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Electromagnetic system for detection and localization of the miners caught by accident in mine

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It is well known that the profession of a miner is one of the most dangerous in the world. Among the main causes of the people death in the underground coal mining enterprises is their untimely alerting of the accident, as well as the lack of information for the rescuers about the actual location of the miners after the accident.
As world practice shows, the electromagnetic (EM) systems for the search and detection of people across a massive layer of rock are the most effective. Such systems are under development almost half a century in many countries dealing with mine industry. However, substantial progress related to the localization of personnel at a distance at least of 20-30 meters through the rock is not reached.
In an emergency situation (failure or destruction of underground infrastructure), personnel search behind and beneath of obstruction should be provided urgently. But none of the standard technologies (RFID, DECT, WiFi, emitting cable), which use the stationary technical devices in mines, do not provide notification of people caught by accident location. The only technology that provides guaranteed delivery of messages about the accident to the mine personnel, regardless of their location and under any destruction in the mine, is low-frequency radio technology able to operate through the thickness of rocks.
From the general theoretical considerations, it is clear that the miners localization system requires solving the inverse problem of the magnetic field source coordinates determining using the data of 3-component magnetic field measurements. A fundamentally new approach, based on the measurement of the magnetic field of the miner's responder beacon by two fixed and spaced three-component magnetic field receivers and solution of the inverse problem using the results of the magnetic field measurement, was proposed.
As a result, the concept of the equipment for miners beacon search and localization implementation (MILES - miner's location emergency system) was designed. The system consists of:
- miner's responder beacon (MRB) which is working using a principle of "friend or foe". MRB consists of transmitting coil (MC - miner's coil), powered by a crystal-controlled oscillator and magnetic field receiver (MS - miner's sensor) with a circuit for extraction and identifying of the individually coded pulse sequence dispatched by rescue team instrumentation;
- rescue team instrumentation (RTI), consisting of the source of magnetic field (RTC - rescue team coil) to call a specific MRB, and two three-component magnetic field receivers (RTS - rescue team sensors), connected to a portable computer such as a laptop.
The details of MILES system are presented in the report, as well as the results of its tests are discussed. They showed that the system has a high resource for remote operation even in the presence of large amounts of ferromagnetic masses between the miner's responder beacon and the rescue team instrumentation and under the influence of electromagnetic interference. The MILES assured miner's responder beacon call at the distance up to 100 m, and its detection and localization - up to 30 meters.