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ACME MINER BOLTER
Design, Assembly and Field Testing

Final Technical Report

Acme Machinery Company
Huntington, West Virginia

January 1983

Contract No. U.S.D.O.E. AC01-80ET14180



U. S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Coal Mining

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ACME MINER BOLTER

DESIGN, ASSEMBLY AND FIELD TESTING

FINAL TECHNICAL REPORT

30 September 1979 – 31 March 1982

STEWART L. MYERS

January, 1983

Work Performed Under Contract
DE-AC01-80ET14180

ACME MACHINERY COMPANY

P.O. Box 2409
Huntington, WV 25725

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ABSTRACT

The purpose of this report is to convey information and data concerning the manufacture, surface and underground testing of the Acme Miner Bolter under the Department of Energy Contract #DE-AC01-80ET14180.

The manufacture of the A.M.B. was completed in March 1982; and the machine was shipped to the D.O.E. test facility in Bruceton, Pennsylvania, to undergo surface testing by cutting on a block of coalcrete in the Cutting Trials Area and taking data of the various functions.

After completing the surface testing in May 1982, the A.M.B. was shipped to R & P Coal Company's Urling #3 Mine to undergo underground testing. Primarily the A.M.B. was to mine 150 tons of coal per shift for five consecutive shifts. The A.M.B. satisfactorily completed this test on November 4, 1982.

The general consensus of the people involved with the testing of the A.M.B. was that it was a valid coal mining concept. They also felt it should be further developed to obtain a production model.

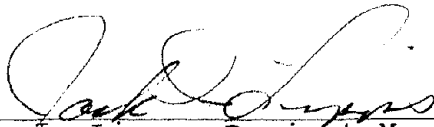
ACKNOWLEDGMENTS

We are especially grateful to the Rochester and Pittsburgh Coal Company of Indiana, Pennsylvania, who supplied the test site for the A.M.B. We also appreciate the support, advice, and cooperation afforded to us by R & P Coal Company.

William D. Mayercheck served as Technical Project Officer during the latter stages of the contract period. Michael N. Mahaffy was the Technical Project Officer at the outset of the project. A special word of thanks is sent to these gentlemen for their direction and guidance in fulfilling this contract.

We are also grateful to the personnel of the Department of Energy at the Office of Procurement Operations and at the Pittsburgh Mining Technology Center for their cooperation in fulfilling the contract.

We would like to especially thank the men of the Urling #3 Mine at Shelocta, Pennsylvania, for their cooperation and patience during the test period.



Jack I. Lipps, Project Manager



Earl M. Damron, Vice President

INTRODUCTION

PURPOSE

The purpose of this project was to develop a truly "continuous" coal mining system or machine that is capable of mining coal comparable to today's equipment while simultaneously installing permanent roof support to increase safety at the face.

PROBLEM

Today's mining laws restrict miner operators from advancing the cab of the mining machine past the last row of permanent roof support, thus making it necessary for the mining machine to be backed away from the face while permanent roof support is installed. This frequency of place changing results in a loss of production time and an increased probability of accidents occurring due to moving equipment.

SCOPE

In this report, background information is given on the preliminary design of the A.M.B. along with the actual design and assembly of the machine, followed by sections on the operational procedure, safety features and testing of the A.M.B.

SECTION I - BACKGROUND INFORMATION

In 1976 the Bituminous Coal Research Committee developed a list of guidelines that could drastically change the way coal is mined today. The guidelines are designed to increase production while simultaneously making the working section a safer, cleaner and quieter place to work. The list was divided into two categories consisting of Primary and Secondary Guidelines.

Primary Guidelines

1. The machine should be capable of advance on the order of 100 feet or more in a straight line without need to withdraw from the working face to install permanent roof support.

2. The machine should permit, as part of the mining machine or otherwise, the installation of roof support to protect the machine and its operators. Such support must be permanent rather than temporary and cover the full entry width within 9 feet of the work face, or less.

3. The machine should be capable of mining a minimum entry width of 14 feet.

4. The machine should be capable of developing a 90 degree crosscut while permitting roof support or have an alternative mining system that uses auxiliary devices to provide the crosscuts.

Secondary Guidelines

1. The machine should have a ventilation system, such as a telescopic vent tube which stays within 5 feet of the face.

2. The machine should minimize dust production by incorporating proven dust control methods.

SECTION I - BACKGROUND INFORMATION

3. The machine should have a clean-up system which can meet all legal standards regarding coal dust suppression with minimal delays.
4. The noise level should remain below 85 decibels.
5. The machine should maintain centerline orientation within a six inch tolerance.
6. Bit tip speed should not exceed 400 fpm, if bits are used.
7. If bolting is the roof support method, the machine should verify bolt torque.
8. The machine should achieve a maximum rate of advance consistent with the primary guidelines.
9. The machine should be adaptable to low coal down to 30 inches.
10. The machine should be used with a continuous haulage system.
11. If the machine is not a full face machine, it should be capable of automatically cycling face activity even if manual activation is required.

During the year of 1976, Acme Machinery Company began work on a preliminary design of a miner that fit all of the Primary Guidelines except for #3 and should meet all of the Secondary Guidelines except for #9.

On the advice of executives of the Rochester and Pittsburgh Coal Company of Indiana, Pennsylvania, Acme Machinery Company submitted to the United States Department of Energy an unsolicited proposal to build the Acme Miner Bolter on October 25, 1979.

SECTION I - BACKGROUND INFORMATION

On September 30, 1980, the Department of Energy awarded a 24 month contract to construct the A.M.B., do field testing at the D.O.E. test facility in Bruceton, Pennsylvania, and an underground test at one of the Rochester and Pittsburgh Coal Company's mines.

SECTION II - DESIGN AND ASSEMBLY

FRAME

Before Acme Machinery Company had received the Department of Energy contract, it had purchased several pieces of a Westfalia VM08 Shortwall-Heading-Machine from Island Creek Coal Company to use as the basic frame for the Acme Miner Bolter. Refer to (Fig. 1).

The frame is designed to skid on the mine floor thus minimizing ground pressure. It is geometrically shaped like a "T" and incorporates a unique zipper chain conveyor haulage system.

CUTTING SYSTEM

The cutting system consists of two hydraulically driven augers that are 32 inches in diameter and sump to a depth of 2 feet in the coal seam. The augers are mounted to a slide frame arrangement that is pulled across the front of the machine by a chain and a hydraulic drive unit. The augers range up and down much like a double shear drum longwall.

TRAMMING SYSTEM

The A.M.B. is moved about the mine primarily by pushing or pulling on a wedge system. The wedge effect is created with two large hydraulic cylinders that are tilted outby for traveling forward and vertical when backing out. The A.M.B. is pushed or pulled along the mine floor by two large ram cylinders that are connected to the main frame and the rear chock modules. Each of these cylinders are capable of developing 26 tons of thrust when sumping into the face.

SECTION II - DESIGN AND ASSEMBLY

ROOF BOLTERS

The roof bolter modules, refer to (Fig. 2), consist of an Acme D-9 Short Stroke, Special Pantigraph Feed arrangement that is mounted to the rear chock assembly and is connected to the A.M.B.'s main frame by the ram cylinders.

CUTTER HEAD HYDRAULIC CIRCUIT

The cutter head hydraulic circuit has two separate identical closed loop systems that share a common reservoir. Refer to (Fig. 3). A system consists of a Rexroth AA4V-90 axial piston pump, a Sun Flushing Valve and a Dynapower Standard Fixed Piston Motor, Model 60.

ROOF DRILL AND TRAM CIRCUITS

This open loop circuit consists of 3 Commercial Shearing P-75 two stage pumps with a common reservoir. This circuit feeds both roof bolters, powers all the miner functions and also drives the tram system on the power pack.

POWER PACK

The power pack is a hydraulically driven unit mounted on foam filled tires that contains all the electrical motors, starter box, methane monitor power supply, lighting power supply, hydraulic pumps and the reservoirs. The power pack trails 35 feet behind the A.M.B.'s operator compartment, making the distance between the power pack and the immediate face approximately 50 feet.

ROOF DRILL DUST SYSTEM

The roof drill dust system consists of two separate dust collecting circuits for each roof bolter assembly. The circuit

SECTION II - DESIGN AND ASSEMBLY

consists primarily of a Permco Type 33 Blower and an Acme Dust Collector DK288 (Approval No. 2135).

WATER SPRAY SYSTEM

The water used for dust suppression is brought up through the power pack and is used to cool the oil that is returned and circulated through two Young Radiator heat exchangers (Model #SSF502-EY-2-P). The water is then routed to the A.M.B. where it is discharged through the spray nozzles. On the left side of the A.M.B. is a Venturi spray nozzle directing air flow to the left corner of the face area. Each auger is surrounded by a water fog created by three nozzles that are mounted on the ranging arm covers. The conveyor throat is equipped with a water spray to keep air borne dust from traveling along the conveyor.

METHANE MONITORING SYSTEM

The A.M.B. utilizes a Methane Monitoring System (Model VI), that is manufactured by Mine Safety Appliance Company. The power supply unit is mounted on the left side of the outby end of the power pack. The methane monitor sensing head is mounted on the left end of the A.M.B. within 5 feet of the immediate face. The unit is equipped with a warning signal for methane concentration of 1.0% in normal air and the alarm point (machine shutdown) at 2.0% methane in normal air; these settings are adjustable for various operating conditions. The sensing head and warning unit that are mounted on the A.M.B. are intrinsically safe.

LIGHTING SYSTEM

The area lighting system used on the A.M.B. was designed and

SECTION II - DESIGN AND ASSEMBLY

supplied by Ocenco Incorporated. The lighting system consists of eight intrinsically safe lights, four on the ATRS crossbar, one on each of the two chock assemblies and one on each outboard side of the front rack. The power supply and on/off switch are located on the outby end of the power pack.

SECTION III - OPERATIONAL PROCEDURE

MINER

To begin the operational procedures of the A.M.B., we will assume that the miner is in a "Closed Attitude," all hydraulic cylinders are retracted, and the roof drills are parallel with the respective ram cylinders.

1. Go to the starter box on the power pack and turn the Main Circuit Breaker, Control Circuit Breaker and Area Lighting Switch to the ON position.

2. Go to the A.M.B. operator's compartment and push the START button.

3. Extend CLEAN-UP ARMS.

4. Raise LEFT CHOCK and RIGHT CHOCK CYLINDERS to engage roof.

5. Set AUGER ROTATION to desired speed.

6. Turn on WATER SPRAYS.

7. Start CONVEYOR CHAIN.

8. Center the auger frame using the TRAVERSE LEVER.

9. Extend both LEFT and RIGHT RAM CYLINDERS equally to sump the A.M.B. two feet into the face.

10. Now retract both CHOCK CYLINDERS and both RAM CYLINDERS. Once the RAM CYLINDERS are fully retracted, engage the CHOCK CYLINDERS with the roof.

11. Raise the A.T.R.S. to the roof and begin roof bolting with the two inside bolts and then swing the drills outboard to get the outside bolts. NOTE: While the roof bolter operators are installing the roof bolts, the A.M.B. operator is cutting out the two foot lift.

SECTION III - OPERATIONAL PROCEDURE

After the A.M.B. has removed the first two foot lift of coal, 20 feet wide, it will sump and cut out a second two foot lift. Once four feet of coal have been removed and a line of four roof bolts installed, proceed as follows:

12. Lower the A.T.R.S. and bring it to its closed position.

13. After making the third sump, lower both CHOCK CYLINDERS and retract both RAM CYLINDERS fully.

Refer to step #4 to begin and repeat another cycle.

ROOF BOLTER

NOTE: Do not operate the roof bolter unless the A.T.R.S. and the CHOCK CYLINDERS are engaged with the mine roof.

1. Swing the roof bolters to the inboard position.

2. Extend floor jack.

3. Using a drill starter, engage the roof with the steel and set the drill rotation in the drill mode while simultaneously applying upward thrust.

4. Complete hole with appropriate steels.

5. Push the roof bolt up into the hole and set the drill rotation in the bolt torque mode. When the rotation is stalled, the bolt is torqued to the proper specifications.

6. Raise the floor jack, swing the roof drill to the outboard position and repeat steps #2 through #5.

7. When the last bolt is installed, raise the floor jack and swing the roof bolter to its centered position.

SECTION IV - SAFETY FEATURES

1. A.M.B. operator is always under permanently supported roof and an operator's cab.

2. The roof bolter operator and the A.M.B. are protected by an A.T.R.S. system that engages the roof 6.5 feet outby the inby end of the augers.

3. Roof bolts are installed 7.5 feet outby the inby end of the augers.

4. All electrical power and lighting on the A.M.B. are intrinsically safe.

5. All electric motors and corresponding electrical equipment are on the power pack which is approximately fifty feet from the face.

6. Reduced noise level at the face. The average "A" scale reading around the A.M.B. with the conveyor chain running empty and the augers rotating was 88 decibels. Reading taken above ground.

7. Line curtain can be kept within 7 feet of the face at all times.

8. Since the A.M.B. does not make place changes the chance of being injured by moving equipment is greatly reduced.

SECTION V - SURFACE TESTING

The Department of Energy had a surface test site under construction that would ideally accommodate the A.M.B. for mining and roof bolting. However, due to delays in construction, the test site would not be completed in time to test the A.M.B. in its contract period.

Alternate plans were made to test the A.M.B. at the Cutting Trials Area (CTA) of the Mine Production Research Facility (MPRF) in Bruceton, Pennsylvania. The tests were to be performed by Boeing Services International in conjunction with Acme Machinery Company.

Refer to Appendix C for the test procedure, data and results prepared by Boeing Services International.

Even though the surface test was not ideal for the A.M.B., it proved to be an invaluable experience to prepare for the underground operations.

SECTION VI - UNDERGROUND TESTING

INTRODUCTION

The Rochester and Pittsburgh Coal Company of Indiana, Pennsylvania, agreed to supply Acme Machinery Company with a test site at one of their mines to test the A.M.B.

The site selected and agreed upon by all parties was the Urling #3 Mine located at Shelocta, Pennsylvania. The A.M.B. would be placed in the #1 Butt off of 5 North Mains (Fig. 4) to drive rooms.

The average height of the coal on this section was 54 inches, the rooms would be mined 20 feet wide and on 45 foot centers. The bottom consisted of a firm fireclay and the roof was slate.

DELIVERY AND ASSEMBLY

The A.M.B. was delivered at the Urling #3 supply house on May 11, 1982; and the mine superintendent, Charles Lockard, said he would get the A.M.B. underground and on section as soon as possible.

The six major components that the A.M.B. was divided into were delivered to the section without any difficulty from the supply track to the face area by an Elkhorn scoop.

On May 25, 1982, the A.M.B. was on section and in position to be reassembled. The assembly work was done by two men (Acme personnel) and one scoop operator (R & P personnel). By June 1, 1982, the A.M.B. was completely assembled and ready to be run so the hydraulic functions could be checked out and the necessary adjustments made to them for cutting coal.

SECTION VI - UNDERGROUND TESTING

Also by this date, the Long-Airdox Continuous Haulage System had been installed behind the miner and was ready for operation. The system consisted of a M.B.C. (Mobile Bridge Conveyor), a "Pig" (Piggyback Bridge Conveyor), and two Room Chain Conveyors which discharged onto the mine's belt system.

FAMILIARIZATION PERIOD

Since this was the first underground operation of the A.M.B., it was planned to operate it for a short time to learn how it would function in underground conditions before attempting the test planned for it. Also this time would be utilized to train a crew of four men in the procedure and operation of the A.M.B.

The four jobs the men were trained for were: 1) miner operator, 2) right roof bolter operator, 3) left roof bolter operator, and 4) M.B.C. operator.

During this Familiarization Period, June 1, 1982, through October 28, 1982, two major problems occurred and were dealt with. The first and most crucial problem was the design of the cutting augers and the other was the breakage of the ram cylinders.

Augers

During the Familiarization Period there were five different sets of augers used on the A.M.B. to attempt to achieve the correct combination of sumping and shearing.

The auger designs that were employed can be separated into two major styles: 1) closed face and 2) open face. Refer to (Fig. 5) and (Fig. 6) respectively.

SECTION VI - UNDERGROUND TESTING

The first three sets of augers used on the A.M.B. were of the closed face style. They were designed and built by a well known and established auger manufacturer.

The last two sets were of the open face style. The geometrical shape of the augers was designed by Acme Machinery Company and the lacing specifications were set up by the Longwall Mining Group of a well known mining tool manufacturer.

Closed Face Augers

The first set of augers was a 32 inch diameter auger with two scrolls that wrapped 360 degrees; lateral bit spacing was 1.5 inches from bit to bit and the bit used was a U43 series. The problems experienced with this auger were grinding of coal and poor loading characteristics.

To make improvements to this auger design, the general consensus was to build another set of augers with seven inch scrolls to improve the loading conditions and refine the lacing pattern for cutting.

The second set of augers turned out to be 42 inches in diameter tip to tip, three scrolls that wrapped 180 degrees, 1.5 inch lateral bit spacing and used the U43H series block and the U50 series sleeve and bit.

While these augers were being built, alterations were being made to the auger frame to improve the loading characteristics by bringing the augers closer to the conveyor chain and moving the auger frame legs inboard to the center of the frame (Fig. 7).

SECTION VI - UNDERGROUND TESTING

When these augers were tried, the A.M.B. could not sump into the coal at all. Once the A.M.B. was backed from the face, it revealed two large cores, 9 inches and 11.75 inches from the center of the sump hole. It was necessary to remove these augers and send them back to the shop to get a lacing pattern that would remove these cores.

The third set of augers was delivered and used for approximately three weeks. These augers were the best that we had on the A.M.B. However, it was the general consensus that the augers were not cutting coal as they should.

At this time another manufacturer was called in to look at the augers. They were certain they could develop a lacing pattern that would increase the A.M.B.'s production. The decision was made to remove the augers and send them to Acme's shop to be rebuilt to their specifications.

Open Face Augers

While the preliminary design work was being done on the auger lacing, Acme's Engineering Department came up with the open face auger design. This design is a cross between a high wall auger and a longwall shear drum. Refer to (Fig. 6)

The fourth auger set was built using this style. It was 42 inches in diameter, had a 1.5 inch lateral bit spacing, used the U43H blocks and the U50 sleeves and bits. It also employed a sump ring similar to that used on a sumping longwall.

When this auger was tried, the sizing was much better than

SECTION VI - UNDERGROUND TESTING

the other three sets of augers; the sumping was much better but the augers were stalling quite frequently.

The fifth set of augers was designed to retrieve power that was lost as a result of going from a 32 inch diameter auger to the 42 inch diameter auger. By dropping back in size, a gain in torque of 24% should be realized. Additional torque was recovered through weight reduction; this auger set weighed 1000 pounds less than the previous 42 inch diameter set.

This auger set consisted of two scrolls that wrapped 280 degrees, had a lateral bit spacing of 2.25 inches tip to tip, and used the U43NS block and the U43KL bit.

This auger design increased the sizing tremendously and produced less dust than any of the other augers. On the average, the A.M.B. was making a 2 ft. x 4.5 ft. x 20 ft. (7.2 tons) lift in 7.5 minutes.

Ram Cylinders

There were three ram cylinder rod ends broken on the left side of the A.M.B., one rod end bent on the right side and one rod end broken on the right side during the Familiarization Period. The reason for the frequent breakage of the left ram cylinder rod end can probably be attributed to the fact that the A.M.B. was cutting right-handed crosscuts and mechanical binding occurred while turning the machine.

Another flaw in the design was that the ram cylinder clevis on the rear chock assembly was weakly designed. It was also felt

SECTION VI - UNDERGROUND TESTING

that the poor design of the first three auger sets contributed to the spreading of the ram cylinder clevis by offering excessive resistance to the penetration of the coal seam.

To work around these problems, heavier clevises were designed and the design of the rod end was changed slightly. As for the mechanical binding which occurred when turning the machine, it was necessary to limit the stroke of the ram cylinder to approximately 18 inches while turning. The limiting was not done mechanically or hydraulically but was left to the miner operator's own discretion.

TEST AND EVALUATION

The original test plans stated that a successful trial is defined as the use of the "Acme Miner Bolter" to mine 150 short tons or more of run-of-mine coal at the approved site for five consecutive shifts during a specified one month period. Production shift is defined as an eight consecutive hour period when all supporting mine systems and services (labor, water, power, ventilation, coal clearance, etc.) are available to allow the Acme Miner Bolter to operate as designed.

However, during the Familiarization Period it became obvious that the A.M.B. could only run a maximum of three hours per shift because of the time required to add pans to the Room Conveyor. This meant that during the test period if the A.M.B. was down for more than an hour or so and pans had to be added to the Room Conveyor it would be unlikely if not impossible to achieve the

SECTION VI - UNDERGROUND TESTING

150 tons per shift of production, which would not be entirely a result of the A.M.B. malfunctioning.

In order to overcome these unreasonable delays due to mainly coal clearance problems, an arrangement was reached with William D. Mayercheck (TPO) and Acme Machinery Company that would allow 80% of the time used for adding pans to the Room Conveyor as "projected running time".

The A.M.B. would be rated at the end of the shift using the "actual production time" and "actual tonnage." Then the "actual production time" and "projected running time" would be added together and then multiplied by the "actual production rate" to yield the "projected tonnage" for that shift.

Under these guidelines, the test was begun on October 29, 1982, and ran for five consecutive production shifts to November 4, 1982, thus completing the requirements for the underground test. Refer to Appendix D for the daily test records.

SECTION VII - CONCLUSION AND RECOMMENDATIONS

The A.M.B., as a "prototype" machine, has proven through underground testing that coal can be mined while simultaneously bolting the roof. This concept can dramatically increase safety conditions at the face through its improved roof control techniques, dust suppression, methane detection, absence of high voltage electrical equipment at the face, reduction of noise and the elimination of the necessity for equipment to make numerous place changes.

While watching the A.M.B. cut coal, one might think that the mining system is advancing at such a relatively "slow" rate in comparison with a conventional miner that it would never produce enough tonnage to be practical. However, during the five day underground test, the A.M.B. advanced at an average rate of 15.5 feet per hour or 55.8 tons per hour.

This concept of a "slow" but steady progression allows the men to keep their supplies, line curtain, rock dusting, and other dead work advancing with the mining system.

During the underground trials, several different men were used as roof bolt operators and power pack- M.B.C. operator before a crew was permanently assigned to the A.M.B. The men had reservations about working the A.M.B. at first, probably because it was totally different from any machine they had ever worked. However, as they became familiar with the machine and its functions, they felt it was a good concept. The men particularly liked the safety features of the machine and the ability of the roof bolt operators to communicate with one another and with

SECTION VII - CONCLUSION AND RECOMMECDATIONS

the miner operator while the machine was in operation.

The A.M.B. in its present configuration would not lend itself to a day-in, day-out production operation. But, by incorporating the power pack unit and the M.B.C. or other type of continuous face haulage to make a coal conveying power unit, one could (1) greatly increase the mobility of the mining system, (2) make more area available in the heading for transporting supplies to the face area and (3) allow more operating time per shift. With the redesign of the A.M.B. and the addition of various improvements, the A.M.B. could become the safest and most advanced mining system in the coal industry.

The general consensus from the people that were instrumental to the design of the A.M.B. and the people involved with the surface and underground testing is that the A.M.B. is a good and valid coal mining concept and that it should be further developed to produce an optimized production model.

Appendices
To The
Final Technical Report

ACME MINER BOLTER

Design, Assembly and Field Testing

Contract No. DE-AC01-80ET14180

Appendix A

Figures

A.M.B. Main Frame

Westfalia VM08 Shortwall-Heading-Machine

Section 1:	End Pan R. H.,	1675 lbs.
Section 2:	Intermediate Pan.	1239 lbs.
Section 3:	T-Pan With Bracket,	1786 lbs.
Section 4:	Intermediate Pan.	1239 lbs.
Section 5:	End Pan L. H.,	1664 lbs.
Section 6:	Intermediate Conveyor Pan,	463 lbs.
Section 7:	Drive Head Frame With Drive,	2558 lbs.

TOTAL WEIGHT

10,624 lbs.

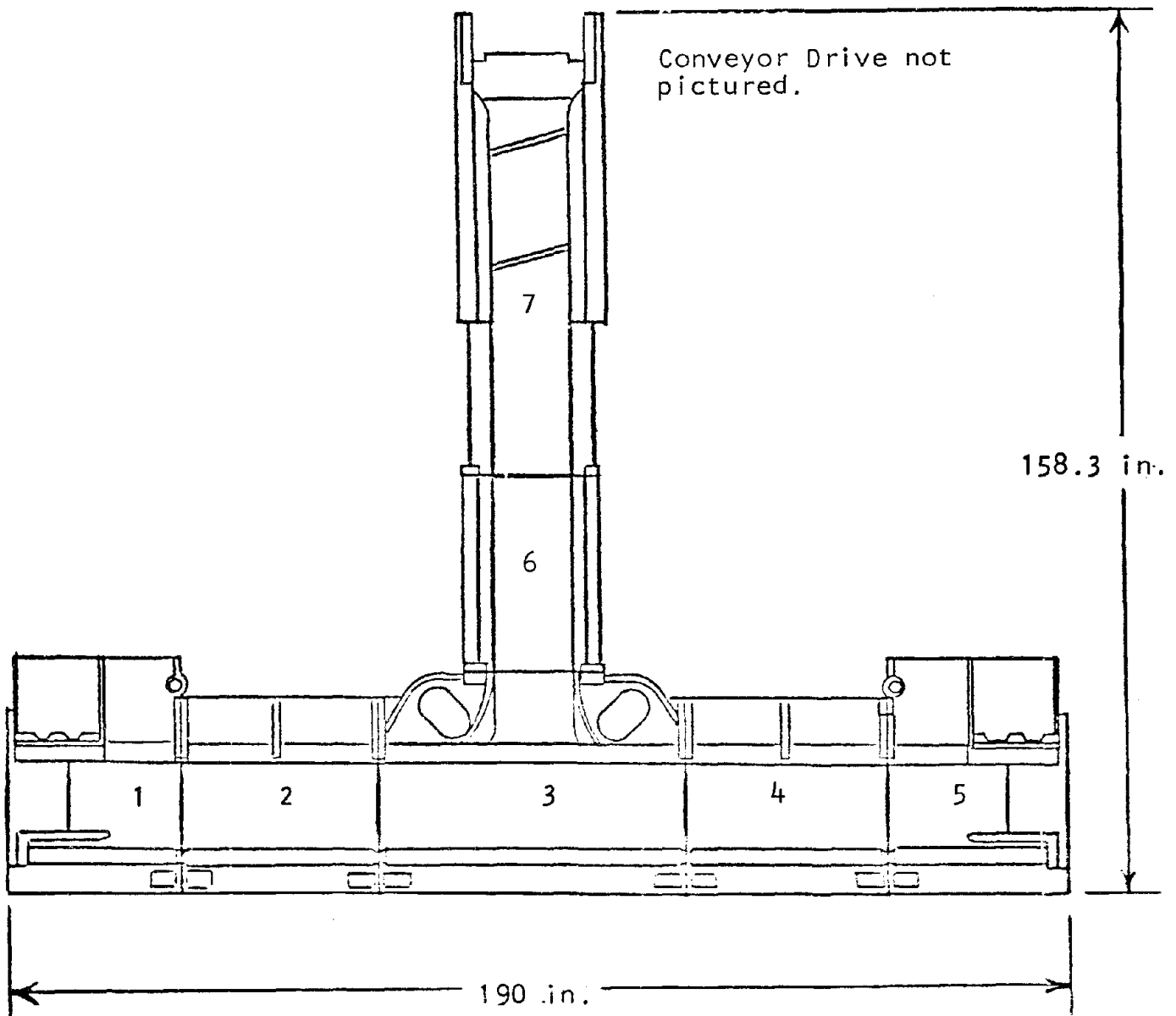


FIGURE 1

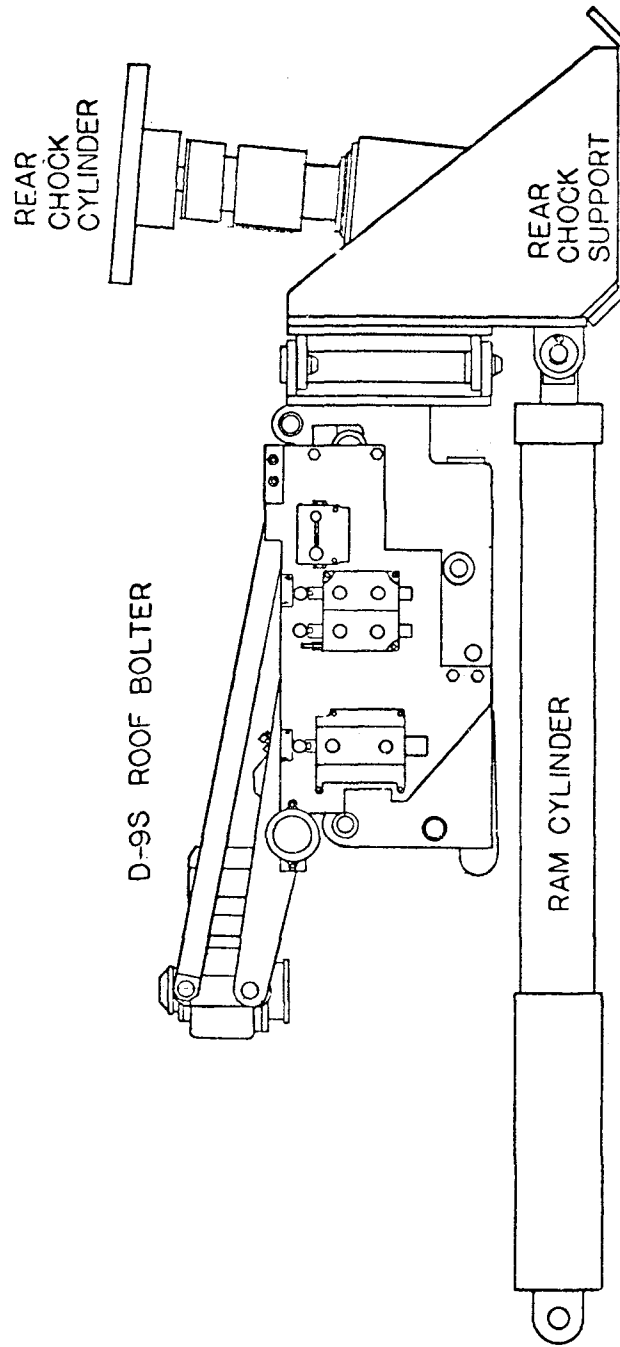


FIGURE 2
ROOF BOLTER MODULE

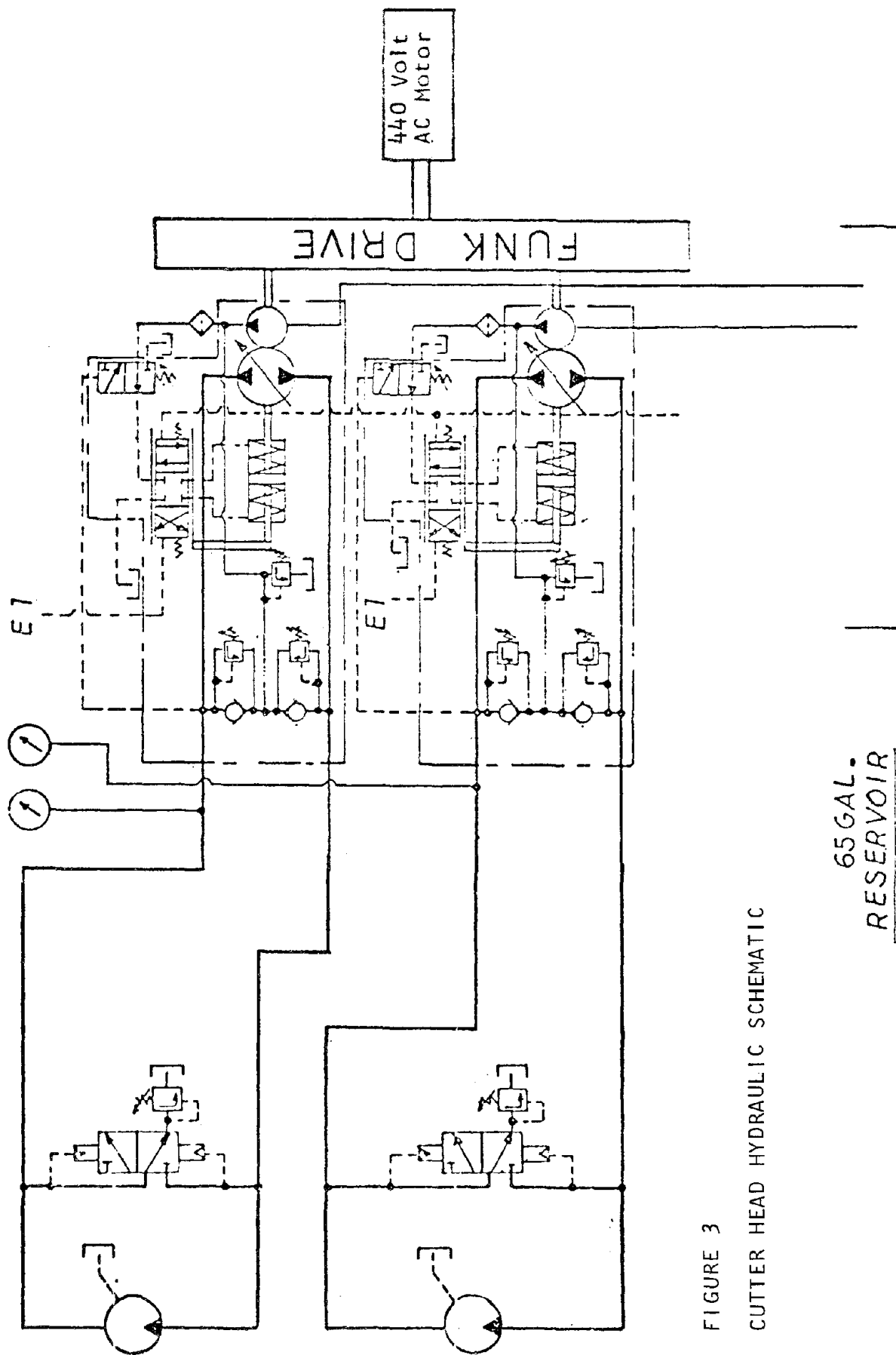


FIGURE 3
CUTTER HEAD HYDRAULIC SCHEMATIC

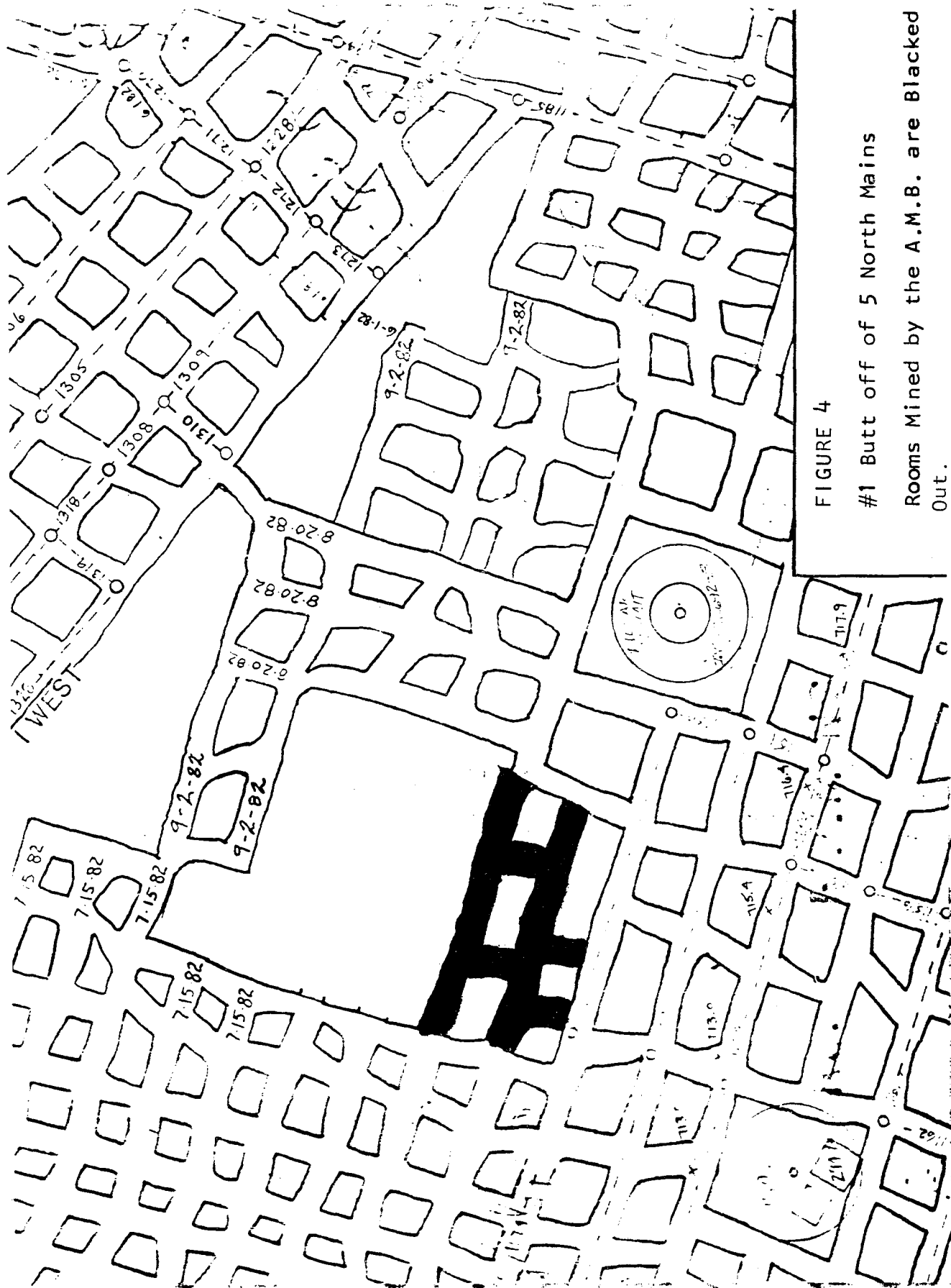


FIGURE 4

#1 Butt off of 5 North Mains

Rooms Mined by the A.M.B. are Blacked Out.

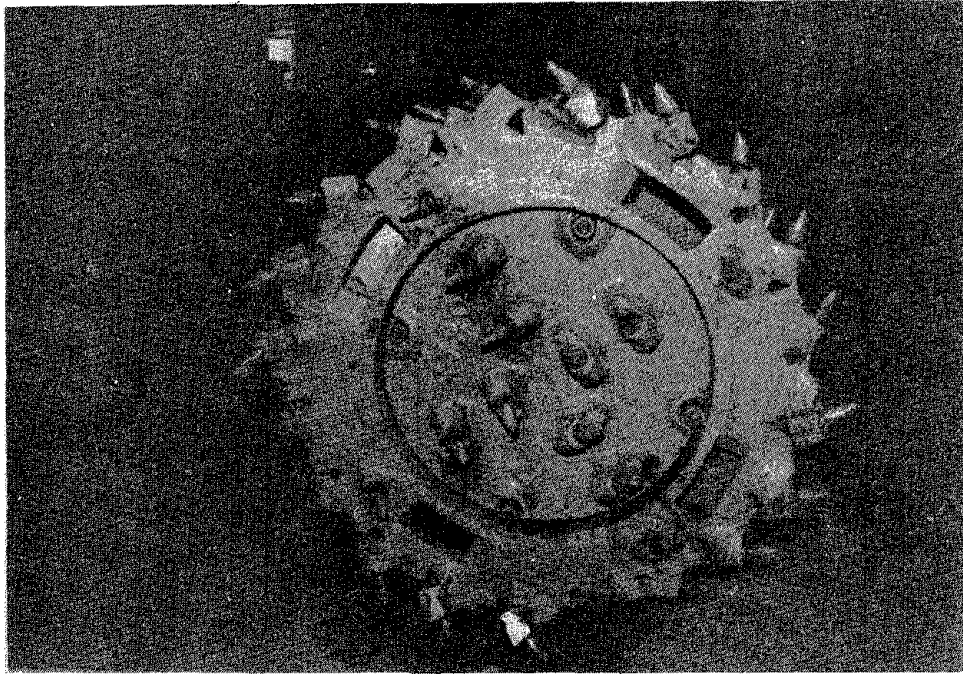


FIGURE 5
CLOSED FACE STYLE

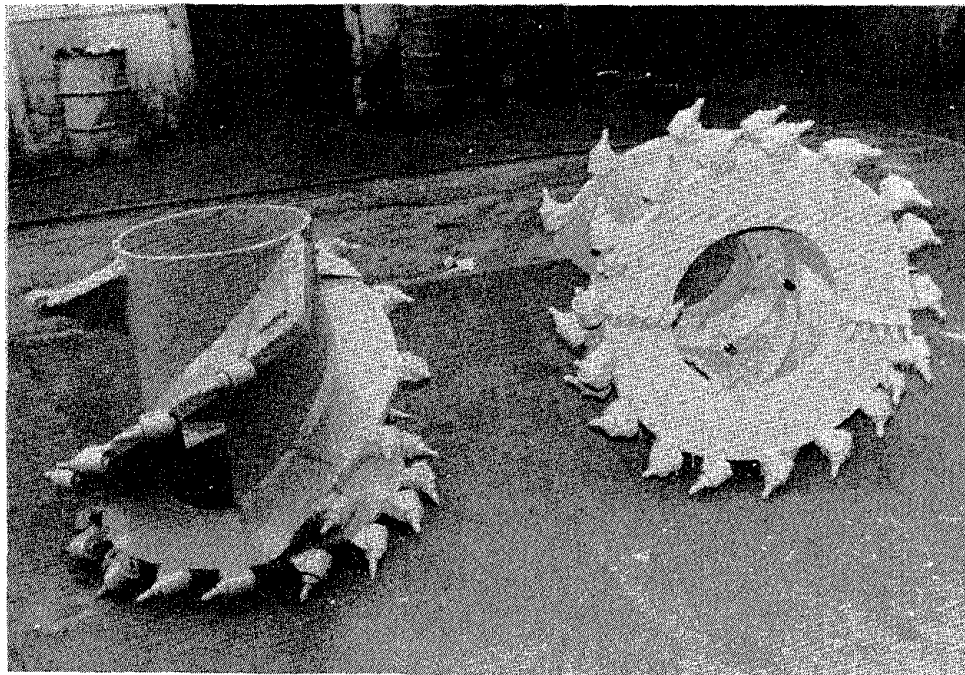


FIGURE 6
OPEN FACE STYLE

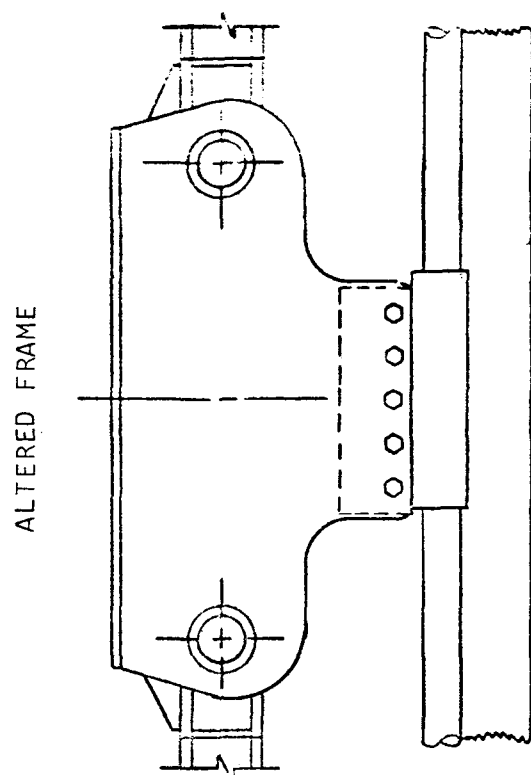
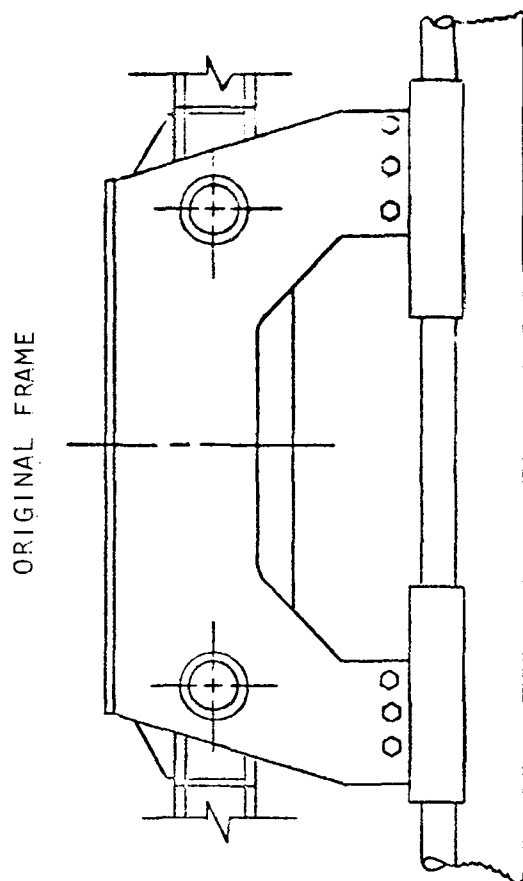
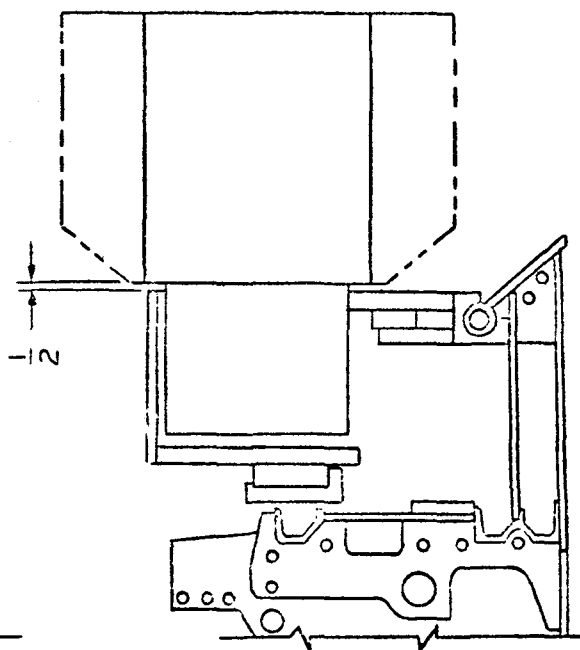
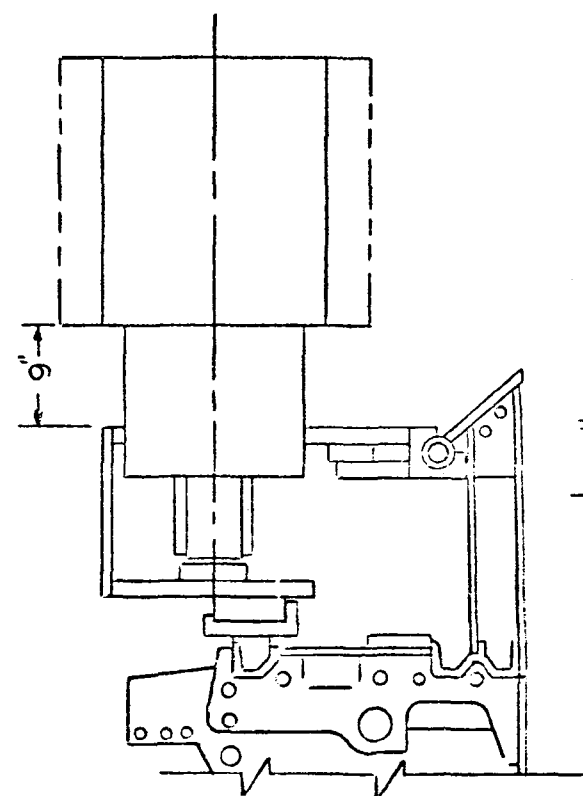


FIGURE 7
COMPARISON OF AUGER FRAMES

Appendix B

General Specifications and Capacities

GENERAL SPECIFICATIONS AND CAPACITIES

POWER PACK

1. Body Dimensions

Length	195 inches
Width	60 inches
Height	37 inches
Ground Clearance	Adjustable 4, 6 & 8 inches
Weight	16,000 pounds

2. Onboard Electrical Equipment

Electric Motors, 2-100 HP 440 Volt AC

Starter Box, BUL. XM6320-D 25 to 100 HP 460 Volt AC

Methane Monitor Power Supply, 120 Volt AC

Area Lighting Power Supply, 120 Volt AC

3. Gear Reductions

Double Pump Drive - Spur Gears	1.12 to 1
Triple Pump Drive - Spur Gears	1.15 to 1
Tram - Sprockets and Chain	10.91 to 1

4. Hydraulic Capacities

A. Auger System

Pumps, 2-AA4V Rexroth Variable Volume, 5.49 cu. in./rev.

Tank, 73 Gallons

B. Miner Functions

Pumps, 2-2 Sections 42/15 P-75 Commercial Shearing

1-2 Section 15/15 P-75 Commercial Shearing

Tank, 170 Gallons

GENERAL SPECIFICATIONS AND CAPACITIES

5. Tram System

Type of Tram	Hydraulic Chain Drive
Tram Speed	30 ft/min
Type of Steering	Slue

GENERAL SPECIFICATIONS AND CAPACITIES

A.M.B.

1. Body Dimensions

Length	186 inches
Width	191 inches
Height	37 inches
Weight	25,200 pounds
Ground Bearing Pressure:	
Front Rack	2.5 p.s.i.
Conveyor Slide	12.3 p.s.i.
Rear Chock	3.3 p.s.i.

2. Gear Reductions

Auger Drives - Planetary	19.04 to 1
Conveyor Drive - Straight Bevel and Spur Gears	23.3 to 1
Traverse Drive - Spur Gears	6 to 1
Drill Chuck - Straight Bevel Gears	2.05 to 1

3. Augers

Diameter	32 inches
Length	29 inches
Number of Bits	26 bits
Rotational Speed	72 rpm (max)
Bit Tip Speed	603 fpm (max)

4. Conveyor Specifications

Width	16.25 inches
Depth	9.25 inches
Chain Speed	120 fpm
Tonnage Rate	1.5 tpm

GENERAL SPECIFICATIONS AND CAPACITIES

5. Roof Bolters

Thrust	8000 pounds (max)
Rotational Speed (Variable)	460 rpm (max)
Torque (@ 2200 psi)	300 ft-lbs (max)
Feed Rate	4 to 5 ft/min
Bolt Torque	150 to 180 ft-lbs.

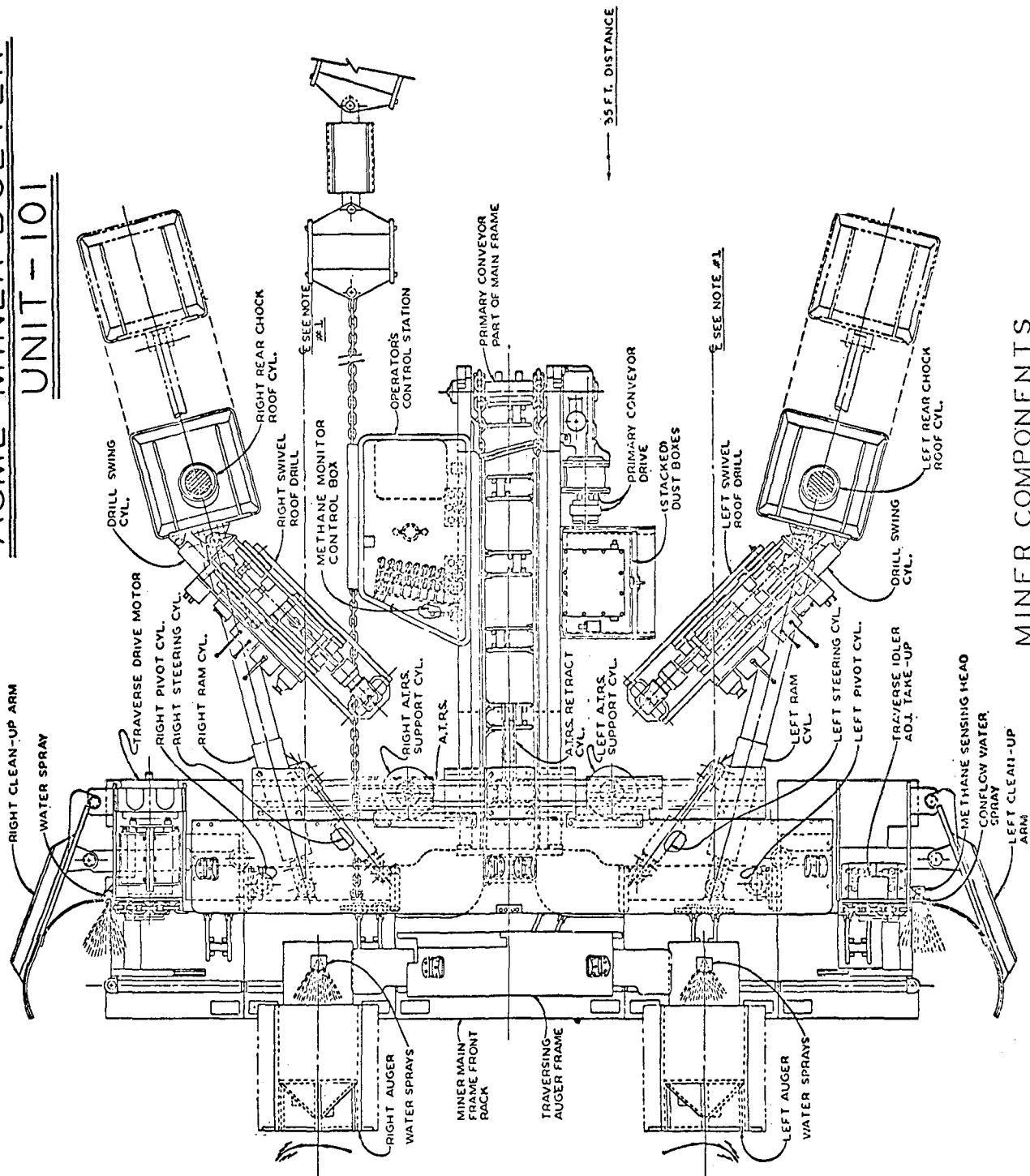
NOTE: The D-9S Acme Roof Bolter is equipped with an Auto-Bolt Torque Valve. Whenever a roof bolt is being installed, the Auto-Bolt Torque Valve puts the drill in a low thrust condition so excessive frictional force is not generated when torquing a bolt. This creates a consistency in bolt torque from bolt to bolt.

Vacuum	15 in. Hg. (max)
--------	------------------

6. Onboard Electrical Equipment

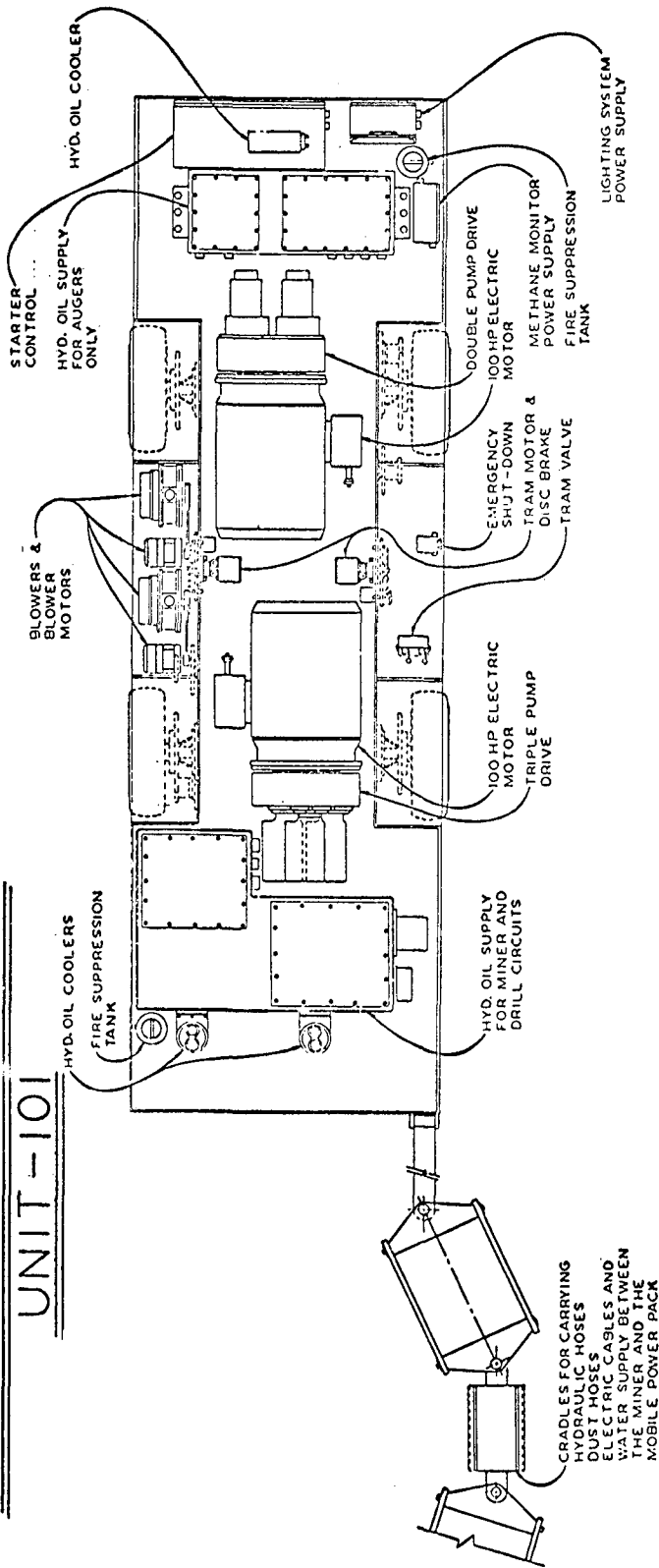
Area Lighting, 12 Volt DC	Intrinsically Safe Circuit
Methane Monitor, 4 Volt DC	Intrinsically Safe Circuit
Control Circuit, 12 Volt DC	Intrinsically Safe Circuit

ACME MINER BOLTER UNIT-101



MINER COMPONENTS

ACME MINER BOLTER UNIT-101



MOBILE POWER PACK COMPONENTS

MINER-BOLTER DATUM	
MACH. WGT. --- 12 TONS	
MACH. WIDTH --- 17 FT.	
MACH. HGT. --- 37.5 IN.	
MACH. LGT. 15.4 FT.	
CUTTING WIDTH --- 20 FT.	
CUTTING HGT. --- 5 FT. MAX.	
ATRS. LGT. --- 10 FT.	
ATRS. MIN. SET-UP --- 8.5 FT. F/FACE	
MIN. BOLTING PLACEMENT --- 7.5 FT. F/FACE	
AUGER DIAMETER --- 32 IN.	
AUGER LGT. --- 24 IN.	
AUGER LGT. TO 10 TO 72 RPM	
CUTTING SPEED --- 125 FPM	
MACH. LGT. --- 16.3 FT.	
MACH. WGT. --- 9 TONS	
MACH. WIDTH --- 5 FT.	
MACH. HGT. --- 37 IN.	
MACH. LGT. --- 16.3 FT.	
MACH. SPEED --- 40 FPM	
GROUND CLEARANCE --- 40.1 IN. 5' 2 3/8 IN.	

NOTE #1
THE C'S MARKED #1 ARE THE NORMAL OPERATING POSITIONS FOR THE RAM CYLS AND ROOF DRILLS, WHEN THEY ARE PERPENDICULAR TO THE FRONT PACK. FROM THIS POSITION THE MINER IS ABLE TO ADVANCE STRAIGHT AHEAD, WHILE THE ROOF DRILLS ARE ABLE TO SWING TO THE INSIDE TO INSTALL THE INSIDE ROW OF BOLTS, THEN SWING TO THE OUTSIDE TO INSTALL THE OUTSIDE ROW OF BOLTS, FOR A NORMAL 4 FT. BOLT PATTERN. THE RAM CYLS AND ROOF DRILLS ARE SHOWN SWUNG OUT FOR CLARITY OF THEIR ARTICULATING ABILITY.

BETWEEN MINER & MOBILE POWER PACK

ACME MACHINERY CO. HUNTINGTON, W. VA.
ACME MINER BOLTER
PHASE I
USDOE CONTRACT N°
DE-ACOL-00ET1480
CON. BY - H. L. WINTERLEY
DATE - 12-16-82
DWG N°

Appendix C

Surface Testing Report

Boeing Services International

MINE PRODUCTION RESEARCH FACILITY (MPRF)

Acme Low-Seam Miner-Bolter Cutting Trials

INTRODUCTION

BACKGROUND

The Acme Miner-Bolter System was developed by the Acme Machinery Company of Huntington, West Virginia, under US DOE contract. It is a low-coal mining and bolting system designed to extract, gather, and convey coal from the mining face. This system is also designed to bolt the roof while extracting the coal. The system is primarily intended for low coal, longwall panel development.

The Acme Miner-Bolter System was delivered to the DOE Mining Equipment Test Facility (METF) on 9 March 1982, to undergo approximately six weeks of testing prior to installing the machine underground in central Pennsylvania for in-mine evaluation. The testing was performed by Boeing Services International, Inc., in cooperation with the Acme Machinery Company at the Cutting Trials Area (CTA) of the Mine Production Research Facility (MPRF).

This is the final report describing the Acme Miner-Bolter System cutting trials. BSI data report TPR-82-03, dated July 1982, presented the test description including apparatus, instrumentation, procedure, results and discussions, and a general summary of results. This report presents the data generated during the cutting trials, and the final results and discussions of the test program.

TEST PLAN

The objective of the test program was to determine the sumping and cutting capabilities of the Acme miner-bolter and to discover any system deficiencies prior to the underground mining trials. The METF test plan for the surface testing of the system was developed by BSI in response to DOE Requirements Document No. 19, dated 26 February 1982. The implementation and control of the test program in accordance with the test plan was the responsibility of the following individuals:

M. Mahaffey	DOE Test Director
L. Erhard	BSI Project Test Engineer
J. Saliunas	BSI Safety Engineer

The Acme miner-bolter was operated during the test period by Acme personnel under the direction of the test directors.

APPARATUS

MINER-BOLTER SYSTEM

The Acme miner-bolter is a low-coal mining and bolting system designed to extract, gather, and convey coal from the mining face. It is also designed to bolt the roof while extracting the coal. The system as tested at the MPRF

consists of two major components: the miner-bolter and the hydraulic power pack. Figures 1 and 2 present descriptive summaries of the miner-bolter and hydraulic power pack, respectively. A detailed description and photographs of each unit, as well as a description of the simulated roof, cutting trials area, coalcrete block, and dust control apparatus, are presented in TPR-82-03.

INSTRUMENTATION

The instrumentation installed on the Acme Miner-Bolter System for the cutting trials consisted of the following:

ELECTRICAL POWER CONSUMPTION

The electrical power consumption of the two 100 hp, 440 volt, 3 phase, pump drive motors was monitored by utilizing two Square D, type 54-201 current transformers, with a C/T ratio of 200/5. The current transformers were connected to RIS model No. PCE-20 watt transducers which provided a 0-10 VDC output for a 0-120 kw motor power span.

In the hydraulic power pack, one motor, identified as M-1, drives the pumps which power both the left and right cutting drums. The second motor, identified as M-2, drives the hydraulic pumps which power all other system functions for both the miner-bolter and the hydraulic power pack. The cutting drum hydraulic circuit powered by M-1 is an open loop circuit; the remaining hydraulic circuits, all powered by M-2, are closed loop circuits.

CUTTING HEAD HYDRAULIC POWER

Each cutting drum hydraulic motor was instrumented to monitor and record the hydraulic oil flow rate and pressure to and from each motor. The pressure transducers were Sensotec A-5 series with full strain gage bridge elements on each transducer. The transducers were excited with 10 VDC and the output was 3 mV/V of excitation. The excitation and transducer output was supplied by and returned to Honeywell Accudata 218 bridge amplifiers. The input to the bridge amplifier was conditioned, and a 0-10 VDC output signal was supplied to recorders to cover the pressure range. The hydraulic oil flow rates were monitored utilizing Flo-tech FS turbine block flowmeters and Flo-tech RSC-10V flow rate signal conditioners. The signal conditioners provided a 0-10 VDC output for the flow range of 0 to 190 lpm (0-50 gpm).

CUTTING DRUM RPM

The cutting drum rotational speeds were monitored utilizing Red Lion Model CMPC magnetic pickups and Red Lion Model 351 frequency to analog converters. The converters provided a 0-5 VDC signal over the rotational speed range of 0-90 rpm.

SUMPING AND CHOCK CYLINDER PRESSURES

The hydraulic oil pressures to each of the two sumping cylinders and to each of the two chock cylinders, were monitored utilizing Sensotec A-5 pressure transducers and the Honeywell Accudata 218 bridge amplifiers.

HYDRAULIC OIL TANK TEMPERATURE

The hydraulic oil temperature in the two tanks on the power pack was monitored with two Marlin, Type J, thermocouple assemblies whose outputs were sent to one Moore, Type J, thermocouple transmitter and one ACROMAG, Type J, thermocouple transmitter to provide a 0-10 VDC output over the temperature range.

DATA RECORDING

All instrumented data was recorded in strip-chart form by two Brush Gould 481 eight-channel strip-chart recorders.

PHOTO/VIDEO

A Sony Model 1800 color video camera was used with a Sony Model 4800 3/4 inch video recorder to document significant testing events. Black and white and color still photos were also used to record test data.

PROCEDURE

The Acme Miner-Bolter System test program encompassed the time period from 9 March through 11 May 1982.

A chronological event log of the major test activities is shown as Appendix A.

TEST PREPARATIONS

During the time period of 9 March through 22 April 1982, preparations were made for the instrumented cutting trials. The Miner-Bolter System was assembled in the CTA and all machine functions were checked for proper operation. Numerous trial coalcrete cuts were made while attempting to achieve an efficient bit lacing pattern for the two cutting drums. A formal test plan was developed for the instrumented cutting trials and several machine operation demonstrations were conducted for METF visitors.

INSTRUMENTED CUTTING TRIALS

Four instrumented cutting trials and one no-load equipment function trial were conducted.

The instrumented cutting trials were initiated by powering up all instrumentation and conducting pretest calibrations. Upon completion of the calibrations, the miner-bolter was positioned at the face and the cutting drums and conveyor were started. Utilizing the chock and sump hydraulic cylinders, the operator would sump the cutting drums into the face and take one full cut. All instrumentation outputs were recorded on strip charts during each sump-and-cut cycle. As shown in Figure 3, a typical sump-and-cut operation was made in six distinct steps as follows:

Step 1 - Sump - The two 0.8 m (32 inch) diameter cutting drums were pushed, while rotating, into the center of the face to a maximum depth of 0.6 m

(24 inch). One drum was sumped in at floor level while the remaining drum was sumped in at roof level. Typically, if a cut was to be made to the left, the left drum was positioned at floor level and the right drum was positioned at roof level, the opposite configuration was utilized for a shear to the right.

Step 2 - Shear - The two drums cut the coal horizontally until the leading drum reached the rib.

Step 3 - Reverse Drum Positions - The vertical positions of the two drums were reversed. The drum at floor level cut vertically up the rib to roof level. The drum at roof level cut vertically down to floor level.

Step 4 - Shear - The two drums cut horizontally until the leading drum, at floor level, reached the rib.

Step 5 - Reverse Drum Positions - The vertical positions of the two drums were reversed. The drum at floor level cut vertically up the rib to roof level. The drum at roof level was lowered to floor level.

Step 6 - Shear - The drums were returned to the original sump position to complete the cut.

NO-LOAD FUNCTION TRIAL

The no-load function trial was initiated by powering up all instrumentation and conducting pretest calibrations. Upon completion of calibrations, various machine functions of the Miner-Bolter System were exercised without load to generate baseline function data. This data was recorded on strip charts.

RESULTS AND DISCUSSIONS

The results of this test program verified that the Acme Miner-Bolter System is a viable system for mining low-seam coal and is worthy of a full-scale, in-mine production evaluation.

NO-LOAD FUNCTION TRIAL

Results of the no-load function trial are shown in Table 1. In the table, electrical power consumption of the two drive motors and function rates are shown for various machine functions in a no-load situation.

The starting current of the two, 480 volt electric motors exceeded the instrumentation capacity of 120 kw. At idle; i.e., no functions operating, motor No. 1 (M-1) draws 12 kw, and motor No. 2 (M-2) draws 55 kw of electricity. As stated previously, M-1 drives the pumps which supply hydraulic power to the two cutting drums through an open loop circuit. M-2 drives the pumps which supply hydraulic power for all other functions, but in a closed loop circuit. The difference in two types of hydraulic circuits is the reason for the much higher power draw of M-2. Both cutting drums were rotated at 72 rpm which was reflected in a power draw of 43 kw for M-1. The cutting head assembly was traversed horizontally at a maximum rate of 0.06 m/s (12.3 ft/min) which required 53 kw of electrical power for M-2. Both cutting drums were raised from floor level to their maximum height at a rate of 0.027 m/s

(5.4 ft/min), this function required a power draw for M-2 of 58 kw. M-2 required 60 kw to run the unloaded conveyor at its maximum speed of 0.56 m/sec (110 ft/min). In the combined functions of running the conveyor, rotating the cutting drums, traversing the cutting drum assembly horizontally, and raising both drums, M-1 required 36 kw, and M-2 required 72 kw of electrical power. A power draw of 57 kw was required for M-2 to tram the hydraulic power pack at 0.24 m/s (48 ft/min).

INSTRUMENTED CUTTING TRIAL NO. 1

The first instrumented cutting trial was conducted on 23 April 1982. The actual cut took 15 minutes to complete, was 6.1 m (20 ft) wide, 1.5 m (60 inch) high, and 0.36 m (14 inch) deep. The tonnage cut on a volume basis was 5.7 tons at 106.2 lb/ft³. Production rate averaged 0.4 ton/min. The average and minimum/maximum values of all data collected on strip charts during this trial are shown in Table 2.

During the third step in the cutting operation, reverse drums, the right drum had difficulty cutting the right rib from floor to roof level. Significant bouncing of the right drum occurred during the operation. This may have been caused by an inconsistency in the coalcrete material creating a hard spot in that area. The total cut time was extended by approximately 3 minutes due to this problem.

In Table 2, data was not presented for the cutting drum supply pressure, pressure difference, and hydraulic horsepower in the sump, reverse drums and shear-right columns because the cutting drum supply pressure was higher than the anticipated 5000 psi, which exceeded the strip-chart range. At the completion of this cutting trial, the cutting drum supply pressure instrumentation was recalibrated for a 0-10,000 psi pressure range.

INSTRUMENTED CUTTING TRIAL NO. 2

The second instrumented cutting trial was conducted on 27 April 1982. The actual cut took 13 minutes 49 seconds to complete. The cut was 6.1 m (20 ft) wide, 1.5 m (6 ft) high, and 0.5 m (20 inch) deep. The tonnage cut on a volume basis was 7.9 tons at 106.2 lb/ft³. Production rate averaged 0.57 ton/min. The average and minimum/maximum values of all data collected on strip charts during this trial are shown in Table 3.

INSTRUMENTED CUTTING TRIAL NO. 3

The third instrumented cutting trial was conducted on 29 April 1982. The cut was not completed because an accumulation of coalcrete between the left drum rpm sensor and the interior of the drum forced the drum to overload and stall. The first three steps in the cut sequence were completed. An indication of the problem can be seen in the "reverse drums" column in Table 4; the left drum, average rpm dropped to 48 with minimum of "0" (stall), the flow rate also dropped to an average of 94.6 lpm (25 gpm), with a minimum of "0" lpm (stall).

The partial cut took 7 minutes 4 seconds to complete. The cut depth averaged 0.51 m (20 inch) for a production of approximately 3.5 tons. Production rate averaged 0.49 tpm.

INSTRUMENTED CUTTING TRIAL NO. 4

The fourth instrumented cutting trial was conducted on 30 April 1982. The actual cut took 18 minutes 25 seconds to complete. The completed cut was 6.1 m (20 ft) wide, 1.5 m (60 inch) high, and 0.56 m (22 inch) deep. The tonnage cut on a volume basis was 8.9 tons at 106.2 lb/ft³ for a production rate of 0.48 tons/min. The average and minimum/maximum values of all data collected on strip charts during this trial are shown in Table 5.

Problems with the left drum stalling due to compacted coalcrete between the rotation sensor and drum interior occurred again during this trial. The rotation sensor for the left drum did not function during the sumping operation. The test was halted, coalcrete cuttings were removed from the compaction area, and the trial was resumed. It can be noted in Table 5 that the left drum rotational speed is slightly lower during the test; this is mainly due to the clogging problem.

CUTTING TRIAL SUMMARY

A summary of the data collected during the four cutting trials is shown in Table 6.

The average coalcrete production per cut was 6.5 tons during an average cut duration of 13.6 minutes, yielding coalcrete production rate 0.5 tpm. The average sump speed was 0.31 m/min (12.2 in/min). The horizontal and vertical shear rates of the cutting drums were 1.1 m/min (43 in/min) and 0.27 m/min (10.6 in/min), respectively. The cutting drums averaged a rotational speed of 66.4 revolutions per minute during coalcrete cutting. The cutting drum hydraulic oil flow rate and pressure loss averaged 126.4 lpm (33.4 gpm) and 1792 psi, respectively. The average roof chock cylinder force was 30.2 ton per cylinder and the average sump cylinder force was 20.8 tons per cylinder. The electrical power consumption of motors M-1 and M-2 averaged 40.9 kw and 49.7 kw, respectively. During the four cutting trials, the temperature of the hydraulic oil ranged from 50°C to 71°C (120°F - 160°F). No problems occurred from overheating.

CUTTING BIT LACING PATTERN

The number of cutting bits, bit positions, and spacing of the bits on the drums was changed five times during the test program. These changes were necessary to improve the sumping and cutting capabilities of the heads, and to reduce bit-block erosion from incorrect bit positions and abrasiveness of the coalcrete.

FACE CLEANUP AND ADVANCING PROBLEMS

At the completion of each cut, a large amount of cut coalcrete which was not picked up by the conveyor remained at the face. Normally, the cuttings would be pushed into the conveyor as the machine sumped into the face for the next

cut. The problem occurred when the volume of material at the face was too large for the machine to push through during the sump. This problem could possibly be corrected by one or more of the following modifications: (1) Decrease the angle of the ramp plate at the front of the miner-bolter so the cut coal would be easier to push onto the conveyor during sumping, (2) Modify the scroll pattern on the cutting heads to move the cut coal farther from the face and thereby deposit more coal on the conveyor, (3) Modify the cutting bit spacing on the head to increase product size, thereby reducing the compaction potential of the product making it easier for the miner-bolter to push through, and (4) Investigate alternate cutting patterns.

SYSTEM MOBILITY

The use of hydraulic cylinders reacting against the roof and floor to move the miner-bolter works adequately during face cutting operations, but will prove to be both awkward and time-consuming during machine tramming and turning crosscuts. It is suggested that a small set of hydraulically powered, retractable cats be mounted under the main frame of the miner-bolter to improve the system mobility.

SUMMARY OF RESULTS

The results of the Acme miner-bolter cutting trials are summarized as follows:

1. The Acme Miner-Bolter System was subjected to cutting trials at the METF from 9 March through 11 May 1982. The ability of the machine to cut coalcrete was demonstrated and the machine was recommended for in-mine production evaluation.
2. The system averaged a production rate of 0.5 ton/min of coalcrete during four instrumented cutting trials.
3. Improvements are needed in the system mobility to increase the underground tram rate.
4. Modifications are needed to increase the loading potential of cut coal at the face.

APPENDIX A

CHRONOLOGICAL LOG OF TEST PERIOD

Test Activity A

The Acme Miner-Bolter System arrived in the CTA on 9 April 1982.

Test Activity B

The Miner-Bolter System was assembled in the CTA by Acme and BSI personnel. The simulated roof was moved into position at the coalcrete face and its weight increased by loading concrete blocks into the bins. The miner-bolter was moved into position at the face.

Test Activity C

As initial trial sump was made at the face, it was discovered that the simulated roof was not sufficiently weighted to allow the miner-bolter to efficiently sump into the face. Additional concrete blocks were added to the bins.

Test Activity D

The first full cut of the coalcrete was made. It was found that the cutting bit and bit-block erosion rate was extremely high due to an incorrect lacing pattern for cutting the coalcrete. A meeting of Acme, DOE and BSI personnel was held to discuss formal test plans for the cutting trials.

Test Activity E

The two cutting drums were removed from the machine and sent to a machine shop in West Virginia for modification of the bit lacing pattern.

Test Activity F

The modified cutting drums were installed and a trial cut was conducted. Bit wear was still excessive. The drums were removed and sent back for further modifications.

Test Activity G

The cutting drums were modified for the second time.

Test Activity H

The modified cutting drums were reinstalled and a trial cut was made again with little improvement in the bit wear problem.

Test Activity I

The cutting drums were removed from the miner-bolter and sent out for modification. The two cutting drum rotation speed sensors were mounted on the miner-bolter.

Test Activity J

The modified cutting drums were reinstalled on the machine. The simulated roof structure was bolted to the floor to increase the load reactance capacity.

Test Activity K

Two trial cuts were made. Problems were again encountered due to the high rate of cutting bit and bit-block erosion during coalcrete cutting. The cutting drums were removed and sent out for further modifications.

Test Activity L

A defective hydraulic pump seal was replaced in the hydraulic power pack.

Test Activity M

During this time period, some of the instrumentation components were installed on the machine. The simulated roof was advanced forward for the next series of trial cuts.

Test Activity N

The remodified drums were installed and a trial cut was made. The hydraulic pump seal problem reoccurred and new seals were installed.

Test Activity O

A demonstration cut was made for representatives of the R&P Coal Company of Indiana, Pennsylvania.

Test Activity P

Cutting drums were removed and sent out for bit lacing modifications.

Test Activity Q

Completed and checked the instrumentation installation on the system.

Test Activity R

The modified cutting drums were reinstalled and the first instrumented cutting trial was conducted.

Test Activity S

The second instrumented cutting trial was conducted.

Test Activity T

The cutting-trial test face was relocated from the east edge of the coal block to the north edge.

Test Activity U

Two instrumented cutting trials were conducted.

Test Activity V

No-load function trials were conducted.

Test Activity W

All instrumentation was removed from the system.

Test Activity X

The Miner-Bolter System was disassembled and prepared for shipping.

Test Activity Y

The system was shipped to R&P Coal Company in Indiana, Pennsylvania.

Table 1
No-Load Functions

Function	Power Consumption (kw)		Rate
	Motor 1	Motor 2	
Start Motors	120+	120+	-
Run Pumps	12	55	-
Rotate Cutting Drums	43	53	72 rpm 138 L/min (36.5 gal/min) 900 psi drop
Traverse Drums Horizontally	12	53	0.06 m/s (12.3 ft/min)
Raise Both Drums	12	58	0.027 m/s (5.4 ft/min)
Run Conveyor	12	60	0.56 m/s (110 ft/min)
Run Conveyor - Rotate Drums Traverse and Raise Drums	36	72	-
Tram Power Pack	12	57	0.24 m/s (48 ft/min)

Table 2
Instrumented Cutting Trial No. 1

[illegible]

Table 3
Instrumented Cutting Trial No. 2

Parameter	Sump		Shear Right		Reverse Drums		Shear Left		Reverse Drums		Shear Right	
	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum
60 sec.												
160 sec.												
304 sec.												
54 sec.												
116 sec.												
140 sec.												
1000	Average (Min.-Max.)	58 (16-72)	69 (67-71)	57 (11-72)	70 (67-72)	67 (65-70)	68 (67-70)	67 (7-72)	68 (59-70)	67 (12-72)	60 (16-72)	60 (12-72)
Supply (psi)	Average (Min.-Max.)	1770 (1000 - 4200)	4800 (1100 - 6200)	2460 (1000 - 7200)	2440 (900 - 4200)	1800 (800 - 3600)	1640 (900 - 3200)	2090 (1000 - 4500)	1900 (900 - 4600)	1800 (800 - 4800)	2000 (1100 - 6300)	2000 (800 - 4800)
Return (psi)		400	300	400	300	400	400	300	400	400	400	400
AP (psi)		1370	4500	2060	2140	1400	1240	1790	1500	500	2200	500
Flow (LPM)	Average (Min.-Max.)	132.5 (0-170)	136.3 (102-155)	132.5 (8-170)	136.3 (102-163)	132.5 (114-182)	132.5 (98-167)	117.3 (0-163)	132.5 (87-170)	117.5 (13-133)	119.2 (4-167)	117.5 (11-133)
Hydraulic HP		25.5	86.2	38.4	41	26.1	23.1	29.5	27.9	9.34	36.9	9.34
Electrical Power Consumption (kw)		M-1 48.4	M-2 67.8	M-1 59.9	M-2 81.2	M-1 39.5	M-1 42.3	M-2 77	M-1 30.2	M-2 52.1	M-1 34	M-2 46
Crank Cylinders Force (tons)	Right	37.9	Left	25.9	Right	37.9	Left	25.9	Right	37.9	Left	25.9
Comp. Cylinders Force (tons)	Right	16.9	Left	18.2	Right	16.9	Left	18.2	Right	16.9	Left	18.2

Table 4
Instrumented Cutting Trial No. 3

Duration	Sump		Shear Right		Reverse Drums		Shear Left		Reverse Drums		Shear Right	
	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum
	69 sec.		190 sec.		165 sec.							
Oil	Average (Min.-Max.)	69.5 (68-72)	66 (27-70)	68.5 (56-72)	67 (6-72)	48 (0-72)	N O		H O			
Supply (psi)	Average (Min.-Max.)	1800 (1100 - 2800)	2490 (1000 - 5000)	1800 (800 - 3000)	1100 (300 - 7000)	2100 (400 - 3800)						
Return (psi)		400	400	300	300	300						
AP (psi)		1910	2090	1500	800	1800						
Flow (LPM)	Average (Min.-Max.)	132.5 (91-178)	128.7 (11-185)	128.7 (85-148)	124.9 (0-170)	94.6 (0-151)						
Hydraulic HP		35.6	37.8	27.1	14.0	23.9						
Electrical Power Consumption (W)		M-1 47.5	M-1 50.4	M-2 46.8	M-1 36	M-2 40.8						
Chuck Loaders Force (lb)		Right 22.4										
		Left 34.5										

Table 5
Instrumented Cutting Trial No. 4

	Sump	Shear Right	Reverse Drums	Shear Left	Reverse Drums	Shear Right
	145 sec.	138 sec.	70 sec.	273 sec.	30 sec.	300 sec.
	R. Drum	L. Drum	R. Drum	L. Drum	R. Drum	L. Drum
WPH Average (Min.-Max.)	69 (25-72)	N/A	70 (68-72)	68 (67-72)	67.5 (57-72)	67 (22-72)
Supply (psi) Average (Min.-Max.)	1900 (400 - 3600)	3500 (400 - 4000)	1860 (800 - 2500)	1570 (800 - 2200)	1810 (1100 - 3000)	1330 (705 - 3800)
Return (psi)	400	300	400	300	400	300
Air (psi)	1500	3200	1460	1270	1410	1030
Flow (FPM) Average (Min.-Max.)	136.3 (0-159)	45.4 (0-148)	136.3 (102-155)	132.5 (76-167)	132.5 (57-174)	124.2 (0-170)
Hydraulic HP	28.7	20.4	28.0	23.6	26.3	18.0
Electrical Power Consumption (kW)	M-1 57.6	M-2 48	M-1 38.3	M-2 44.1	M-1 32.8	M-2 42
Pump Cylinders Force (Tons)	Right 18.7	Left 24.8	—	—	—	—

Table 6
Cutting Trials Summary

	Cut #1	Cut #2	Cut #3	Cut #4	Average
Production (tons)	5.7	7.9	3.5	8.9	6.5
Cutting Time (min)	15.0	13.8	7.1	18.4	13.6
Production Rate (tons/min)	0.4	0.6	0.5	0.5	0.5
Sump Speed (m/min)	0.14	0.47	0.44	0.17	0.31 (12.2 in/min)
Drum Shear Rate (m/min) Horizontal	1.6	1.2	0.5	0.9	1.1 (43 in/min)
Drum Shear Rate (m/min) Vertical	0.14	0.25	0.26	0.43	0.27 (10.6 in/min)
Drum Rotation (RPM)	67.9	66.3	64.5	66.7	66.4
Cutting Drum Hydraulic Oil Flow Rate (LPM)	130.6	130.6	123.8	120.4	126.4 (33.4 gpm)
Cutting Drum Hydraulic Oil Pressure Loss (psi)	2618	1775	1600	1353	1792
Check Cylinder Force (tons)		Right 37.9 Left 25.9	Right 22.4 Left 34.5		Right 30.2 Left 30.2
Sump Cylinder Force (tons)	Right 24.9 Left 21.0	Right 16.9 Left 18.2		Right 18.7 Left 24.8	Right 20.2 Left 21.3
Power Consumption (kw) M-1 M-2	39.6 46.5	42.4 66.0	44.6 43.6	36.8 42.8	40.9 49.7

Height - 0.95 m (37-1/2 in)
Width - 5.2 m (17 ft)
Length - 4.7 m (15 ft - 5 in)
Weight - 10,866 kg (12 ton)

Cutting Heads - 2
Head Diameter - 0.31 m (32 in)
Max. Head Rotation - 72 rpm
Bit Tip Speed - 3.1 m/sec (603 ft/min)

Roof Bolters - 2
Face to Bolt Distance - 2.3 m (7.5 ft)

Mining Height - 0.9 m - 1.5 m
(37.5 in - 60 in)
Mining Width - 0.1 m (20 ft)
Depth of Cut - 0.61 m (24 in)

Conveyor Speed - 0.56 m/sec (110 ft/min)
Conveyor Width - 0.41 m (16 in)

Roof Chock Cylinders - 2 each -
168 mm (6-5/8 in) dia.
Sump Cylinders - 2 each - 146 mm
(5-3/4 in) dia.

Figure 1
Miner-Bolter System Description

Height - 0.93 m (36-1/2 in)
Width - 1.51 m (59-1/2 in)
Length - 4.97 m (16 ft - 3-1/2 in)
Weight - 7257 kg (8 ton)

Drive Motors - 2 each
100 hp - 1775 rpm
400 V, 3 ϕ , cont. duty
128 amps, 40°C rise
Frame FBX 405 TY-XP

Tram Speed - 0.24 m/sec (48 ft/min)
Hydraulic Tanks - 2 each
Capacity - 606L (160 gal)
284L (75 gal)

Tires - 4 each - 0.6 m (23-1/2 in) dia.
Ground Clearance - 0.1 - 0.2 m (4-8 in)
Drive - Chain 4 wheel

Figure 2
Hydraulic Power Pack Description

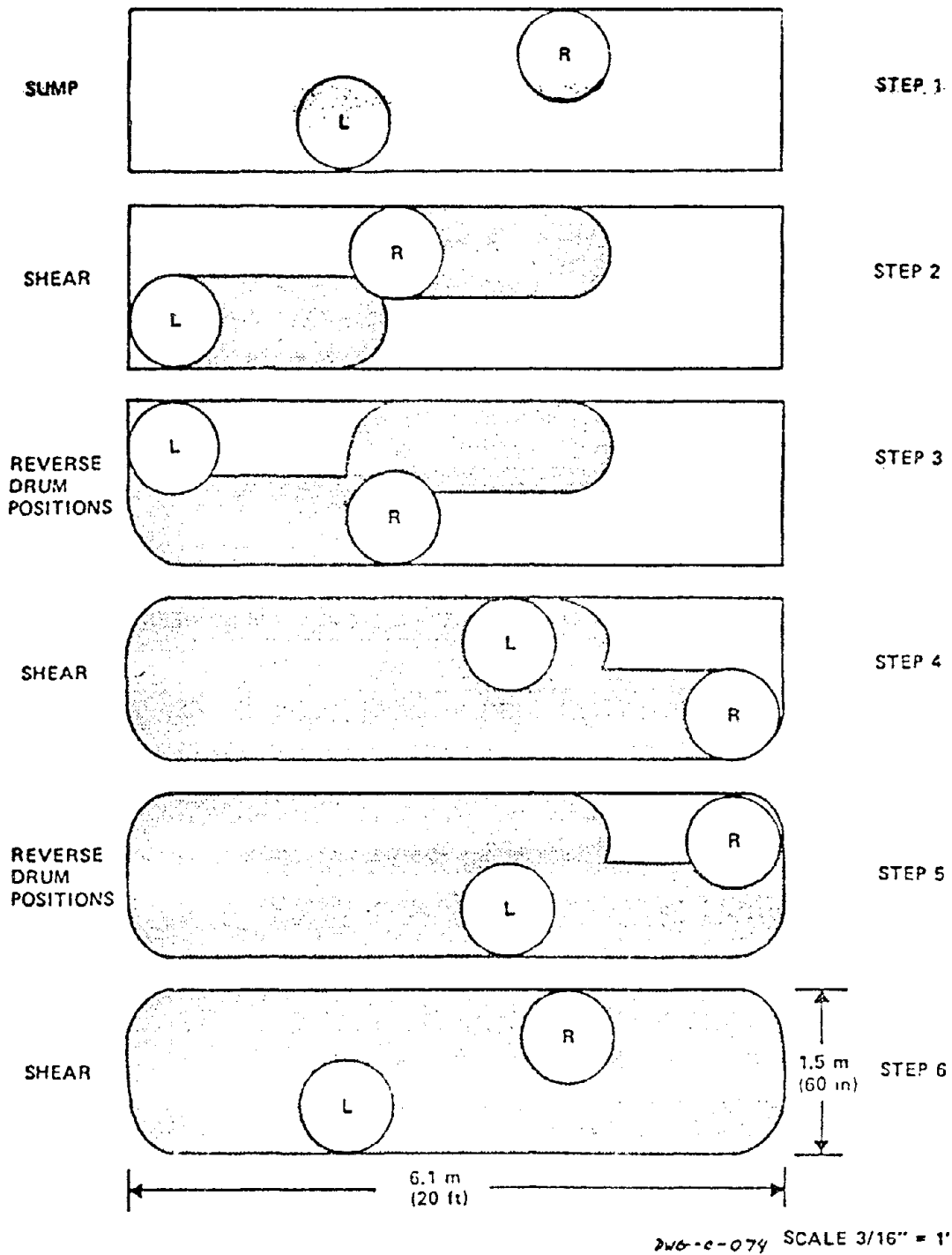
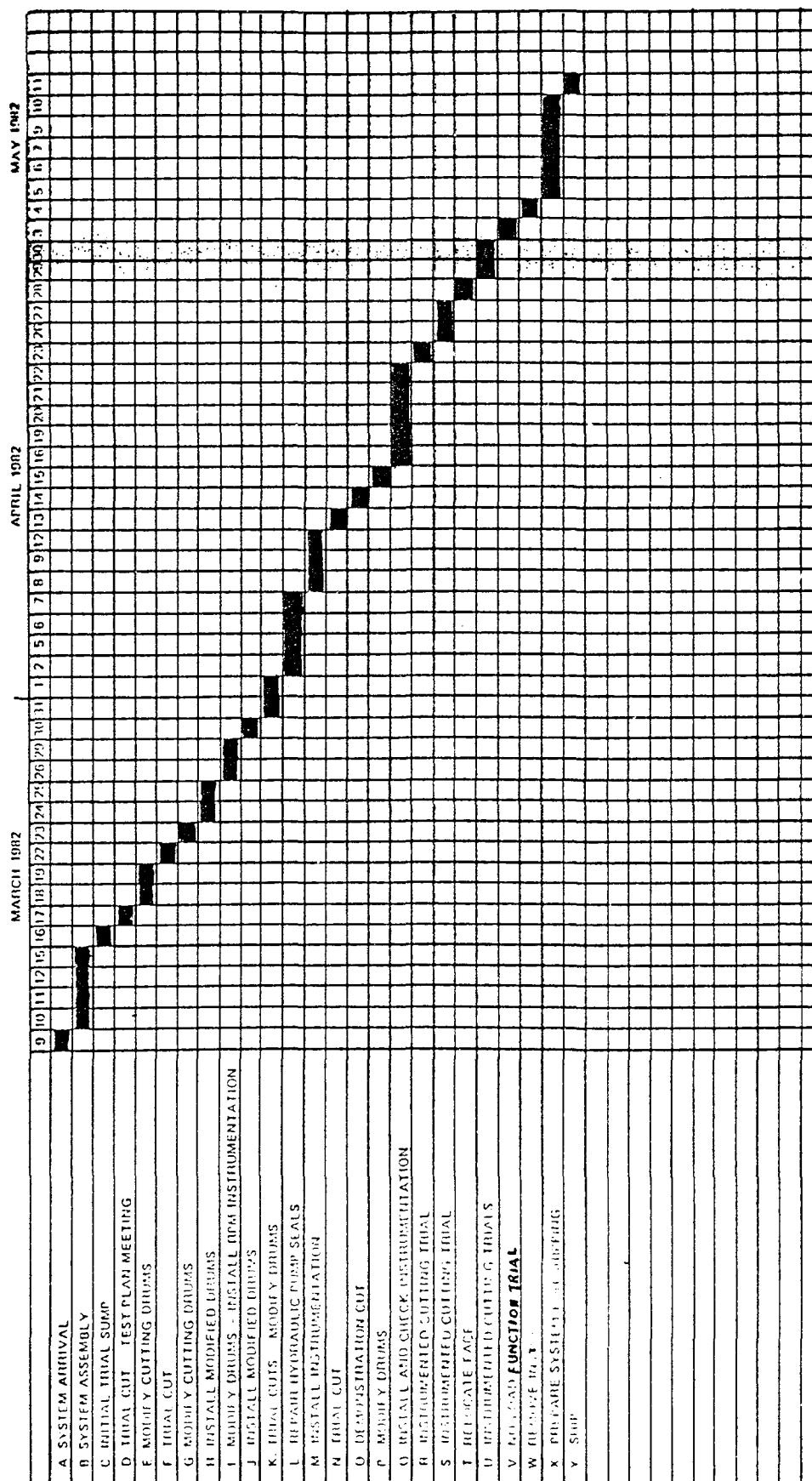


Figure 3
Face Cutting Sequence

Figure 4
Chronological Event Log of Major Activities



D46-000000

Appendix D
Underground Testing Data
Five Day Test
A.M.B. Unit #101
R & P Coal Company
Urling #3 Mine

DAILY PRODUCTION RECORD

October 29, 1982

9:37 a.m. Start mining

*9:43 a.m. M.B.C. operator did not start the pan line.
Excessively large spillage to clean.

10:00 a.m. Start mining

10:08 a.m. Damaged hose carrier linkage on line curtain post.

10:18 a.m. Start mining

10:28 a.m. Stop - change roof drill bits

10:32 a.m. Start mining

*10:39 a.m. Completed cross cut, began moving conv. back to rib
(pan line to far to center of room).

12:48 p.m. Eat lunch

1:08 p.m. Start backing A.M.B. out of cross cut and advance
to face.

1:50 p.m. Start mining

2:35 p.m. Stop to splice control cable

2:50 p.m. Continue mining

3:20 p.m. Stop - end of shift

Total Coal Mined:	24.5 ft. or 88.2 tons
Total Cutting Time:	106 minutes
Average Production Rate:	0.83 t/min (APR)
Pan Related Downtime:	146 minutes
Assumed Production Time 80% of Pan Related Downtime:	116.8 minutes
Total Projected Running Time:	222.8 minutes (PRT)
Projected Tonnage:	(PRT) x (APR) = 184.9 tons

NOTE: Projected Running Time (PRT) Noted by *

DAILY PRODUCTION RECORD

November 1, 1982

9:08 a.m. Start mining coal

9:17 a.m. Stop - down to move tail conveyor so M.B.C. (Mobil Bridge Conv.) could move under it better.

9:22 a.m. Start mining

9:58 a.m. Stop - empty dust boxes (roof drill)

10:18 a.m. Start mining

*10:35 a.m. Stop - add pans to conveyor chain line. Put on three 6' pans.

11:55 a.m. Start mining

12:07 p.m. Stop - lunch

12:47 p.m. Start mining

1:05 p.m. Stop - shovel coal left as a result of a dip in the floor.

1:15 p.m. Start mining

1:30 p.m. Stop - shovel bottom coal

1:56 p.m. Start mining

1:58 p.m. Stop - Broken hydraulic hose fitting on auger (pressure hose at power pack bulkhead). Down for rest of shift.

Total Coal Mined:	33 ft. or 118.8 tons
Total Cutting Time:	117 minutes
Average Production Rate:	1.02 t/min (APR)
Pan Related Down Time:	80 minutes
Assumed Production Time 80% of Pan Related Down Time:	64 minutes
Total Projected Running Time:	181 minutes (PRT)
Projected Tonnage:	(PRT) x (APR) = 184.6 tons

NOTE: Projected Running Time (PRT) Noted by *

DAILY PRODUCTION RECORD

November 2, 1982

8:51 a.m. Empty the dust boxes
 8:53 a.m. Start mining coal. We had 7½' of useable pan line.
 *9:24 a.m. Stop to add three 6' sections to pan line
 10:49 a.m. Continue mining
 11:53 a.m. Used all available pan line and stopped for lunch
 12:31 p.m. Start backing A.M.B. to turn cross cut
 12:32 p.m. Stop to unload pans out of scoop bucket
 12:35 p.m. Continue backing
 12:46 p.m. Start cutting outby corner of corss cut
 *1:10 p.m. Stop to add three 6' sections to pan line
 2:17 p.m. Continue mining
 2:29 p.m. Stop to empty dust boxes
 2:34 p.m. Continue mining
 2:44 p.m. Full face cutting
 3:07 p.m. Stop A.M.B. End of Shift

Total Coal Mined:	40 ft. or 144 tons
Total Cutting Time:	164 minutes
Average Production Rate:	0.88 t/min (APR)
Pan Related Down Time:	152 minutes
Assumed Production Time 80% of Pan Related Down Time:	121.6 minutes
Total Projected Running Time:	285.6 minutes (PRT)
Projected Tonnage:	(PRT) x (APR) = 251.3 tons

NOTE: Projected Running Time (PRT) Noted by *

DAILY PRODUCTION RECORD

November 3, 1982

8:55 a.m. Start A.M.B. mining

*9:31 a.m. Adjust M.B.C. under the miner tail conveyor

9:32 a.m. Continue mining

*9:45 a.m. Stop to add pans to pan line - added two pans

10:38 a.m. Continue mining

11:25 a.m. Replace broken bits in left and right auger. Total of eight broken by a sulfur ball in the seam.

12:00 noon Continue mining

12:01 p.m. Opening cross cut face

12:18 p.m. Stop for lunch. Opening is complete. Total 26' today in cross cut.

12:50 p.m. Started A.M.B. to install the necessary roof bolts between the cross cut and heading

1:34 p.m. Start backing out of cross cut

1:54 p.m. Grounding problem with control cable

1:55 p.m. Continue backing

2:11 p.m. A.M.B. back at the face of the heading. Stop to bring M.B.C. in to position.

2:22 p.m. Start mining

*3:01 p.m. The mine's belts went down.

3:07 p.m. Belts running. Continue mining

3:21 p.m. Belts down again. End of shift.

Total Coal Mined:	40 ft or 144 tons
Total Cut Time:	167 minutes
Average Production Rate:	.86 t/min (APR)
Pan Related Down Time:	60 minutes
Assumed Production Time 80% of Pan Related Downtime:	48 minutes
Projected Running Time:	215 minutes (PRT)
Projected Tonnage:	(PRT) x (APR) = 184.9 tons

NOTE: Projected Running Time (PRT) Noted by *

DAILY PRODUCTION RECORD

November 4, 1982

9:03 a.m. Warm up the A.M.B.
 9:13 a.m. Begin mining coal
 10:03 a.m. Stop to empty dust boxes
 10:09 a.m. Continue mining
 10:11 a.m. Stop - M.B.C. Conveyor stalled
 10:13 a.m. Continue mining
 *10:20 a.m. Stop to add pans to pan line. Added 4 sections
 11:45 a.m. Break for lunch
 12:20 p.m. Start mining coal
 *1:08 p.m. Stop to reposition M.B.C. under secondary conveyor
 1:09 p.m. Continue mining
 1:34 p.m. Stop - busted the right high pressure auger hose
 2:14 p.m. Continue mining
 2:27 p.m. Belts shut down and remained down for the remainder of the shift.

Total Coal Mined:	43 ft or 154.8 tons
Total Cutting Time:	145 minutes
Average Production Rate:	1.07 t/min (APR)
Pan Related Down Time:	86 Minutes
Assumed Production Time 80% of Pan Related Down Time:	68.8 minutes
Projected Running Time:	213.8 minutes (PRT)
Projected Tonnage:	(PRT) x (APR) = 228.8 tons

NOTE: Projected Running Time (PRT) Noted by *



Appendix E

Log of Main Events

Underground Test

LOG OF MAIN EVENTS

UNDERGROUND TEST

Event A

The Acme Miner Bolter was delivered to the Urling #3 Complex on May 11, 1982.

Event B

During this time period the A.M.B. was transported underground by rail car to the #1 Butt off of 5 North Mains. It was moved approximately 200 feet from the track to the section by an Elkhorn scoop.

Event C

The A.M.B. was assembled by two Acme personnel and the equipment was moved into position by an R & P scoop operator.

Event D

The initial cutting trial showed that the ranging arms and traverse speeds needed to be reduced to prevent stalling of the augers.

Event E

A special U43 series bit that is 7/8 of an inch longer than a standard U43 bit was used to reduce grinding of the coal.

Event F

Representatives of bit and auger manufacturing companies were called in to observe the cutting operation of the A.M.B. and suggested that an auger be built with larger scrolls to improve loading conditions.

LOG OF MAIN EVENTS

UNDERGROUND TEST

Event G

Ralph Lewis' first day as the miner operator, the system was strange to him but once he became familiar with it he was an excellent operator.

Event H

The right rear chock cylinder clevis broke as a result of a poor weld.

Event I

A demonstration of the A.M.B. was given for the R & P executives. It went very smoothly and all comments were favorable.

Event J

This time period was used to become familiar with the A.M.B. and to learn how it would function in underground conditions

Event K

The augers were removed to build a new set with larger scrolls and the auger frame was removed to be reworked to improve loading conditions.

Event L

The A.M.B. was positioned in the cross cut and curtained off from ventilation to prepare for dust test.

Event M

The roof bolter dust test was performed by MSHA to certify the dust collecting system.

Event N

Reassembled the auger frame and augers to the A.M.B. Changes

LOG OF MAIN EVENTS

UNDERGROUND TEST

were made to the traverse and ranging arm stops to insure proper cutting dimensions.

Event O

Tried the new augers, cores were left by the face plate bits indicating improper lacing.

Event P

We attempted to add blocks and bits to correct the coring problems.

Event Q

The augers were tried again. However, the lacing pattern still wasn't correct. The augers were removed to be relaced.

Event R

The augers were being relaced at the shop and modifications were being made to the auger frame shoes to cure a binding problem.

Event S

The coring problem had been corrected and the A.M.B. continued mining.

Event T

The left ram cylinder broke. It was removed along with the right ram cylinder because its rod eye was bent.

Event U

Repairs and reassembly were performed to the two cylinders.

Event V

Start and continue mining.

LOG OF MAIN EVENTS

UNDERGROUND TEST

Event W

The A.M.B. was idled while new air courses were being cut for its section.

Event X

Augers were removed to be redesigned and laced at Acme's plant.

Event Y

Installed a heat exchanger in the cutter head hydraulic circuit to reduce heat and reinstalled the new augers.

Event Z

It was necessary to reassemble the #1 pan line because it was taken apart while another section was being moved.

Event A¹

Started mining and broke the rod end on the right ram cylinder.

Event B¹

Repairs were being made to the right ram cylinder.

Event C¹

Continued mining to finish the first heading.

Event D¹

Clean-up heading to take pictures and dismantling #2 pan line.

Event E¹

Underground pictures were taken of the A.M.B.

Event F¹

Set A.M.B. up at the new heading along with the necessary support equipment.

LOG OF MAIN EVENTS

UNDERGROUND TEST

Event G¹

Start cutting new heading and evaluate augers.

Event H¹

Build the 32 inch diameter augers at Acme Machinery Company in Huntington, WV.

Event I¹

Start mining with new augers.

Event J¹

Broke the rod eye off of the left ram cylinder.

Event K¹

Ram cylinder back on the A.M.B., however experienced trouble with 80/20 flow divider.

Event L¹

Start mining after springs were installed in the 80/20 flow divider to stop the sticking problem.

Event M¹

The main circuit breaker on the power pack burnt up.

Event N¹

The left ram cylinder eye broke again. Repairs were made to the cylinder.

Event O¹

Started mining after the left ram cylinder was installed.

Event P¹

Conducted the first day test that was necessary to complete the contract.

LOG OF MAIN EVENTS

UNDERGROUND TEST

Event Q¹

Clean-up the miner and the heading to begin dismantling.

Event R¹

Dismantle the A.M.B.

Event S¹

Transport the A.M.B. outside at the convenience of the mine's personnel.

Event T¹

The A.M.B. was shipped back to the D.O.E. at Bruceton, Pennsylvania.

LOG OF MAIN EVENTS

		MAY 1982													
		11	12	13	14	15	16	17	18	19	20	21	22	23	24
A.	SYSTEM ARRIVAL														
B.	TRANSPORT UNDERGROUND														
C.	SYSTEM ASSEMBLY														
D.	INITIAL CUTTING TRIAL														
E.	TRIAL CUT														
F.	DEMONSTRATION CUT														
G.	BEGAN TRAINING OPERATOR														
H.	BROKE CHOCK CYL. MOUNT														
I.	DEMONSTRATION R&P EXEC.														
J.	PRACTICE MINING PROCEDURES														
K.	MODIFY AUGERS & AUGER FRAME														
L.	PREPARE FOR R.B. DUST TEST														
M.	PERFORM DUST TEST														
N.	ASSEMBLE AUGERS & A.F.														
O.	TRY AUGERS														
P.	ADD BLOCKS & BITS														
Q.	TRY AUGERS														
R.	MODIFY AUGERS & A.F. SHOE														
S.	TRY AUGERS - CONT. MINING														
T.	BROKE RAM CYL.														
U.	REPAIRED & ASSEMBLED CYL.														
V.	CONT. MINING														
W.	IDLE-AIR COURSES														
X.	MODIFY AUGERS - KENNAME TAL														
Y.	INSTALL H.E. & AUGERS														
Z.	PUT PANLINE IN SERVICE														
A.	START MINING - BROKE RAM CYL.														
B.	REPAIRED RAM CYL.														
C.	CONTINUE MINING														
D.	CLEAN-UP DISMANTLE #2 PANLINE														
E.	TOOK PICTURES														
F.	SET-UP AT NEW HEADING														
G.	CUT COAL - EVALUATE AUGERS														
H.	MODIFY AUGERS														
I.	START MINING														
J.	BROKE RAM CYL.														
K.	TROUBLE - 80/20 FLOW DIVIDER														
L.	START MINING														
M.	BLEW MAIN CIRCUIT BREAKER														
N.	START MINING - BROKE RAM CYL.														
O.	START MINING														
P.	BEGIN FIVE DAY TEST														
Q.	CLEAN-UP FOR DISMANTLING														
R.	DISMANTLE														
S.	TRANSPORT OUTSIDE														
T.	SHIP TO BRUCETON, PA.														

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 1 of 7

LOG OF MAIN EVENTS

	JUNE 1982																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A. SYSTEM ARRIVAL																														
B. TRANSPORT UNDERGROUND																														
C. SYSTEM ASSEMBLY																														
D. INITIAL CUTTING TRIAL																														
E. TRIAL CUT																														
F. DEMONSTRATION CUT																														
G. BEGAN TRAINING OPERATOR																														
H. BROKE CHOCK CYL. MOUNT																														
I. DEMONSTRATION R&P EXEC.																														
J. PRACTICE MINING PROCEDURES																														
K. MODIFY AUGERS & AUGER FRAME																														
L. PREPARE FOR R.B. DUST TEST																														
M. PERFORM DUST TEST																														
N. ASSEMBLE AUGERS & A.F.																														
O. TRY AUGERS																														
P. ADD BLOCKS & BITS																														
Q. TRY AUGERS																														
R. MODIFY AUGERS & A.F. SHOE																														
S. TRY AUGERS - CONT. MINING																														
T. BROKE RAM CYL.																														
U. REPAIRED & ASSEMBLED CYL.																														
V. CONT. MINING																														
W. IDLE - AIR COURSES																														
X. MODIFY AUGERS - KENAMETAL																														
Y. INSTALL H.E. & AUGERS																														
Z. PUT PANLINE IN SERVICE																														
A. START MINING - BROKE RAM CYL.																														
B. REPAIRED RAM CYL.																														
C. CONTINUE MINING																														
D. CLEAN-UP DISMANTLE #2 PANLINE																														
E. TOOK PICTURES																														
F. SET-UP AT NEW HEADING																														
G. CUT COAL - EVALUATE AUGERS																														
H. MODIFY AUGERS																														
I. START MINING																														
J. BROKE RAM CYL.																														
K. TROUBLE - 80/20 FLOW DIVIDER																														
L. START MINING																														
M. BLEW MAIN CIRCUIT BREAKER																														
N. START MINING - BROKE RAM CYL.																														
O. START MINING																														
P. BEGIN FIVE DAY TEST																														
Q. CLEAN-UP FOR DISMANTLING																														
R. DISMANTLE																														
S. TRANSPORT OUTSIDE																														
T. SHIP TO BRUCETON, PA.																														

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 2 of 7

LOG OF MAIN EVENTS

JULY 1982																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A.																														
B.																														
C.																														
D.																														
E.																														
F.																														
G.																														
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X.																														
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P.																														
Q.																														
R.																														
S.																														
T.																														

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 3 of 7.

LOG OF MAIN EVENTS

[illegible]

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 4 of 7

LOG OF MAIN EVENTS

		SEPTEMBER 1982																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A.	SYSTEM ARRIVAL																														
B.	TRANSPORT UNDERGROUND																														
C.	SYSTEM ASSEMBLY																														
D.	INITIAL CUTTING TRIAL																														
E.	TRIAL CUT																														
F.	DEMONSTRATION CUT																														
G.	BEGAN TRAINING OPERATOR																														
H.	BROKE CHOCK CYL. MOUNT																														
I.	DEMONSTRATION R&P EXEC.																														
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S.	TRY AUGERS - CONT. MINING																														
T.	BROKE RAM CYL.																														
U.	REPAIRED & ASSEMBLED CYL.																														
V.	CONT. MINING																														
W.	IDLE-AIR COURSES																														
X.	MODIFY AUGERS-KENNAME TAL																														
Y.	INSTALL H.E.& AUGERS																														
Z.	PUT PANLINE IN SERVICE																														
A.	START MINING - BROKE RAM CYL.																														
B.	REPAIRED RAM CYL.																														
C.	CONTINUE MINING																														
D.	CLEAN-UP DISMANTLE #2 PANLINE																														
E.	TOOK PICTURES																														
F.	SET-UP AT NEW HEADING																														
G.	CUT COAL - EVALUATE AUGERS																														
H.	MODIFY AUGERS																														
I.	START MINING																														
J.	BROKE RAM CYL.																														
K.	TROUBLE - 80/20 FLOW DIVIDER																														
L.	START MINING																														
M.	BLEW MAIN CIRCUIT BREAKER																														
N.	START MINING - BROKE RAM CYL.																														
O.	START MINING																														
P.	BEGIN FIVE DAY TEST																														
Q.	CLEAN-UP FOR DISMANTLING																														
R.	DISMANTLE																														
S.	TRANSPORT OUTSIDE																														
T.	SHIP TO BRUCETON, PA.																														

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 5 of 7

LOG OF MAIN EVENTS

		OCTOBER 1982																											
		1	4	5	6	7	8	11	12	13	14	15	18	19	20	21	22	25	26	27	28	29							
A.	SYSTEM ARRIVAL																												
B.	TRANSPORT UNDERGROUND																												
C.	SYSTEM ASSEMBLY																												
D.	INITIAL CUTTING TRIAL																												
E.	TRIAL CUT																												
F.	DEMONSTRATION CUT																												
G.	BEGAN TRAINING OPERATOR																												
H.	BROKE CHOCK CYL. MOUNT																												
I.	DEMONSTRATION R&P EXEC.																												
J.	PRACTICE MINING PROCEDURES																												
K.	MODIFY AUGERS & AUGER FRAME																												
L.	PREPARE FOR R.B. DUST TEST																												
M.	PERFORM DUST TEST																												
N.	ASSEMBLE AUGERS & A.F.																												
O.	TRY AUGERS																												
P.	ADD BLOCKS & BITS																												
Q.	TRY AUGERS																												
R.	MODIFY AUGERS & A.F. SHOE																												
S.	TRY AUGERS - CONT. MINING																												
T.	BROKE RAM CYL.																												
U.	REPAIRED & ASSEMBLED CYL.																												
V.	CONT. MINING																												
W.	IDLE - AIR COURSES																												
X.	MODIFY AUGERS - KENNAME TAL																												
Y.	INSTALL H.E. & AUGERS																												
Z.	PUT PANLINE IN SERVICE																												
A.	START MINING - BROKE RAM CYL.																												
B.	REPAIRED RAM CYL.																												
C.	CONTINUE MINING																												
D.	CLEAN-UP DISMANTLE #2 PANLINE																												
E.	TOOK PICTURES																												
F.	SET-UP AT NEW HEADING																												
G.	CUT COAL - EVALUATE AUGERS																												
H.	MODIFY AUGERS																												
I.	START MINING																												
J.	BROKE RAM CYL.																												
K.	TROUBLE - 80/20 FLOW DIVIDER																												
L.	START MINING																												
M.	BLEW MAIN CIRCUIT BREAKER																												
N.	START MINING - BROKE RAM CYL.																												
O.	START MINING																												
P.	BEGIN FIVE DAY TEST																												
Q.	CLEAN-UP FOR DISMANTLING																												
R.	DISMANTLE																												
S.	TRANSPORT OUTSIDE																												
T.	SHIP TO BRUCETON, PA.																												

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 6 of 7

LOG OF MAIN EVENTS

NOVEMBER 1982																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A. SYSTEM ARRIVAL																	
B. TRANSPORT UNDERGROUND																	
C. SYSTEM ASSEMBLY																	
D. INITIAL CUTTING TRIAL																	
E. TRIAL CUT																	
F. DEMONSTRATION CUT																	
G. BEGAN TRAINING OPERATOR																	
H. BROKE CHOCK CYL. MOUNT																	
I. DEMONSTRATION R&P EXEC.																	
J. PRACTICE MINING PROCEDURES																	
K. MODIFY AUGERS & AUGER FRAME																	
L. PREPARE FOR R.B. DUST TEST																	
M. PERFORM DUST TEST																	
N. ASSEMBLE AUGERS & A.F.																	
O. TRY AUGERS																	
P. ADD BLOCKS & BITS																	
Q. TRY AUGERS																	
R. MODIFY AUGERS & A.F. SHOE																	
S. TRY AUGERS - CONT. MINING																	
T. BROKE RAM CYL.																	
U. REPAIRED & ASSEMBLED CYL.																	
V. CONT. MINING																	
W. IDLE-AIR COURSES																	
X. MODIFY AUGERS - KENNA METAL																	
Y. INSTALL H.E. & AUGERS																	
Z. PUT PANLINE IN SERVICE																	
A. START MINING - BROKE RAM CYL.																	
B. REPAIRED RAM CYL.																	
C. CONTINUE MINING																	
D. CLEAN-UP DISMANTLE #2 PANLINE																	
E. TOOK PICTURES																	
F. SET-UP AT NEW HEADING																	
G. CUT COAL - EVALUATE AUGERS																	
H. MODIFY AUGERS																	
I. START MINING																	
J. BROKE RAM CYL.																	
K. TROUBLE - 80/20 FLOW DIVIDER																	
L. START MINING																	
M. BLEW MAIN CIRCUIT BREAKER																	
N. START MINING - BROKE RAM CYL.																	
O. START MINING																	
P. BEGIN FIVE DAY TEST																	
Q. CLEAN-UP FOR DISMANTLING																	
R. DISMANTLE																	
S. TRANSPORT OUTSIDE																	
T. SHIP TO BRUCETON, PA.																	

MISCELLANEOUS	
CUTTING TIME	
MODIFICATION TIME	
ASS'Y & REPAIR	

Sheet 7 of 7

Appendix F
Comments and Suggestions
Rochester & Pittsburgh Coal Company

INTER-DEPARTMENT CORRESPONDENCE

November 22, 1982

From J. E. Stewart - C. E. Lockard
D. King - G. Naradi - G. Guarino
To E. H. Jones
Vice President - Operations

Subject: "The Pro's, Con's, and Recommendations for
Improvement of the Acme Miner/Bolter AMB-1"

The concensus among the personnel involved with the AMB-1 was that the overall concept was good, but many improvements need to be made. The following is a list of the favorable and unfavorable points of the AMB-1 and recommendations for its improvement.

I. Safety

Pros'

- the overall safety of the AMB-1 was excellent, not a single lost time accident occurred throughout the test.
- no high voltage electrical components near the face area, the 420-580 VAC power pack is always 35 feet outby the miner/bolter.
- the only energized portion of the machine is an intrinsically safe, 12 volt lighting and emergency panic bar system, everything else is powered by hydraulics.
- miner cleans up loose coal along the rib well.
- rock dusting was easy to maintain within prescribed distances as the line brattice was advanced and during pan-up times.
- the Automatic Temporary Roof Support (ATRS) system virtually eliminates the exposure of personnel to unsupported roof.
- ventilation was adequate to reduce methane buildups and dust concentrations.
- good lighting and overall visibility for the operators.

Cons'

- the overall size of the power pack and its close proximity to the panline created clearance problems and the potential for pinch points.
- most parts are heavy and require two people to handle.
- the bundle of hydraulic hoses close to the operators head could create a hazard.
- the amount of hydraulic oil, hydraulic hoses, oil leaks, and high temperatures creates a potential fire hazard.

Improvements

- split the power pack and mount it directly on the mobile bridge conveyor with quick disconnects between the miner and MBC to decrease the number of moving machines in the face area.
- enclose the hydraulic hoses in conduit.

II. Ventilation and Dust Control

Pros'

- miner/bolter unit can be operated on a single split of air.
- the line brattice can be maintained within ten feet of the face at all times.
- the machine is "open" enough to permit the ventilating current to sweep the face.
- water spray position and volume reduced dust concentrations.
- nobody exposed to excessive dust, even the bolter operator opposite the line brattice.

Cons'

- again, methane and oxygen deficiency checks had to be made with an extendible probe.

Improvements

- with the use of an extendible line brattice attached to the cutter frame, the canvas could be maintained within 7.5 feet of the face with little attention.

III. Roof Control

Pros'

- the ATRS can be maintained to within 6.5 feet of the face, reducing the exposure of persons to unsupported roof.
- the roof is "caught" quickly, reducing immediate roof sag and separation.
- the bolter drill heads pivot and adjust to adapt to almost any bolting pattern.
- conventional bolts were installed with no build-up or bleed-off within the specified torque range.
- the ability to install roof bolts while mining seemed to work well, a decided advantage since machine moves and idle time are reduced.

Cons'

- in the event of the necessity for crossbars, it would take more time and effort than normal to get materials to the vicinity of the bolter heads, position, and install those materials.
- also, posts under the crossbars would have to be removed and replaced as the miner moved out of the working place.

Improvements

- none suggested.

IV. Machine Maneuverability

Pros'

- none.

Cons'

- the roof and bottom conditions were excellent in the section where the AMB-1 was tested, in the event of bad roof or bottom, this machine would be virtually immobile.

- the foot jacks would be useless if any appreciable amount of the roof came down.
- bad bottom (wet/soft) could create real mobility problems, the miner/bolter itself would be difficult if not impossible to maneuver, the trailing power pack would also be difficult to tram because of its low ground clearance and poor traction.
- the ram jack hoses are poorly placed and must slide through the machine.

Improvements

- mount the miner/bolter on crawlers.
- again, split the power pack and mount it on the MBC to eliminate the power pack and long hydraulic hoses.
- reroute the ram jack hoses.

V. Material Cutting, Conveyance, and Discharge

Pros'

- the concept of full face cutting was well received, overall production by the AMB-1 was good.

Cons'

- conveyor discharge was not practical.
- experienced long delays while panning up due to inexperience of our people with this task.
- the MBC system was not compatible with the AMB-1.
- augers never achieved good penetration despite numerous attempts to modify the speed and lacing of the cutter bits.

Improvements

- increase area around conveyor discharge to more easily accommodate a panline or shuttle car.
- an extension of the discharge conveyor on the miner could eliminate the second stage conveyor that was in use.
- a smaller conveyor could be attached to the miner to extend a panline dolly similar to the arrangement on the Wilcox miner.
- increase power to augers.

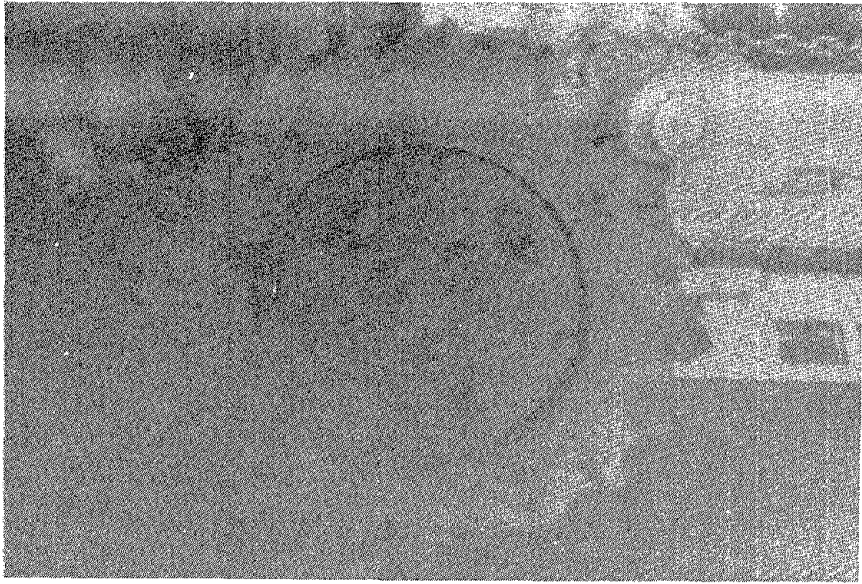
VI. Miscellaneous

Pros'

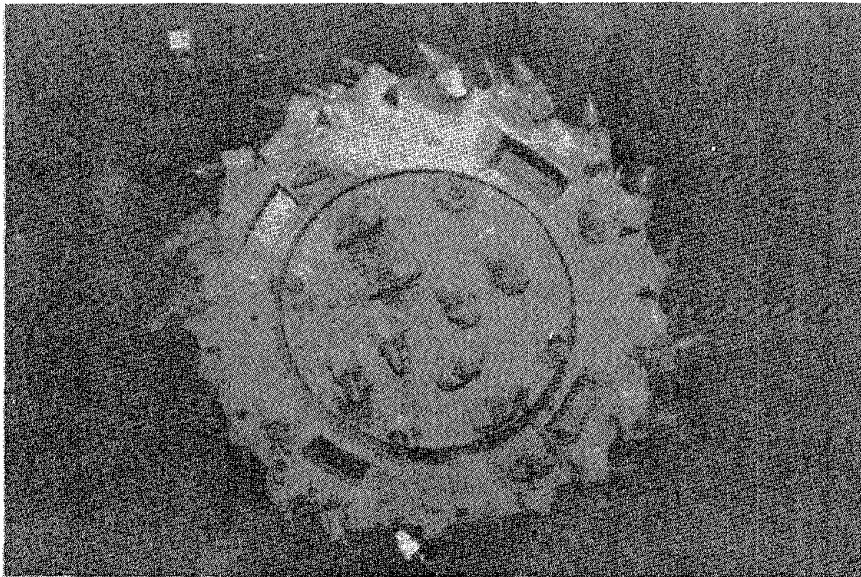
- at no time should the rock dust degrade coal quality.
- maintenance on machine was minimal during testing, largest single item was broken ram jacks.

Appendix G

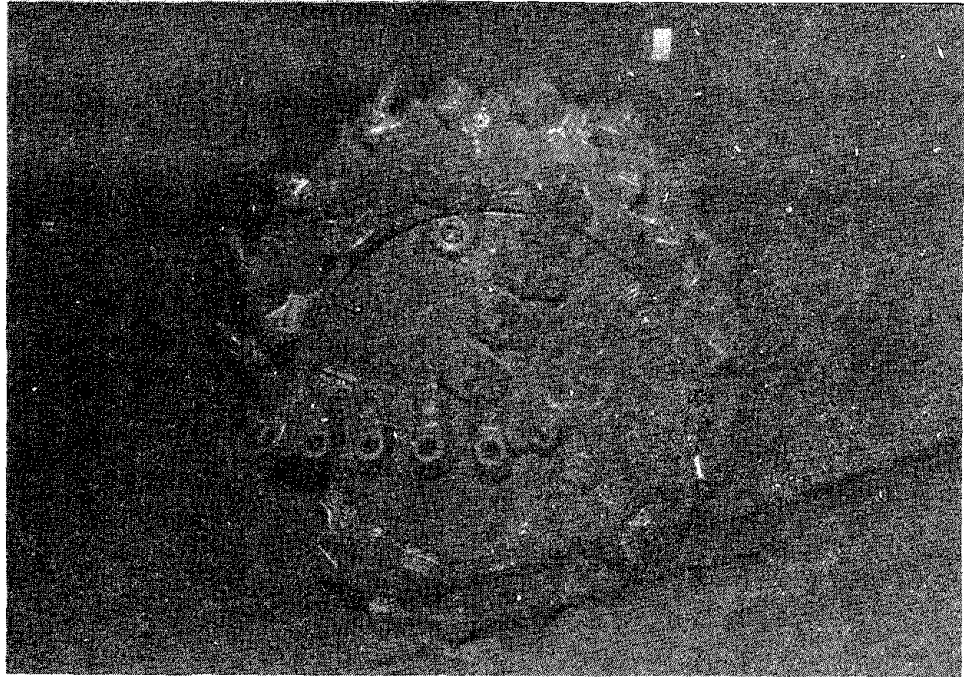
Photographs of Augers



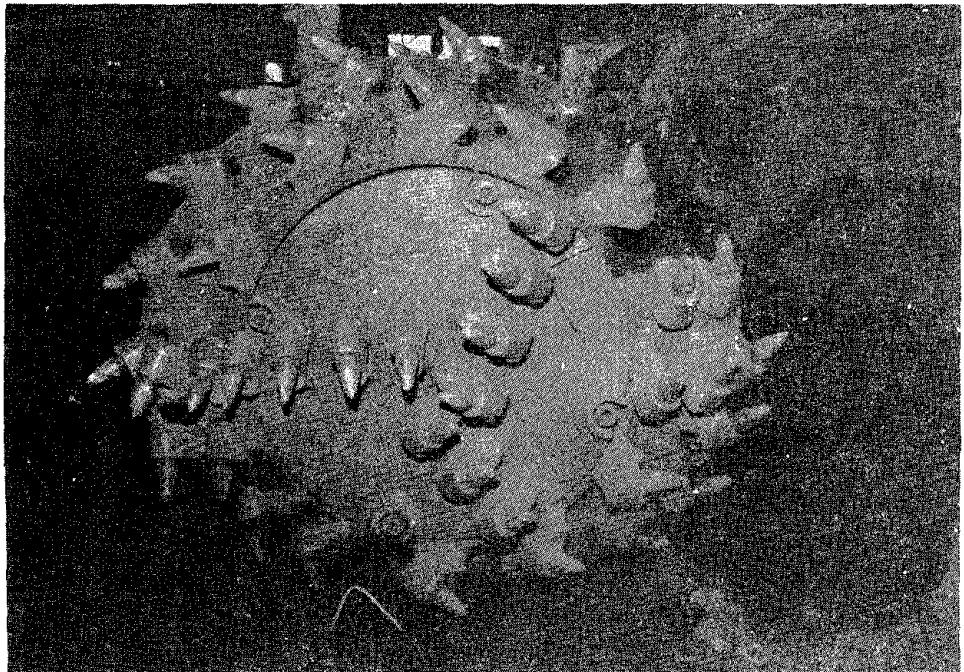
FIRST AUGER SET



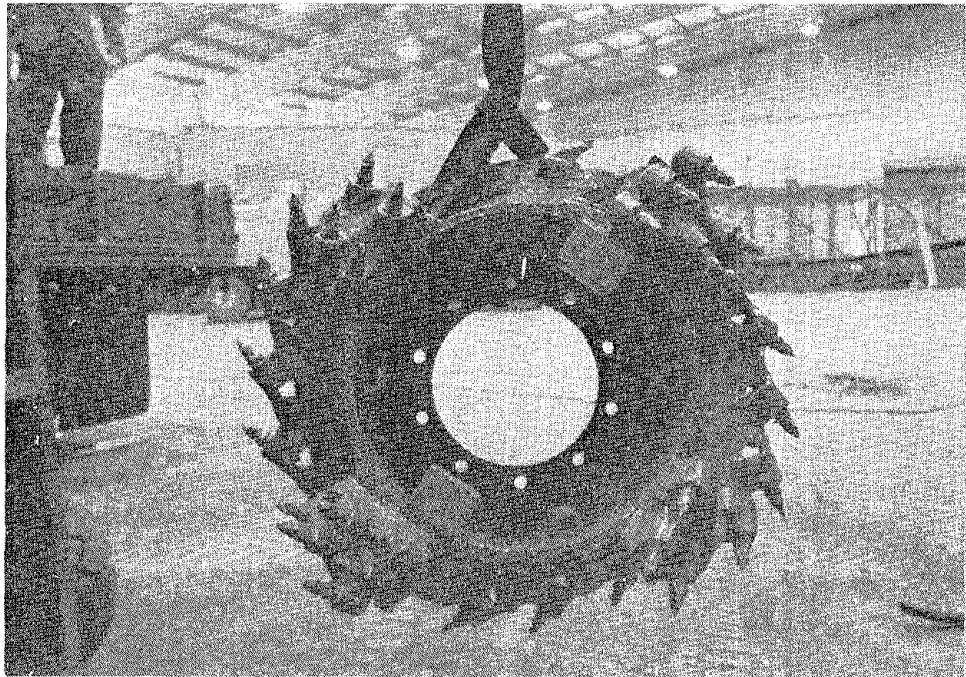
SECOND AUGER SET



THIRD AUGER SET



FOURTH AUGER SET



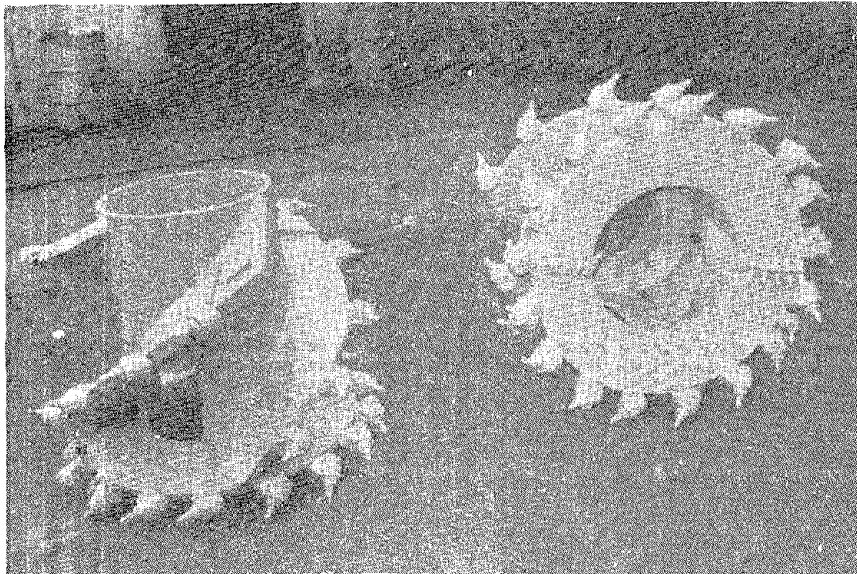
FIFTH AUGER SET

(Picture not available)

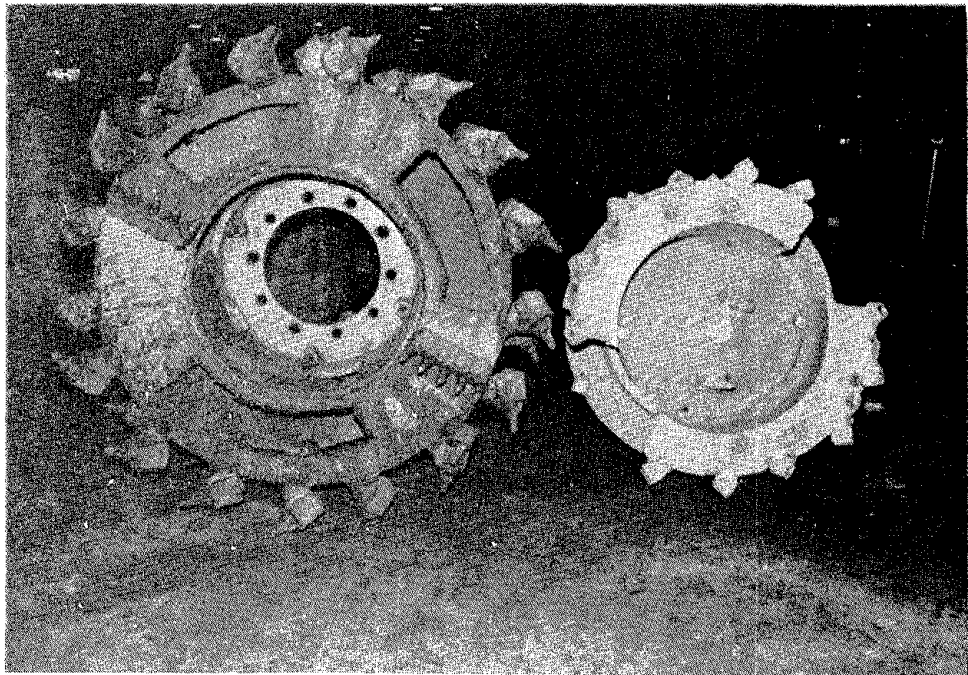
SIXTH AUGER SET

(Picture not available)

SEVENTH AUGER SET



EIGHTH AUGER SET



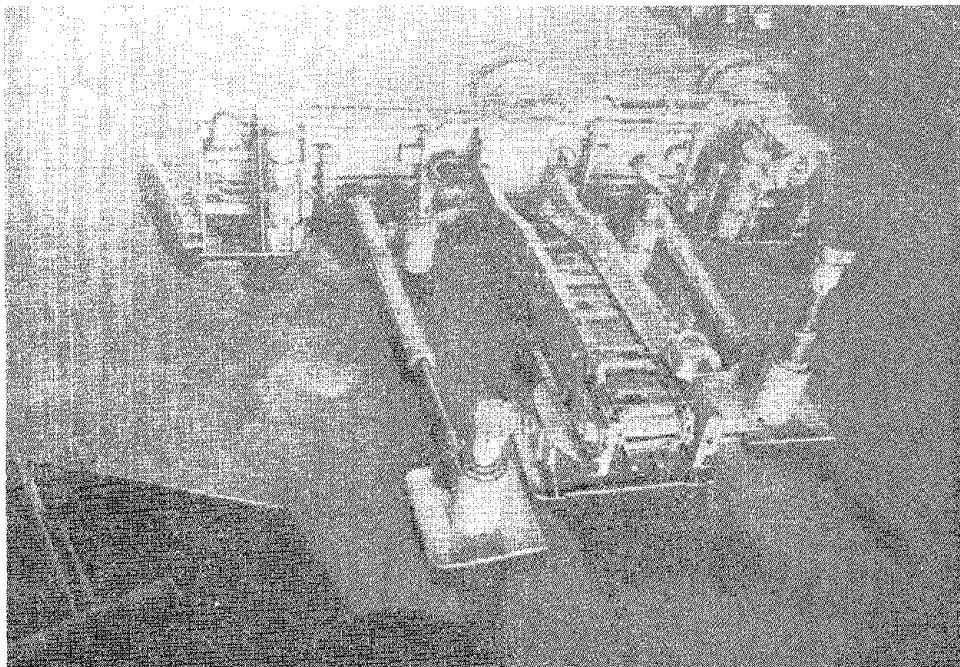
NINTH AUGER SET
(Smallest)

Appendix H

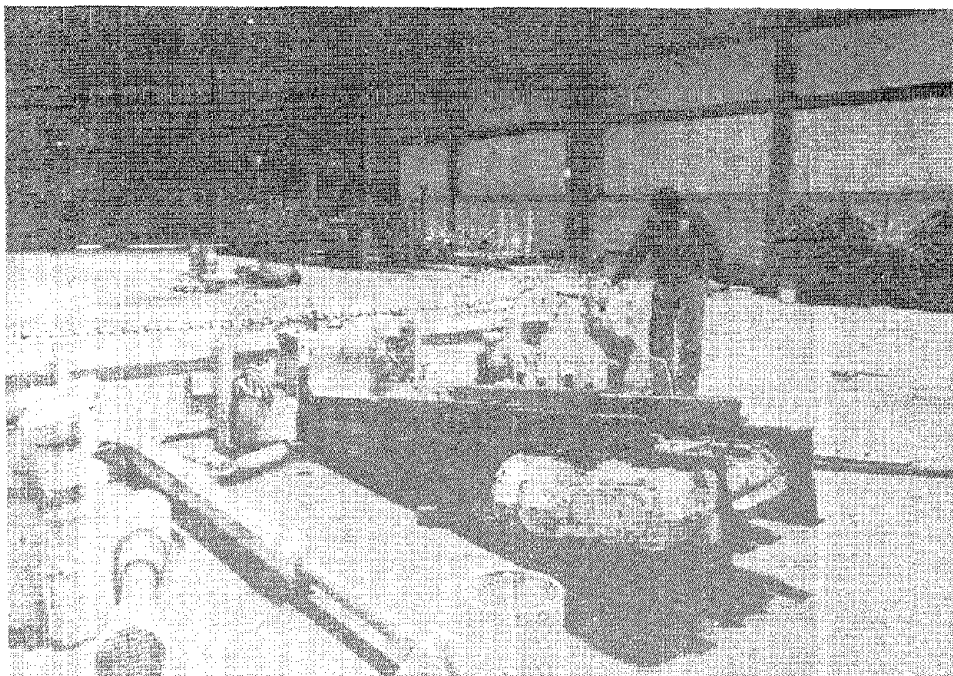
General Photographs

ACME MINER BOLTER

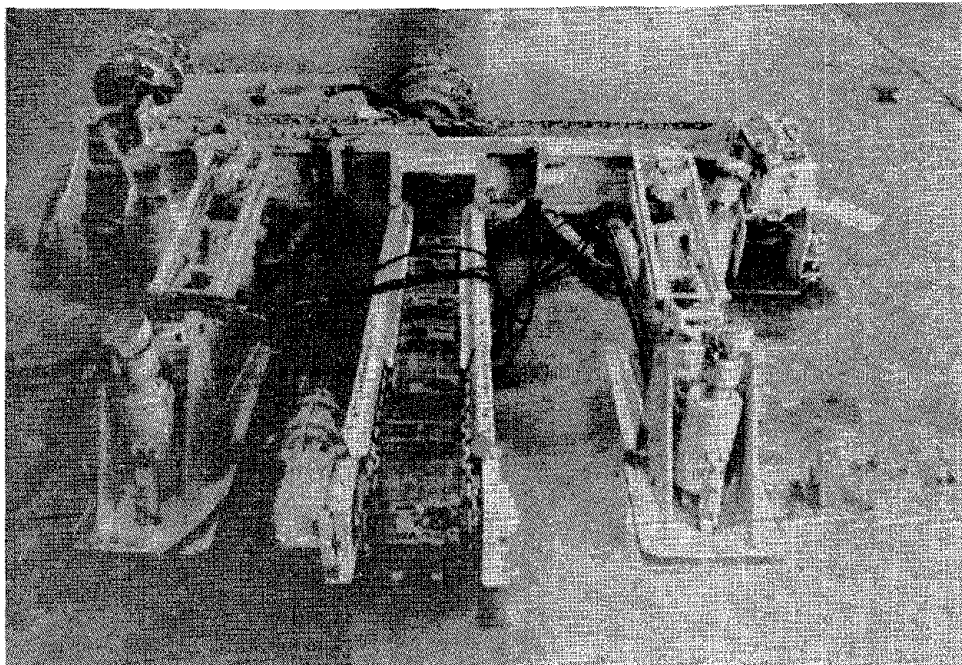
Construction Photographs



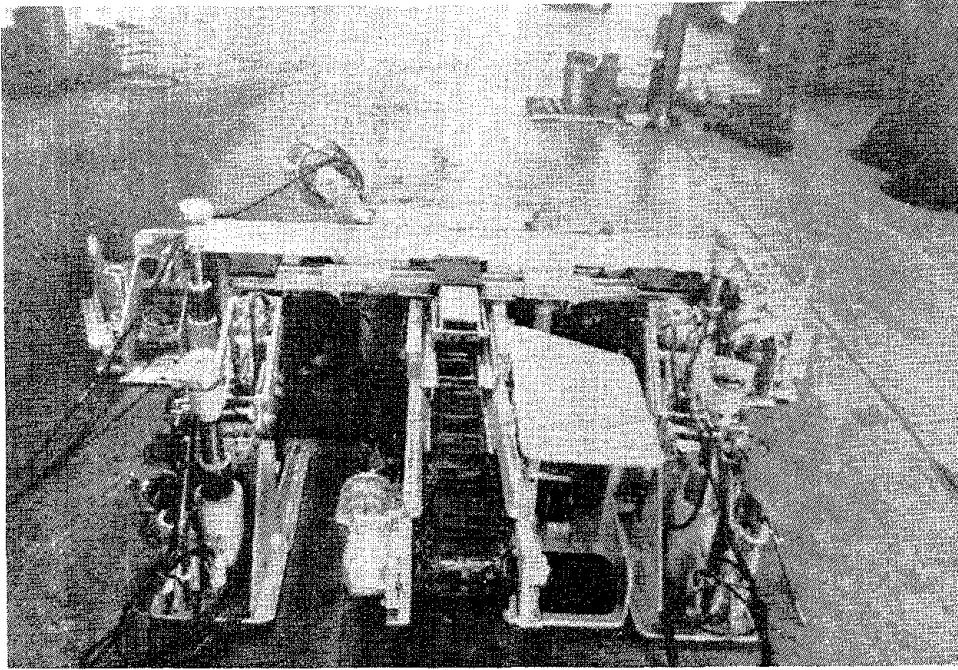
January 1981



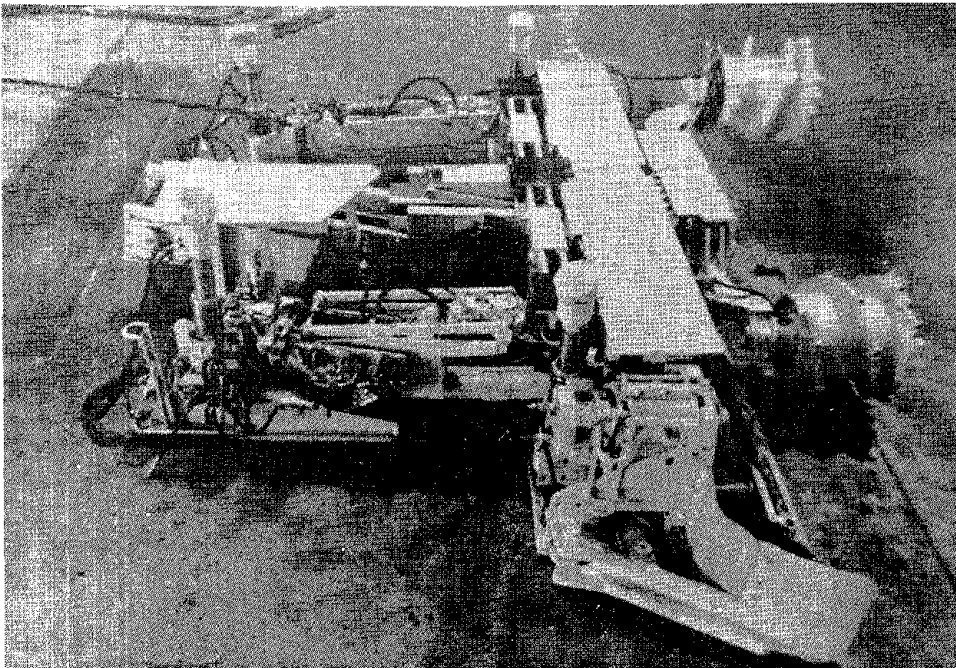
March 1981



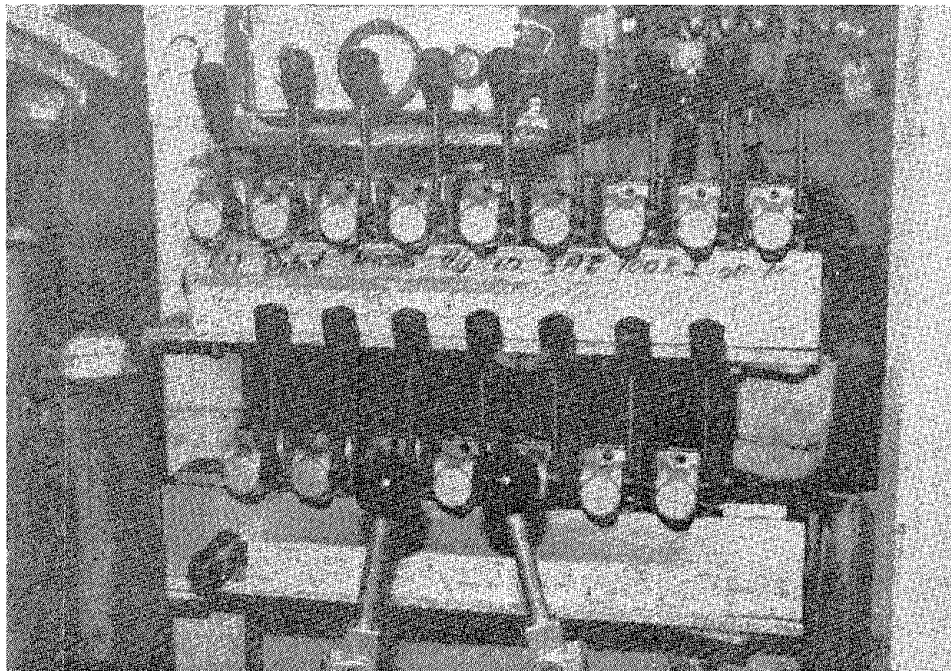
May 1981



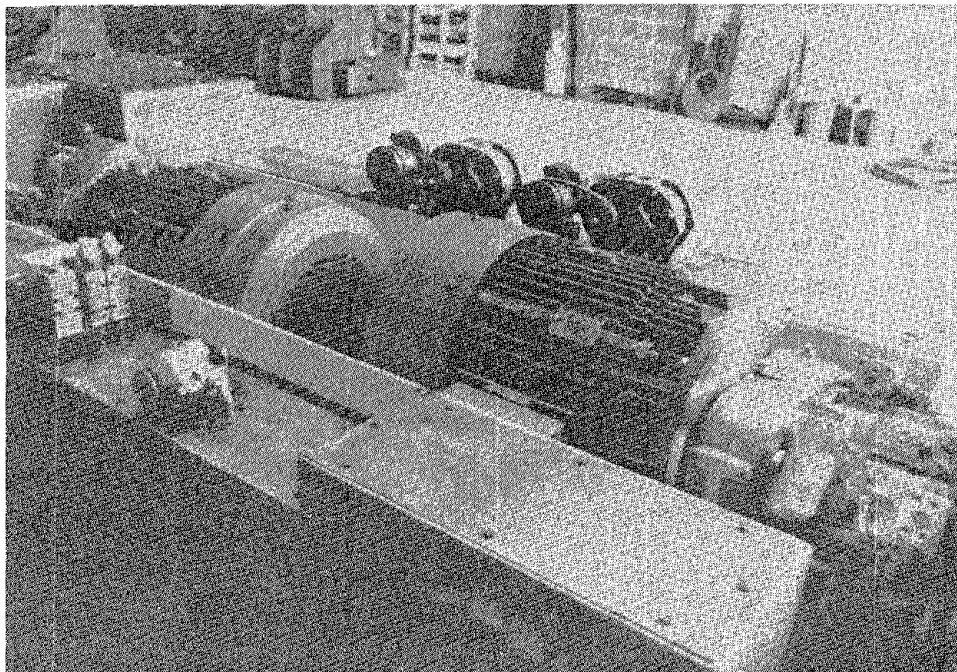
August 1981



August 1981

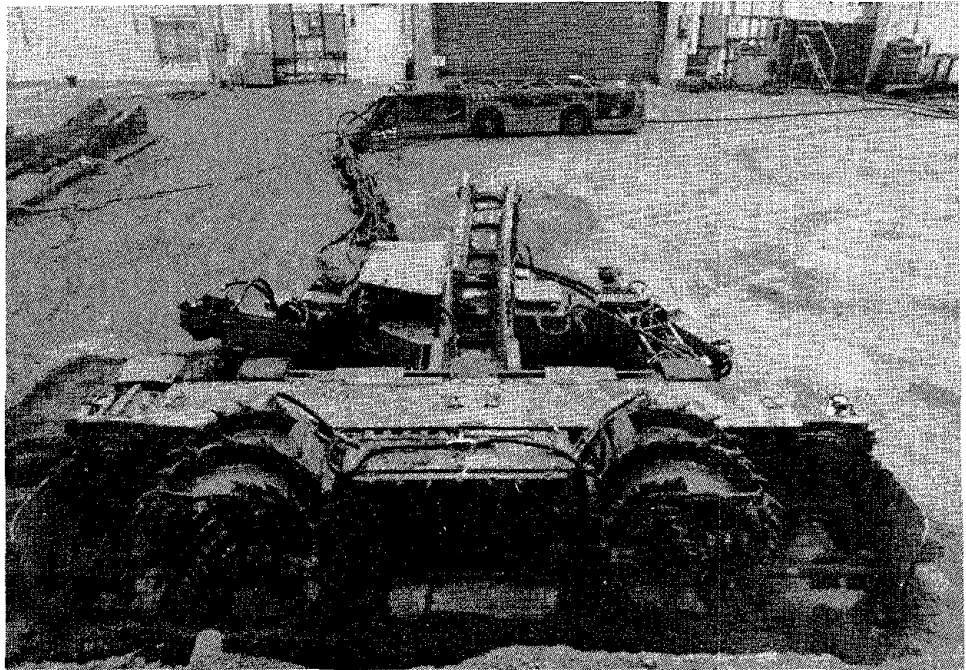


OPERATOR'S PILOT CONTROL VALVES

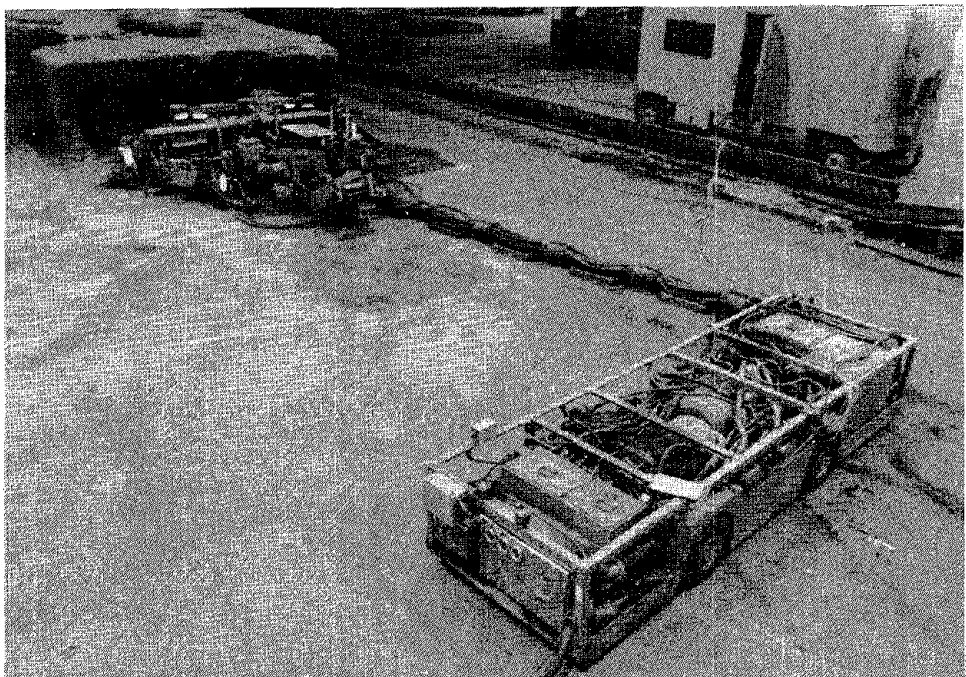


100 Hp MOTORS ON POWER PACK

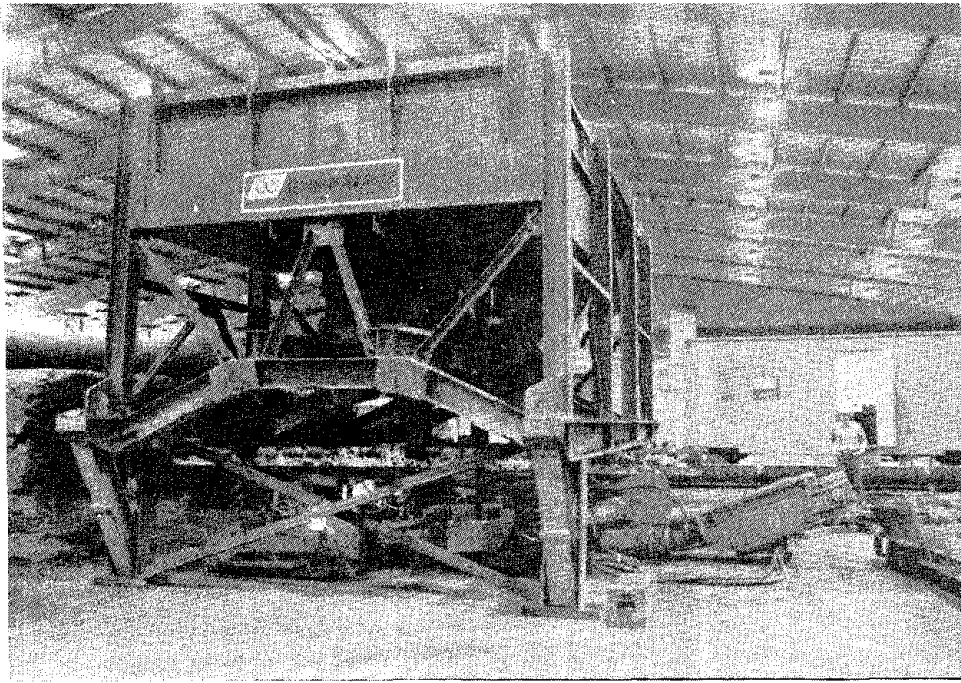
ACME MINER BOLTER
at
Mining Equipment Test Facility
Bruceton, Pennsylvania



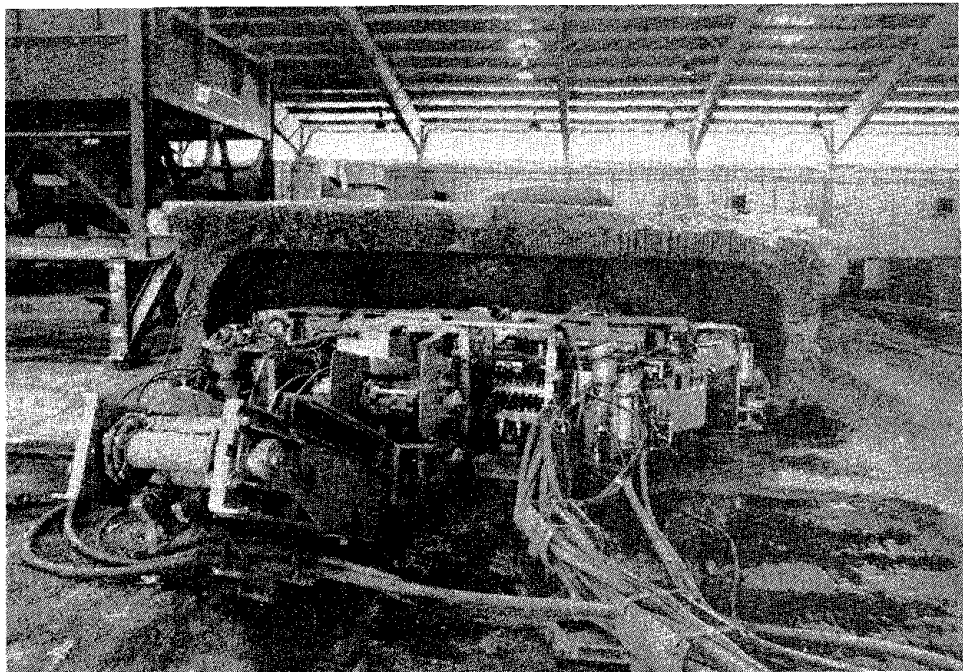
FRONT VIEW OF A.M.B.



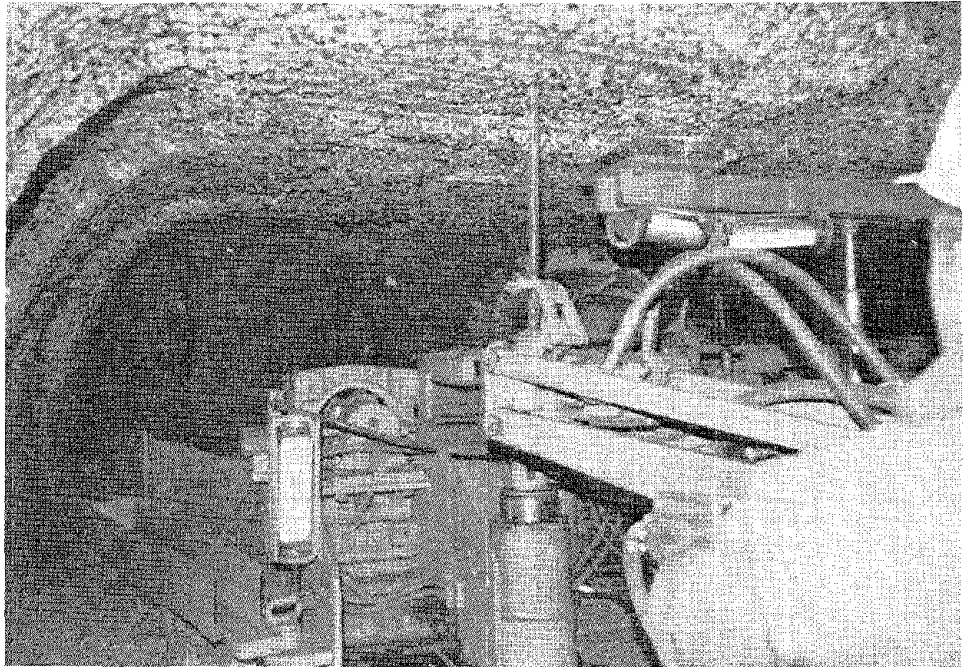
REAR VIEW OF A.M.B.



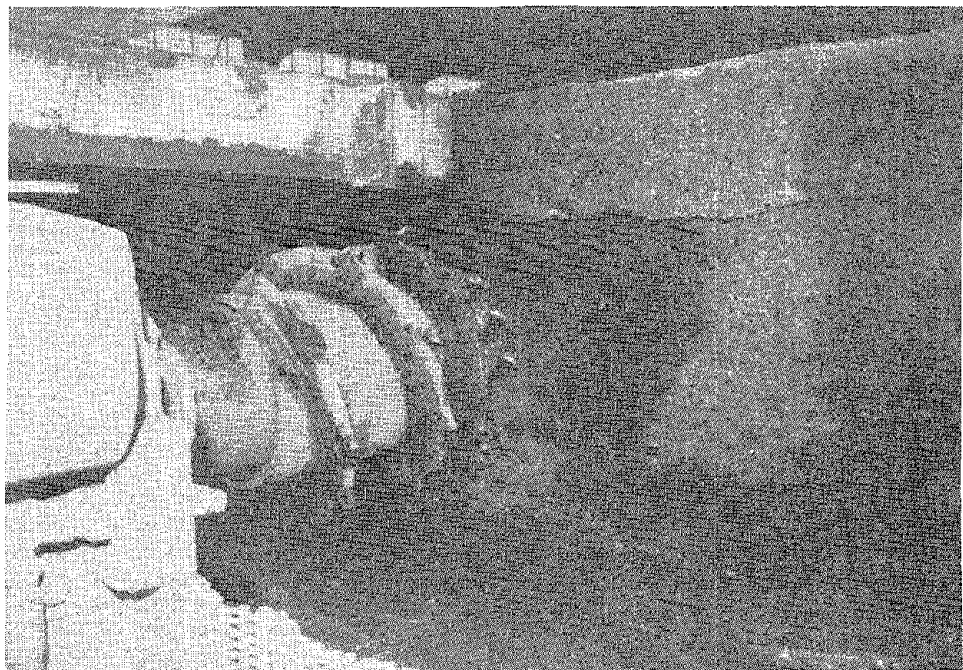
APPARATUS ENGAGED BY REAR CHOCKS
TO SIMULATE MINE ROOF



A.M.B. POSITIONED AT FACE

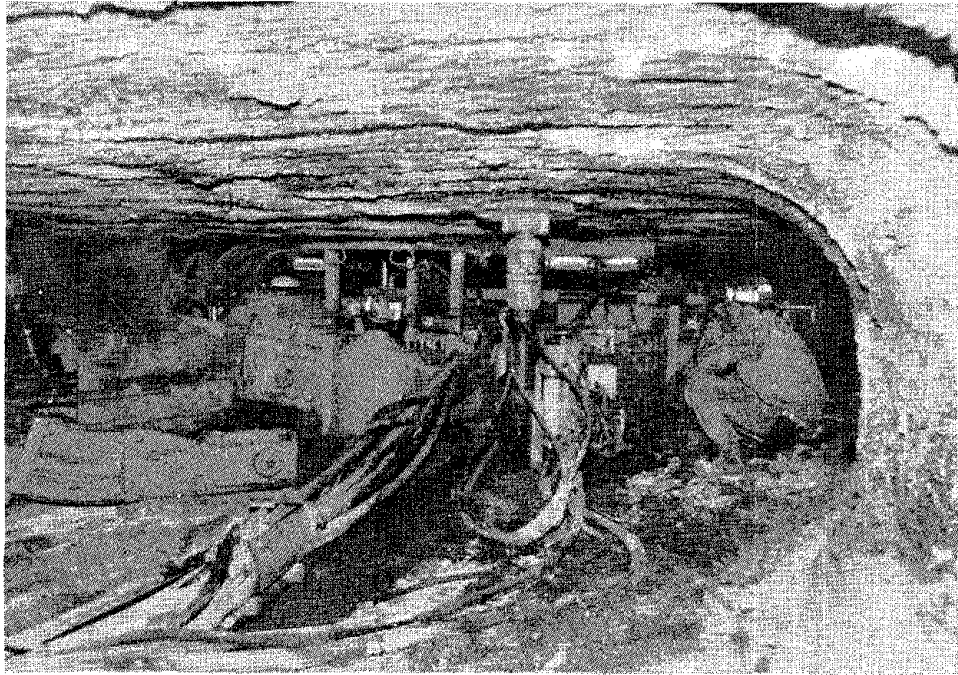


DRILL MODE WITH ROOF ENGAGED BY ATRS

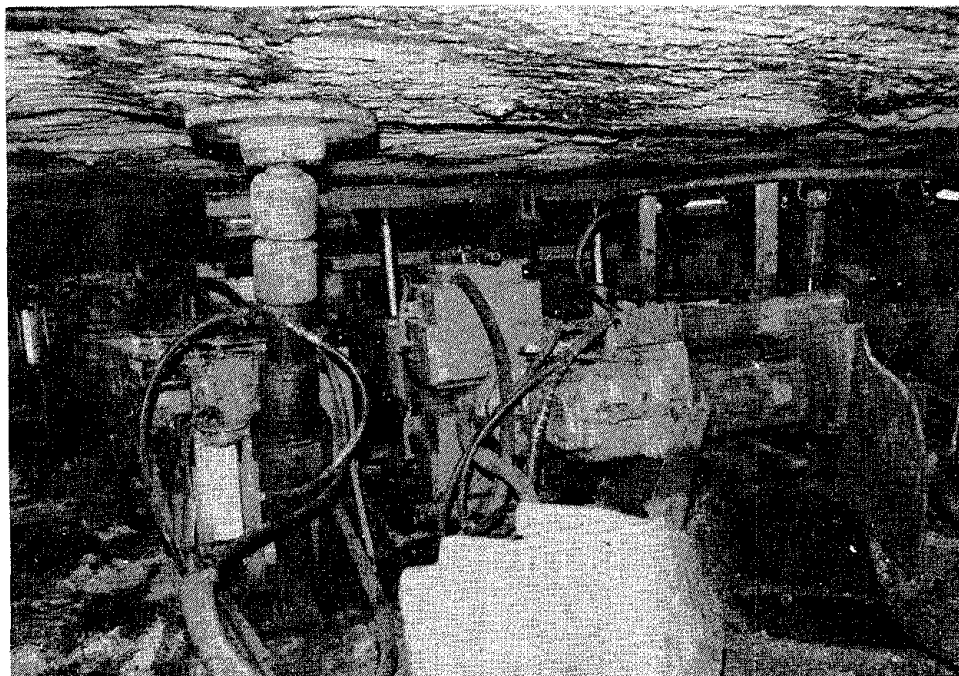


FACE AFTER BEING SHEARED

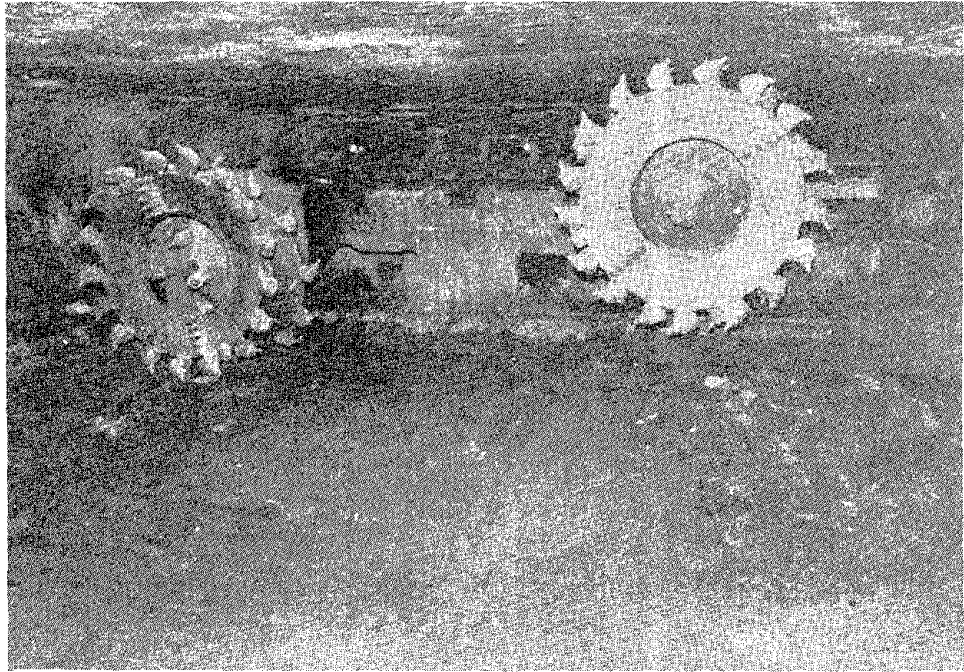
ACME MINER BOLTER
Underground Photographs
R & P Coal Company
Urling No. 3



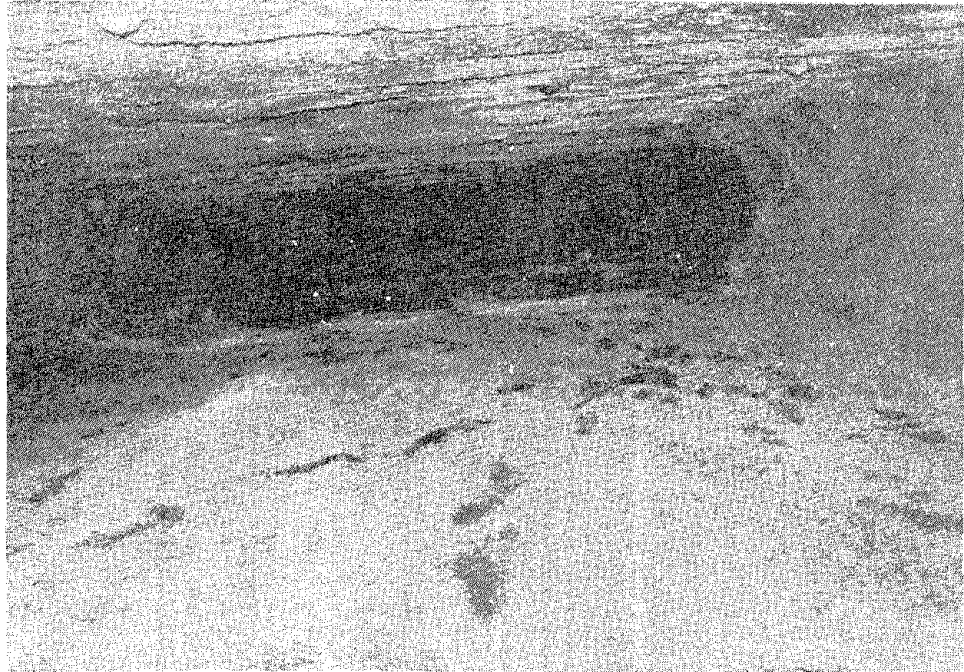
Miner Operator in Cab and Right
Roof Bolter at Drill Station



View of Left Rear Chock and A.T.R.S.
Engaged With Top



A.M.B. RETREATING AFTER COMPLETING
THE FIRST ROOM



FIRST COMPLETED ROOM
Note the smooth floor, roof and rib contours.



RIGHT RAM CYLINDER
ROD END BENT



LEFT RAM CYLINDER
ROD END BROKEN

APPENDIX I

INVENTION DISCLOSURE

INVENTION DISCLOSURE

This is to certify that, to the best of our knowledge, there were no invention disclosures during the life of this contract by parties associated with this contract.

Certain components of the machine may be covered under existing ACME MACHINERY CO. PATENT #79 19 266 JULY 26, 1979

