Technology News

From the Bureau of Mines, United States Department of the Interior

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No. 439, August 1994

REMOTE RESET SYSTEMS FOR CONTINUOUS MINING MACHINES USED IN EXTENDED CUTS

Objective

Provide the technology to remotely reset circuit breakers on continuous mining machines used in extended cuts.

Background

The popularity of extended cut mining is increasing in U.S. coal mines. With this mining method, remote-controlled continuous miners are used to drive entries in excess of 6.1 m (20 ft) inby permanently supported roof. Industry-wide attention is focusing on safety considerations in extended cut mining. A particular problem area is the interruption of power to the continuous miner during an extended cut. Mine workers are tempted to dart under unsupported roof, disregarding regulations and personal safety, to reset circuit breakers on the continuous miner. Information was solicited from various organizations to determine the circumstances that cause power interruptions to extended cut continuous miners. The data accumulated permitted several conclusions to be drawn about why high-voltage circuit breakers trip. From this information, designs for remote reset systems were developed.

How It Works

Two reset systems were developed, a mechanical system and an electrohydraulic system. These system designs allow for installation on most brands of remotely controlled continuous miners employed in extended cuts.

The manual reset version, shown in figure 1, is the simpler of the two designs and can be easily implemented by any extended cut mine operator. This system essentially consists of two pull cables anchored to opposite sides of the circuit-breaker lever and associated guide pulleys. Minor modification to the breaker lever is required to accommodate attachment of the two pull cables. The pulleys are used to route the two pull cables to the inby end of a length of hose conduit anchored to the continuous miner. At the outby end of the hose conduit, each cable is terminated with a color-coded pull handle, typically red for breaker trip action and yellow for reset. The lengths of the hose and cables are dictated by the depth of the extended cut operation. During mining operations, the pull handles are located near the continuous miner operator. Where practical, the hose conduit can be located alongside the continuous miner trailing cable.

The electrohydraulic system is a more elaborate design. A schematic diagram of this system is shown in figure 2. This version is more suitable for incorporation into new equipment by the manufacturers but, if adequate space exists, could be retrofitted on any continuous miner.

On board the continuous miner, the electrical portion of this reset system contains the radio remote-control decoder-receiver unit interfaced to an intrinsically safe (I.S.) solenoid valve. Modification to the radio remote-control system may be required to dedicate two spare discrete-function outputs to control the dual coils of the solenoid valve. If multiple breakers are to be controlled independently, each breaker will require a separate solenoid valve and a pair of radio remote-control, discrete-function outputs. The operator's encoder-transmitter unit will require modification to include "TRIP" and "RESET" console function switches for each remotely controlled circuit breaker. The power source for the continuous miner's radio remote decoder-receiver must remain active after any breaker has tripped. This can be accomplished by powering the decoder-receiver unit from an uninterrupted ac voltage source on the continuous miner or powering the decoder-receiver with a battery pack that is trickle charged during normal operations. Ideally, the solenoid valve and decoder-receiver should be powered

from the same source. Intrinsically safe solenoid valves are available with a variety of alternating and direct current type coils.

The design of the hydraulic-mechanical portion of the system is simple and consists of a few inexpensive components. A small, double-acting cylinder is mechanically linked to the circuit-breaker lever. The cylinder is mounted to both trip and reset the circuit breaker. This requires a custom installation for each circuit breaker.

A small accumulator, charged by the continuous miner hydraulic system, powers the hydraulic cylinder. The charge in the accumulator is retained by a check valve after the continuous miner's hydraulic pump is turned off or shut down because of a breaker trip. Other components include a pressure-reducing valve and an I.S., 4-way solenoid valve. For testing purposes at the U.S. Bureau of Mines (USBM), the available components were connected with hydraulic hoses and fittings. A more compact hydraulic subsystem would use National Fluid Power Association subplate-mounted, stackable components. All of the components, except the accumulator, can be combined and mounted on a single subplate or manifold. Depending on the space available, the accumulator can be directly or remotely connected to this manifold or valve stack.

The pressure-reducing valve is necessary to provide a constant and limited force to the hydraulic cylinder. For the prototype test setup, 1,724 kPa (250 psi) was adequate to generate the required force to operate the continuous miner's main circuit-breaker lever. Because the internal leakage of the pressure-reducing valve will eventually drain the accumulator, the remote reset capability will exist only for a finite time after the continuous mining machine is shut down. Since the volume of the accumulator is large compared with the internal leakage of the pressure-reducing valve, a period of several hours can be realized and is considered adequate for most breaker resetting situations. A larger accumulator will yield a longer time interval. To achieve an infinite time period, an I.S., zero-leak, solenoid poppet valve could be installed in the pressure-reducing valve inlet circuit. This solenoid valve would have to be activated when the 4-way valve is activated in either direction.

Test Results

Both of the reset systems have been installed and tested on a Jeffrey 101MC[1] continuous miner at the USBM's Pittsburgh Research Center. The mechanical reset was also successfully tested on the USBM's JOY 14CM continuous miner. The systems have been successfully demonstrated to personnel from the Mine Safety and Health Administration and the Bureau of Deep Mine Safety of the Commonwealth of Pennsylvania's Department of Environmental Resources. Both agencies found the designs to be practical and did not expect to require any special approval for use in underground coal mines.

Cooperative Research Opportunity

The USBM is seeking cooperators to assist in further research and development of this technology. Additional information on cooperative research may be obtained by contacting Jacqueline H. Jansky, Technology Transfer Officer, Pittsburgh Research Center, U.S. Bureau of Mines, Cochrans Mill Road, P.O. Box 18070, Pittsburgh, PA 15236, (412) 892-6615.

For More Information

Further details can be obtained from the principal investigators at the Pittsburgh Research Center, U.S. Bureau of Mines, Cochrans Mill Road, P.O. Box 18070, Pittsburgh, PA 15236: August J. Kwitowski, (412) 892-6474; or Albert L. Brautigam, (412) 892-6470.

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

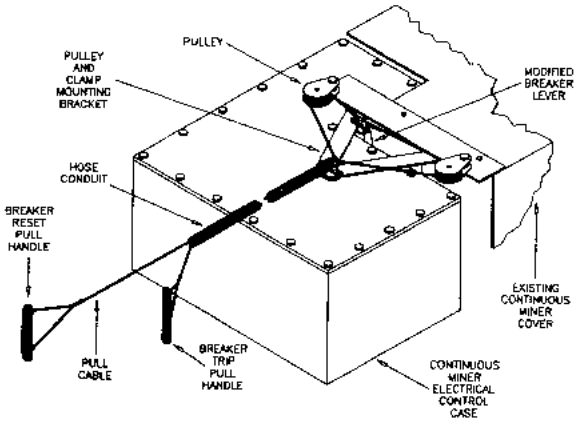

Figure 1—Mechanical reset-system installation on the USBM's Jeffrey 101MC continuous miner.

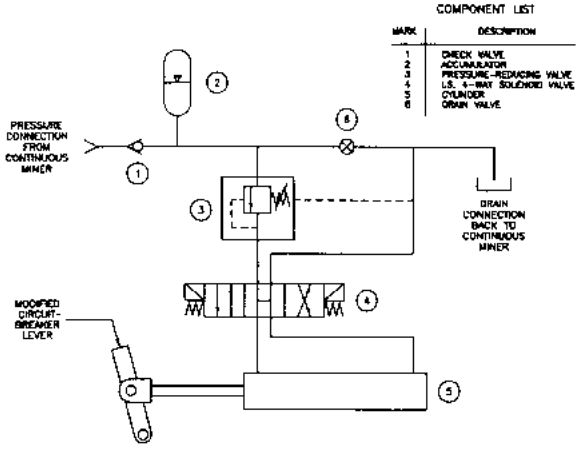

Figure 2.—Schematic diagram of the electrohydraulic reset system.