Mechanization in Roomwork at Borth Mine

Helmut Geyer
Deutsche Solvay-Werke GmbH,
Zweigniederlassung Borth,
4131 Borth Ü. Moers
Federal Republic of Germany

ABSTRACT

In the rock salt mine Borth (W.-Germany) the underground working has been mechanized by:

1. *Changing the mining method*
2. *Working with gadding-cars*
3. *Using ANC-explosive*
4. *Inset of scoop trams*
5. *Working with cable-shovels, practicable crushing plants and belt conveyors.*

The measures (1—3) resulted in the increasing of the out-put in drilling and blasting from 70 to 212 tons per man-shift.

The measures (4—5) gave an increasing of the average out-put in loading from 173,5 to 737 tons per shift. By this mechanization and concentration the out-put per man-shift of all miners underground had an increasing from 10,8 to 27,6 tons per man-shift.

Short description of the previous mining method.

The rock salt mine Borth is situated in Western Germany near the border of the Netherlands. The mine is owned by Messrs. Solvay & Cie in Brussels.

The mine works rock salt in flat measures at a depth of 2,836 ft. in the Permian Limestone (Zechstein 1) in 65.6 ft. wide rooms by a system called "roomwork." The rock salt is very strong. Yet, numerous roof bolts must be set to secure the roofs in the entries and in the haulage roads. The output of rock salt amounts at present to 13,000 tons* daily. Until a few years ago, mining operations were carried out in four phases (Fig. 1). After driving an entry with an area of 43 sq. ft. in the longitudinal axis of the planned room as an airway, the 492 ft. long room was worked in four successive slices starting from the roadway upwards. Rotary drilling machines and scrapers are standard equipment. The scrapers discharged the salt into mine cars which were wound by ropeways and blindshafts to the haulage level.

In order to improve the efficiency of mining operations and to increase production, the entire mining and haulage operations were gradually concentrated and mechanized.

The subject of this paper is the mechanization of our roomwork.

The present mining method and a description of the mining scheme.

Time schedule of the individual mining phases (Fig. 2).

The individual rooms are now worked in a length of 1,148 ft. The haulage road is equipped with conveyor belts. In phase I_1, the entry between haulage road and airway, beginning from the front mouth of the room, is widened to 29.5 ft. and to a height of 16.4 ft. for a length of 1,148 ft. In phase I_2, beginning with the rear end of the room, the definite width of the room of 65.6 ft. is obtained by rounds of shots drilled with an angle of 44.5^g from the 29.5 ft. wide entry. In a distance of 100 to 130 ft. behind the diagonal face to widen the room, the upper slice from 16.4 to 55.8 ft. height is worked, at the same time, in phase II_1 by boreholes drilled upwards at an angle of 44.5^g (Fig. 3). After termination of phase II_1, i.e., after the

* short tons.

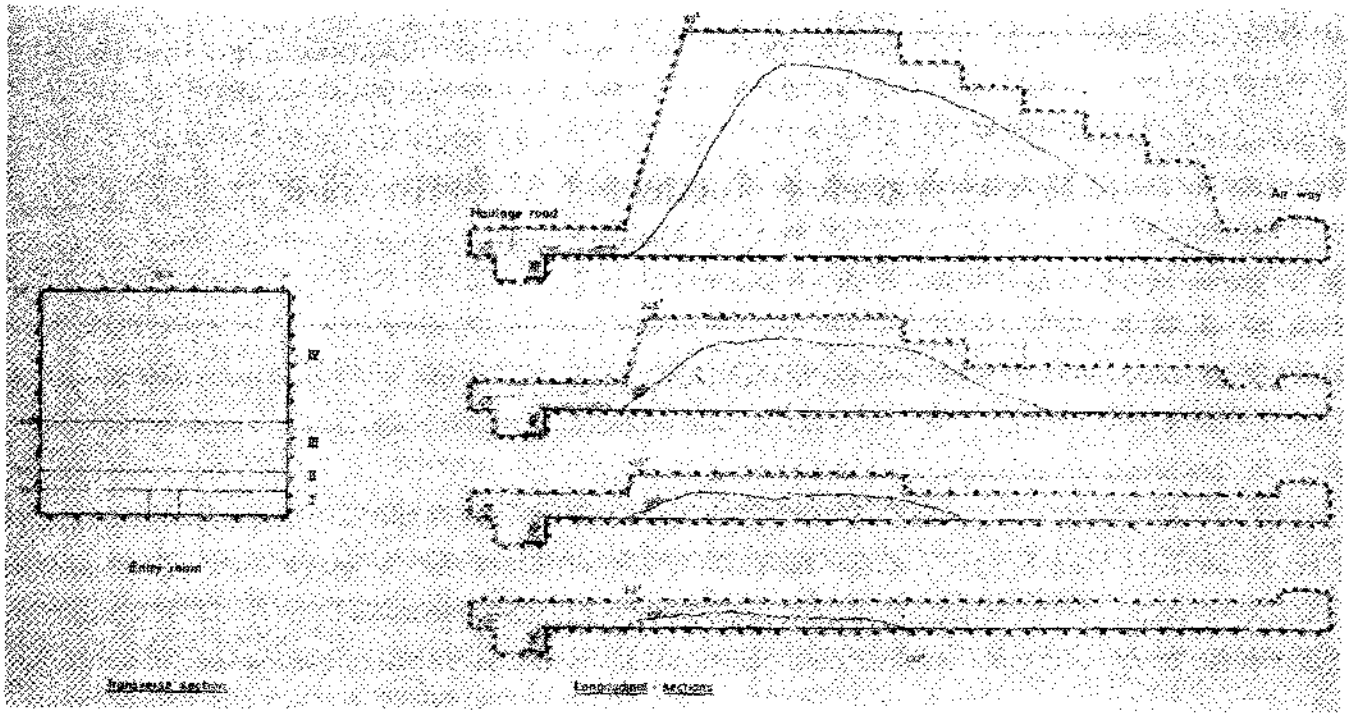

Figure 1. Previous mining method.

upper slice has been worked on the entire length of 1,148 ft., the roof has to be supported and secured by bolts which is done in phase II_2.

Drilling work.

The entire drilling work is done by one-jib electro-hydraulic drill cars on caterpillars (Figs. 4 and 5). 5.6 ft. long spiral drill rods are used, which can be extended by screw joints in order to drill boreholes up to 72 ft. long.

By conversion to a new mining method in connection with the increase in borehole diameter from 1.42 inches to 2.36 inches, the average drilling effect was increased from 51 cu. yds to 159 cu. yds of rock salt per drilled foot. On the average of the three salt getting phases described above, 580 tons of rock salt per shift could be drilled with one drill car.

Blasting work.

Anfo explosives are used, 50% of the ammonium nitrate being pelletized and 50% ground in order to prevent the explosives from gliding out of the boreholes drilled at an angle of 44.5°.

40 gal.-capacity compressed air loading devices serve to charge the blastholes with explosives which are blown into the boreholes through a loading hose (Fig. 6).

In the future loading devices with a capacity of 400 gal. and mounted on Diesel cars will be used.

Figure 7 shows explosives being blown into boreholes from hydraulic working platforms placed on Diesel cars. The blasts in the upper slice produce 4,850 tons of rock salt per round of shots.

Comparison of outputs and efficiency.

Compared with the previous method, the new one has the following advantages in drilling and blasting:

1. the number of slices is reduced from 4 to 2,
2. the salt output is improved by increasing the quantities of rock salt per round,
3. the change to large boreholes by using drill cars leads to higher drilling outputs and wider distances between boreholes,

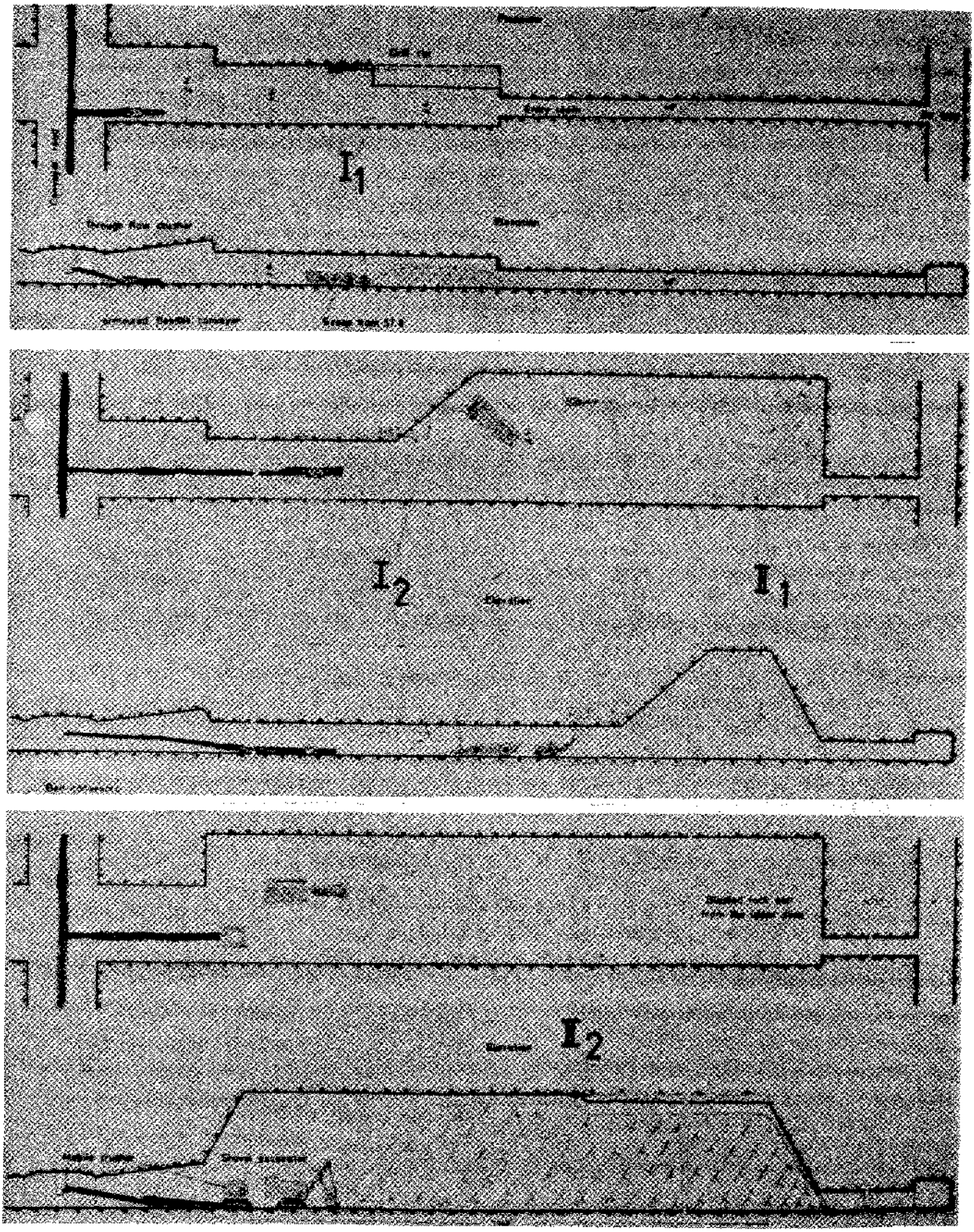

Figure 2. Present mining method.

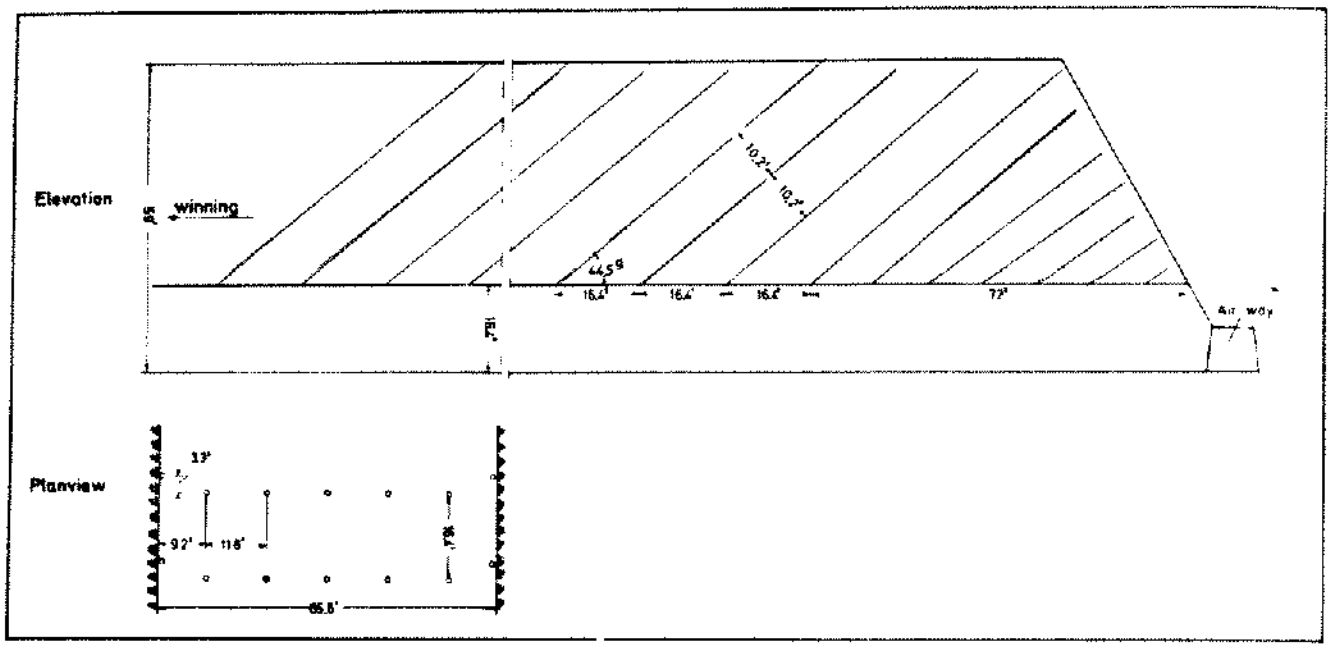

Figure 3. Arrangement of inclined boreholes in the upper slice.

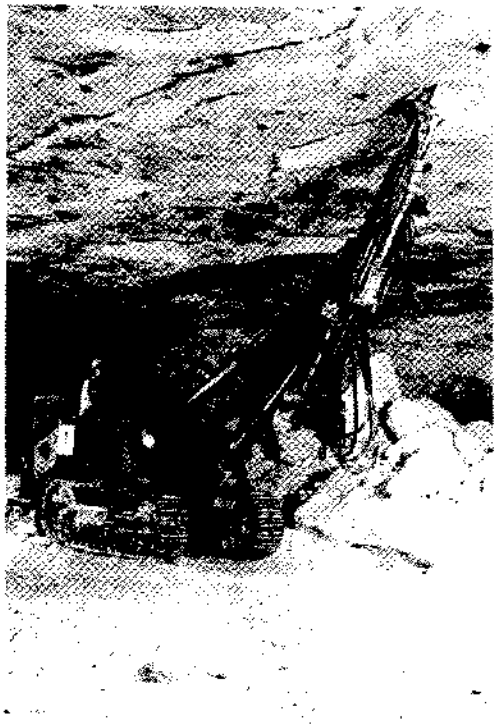

Figure 4. Drill car, type Secoma.

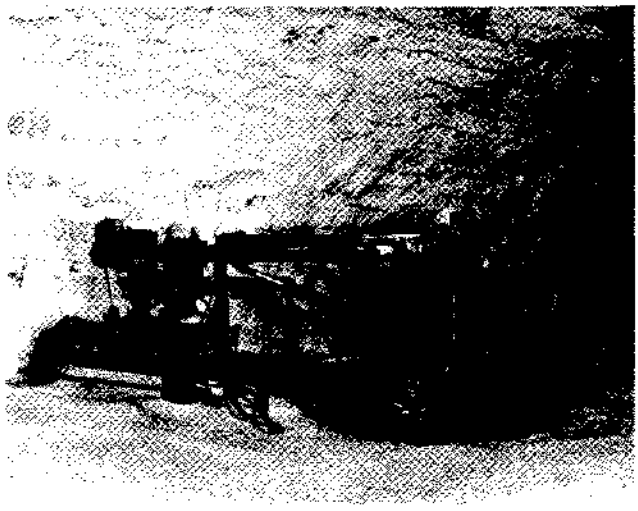

Figure 5. Drill car, type Hausherr.

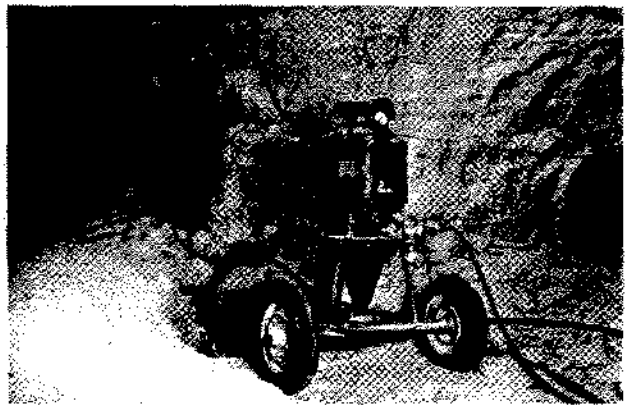

Figure 6. C.a. loading device for Anfo-explosives.

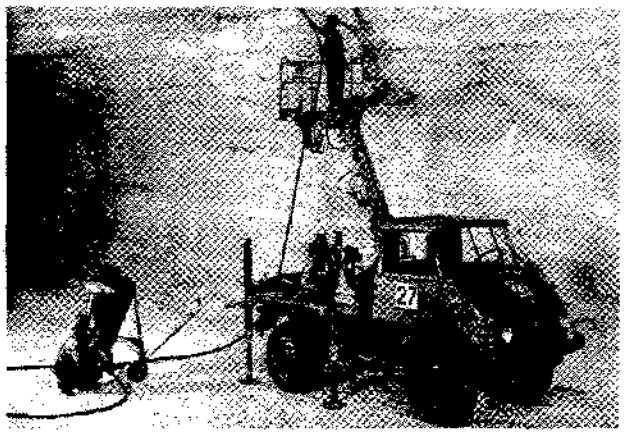

Figure 7. Unimog car with hydraulic working platforms.

4. elimination of the undercutting of the floor employed with the previous method,
5. rapid charging of the boreholes thanks to the use of Anfo-explosives.

Due to these advantages, the output per man/shift in drilling and blasting increased from 76 to 236 tons, i.e, by 200% as against the previous method.

Loading and conveying.

Use of ST8 scoop trams in connection with through-flow crushers and armored flexible conveyors.

Diesel-driven scoop trams ST8 are used for loading the blasting rock salt in the lower slice up to 16.4 ft. height, (Fig. 8).

This scoop loader has an engine section and a working section, both equipped with rubber-tired

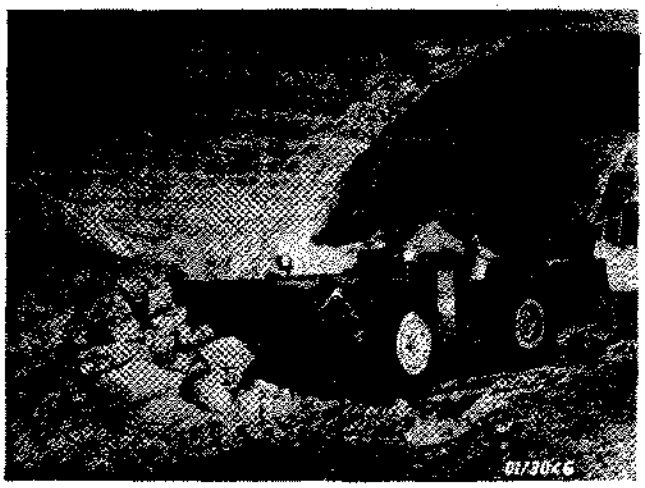

Figure 8. ST8 scoop tram.

wheels. Both sections are connected by an articulated coupling. The front bucket has a capacity of 7.2 cu. yds, i.e., about 7.7 tons of rock salt. Trials with a still larger scoop tram with a 11 tons capacity scoop are planned.

The ST8 scoop trams discharge the filled bucket to a station comprising of an armored flexible conveyor with a through-flow crusher (Fig. 9). This station is positioned in the room. The broken salt is transferred to belt conveyors. The use of ST8 scoop trams caused, with average traveling distances up to 660 ft., an increase of loading outputs from 145 tons per shift to 495 tons per shift, i.e., by 240% against the loading by scrapers in the lowest slice. Figure 10 shows the loading outputs of the scoop trams as a function of their average traveling distance.

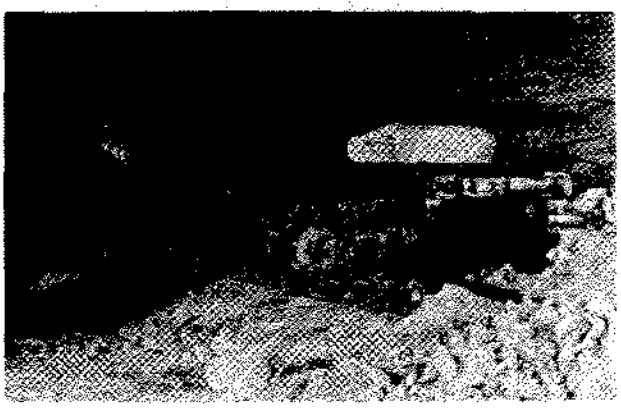

Figure 9. Armored flexible conveyor with through-flow crusher.

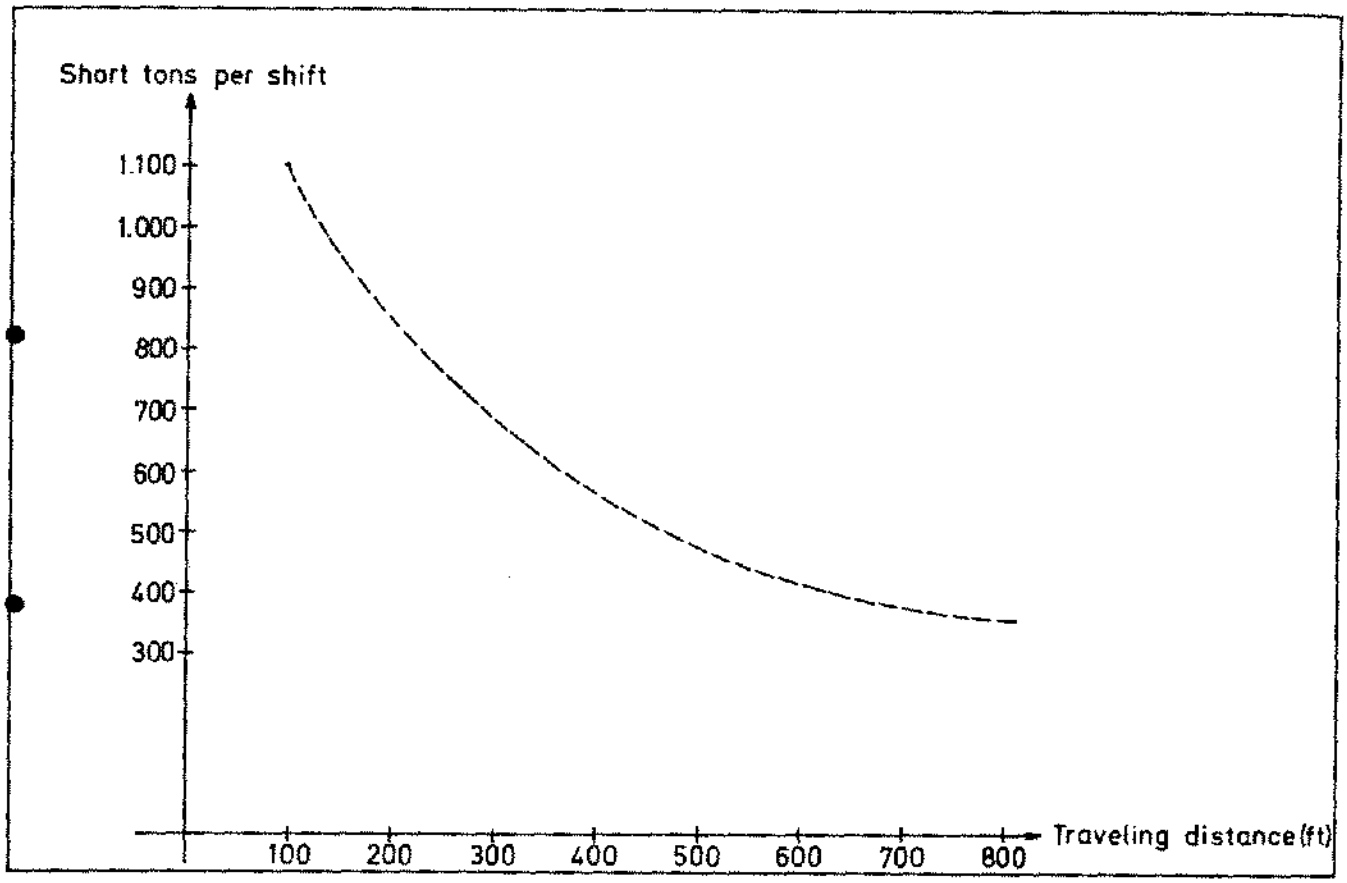

Figure 10. Loading output of scoop tram ST8 as a function of its traveling distance.

Use of shovel excavators in connection with mobile crushers and conveyor belts in rooms.

Electrically driven shovel excavators with 1.44 cu. yds and 1.96 cu. yds bucket capacity are used for loading the 52.5 ft. high blasted rock salt of the upper slice (Fig. 11). The excavator discharges the goods to a mobile crusher on caterpillars built by Humboldt (Fig. 12) which won the "Blue Ribbon" in the International Competition organized by the journal "Mining World."

The crusher has been designed as a one-roll crusher with a crushing roll 5.2 ft. in width and 3.3 ft. in diameter. It runs with a surface speed of 10.2 ft./s. The salt crushed to <0.66 ft. is taken up by an armored flexible conveyor provided below the crushing roll and is then discharged by same to a conveyor belt (Fig. 13). This conveyor belt is 2.6 ft. wide. The PVC-belts have two parts: a permanent and extensible main belt and a 98 ft. long

Figure 11. A shovel excavator M 90 with mobile crusher.

so-called "rider belt" resting by wheels on the structure of the main belt and on the floor. The mobile crusher and the "rider belt" can be

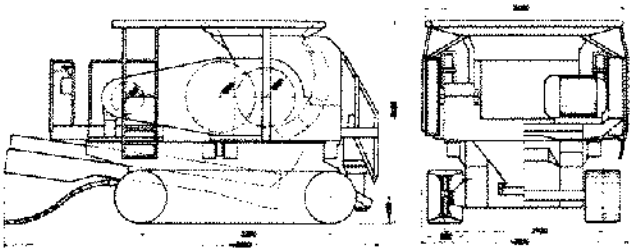

Figure 12. Mobile rock salt crusher.

advanced together if excavator operations so require. The main belt is extended again in regular distances. The belt conveyors in the individual rooms discharge the broken salt to main haulage belts installed for a length of 2.5 miles to a bunker in the pit bottom.

From this bunker, an efficient skip winds the product to the surface.

Comparison of outputs and efficiencies.

The use of shovel excavators, mobile crushers, and conveyor belts for the broken salt from the 16.4 ft. to 55.8 ft. high upper slice made the mining operation much more efficient. Outputs of 935 tons per shift were reached with the excavator with the 1.44 cu. yd bucket and outputs of 1,375 tons per shift with the excavator with the 1.96 cu. yd bucket, compared with the previous average loading output of only 240 tons per shift. Figure 14 compares the loading outputs, on the one hand, by means of scrapers and, on the other, by means of ST8 scoop trams and shovel excavators. The average output per shift and per working point is today with 825 tons by 325% higher than the previous output with 194 tons when scrapers were still used.

Figure 13. Shovel excavator M 154 with mobile crusher and belt conveyor in room.

Summary.

In the roomwork system of the rock salt mine Borth, the output per man/shift was increased by 200% by changing the previous mining method and by mechanizing the drilling and blasting work. By change-over to mechanized loading, a step-up in outputs by 325% was reached. By concentration and mechanization of the entire salt winning and conveying operations, the output in these sectors was increased from 23 tons to 60 tons per man/shift.

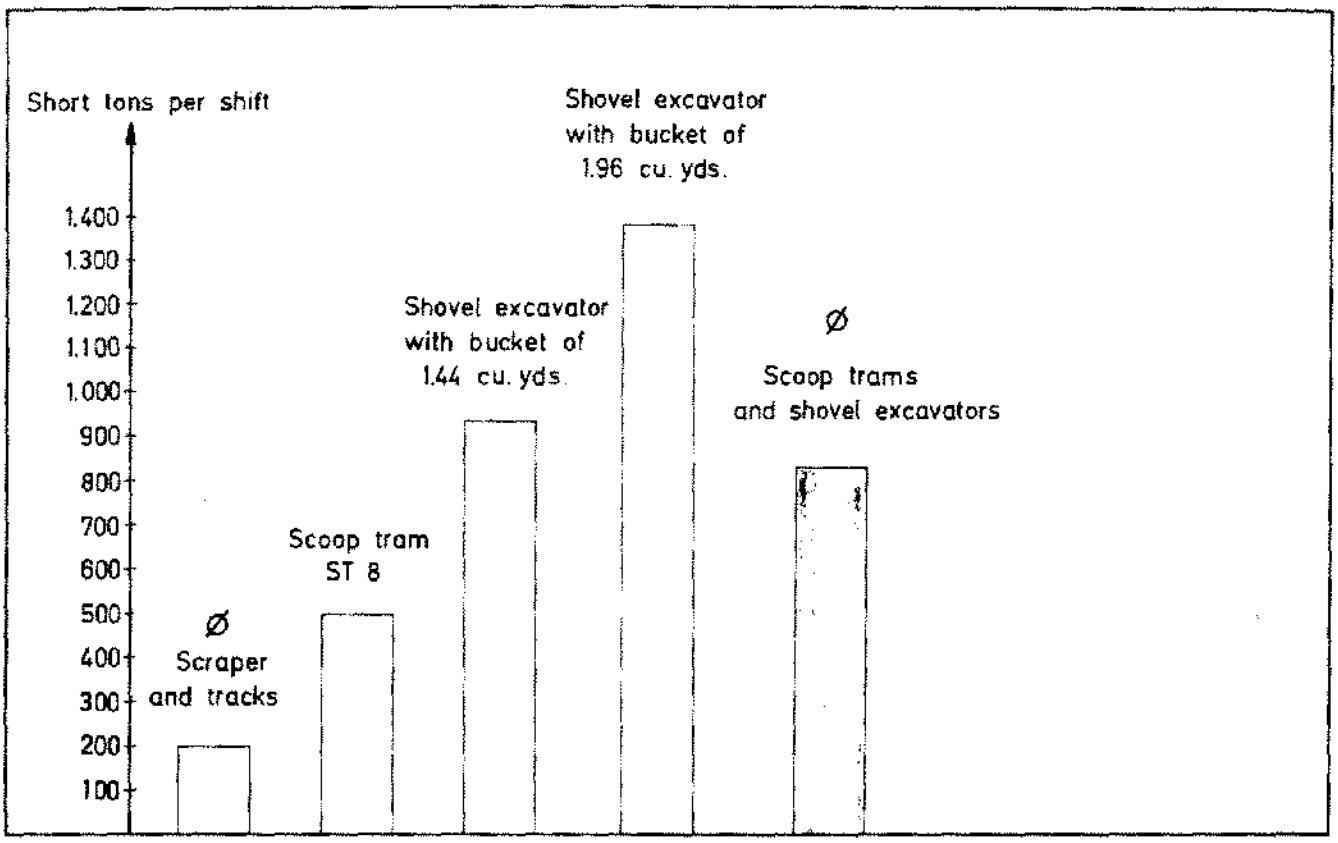

Figure 14. Comparison between old and new loading method.