The RMSS provides a safer, simple, and inexpensive means for measuring roof movement.

### Background

Statistics show that falls of ground (i.e., roof or rib rock) are responsible for a high number of mining injuries and fatalities. In all of mining, workers in the underground stone sector face the most serious risk from fall of ground, according to Mine Safety and Health Administration injury statistics from 1992 to 1996.

In addition to the present dangers associated with underground stone mining, national trends indicate that this sector will expand in future years. A proactive approach toward understanding roof behavior allows for mine planning and development that affords the safest conditions for the mine worker. In the United States, there are currently approximately 95 underground stone mines (predominantly limestone). The stone produced is used primarily for construction and secondarily for lime in chemical applications.

### Approach

During the past few years, the Pittsburgh Research Laboratory of the National Institute for Occupational Safety and Health (NIOSH) examined and characterized conditions at 43 underground stone mines. Observations during these visits revealed a limited degree of roof monitoring beyond visual inspection. Existing

monitors typically require the miner to measure movement at the roof. If conditions are unstable, the miner may be in harm's way while recording data.

Based on these circumstances, researchers concluded that a simple, inexpensive monitoring instrument with the capability for remote readings could lead to a safer way of recording data, as well as more widespread monitoring and understanding of roof movements. A monitor to meet this need was subsequently designed and tested. The key features of this monitor are (1) *remote capability*, i.e., it allows a miner to determine if roof movement occurred while at a location away from where dangerous conditions may exist, and (2) *inexpensive and simple design*, i.e., it allows for fabrication of the monitor at the mine site, as most of the monitor parts are readily available at local hardware or supply stores.

### How It Works

An overview of the RMSS components is shown in figure 1. Movement of rock layers within the mine roof is measured relative to a fixed-point calibration at the monitor housing. The housing contains a spring-loaded cable attached to a plastic rack and spur gear. Movements are detected by the transfer of electromotive forces through the rack to the spur gear, which is attached to a 500-ohm potentiometer. Movements are measured through the tension spring that is attached to one end of the monitor. When movement occurs, the cable is pulled and the resultant electromotive force is recorded by the potentiometer. Movement is precisely measured by comparing the output of the potentiometer to a control-level calibration and can be read from cable extended from the roof to a ground-level location. A reading can be made with a voltmeter at appropriate time intervals or hooked to a data acquisition system for more thorough data collection. The monitor requires a 2-in-diam hole extending approximately 12 to 20 ft into the roof.



## Accomplishments

The RMSS was introduced at a NIOSH "Safety Seminar for Underground Stone Mines" in Evansville, IN, on December 10, 1997. During the first half of 1998, monitors were installed at five mines—one in Illinois, three in Kentucky, and one in Pennsylvania, with plans for installations in another mine in Pennsylvania and two mines in Indiana. A summary report detailing use of the monitors and evaluation by mine workers and operators is planned for January 1999.

## Patent Status

An application for a patent on the RMSS has been filed.

## For More Information

An instruction booklet is available giving complete details on parts, assembly, and installation of the RMSS. To receive a free

copy, contact L. J. Prosser, Jr., or Anthony T. Iannacchione, Ph.D., NIOSH Pittsburgh Research Laboratory, Cochran Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236-0070, phone: (412) 892-4423 or (412) 892-6581, fax: (412) 892-6891, e-mail: lfp2@cdc.gov or aai3@cdc.gov

To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Home Page on the World Wide Web at <http://www.cdc.gov/niosh>

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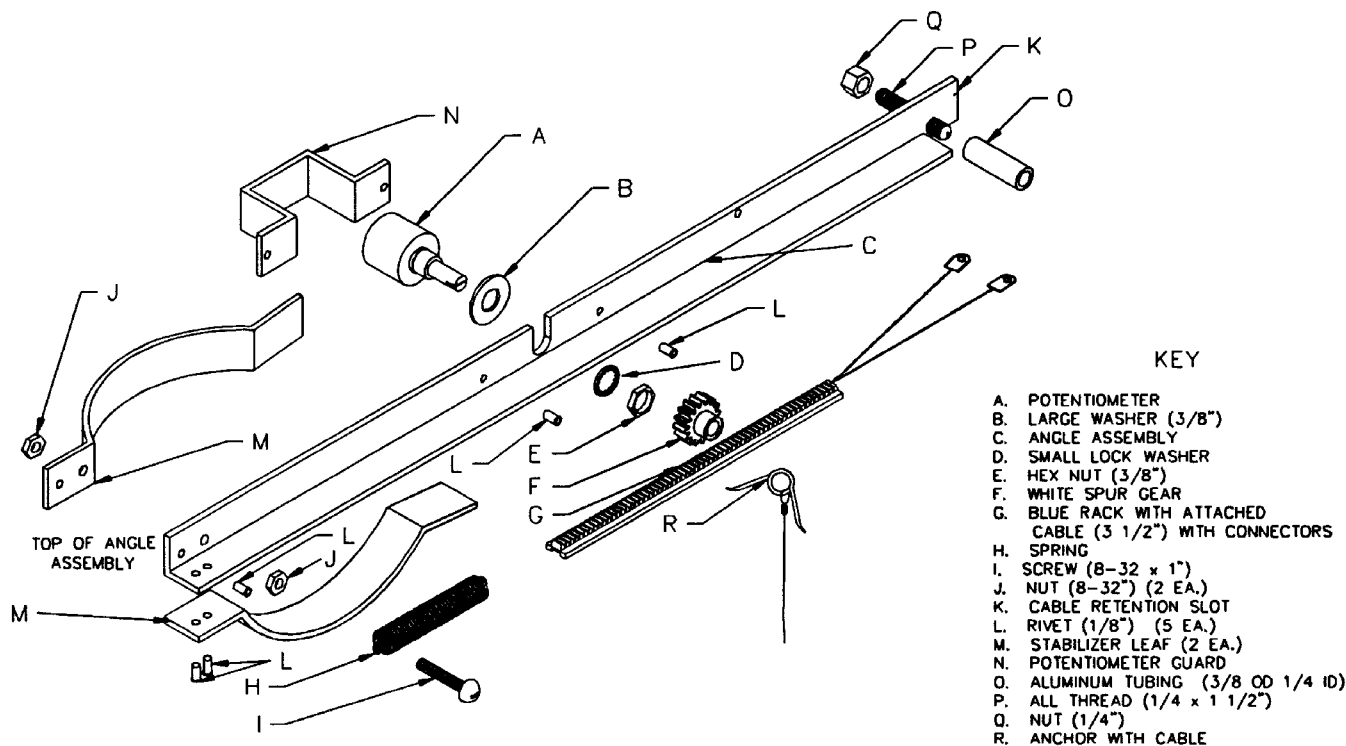


Figure 1 Overview of RMSS components.