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UNITED STATES DEPARTMENT OF THE INTERIOR

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	s	second
in	inch	V	volt
min	minute	yr	year
psi	pound per square inch		

IN-MINE REMOTE-ACTUATED STENCH FIRE-WARNING SYSTEM

By Edward D. Thimons [1] and Mervin D. Marshall [2]

ABSTRACT

A remote-actuated stench gas fire-warning system has been designed and tested by the Bureau of Mines. This system makes use of the hard-wire network for the mine's phone pager system, thus greatly reducing the system cost. By locating stench gas canisters with remote-actuation release capabilities near working sections, the fire-warning time can be greatly reduced.

In a test of the system in a Missouri lead mine, the time required to warn miners of a fire at two working faces was reduced from about 20 min with the conventional system to less than 4 min with the remote-actuated system.

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INTRODUCTION

In earlier work, the Bureau of Mines and MSA Research Corp. developed a stench gas-tracer gas fire-warning canister with a heat-fusible release mechanism.[3] The canister, approximately 12 in long and 3 in in diameter (fig. 1), is charged with an appropriate stench gas mixed with a fluorocarbon to render it inert and a tracer gas. The canister is then pressurized to 100 psi with nitrogen. A stainless steel valve seals the canister during final assembly and storage. When put in use, however, a metal disc is used to seal the contents of the canister.

[3]Marshall, M. D., E. D. Thimons, D. W. Kneebone, and S. Gross. Canister Concept Provides Early Fire Warning in Mines. Min. Congr. J., v. 68, No. 4, 1982, pp. 64-68.

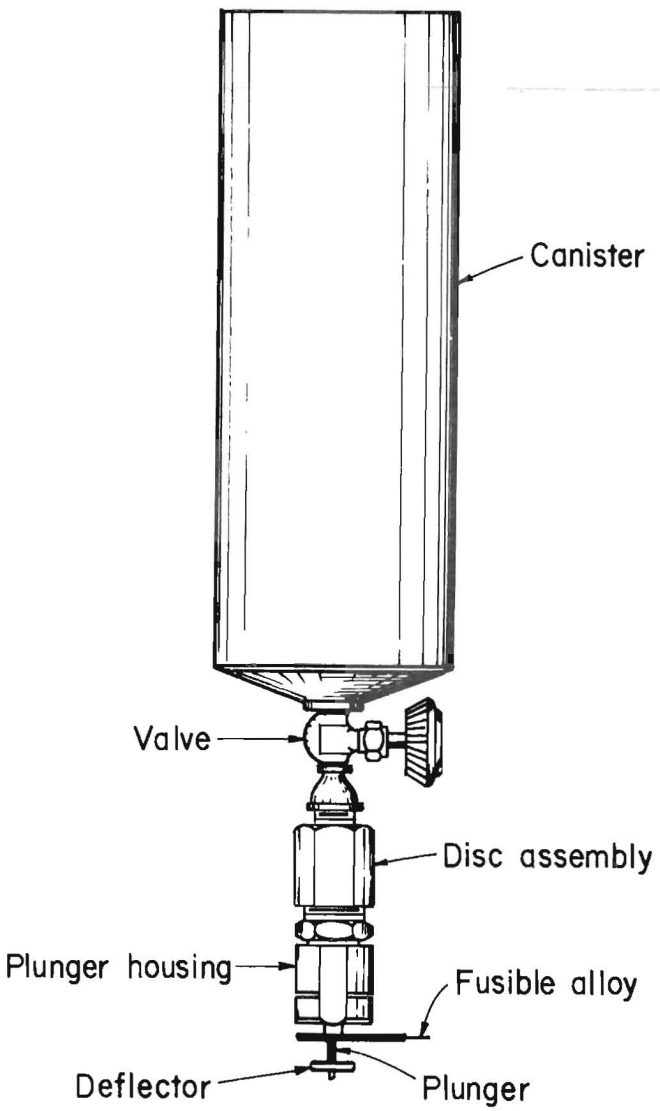

FIGURE 1. - Schematic of stench gas-tracer gas fire-warning canister with heat-fusible release mechanism.

The heat-fusible release mechanism is dependent on a low-temperature alloy which restrains a spring-loaded plunger for actuation during a fire. Upon exposure to heat, the alloy melts and the plunger is released. The plunger ruptures the disc, and the mixture of stench and tracer gas is released from the canister.

Canisters are mounted in areas of a mine that are susceptible to fire such as near fan motors, oil storage sites, and transformer stations. If a fire occurs at a protected location, the heat from the fire melts the low-temperature alloy, the disc is ruptured, and the canister contents are expelled in about 30 s. All miners on downstream ventilation are warned of the fire by the stench gas and take appropriate action. The tracer gas can be detected by instrumentation on the surface. Surface personnel can then take additional action such as dispensing more stench agent into the mine to warn all personnel. The tracer gas can also help notify the surface of a mine fire during off-shift or in a remote area of the mine where no miners are working.

These canisters were designed to provide fire detection capabilities in remote areas of a mine where personnel would not normally be located. In the case where a fire is detected by mine personnel, the problem becomes one of issuing a warning to all areas of the mine in the shortest possible time.

Presently, many metal and nonmetal mines have fire-warning systems that make use of stench gas released from the surface into the mine's intake ventilation air and/or compressed air lines. The stench disseminates throughout the mine

and warns miners. Several warning time delays can result from this procedure. Often, surface personnel must travel to distant shafts or other release locations to introduce the stench gas into the intake air. Times for ventilation air to travel from the surface to working locations can be as much as an hour, especially in large mines. Finally, the effectiveness of compressed air as a transport agent for the stench gas depends upon whether the compressed air is being used in the face areas. These problems led the Bureau of Mines and MSA Research Corp. to do research on an in-mine remote-actuated stench fire-warning system.

DESCRIPTION OF THE SYSTEM

The new remote-actuated stench fire-warning system makes use of the canisters previously discussed. Each canister is housed in a 6- by 24-in cabinet along with its own 12-V battery power source, sealed relays, and electronic circuitry (fig. 2). The system consists of multiple underground canister units located at key points in the mine ventilation network so as to provide quick dissemination of the stench gas to occupied areas of the mine. Each canister unit

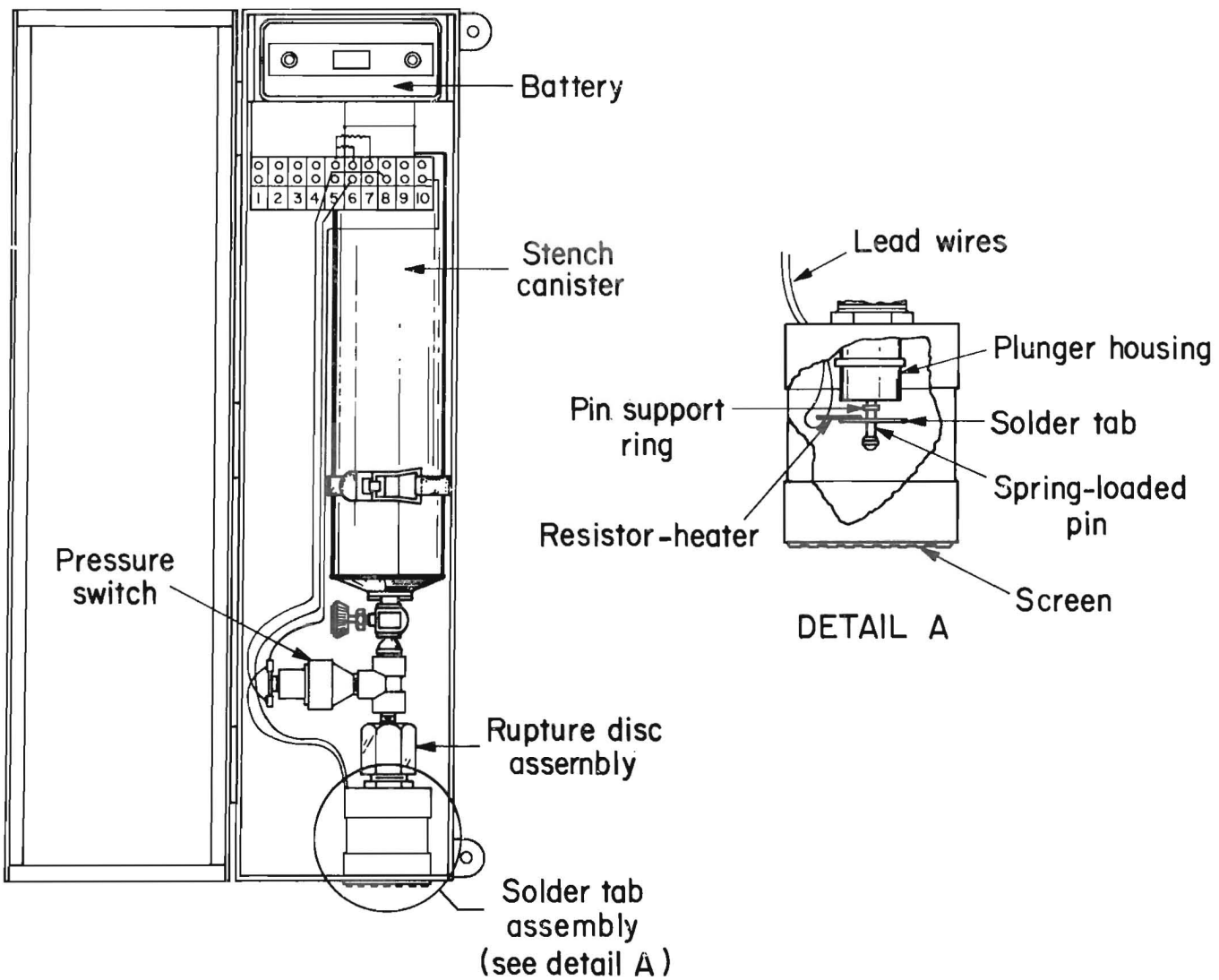

FIGURE 2. - Schematic of remote-actuated canister unit.

is hardwire-connected to a nearby phone which acts as a receiver for transmissions from a control phone aboveground or at a central in-mine site.

The system works as follows: In the event of a mine fire or other emergency, a coded message is dialed into the control phone. A low-amperage signal is sent from the control phone to a mine receiver phone. A relay is closed, and a current is sent to a small carbon resistor heater embedded on the surface of the fusible alloy tab on the canister release mechanism. The carbon resistor heater melts the tab within 30 s, releasing a spring-loaded pin which punctures the metal disc and permits release of the stench gas into the air.

Status checks of each stench gas canister unit can be made from the control station phone through coded signals entered via the telephone keyboard. The status check monitors circuit continuity, battery voltage, and canister pressure. A pressure switch, set to trip at 75 psi decreasing pressure, was inserted between the canister valve and the rupture disc of each canister (fig. 2) to allow the pressure check.

To minimize the possibility of accidental releases, the actual stench gas release requires that a set of two coded signals be placed on the control phone. Each canister unit is released individually, but it takes only a few seconds to enter the coded signals for each station. A successful stench gas release from a canister is signaled back to the control phone.

Some modifications were required on both the control phone and the receiver phones associated with each canister unit to allow for the sending and receiving of status check and release signals for the canister units. However, the phones still function as standard mine phones. By making use of the mine phone hard-wire network, the cost of this remote-actuated stench fire-warning system is greatly reduced. Individual stench gas canister units cost approximately $1,000. In this program the MSA Multiplex phone[4] was used in both laboratory and field testing.

The design life of the stench canisters is 5 yr, based on the canister itself which can be replaced for about $300. The canister cabinet, sealed relays, and electronic circuitry should have a long life under normal mine conditions. By firing one or more of the canisters in conjunction with a mine's semiannual fire evacuation test, a canister replacement system could be established so that canisters are replaced at least once every 5 yrs.

IN-MINE TESTS

A six-station remote-actuated stench fire-warning system was installed and tested in a Missouri lead mine. Each of the fire alarm stations, consisting of a stench canister unit and a receiver phone, was located at the base of a different intake air shaft (figs. 3-4). At each installation site, the receiver phone was mounted on the outside of the intake shaft housing and hard-wired to the stench canister unit inside the intake shaft housing. Fresh air from each intake shaft is distributed to active work areas by one or more fans mounted in the shaft housing wall and 4-ft-diameter ventilation ducting. Mounting the stench canister units inside the intake shaft housing insured that the released stench would be quickly carried to face areas through the ventilation tubing. The sixth station, the control station phone, was mounted in the mine foreman's office at the base of the mine's main shaft.

[4]Reference to specific products does not imply endorsement by the Bureau of Mines.

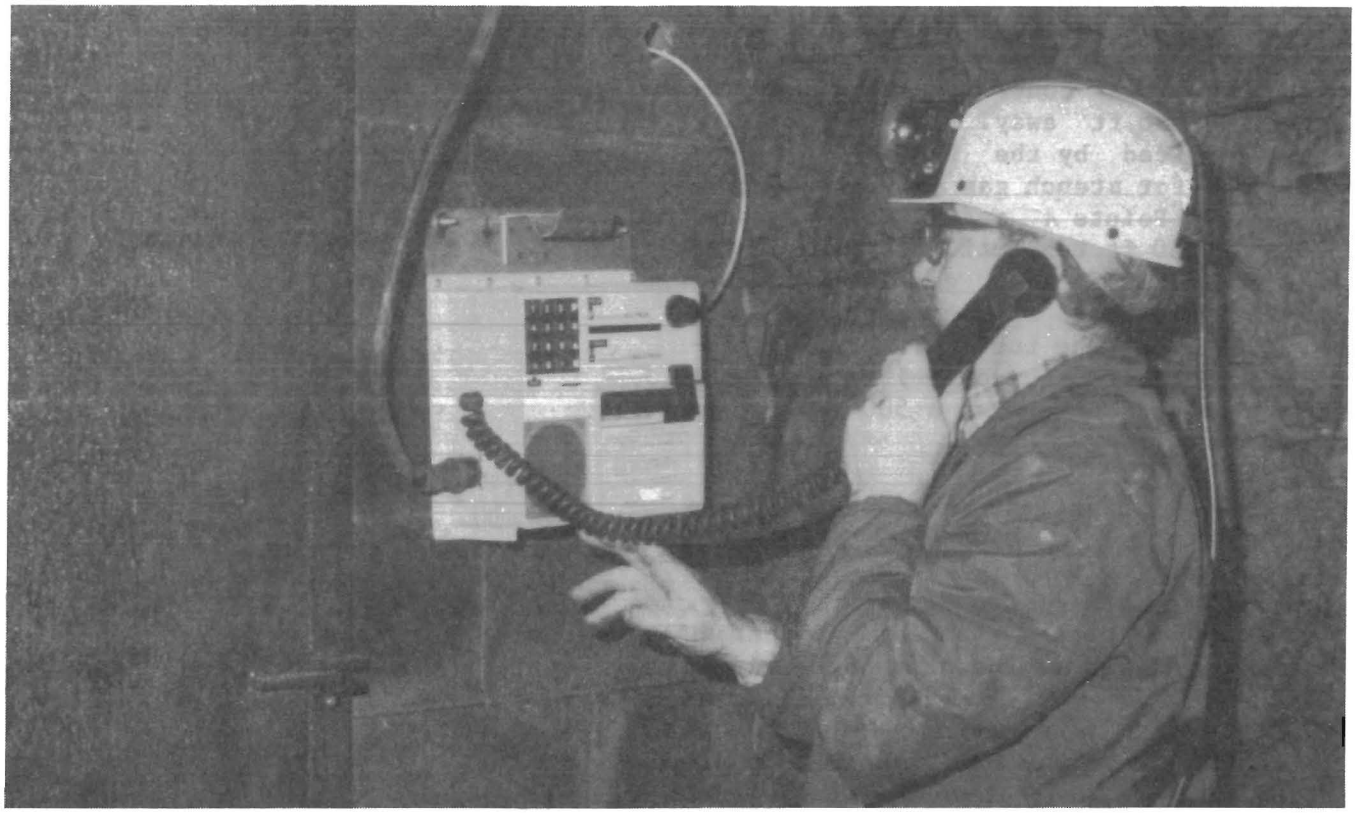

FIGURE 3. - Receiver phone mounted on outside of intake shaft at mine level.

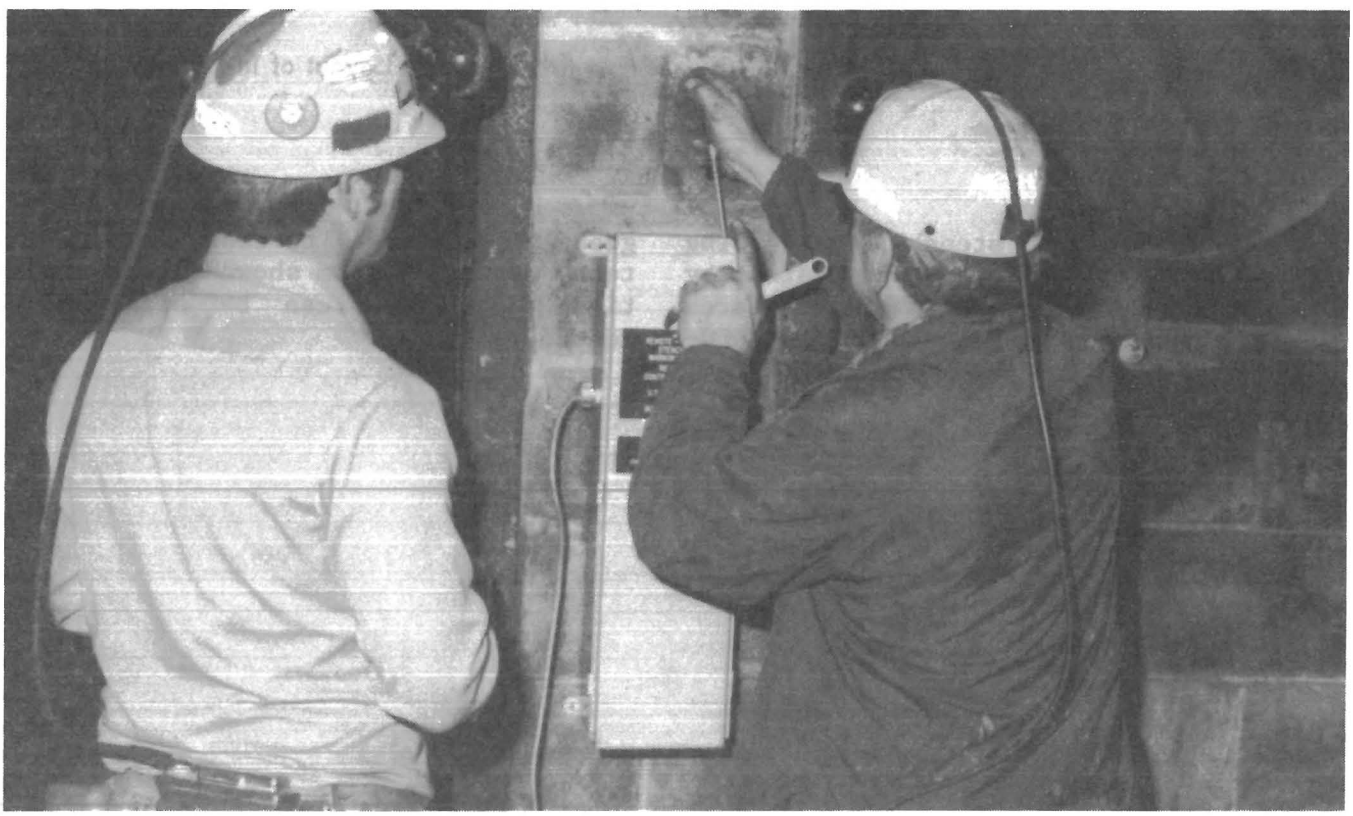

FIGURE 4. - Stench canister unit mounted on inside of intake shaft at mine level.

In a test of system performance, stench gas canister unit 45 (fig. 5) was activated from the control station approximately 4,000 ft away. The two working faces serviced by the intake shaft were monitored for stench gas at locations *A*, *B*, and *C*. Points *A* and *B* were located 300 and 450 ft respectively beyond the end of a 750-ft-long ventilation tube. Neither point had appreciable direct air movement from the tube. Point *C* was located close to the second work face about 200 ft beyond the end of a 500-ft section of tubing.

After the signal to release was given at the control station, the stench gas was clearly evident 3-1/2 and 1-1/2 min later at points *A* and *C*, respectively. While traces of the gas did appear at point *B*, it was not easily detected by smell.

Discussions with mine management indicated that warning times to these areas using their prior system of traveling to the individual shafts were 20 to 25 min. Therefore, warning times were reduced by at least a factor of 5. The remote-actuated stench fire-warning system remains at the mine as an extended test of the system.

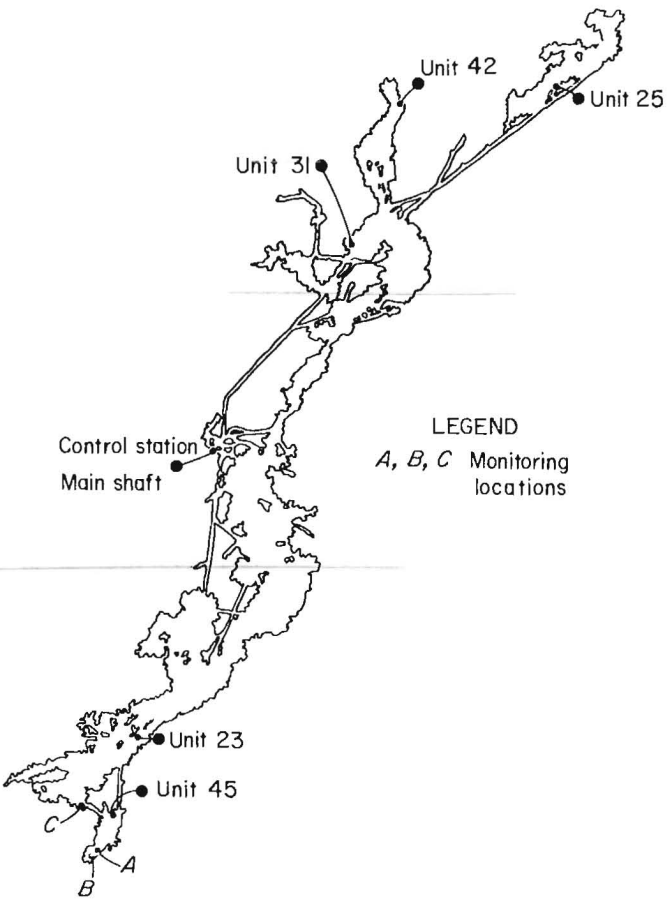

FIGURE 5. - Layout of in-mine test area.

SUMMARY

A remote-actuated stench fire-warning system has been designed and tested by the Bureau of Mines and MSA Research Corp. The system makes use of the hard-wire system of a phone network, thus greatly reducing its cost. An in-mine test of the system showed that warning time to miners can be significantly reduced.

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