Low Profile Remote Roof Bolting Module

Bill Kyslinger, Design Engineer, with co-authors Gene Wilson, R&D Manager; Craig Collins, Project Engineer; and Bill Schwab, Design Technician; all with J.H. Fletcher & Company, Huntington, West Virginia gave a presentation to the Ground Control Conference on ***Development of Low Profile Remote Roof Bolting Module***.

In March 2004 a Letter of Intent was signed between Boart Longyear Poland, KGHM of Poland, and J.H. Fletcher & Company to, "Design and develop a roof bolter able to install 1.2 meter mechanical roof bolts in a heading no lower than 1.6 meters with the operator located in a protected air conditioned cab." The low-profile remote roof bolting machine is shown ***Figure 1***. J.H. Fletcher & Co. designed, developed, and manufactured the boom and drilling module while Boart Longyear Poland designed, developed, and manufactured the chassis and its components.

The objective was to produce a machine to provide ergonomic improvements for the operator while working in the mine environment. This dictated the requirement for a small easily controlled, maintenance-friendly design with a remote operator's control station. The selected design method was to use starter and finisher drill steels. This combination, requiring a number of mechanized machine motions, provides the ability to drill the required depth in the specified mine height. The roof bolting parameters are shown in ***Figure 2***. To accomplish the task from a remote location, a decision was made to employ current technology in the form of small pressure compensated hydraulics and electronic controls. The electronic control system is shown in ***Figure 3*** and the hydraulic control system is shown in ***Figure 4***.

Fig 1 Low profile remote roof bolting module

The result of the design work is a modular assembly with each sub-component designed to be replaceable and adjustable independently from other machine components. The low profile remote roof bolting module is made up of six major subcomponents. Each major component is painted a different color to help the operator make the visual connection from the drill module to the operators control/display monitor.

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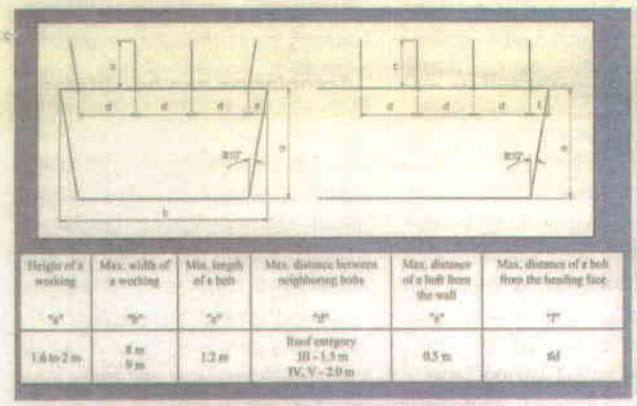
The Stabilizer (white) secures the module between the mine top and floor ***(see Figure 5)***. The Stabilizer also helps with repeatability for finisher steel and roof bolts with the initial hole. The Drillhead (orange) produces the drilling rotation and torque, but also must slide out of position to allow the machine to manipulate the drill consumables ***(see Figure 6)***. The Drill Steel Carousel (blue) holds and indexes as the starter and finisher steel from position to position with a single hydraulic cylinder ***(see Figure 7)***. The Manipulator Arm (green) moves and guides the drill steels and drill consumables from position to position during installation ***(see Figure 8)***. The Roof Reference Guide (yellow) locates the mine roof and guides the drill steels and drill consumables into position. The Linear Bolt Carousel (purple) holds the drill consumables.

The low-profile remote roof bolting module allows the operator to drill and install a roof bolt manually or automatically with the push of a button. The Operator's Drill Module Controls in the cab are shown in ***Figure 9***. This design substantially reduces the operator's exposure in the mine environment, as well as inherent pinch points and rotary hazards, positioning the operator safely in the confines of the air conditioned cab ***(see Figure 10)***. In addition, the operator is always under a supported top eliminating the miner's exposure to skin falls during the drilling operation and ultimately reducing the risk of injury. The improved ergonomics should also help reduce operator injuries and repetitive trauma.

The low profile remote roof bolting machine has recently been delivered to KGHM and since then deployed into the Polkowice-Sieroszowice Mine. The machine has been tested underground with a few minor adjustments and the low profile remote roof bolting machine is currently in production. A patent is pending on the drill module.



Height of a working	Max. width of a working	Min. length of a bolt	Max. distance between neighboring bolts	Max. distance of a bolt from the wall	Max. distance of a bolt from the heading face
"a"	"b"	"c"	"d"	"e"	"f"
1.6 to 2 m	8 m 9 m	1.2 m	Roof category III - 1.5 m IV, V - 2.0 m	0.5 m	≤d

Fig 2 Roof bolting parameters

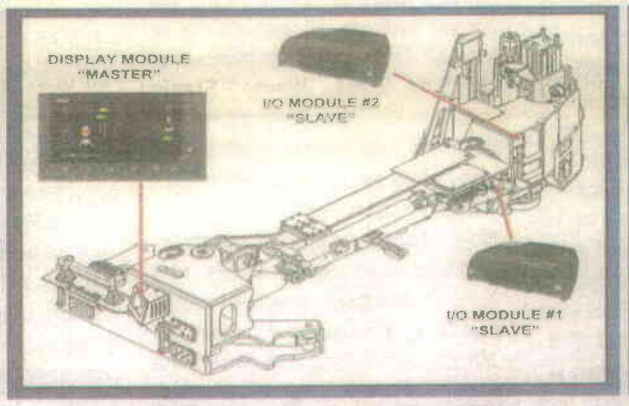


Fig 3 Electronic control system

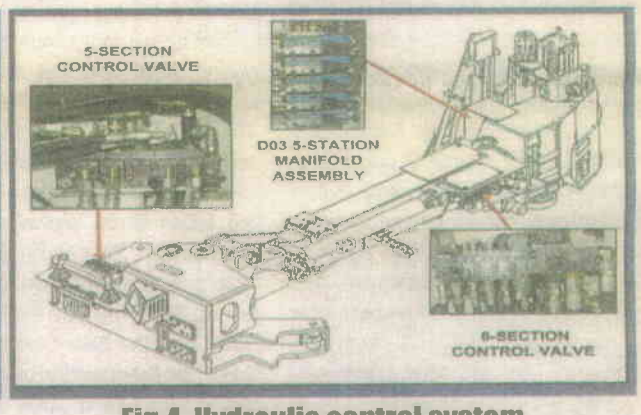


Fig 4 Hydraulic control system

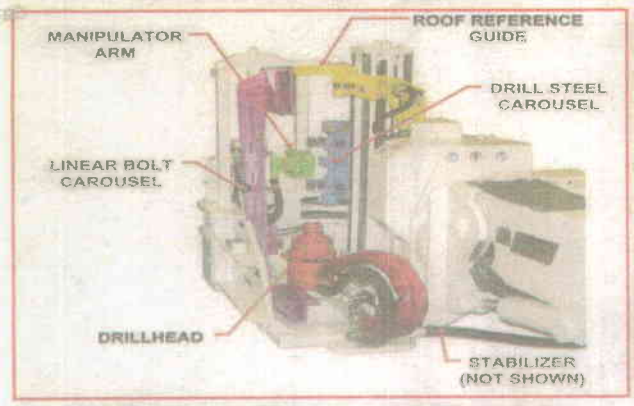


Fig 5 Low profile remote drill module

Fig 6 Drillhead (orange)

Fig 7 Drill steel carousel (blue)

Fig 8 Manipulator arm (green)

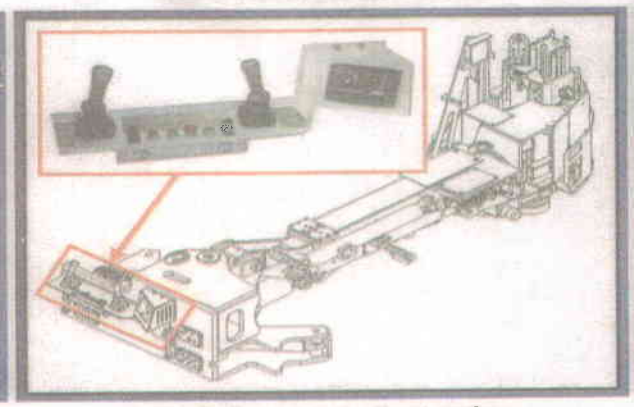


Fig 9 User control console

Fig 10 Low profile remote roof bolter