REPORT OF INVESTIGATIONS/1990

Use of Sheathed Explosive Charges on Longwalls

By Richard J. Mainiero and Lon D. Santis

1910 ★ 80 YEARS ★ 1990

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

Mission: As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

Report of Investigations 9294

Use of Sheathed Explosive Charges on Longwalls

By Richard J. Mainiero and Lon D. Santis

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan, Jr., Secretary

BUREAU OF MINES
T S Ary, Director

Library of Congress Cataloging in Publication Data:

Mainiero, Richard J.
Use of sheathed explosive charges on longwalls / by Richard J. Mainiero and Lon D. Santis.

p. cm. – (Report of investigations / United States Department of the Interior, Bureau of Mines; 9294)

Includes bibliographical references.

Supt. of Docs. no.: I 28.23:9294.

1. Coal mines and mining–Explosives–Testing. 2. Longwall mining. I. Santis, Lon D. II. Title. III. Title: Sheathed explosive charges on longwalls. IV. Series: Report of investigations (United States. Bureau of Mines); 9294.

TN23.U43 [TN803] 622 s–dc20 [622'.334] 89-600272
CIP

CONTENTS

ILLUSTRATIONS

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	in	inch
h	hour	min	minute

USE OF SHEATHED EXPLOSIVE CHARGES ON LONGWALLS

By Richard J. Mainiero[1] and Lon D. Santis[2]

ABSTRACT

The U.S. Bureau of Mines in cooperation with Jim Walter Resources, Inc. (JWR), Brookwood, AL, evaluated the use of sheathed explosive charges in breaking up large stones that can jam the feeder-breaker or pan conveyor on longwalls and halt operations. Use of the sheathed charge reduced the downtime of the longwall panel to 15 to 30 min as compared with the 1 to 2 h required to drill and shoot the stone. Firing the sheathed charge at the face caused no significant damage to longwall equipment. Use of the sheathed charge also represented an improvement in safety by eliminating the exposure of miners to the inherent hazards of the face for extended periods of time. Another benefit, which is difficult to quantify, is the elimination of the temptation to shoot mudcaps or adobes, which is illegal in U.S. underground coal mines.

[1]Supervisory physical scientist.
[2]Mining engineer.
Pittsburgh Research Center, U.S. Bureau of Mines, Pittsburgh, PA.

INTRODUCTION

Since 1981 the U.S. Bureau of Mines has been involved in the development of a sheathed explosive charge that can be safely fired unconfined in underground coal mines. This charge has a variety of applications such as, clearing large stones from roof falls, bringing down loose roof slabs and hanging brows, and removing cribs. Many previous reports detail the sheathed explosive charge's development, its evaluation in the above applications, and its safety for use in flammable atmospheres (*1-6*).[3]

Based on these prior experiences with the sheathed charge, the Bureau worked with the Mine Safety and Health Administration (MSHA) on the development of a test schedule for the approval of sheathed explosive charges as permissible explosives (*7*) and on regulations governing their safe use (*8*). Federal regulations providing for the approval and use of sheathed charges are now in effect, and as of this writing one explosive company has submitted a sheathed explosive charge for approval by MSHA. When sheathed charges are available, however, consult State regulations prior to their use.

In the fall of 1988 the Bureau entered into a cooperative agreement with JWR to evaluate the use of the sheathed charge to deal with problems encountered in their Blue Creek No. 4, No. 5, and No. 7 mines in Brookwood, AL. JWR mines the 70- to 95-in Blue Creek Seam utilizing eight longwalls. Above the Blue Creek Seam is a thinner seam of about 12 in. in thickness separated by a rock binder of one to several feet in thickness.

Ideally, JWR removes the Blue Creek Seam while leaving the thinner, upper seam and the rock binder in place. On occasion the rock binder thins out to the point where it and the upper coal seam cannot be held in place and both fall. The pan conveyor usually carries the rock to the feeder-breaker where it is crushed. Occasionally the rock falls in pieces large enough to jam the feeder-breaker and shutdown the longwall. Sometimes the rocks are so large that the pan conveyor cannot carry them or they damage the longwall support systems.

The traditional practice for dealing with this situation is to drill and shoot the stone, a process that takes from 1 to 2 h. The purpose of the research described here was to determine whether the use of the sheathed charge in this application would be more efficient and safer than previous practices.

MANDATORY EXPERIMENTAL PARAMETERS

All trials with the sheathed explosive charge were conducted according to the standards stipulated in *30 CFR 75, Safety Standards for Explosives and Blasting; Final Rule* (*8*). The section relating specifically to sheathed charges (75.1314) reads as follows:

75.1314 Sheathed explosive unit

(a) A separate instantaneous detonator shall be used to fire each sheathed explosive unit.

(b) Sheathed explosive units shall be primed and placed in position for firing only by a qualified person or a person working in the presence of and under the direction of a qualified person. To prime a sheathed explosive unit, the entire detonator shall be inserted into the detonator well of the unit and be held securely in place.

(c) Sheathed explosive units shall not be primed until immediately before the units are placed where they are to be fired. A sheathed explosive unit shall not be primed if it is damaged or deteriorated.

(d) Except in anthracite mines, rock dust shall be applied to the roof, ribs, and floor within a 40-ft radius of the location where the sheathed explosive units are to be fired.

(e) No more than three sheathed explosive units shall be fired at one time.

(f) No sheathed explosive unit shall be fired in contact with another sheathed explosive unit.

These regulations, permitting the use of the sheathed charge in underground coal mines, were not in effect at the time this research was conducted. MSHA and the State of Alabama, Department of Industrial Relations, Safety and Inspection Division, gave special clearance to conduct the experimental tests as long as Bureau personnel supervised the firing of all charges.

[3]Italic numbers in parentheses refer to items in the list of references at the end of this report.

EXPERIMENTAL PROCEDURES AND RESULTS

During this research the sheathed charge was used in a variety of applications such as breaking large stones on the longwall face, breaking large boulders left from an overcast shot, shooting off the corner of an overhang left from an overcast shot, breaking large boulders from a rib slump, crevice shooting of ribs about to slump, and knocking out a variety of roof supports. This report does not describe all the tests conducted; it concentrates mainly on tests that are different from those previously reported and those that were documented with photographs. In some cases photographs were not available due to technical difficulties, but in all cases the results were similar to those reported here.

A series of underground shots were fired at the site of a previous overcast shot in the Blue Creek No. 5 mine mainly to familiarize personnel involved with the use of the sheathed charge and to observe how well the sheathed charge would break rock of the type found in the JWR mines. Figure 1*A* shows the first rock to be broken with sheathed charges. The stone measured about 8 by 4 by 2 ft. The debris was cleared from the surface of the stone prior to the placement of the sheathed charges to ensure good contact between the sheathed charges and the stone surface. As shown in figure 1*B*, three sheathed charges were placed atop the stone and primed with instantaneous detonators. The area was well rock dusted so additional rock dusting was not necessary. In this trial, bags of rock dust were placed on top of the sheathed charges to determine whether the additional confinement would improve their effectiveness (fig. 1*C*). Figure 1*D* shows that the three sheathed charges broke about two-thirds of the stone; one large piece measuring about 4 by 3 by 1.5 ft remained.

Figure 1.–Familiarization shots at No. 5 Mine. A, 8- by 4- by 2-ft stone from overcast shot; *B*, priming of sheathed charges; *C*, charges confined by rock dust bags; *D*, shot results.

One more sheathed charge shattered the remaining piece of stone (figs. 2*A*-2*B*). For this trial the sheathed charge was covered with loose rock dust to evaluate the effect of this partial confinement on performance. Two sheathed charges were also placed atop another stone measuring approximately 6 by 3 by 2 ft (fig. 2*C*); no rock dust was placed on top of the sheathed charges in this case. Figure 2*D* shows the setup for the second shot; the two sheathed charges atop the stone on the left and the single sheathed charge covered with rock dust on the right. All three charges were wired in series and fired simultaneously. Figures 3*A* and 3*B* show that the sheathed charges shattered the stones quite effectively.

It appeared that the two bare sheathed charges were more effective than either sheathed charges covered with bags of rock dust or the sheathed charge covered with loose rock dust. There is no guarantee that this will always be the case, but the results do suggest that covering the sheathed charges with rock dust may be unnecessary and possibly undesirable from an efficiency point of view. This practice did seem to reduce airblast though. Covering the sheathed charges with rock dust should not have any adverse effect on safety, although this practice has not been evaluated in gallery testing.

The next series of shots were fired along the longwall in the Blue Creek No. 4 mine. These shots represented the main purpose for this research, clearing large rocks that jammed the pan conveyor or the feeder-breaker halting operations as illustrated in figure 4*A*. The typical procedure for handling this situation entails sending someone to get a drill, which can take an extended time depending upon where the drill is located and how near the rock is to the headgate. Next, someone has to climb over the pile of rock on the pan conveyor and maneuver into

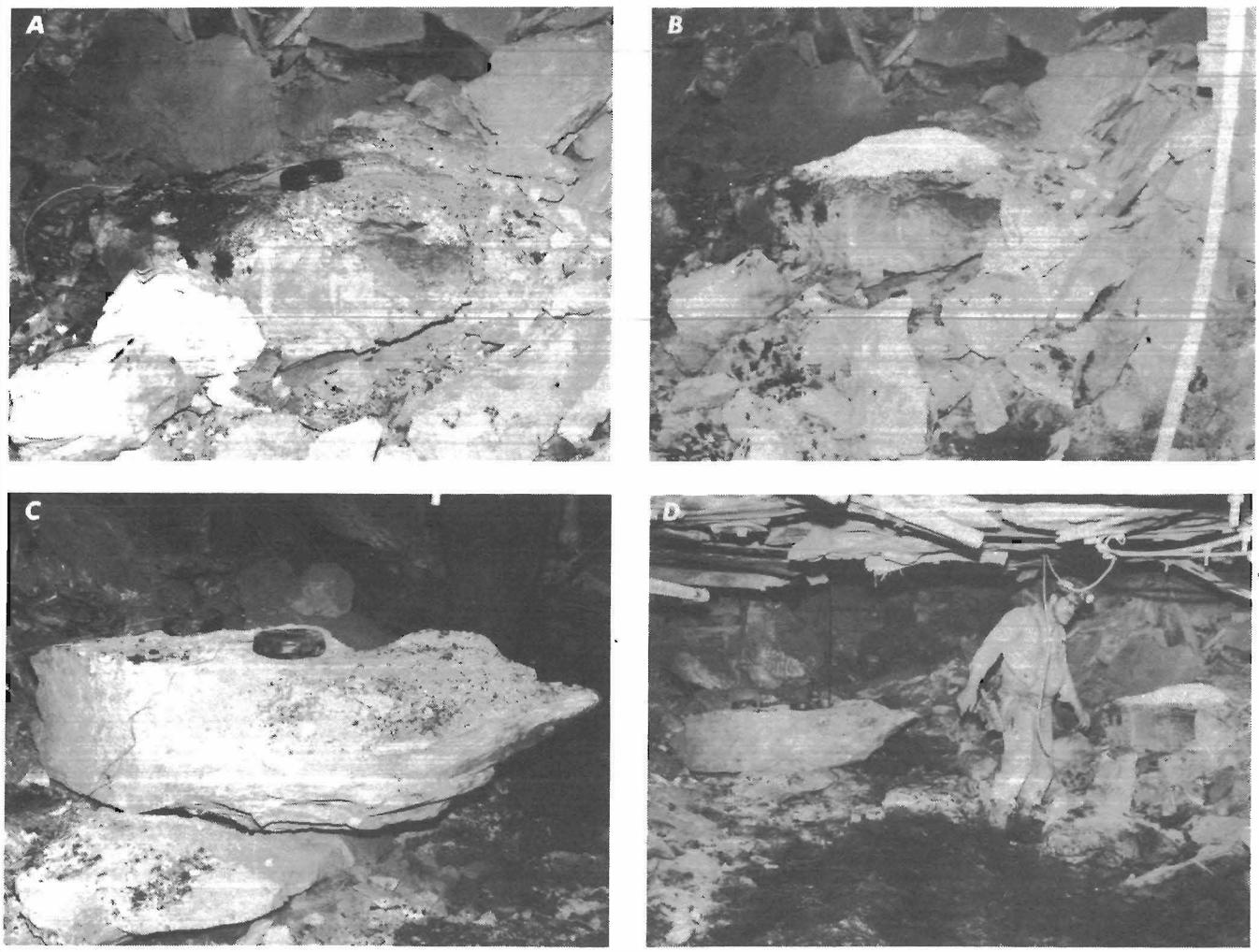


Figure 2.–Simultaneous shot at No. 5 Mine. *A*, Primed sheathed charge on 4- by 3- by 1.5-ft stone; *B*, charge confined by loose rock dust; *C*, primed sheathed charges on 6- by 3- by 2-ft stone; *D*, simultaneous shot setup.

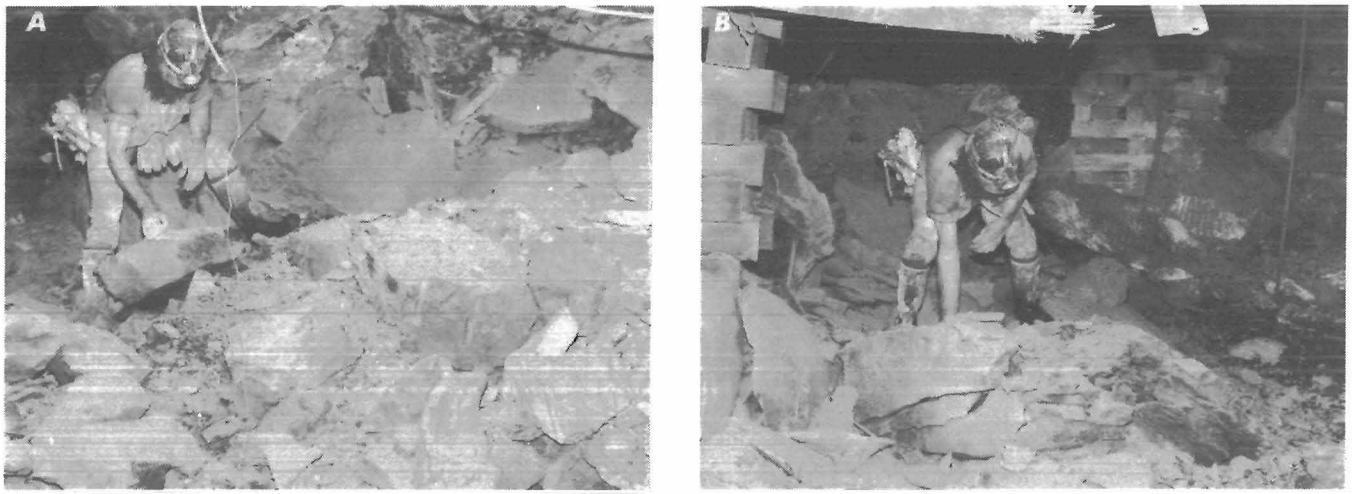


Figure 3.–Results of shot shown in figure 2. *A*, Fragmentation of 4- by 3- by 1.5-ft stone; *B*, fragmentation of 6- by 3- by 2-ft stone.

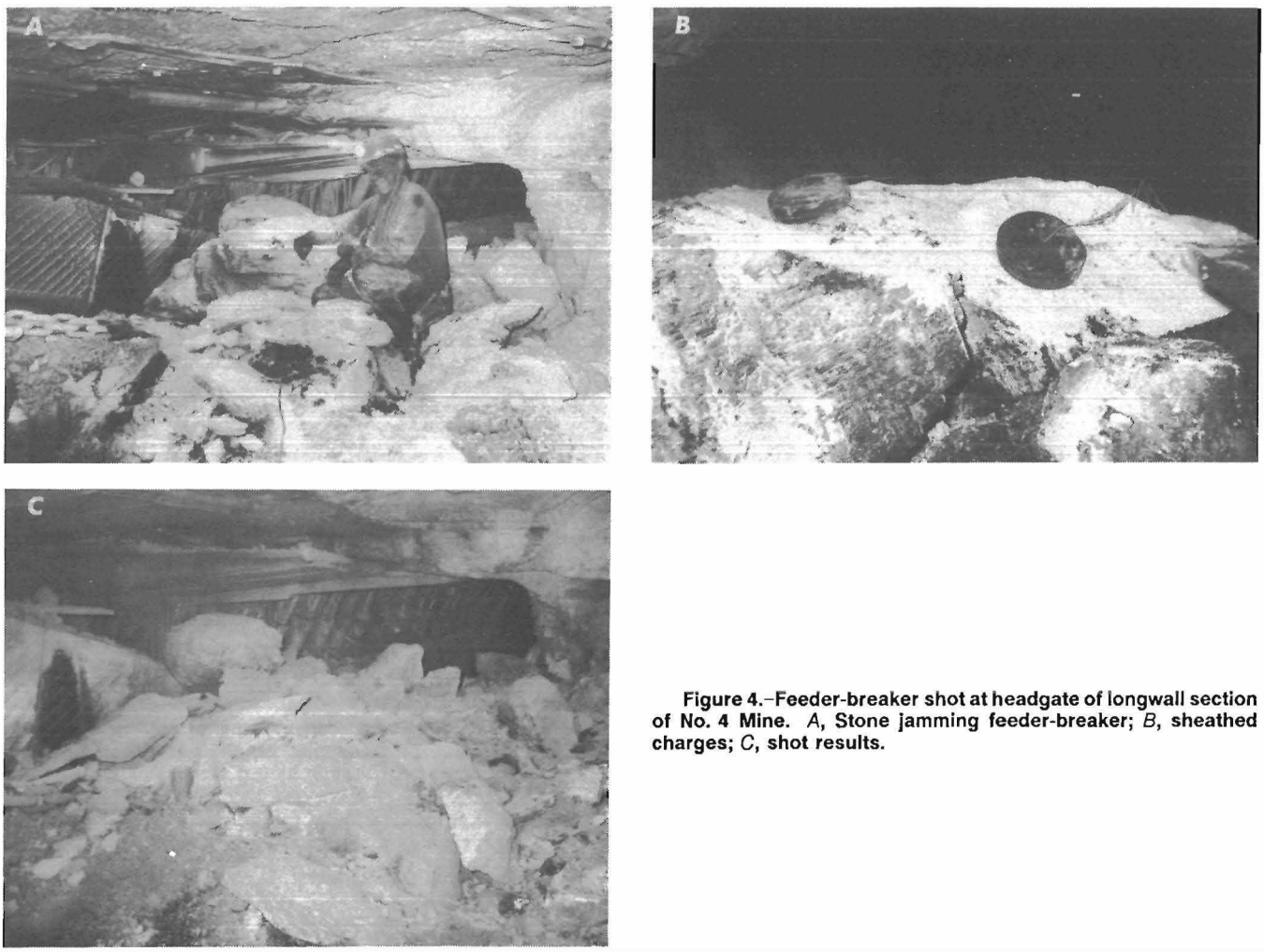


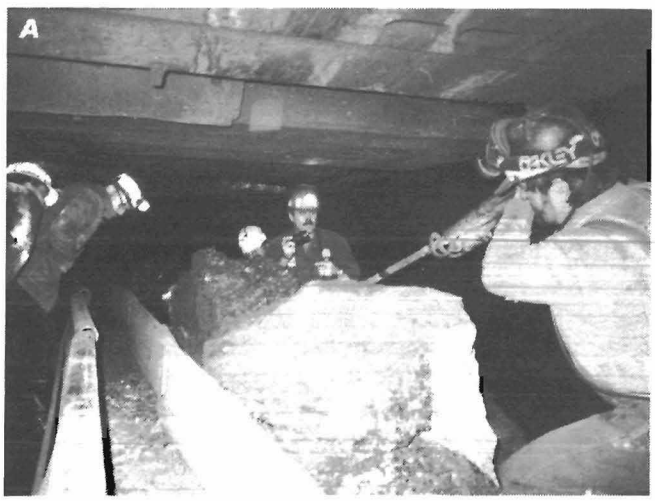
Figure 4.–Feeder-breaker shot at headgate of longwall section of No. 4 Mine. *A*, Stone jamming feeder-breaker; *B*, sheathed charges; *C*, shot results.

position to drill a borehole into the large stone causing the jam. This operation is not only difficult, but also dangerous as stone or coal may fall off the face at any time. The borehole is then loaded with explosive, stemmed, and the shot is fired, breaking up the stone. This operation typically shuts down the longwall for 1 to 2 h, representing a substantial loss of revenue. Eliminating the need to drill and shoot stones on the pan conveyor represents an improvement in safety and productivity.

Toward this end, the face area was rock dusted within 40 ft of the feeder-breaker, and two sheathed charges were placed on the large stone causing the jam (fig. 4*B*). The sheathed charges shattered the stone and longwall operations promptly resumed (fig. 4*C*). The entire operation of placing and firing the sheathed charges, including rock dusting, took about 15 min, representing a significant cost savings to JWR over traditional methods. Some concern was expressed about the possibility that firing the sheathed charges would damage the roof supports or pan conveyor; no damage was observed other than damaging one light on the longwall supports.

The next shot was very similar to that described above, except that the pan conveyor was stopped before the stone had a chance to get stuck at the feeder-breaker. The stone in this case measured about 10 by 3 by 3 ft (fig. 5*A*). In this figure a miner demonstrates how one would drill boreholes in the stone to break it by traditional methods. For our trial no boreholes were actually drilled. Figure 5*B* shows the stone with two charges in place ready for firing. The two sheathed charges shattered the stone very effectively (fig. 5*C*). Again the entire operation required only about 15 min and caused no damage to any equipment.

The third trial involved two large stones (approximately 5 by 4 by 2 ft and 8 by 3 by 2 ft) that had fallen on the pan conveyor. In figure 6*A* one of the miners prepares to rock dust the area. For this situation, two sheathed charges were placed on the larger stone and one on the smaller. Figure 6*B* shows the three charges in place ready for firing. Again the stones were effectively broken (fig. 6*C*) with no damage to equipment and with minimal expenditure of time.



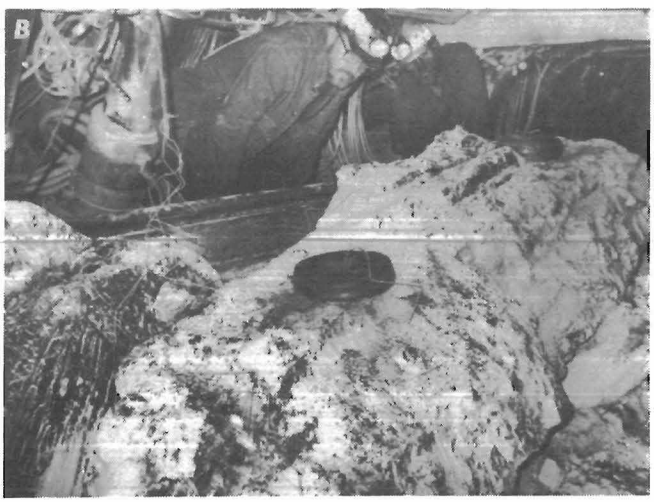


Figure 5.–First pan conveyor shot at No. 4 Mine. *A*, Demonstration of traditional borehole drilling; *B*, primed sheathed charges on 10- by 3- by 3-ft stone; *C*, shot results.

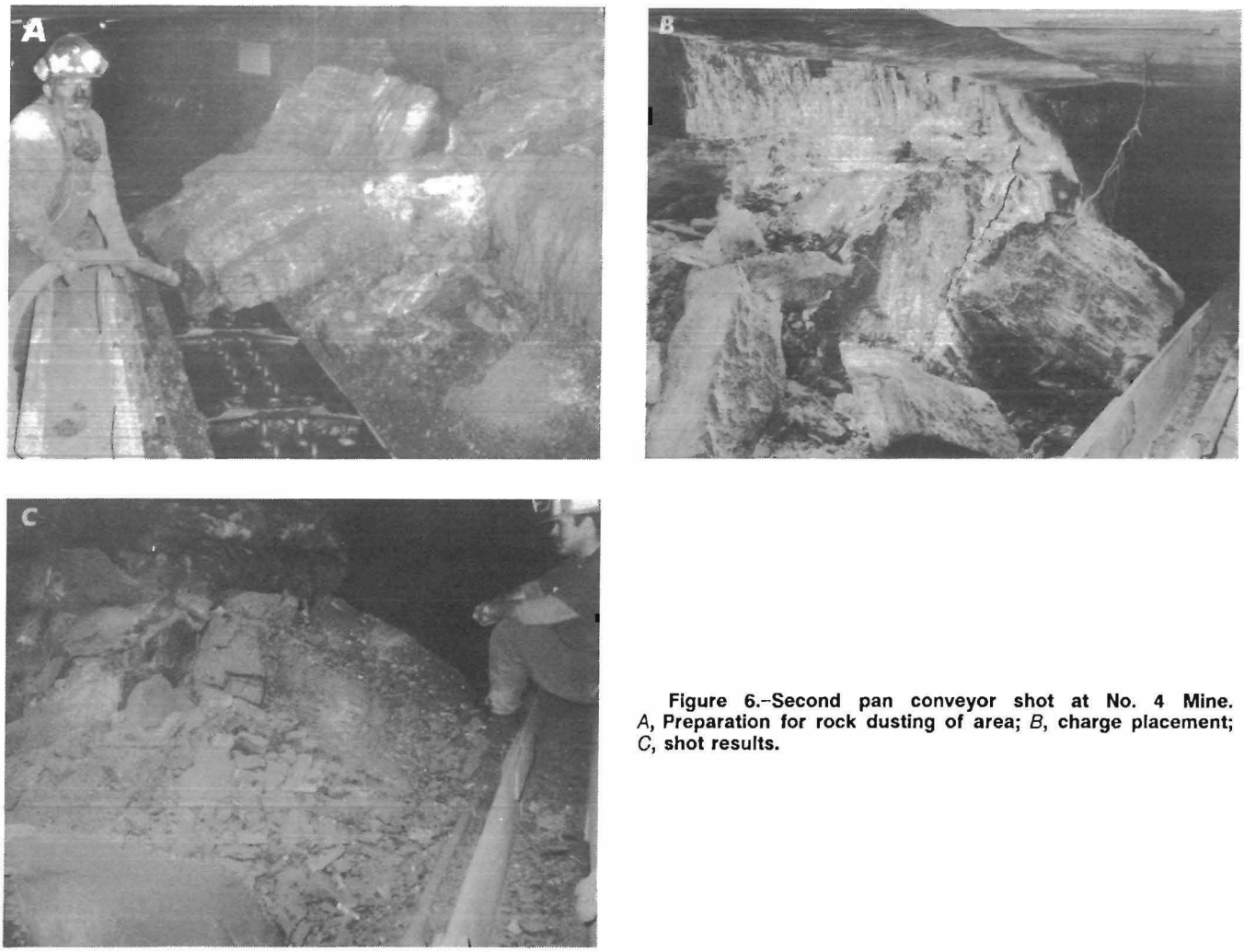


Figure 6.–Second pan conveyor shot at No. 4 Mine. *A*, Preparation for rock dusting of area; *B*, charge placement; *C*, shot results.

Since the sheathed charge had no difficulty breaking any of the stones tried so far, shots were fired to test the limits of its breaking power. A large rock was located measuring 4.5 by 4.5 by 18 ft, which had slumped from the rib. Three charges were placed on the rock in an attempt to break about two-thirds of it. After firing, inspection of the rock showed that although it had not fallen apart, it was fractured clean through. Two more charges placed on the remaining one-third of the intact rock fractured the stone so that with minimal handling it would break apart into manageable pieces.

Several other shots essentially the same as those described above were also fired on longwalls and in other situations with similar results. The sheathed charge was effective, safe, and minimized lost operating time.

CONCLUSIONS

Experimental trials at Jim Walter Resources, Inc. mines have demonstrated that the sheathed explosive charge is a good tool for dealing with large stones that halt longwall operations. Use of the sheathed charge improves safety by eliminating the need for miners to crawl along the face with a drill and bore holes into the stone. It also eliminates the noise and dust hazards associated with drilling. Firing the sheathed charge caused no significant damage to longwall equipment. The sheathed charge also represents significant productivity advantages over drilling and shooting in that the time the longwall must be shut down is reduced from 1 to 2 h to 15 to 30 min.

REFERENCES

1. Mainiero, R. J., and J. E. Hay. Design Criteria for Sheathed Permissible Explosive Charge for Open Shooting in Flammable Atmospheres. BuMines RI 8703, 1982, 12 pp.

2. _____. Evaluation of a Sheathed Permissible Explosive Charge for Open Shooting in Flammable Atmospheres. BuMines TPR 118, 1982, 9 pp.

3. _____. Prototype Sheathed Explosive Rock-Breaker Charge for Open Shooting in Flammable Atmospheres. Paper in Proceedings of the 13th Annual Institute on Coal Mining Health, Safety and Research. VA Polytech. Inst., Blacksburg, VA, 1982, pp. 239-257.

4. U.S. Bureau of Mines. Sheathed Rock-Breaker Explosive Charge. Technol. News 177, July, 1983, 2 pp.

5. Verakis, H. C., R. J. Mainiero, and J. J. Mulhern. Safe Practices for Use of the Sheathed Charge in Underground Coal Mines. Paper in Proceedings of the 13th Conference on Explosives and Blasting Technique. Soc. Explosives Eng., Montville, OH, 1987, pp. 115-130.

6. Mainiero, R. J. Non-Incendive Rock-Breaking Explosive Charge. U.S. Pat. 4,537,133, Aug. 27, 1985.

7. Federal Register. U.S. Mine Safety and Health Administration (Dep. Labor). Requirements for Approval of Explosives and Sheathed Explosive Units; Final Rule. V. 53, No. 223, Nov. 18, 1988, pp. 46748-46764.

8. _____. U.S. Mine Safety and Health Administration (Dep. Labor). Safety Standards for Explosives and Blasting; Final Rule. V. 53, No. 223, Nov. 18, 1988, pp. 46768-46789.

INT.BU.OF MINES,PGH.,PA 29057