Bureau of Mines
Report of Investigations 4709

DEVELOPMENT OF A MOBILE COMPRESSOR AND UTILITY STATION

By Fred D. Wright and Homer J. Ballinger

United States Department of the Interior — July 1950

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UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

Work on manuscript completed March 1950. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4709."

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CONTENTS

	Page
Summary	1
Introduction	1
Acknowledgments	2
Construction of the unit	2
Operation of the unit	3
Performance	4

ILLUSTRATIONS

Fig.		Follows page
1.	Mobile compressor station set up for operation	2
2.	Mobile compressor station supplies compressed air to a four-drill jumbo	2
3.	Essential dimensions of mobile compressor station	2
4.	Piping diagram of mobile compressor station	2

1/ Mining engineer, U. S. Bureau of Mines, Rifle, Colo.

SUMMARY

A compressor and utility station, which is believed to be one of the largest mobile units of this type ever constructed, was placed in operation at the Bureau of Mines experimental oil-shale mine near Rifle, Colo., during 1949. This mobile unit mounts two 770-cubic-feet-per-minute air compressors, a 2,500-gallon water tank, and a 200-cubic-foot air receiver. The mobile base of the unit is a 30-ton trailer 30-feet long and 12-feet wide. Prior to the construction of this unit, compressed air was supplied to underground workings through pipe lines connecting with a stationary compressor plant on the surface. The power consumed in supplying compressed air to underground drilling crews was 0.531 kw.-hr. per ton of shale broken. Use of the mobile unit has cut this figure to 0.421 kw.-hr. per ton of shale broken and, more important, has eliminated the cost of installing and maintaining underground air and water lines.

INTRODUCTION

Three thousand feet above the Colorado River, in the Rifle-DeBeque area of western Colorado, the U. S. Department of the Interior, Bureau of Mines, has opened an experimental mine in the rich oil-shale deposits of the Green River formation. This mine was developed for the purpose of demonstrating the most economical methods and practices for mining oil shale on a commercial scale.

The Bureau's oil-shale mine is developed to exploit a series of flat-lying beds 73 feet thick on three levels by room-and-pillar methods. The top 27 feet of the 73-foot bed is being mined as an advance heading, and two benches, each 23 feet high, follow the advance of the top level. The mine is developed on a checkerboard pattern. All openings are 60 feet wide, and pillars for support of the overburden are 60 feet square.

From the beginning of its work on oil shale, the Bureau of Mines recognized that unusually low mining costs must be achieved before an oil-shale enterprise would be commercially successful. As it was anticipated that one of the principal costs in mining the shale would be the cost of drilling blast holes, much of the early work was directed toward the development of suitable drilling equipment. As a result of this early work, a multiple-drill carriage mounting four pneumatic rock drills was designed and fabricated. This multiple-drill carriage or "jumbo" has been in use in the Bureau's mine for about 2 years. Soon after it was put into operation, it became apparent that the available stationary compressor plant did not have adequate capacity to supply the four-drill jumbo efficiently and still provide air needed for other mining operations. An additional source of compressed air was therefore necessary. Past experience had shown that the cost of supplying compressed air to the underground areas through pipe lines

from stationary compressors on the surface was exceedingly high owing to the cost of installing and maintaining the lines. It was decided, therefore, to design and construct a mobile compressor-utility unit that could be towed to the underground working area, thereby eliminating the necessity for installing pipe lines.

This paper, which outlines the development of the mobile compressor unit, is the third in a series of papers on drilling research conducted at the Bureau's experimental oil-shale mine.2/

ACKNOWLEDGMENTS

The preliminary general design of the mobile compressor and utility station was made by engineers of the oil-shale mining section. Engineers of the Winter-Weiss Co. of Denver, Colo., did all of the detail design and constructed the unit on contract with the Bureau. Electrical design and installation were accomplished by the Construction and Maintenance Section of the Bureau's oil-shale plant.

CONSTRUCTION OF THE UNIT

Figure 1 is a photograph of the mobile compressor unit. It consists essentially of two 770-cubic-feet-per-minute air compressors, a 2,500-gallon water tank, and a 200-cubic-foot receiver mounted on a 30-ton trailer. Although quite large, the unit is maneuverable and may be towed from either end by a dozer or heavy truck. Once the unit is in position, it is easy to connect the air and water lines from the jumbo to the near end of the compressor and plug the trail cable into the 2,300-volt mine circuit (fig. 2).

Figure 3 is a drawing of the mobile utility station showing the most important dimensions and the location of compressors, tanks, piping, and valves. The mobile base of the unit is a 30-ton, drop-frame trailer 30 feet long and 12 feet wide. The trailer is equipped with an eight-wheel steering dolly at each end. These dollies have individual air-operated locks, so that the towing dolly can be left free to turn and the traveling dolly can be locked to the trailer. The tow bars provided on each end of the trailer are hinged, so that they may be folded out of the way when not in use. The trailer is equipped with hand-operated air brakes. A pipe guard-rail 42 inches high encloses the trailer platform.

Two Y-type, two-stage, double-acting, model B, class WN-102, size 14-8X7, Joy air compressors are mounted on the gooseneck ends of the trailer. Each compressor has a piston displacement of 930 cubic feet per minute, a rated free-air output of 770 cubic feet per minute, and a maximum operating pressure

2/ Ertl, T., Wagner, J. R., and Burgh, E. E , Development of a Successful Hard-Surfaced Bit for Drilling Oil Shale: Bureau of Mines Report of Investigations 4177, 1948; and Ballinger, H. J., Development of a Successful Multiple Percussion Drill Carriage: Bureau of Mines Report of Investigations 4265, 1950.

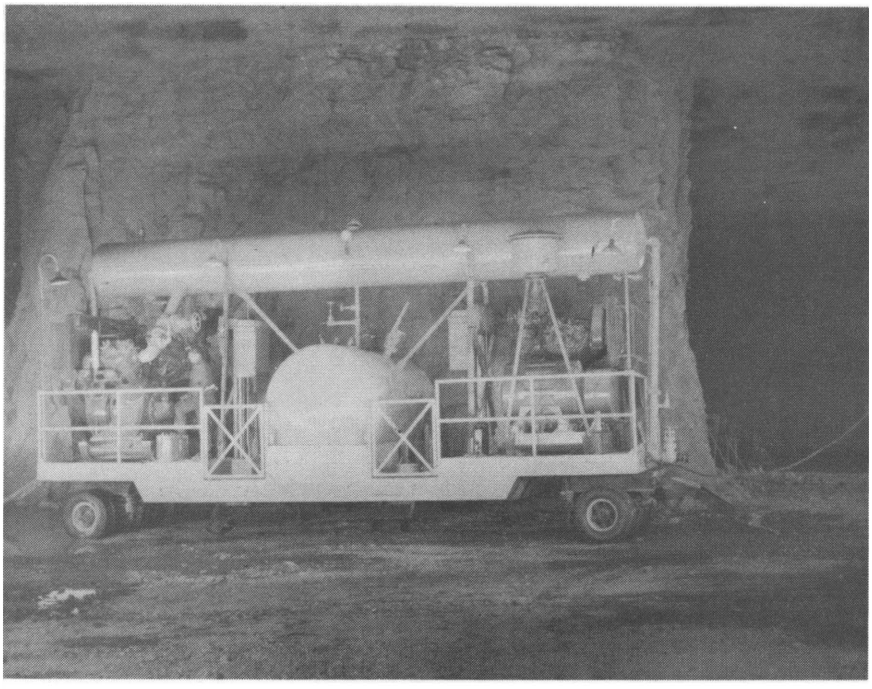


Figure 1. - Mobile compressor station set up for operation.

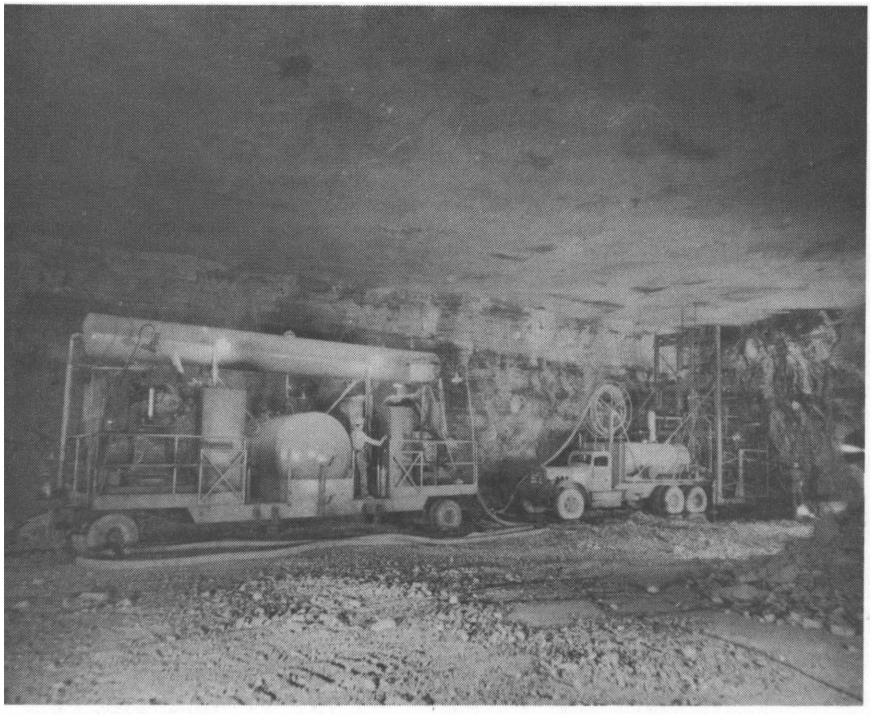
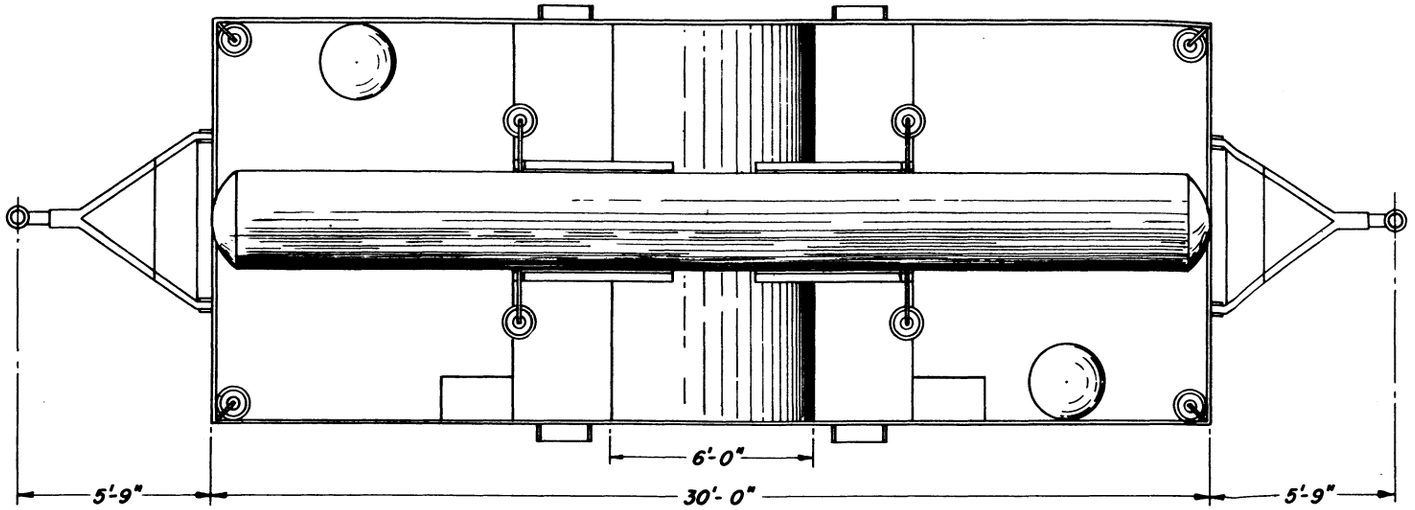
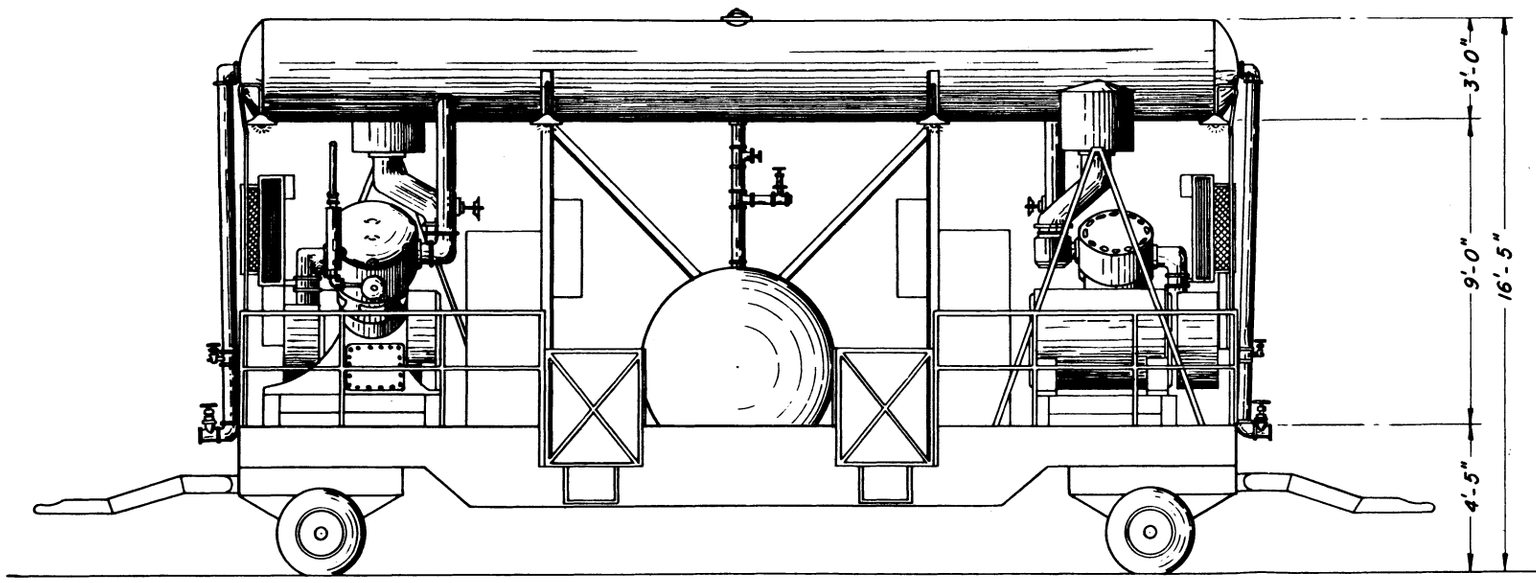


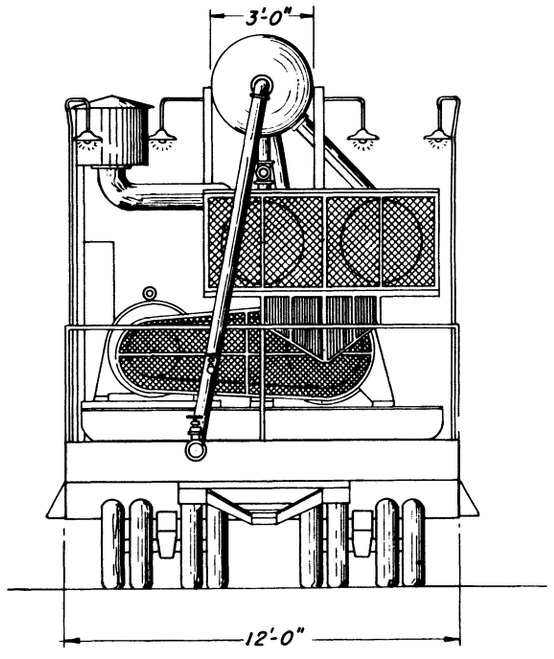
Figure 2. - Mobile utility station supplies compressed air to a four-drill jumbo.



PLAN



SIDE ELEVATION



END ELEVATION

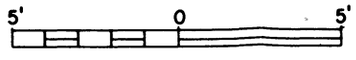


Figure 3.– Essential dimensions of mobile compressor station.

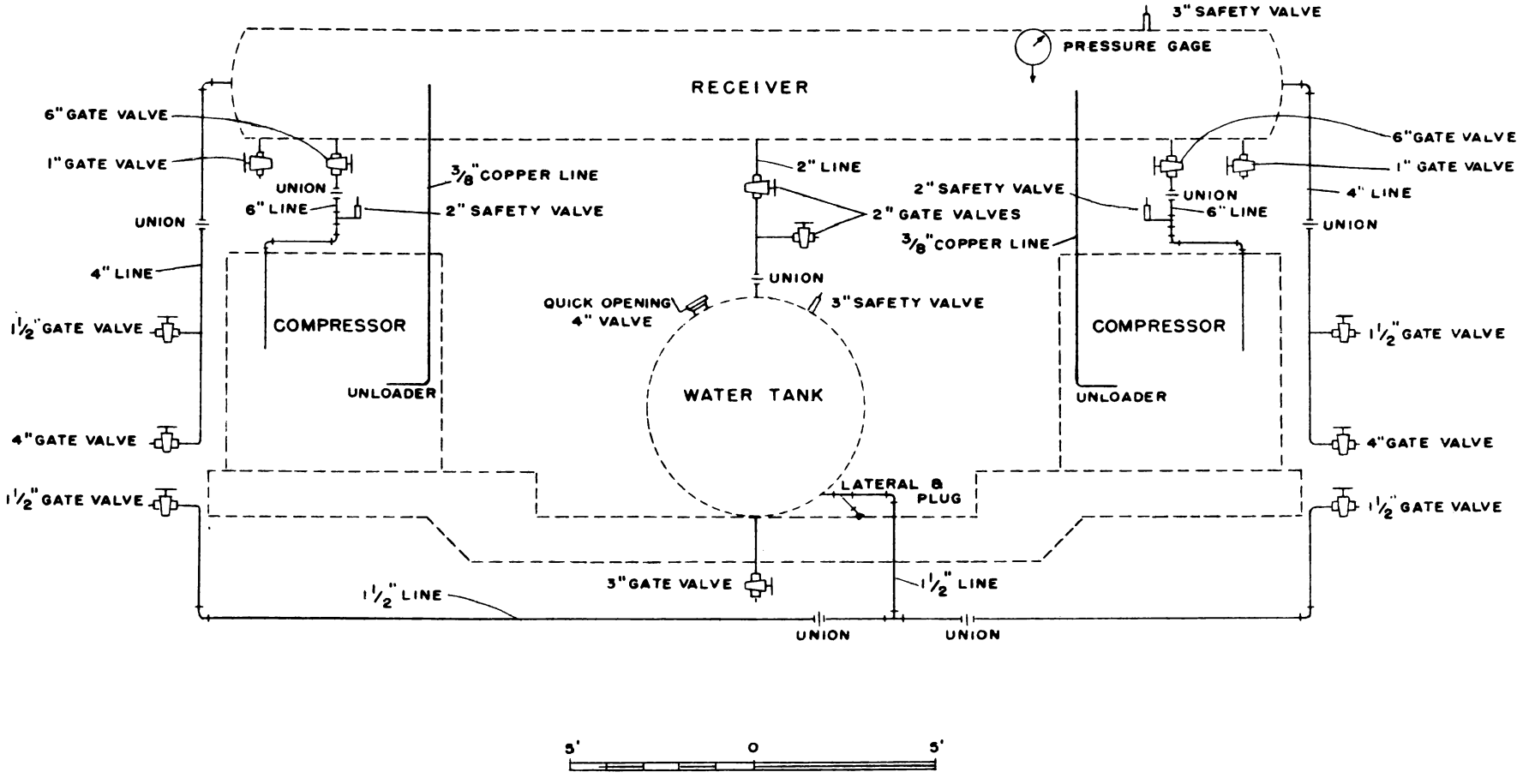


Figure 4. - Piping diagram of mobile compressor station.

of 125 pounds per square inch. Both are equipped with an oil-bath filter and with automatic unloading devices operated by mercury switches. They are water-cooled by a self-contained cooling system with sectionalized radiators. An intercooler is used between the two stages of compression, but no aftercooler is used.

The compressors are driven through V-belt drives by 150-horsepower, 2,300-volt, 3-phase AC, totally enclosed, squirrel-cage induction motors. The circuits for each motor are separately fused and carried to oil-immersed magnetic starting equipment, which provides overload and low-voltage protection. A third circuit is carried through a step-down transformer to provide lighting and convenience outlets.

The trail cable from the unit is a 5,000-volt cable containing three No. 4, shielded, flexible conductors and three ground wires. A 5,000-volt General Electric coupler plug is attached to the end of the trail cable, and coupler sockets are provided at various points in the mine distribution circuit. The plug and socket couple together with a positive interlock in such a manner that the coupler parts cannot be connected or withdrawn while energized. The unit is grounded to the mine grounding system, and the measured resistance between the unit and the ground point is less than one-tenth of one ohm.

A 2,500-gallon water tank for providing drilling water is mounted at the center of the trailer. The tank is 6 feet in diameter and 12 feet long. Mounted over the long axis of the trailer and above the compressors and water tank is an air receiver 30 feet long and 3 feet in diameter. Both the air receiver and the water tank are designed for a 150-p.s.i. safe working pressure. Each has a manhole and drain plugs or blow-off valves to permit periodic cleaning.

Figure 4 is a piping diagram of the unit. The receiver is connected to the compressors with 6-inch pipe and to the top of the water tank with 2-inch pipe. The water is thus under the same pressure as the air in the receiver. One 4-inch air outlet and one 2-inch water outlet are provided at each end of the station. Several additional water and air outlets are provided at convenient places on the station.

Each compressor is guarded by a 2-inch safety valve, and the air receiver and water tank are guarded by 3-inch safety valves set for 125 p.s.i.

OPERATION OF THE UNIT

Immediately after the mobile utility station was placed in operation, temperature readings were taken at various points in the compressed-air system. The mine air had a temperature of 40° F. at the time the readings were taken. Readings taken at the 4-inch gate valve, where the tunnel have to the multiple-drill carriage was connected, showed that the temperature of the compressed air was 100° F. with the compressors idling and a maximum of 170° F. when all the drills on the multiple-drill carriage were operating. The 4-inch tunnel hose has a temperature resistance of 275° F.; so there is a large safety factor in this respect. The temperature of the compressed air at the intake to the drills reached 100° F. within a few minutes of operation, and attained a maximum of

105° F. at the end of the drilling shift. The temperature difference between the air entering the compressors and the compressed air entering the drills was therefore about 60° F. This difference in temperature corresponds to a 12-percent increase in the effective capacity of the compressed-air system over the rated capacity of the compressors. Because they are operated close enough to the drills so that the heat energy in the compressed air is not completely dissipated in long pipe lines, the mobile compressors have an effective capacity equivalent to a 1,725-c.f.m. stationary compressor.

Placing the unit in operation is simple. It is towed into place with a tractor, leveled up with two jacks on the low side if necessary; the trail cable is plugged into a receptacle; the power is switched on; and the compressors are ready to operate. The compressors are operated by Warren G. Ramsey, mine maintenanceman, whose responsibilities include the maintenance of all underground drilling equipment as well as operation of the compressor station.

PERFORMANCE

The mobile utility station has been in operation for over a year and has proved to be a very satisfactory piece of equipment. No difficulties have been encountered in operating the unit and, in some respects, the performance is better than had been anticipated. A portable unit of this type has several advantages that cannot be obtained through the use of stationary compressors and connecting pipe lines. Some of these are as follows:

1. An adequate air supply at constant pressure is assured.

2. The cost of installing and maintaining air and water lines is eliminated.

3. The problem of having to tear out and replace air and water lines as mining progresses on different levels also is eliminated.

4. Losses in efficiency of the compressed-air system due to leaks and friction in pipe lines are minimized.

5. The effective capacity of the compressors is increased by about 12 percent, because the compressed air is used before all of its heat energy is dissipated.