The Development of Special Roof Bolting Machines at the Goderich Mine of Sifto Salt Division—Domtar Chemicals Limited

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ABSTRACT

This paper deals with the development of roof bolting machines at the Goderich Mine of the Sifto Salt Division of Domtar Chemicals Limited.

Details of the progressive steps taken in the design and building of a self-propelled, self-contained roof-bolter capable of placing bolts in a 40-45 foot high back are given.

Two of these machines are presently in use. One suitable for placing bolts up to, and including six feet in length, the other capable of placing bolts up to, and including fourteen feet in length. Both machines are designed to require only one operation.

INTRODUCTION

The mine of Domtar Chemicals Limited, Sifto Salt Division, is located within the town of Goderich, in the Province of Ontario, Canada. It is bounded by water on three sides, the mouth of the Maitland River to the north, the entrance to Goderich Harbour to the south and Lake Huron to the west.

Officially, the mine opened in November of 1959 continuing and adding to, one of Canada's oldest salt producing centres. The deposits were first discovered almost one hundred years previously while drilling for oil. Since that time many companies have produced salt from wells drilled in the top salt deposit but today only one evaporating operation remains and this is owned by Domtar Chemicals and has been recently modernized and enlarged.

In the early days of the discovery of the deposit an attempt was made to sink a shaft but it had to be abandoned as no means were then available to control the large quantities of water which were encountered.

Access to the mine is available from two circular concrete-lined shafts each 16 feet in diameter and both penetrate the working level at 1,760 feet below surface.

Each shaft is equipped with a hoist and each has a ladderway for emergency use.

The production shaft contains two 12 ton capacity combination skip cages in balance which are hoisted by a 12 foot diameter, double-drum hoist, at a maximum speed of 1500 feet per minute. The skips run in conventional wood guides and the hoisting capacity is 350 tons per hour. In the near future this will increase to approximately 500 tons per hour and the cycle will be arranged to be on semi-automatic control.

The service shaft contains a cage and counterweight and is powered by a 6 foot diameter friction hoist. The cage and counterweight run on guide ropes which give a very smooth ride and the hoisting cycle is fully automatic. The capacity of the cage is 36 men or a material load of 8000 pounds.

Mining follows the conventional room and pillar method with sixty feet wide by forty to forty-five feet high rooms and two hundred and ten feet square pillars. This is an extraction of forty percent, yielding about 1,800 tons for each ten foot round.

All crushing and screening operations are conducted underground although additional screening capacity is available on surface when required.

The salt backs were not as stable as in most salt mines and after several large falls had occurred a roof bolting program was put into effect to try to eliminate this hazard.

DISCUSSION

Roof bolting in a mining operation is far from unusual and manufacturers of roof bolting machines for use in coal mining and low headroom operations are many. When the bolting involves 40-50 foot high backs, the story is quite different.

We, at the Goderich Mine of Sifto Salt, found that the solution to this problem was to design our own roof bolter using available equipment as far as possible, and adapting it to our own conditions.

As may be expected, and due to changing conditions, the development of the machines followed, what we believe to be, a logical progression.

Early in 1962 a decision was made to start roof bolting in an effort to overcome poor back conditions and to reduce repetitive scaling which occupied a high percentage of the work force.

Because we were already using the "Trump Giraffe," ariel platforms for scaling and loading, this seemed to be a suitable base machine for the roof bolting operation. A conventional pneumatic stoper and air leg were placed on the giraffe platform to drill the holes and tighten the bolts.

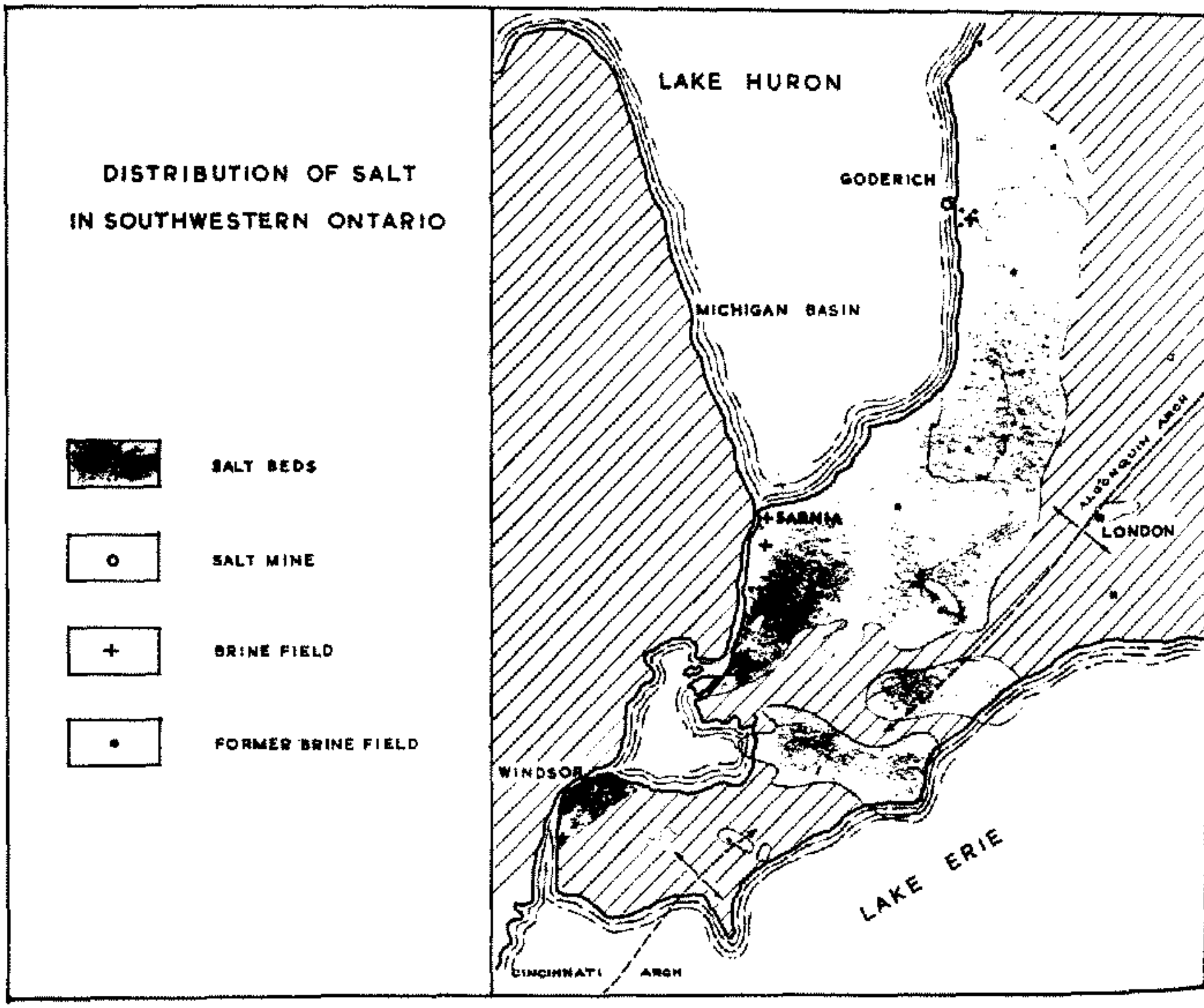

Figure 1. Distribution of salt in southwestern Ontario.

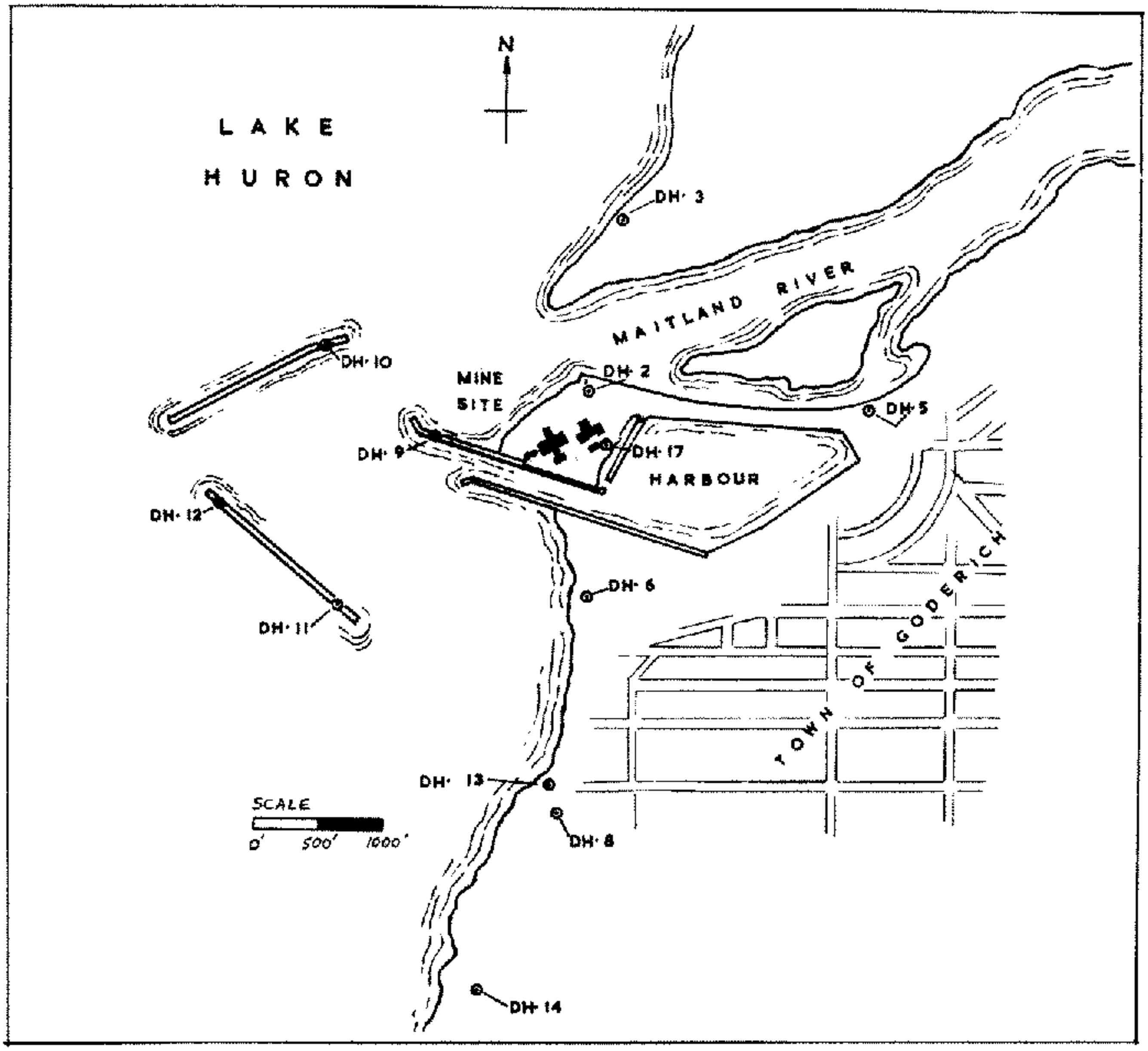

Figure 2.

This was a simple and rapid solution to the problem of placing bolts in a back which averaged forty-three feet above the floor, as all the necessary equipment was already available.

The arrangement was capable of installing the bolts, but after some months of operation it became obvious that there were some serious disadvantages inherent in the system and each one of them was a high cost factor in the operation.

In the first place, it required two men to handle the stoper and air leg to install 30-40 five foot bolts per shift. The continual hammering of the stoper on the giraffe was creating structural problems in the booms and turntables, and this was reflected in high maintenance costs.

The air requirement for the stoper was supplied from an electrically driven 100 psi, 300 cfm portable air compressor. This made an additional piece of equipment to be moved and especially, if some rebolting was required in an area not being actively mined, the supply of electric power posed some problems and extra expense.

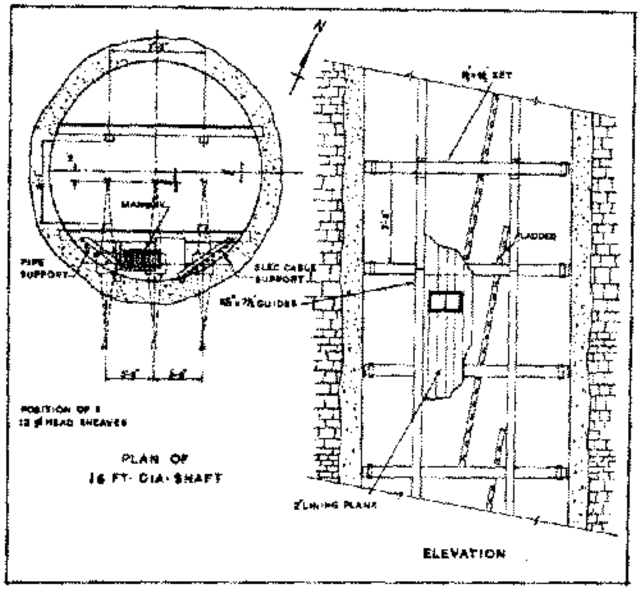

Figure 3.

Finally, as we all know, percussion drilling of salt is not very efficient when compared with using an auger-type rotary drill.

These observations gave us the guidelines for our next roof bolting machine.

1. To be operated by one man.
2. To be a self-contained unit.
3. To have an auger-type drill.

About this time one of the mining equipment companies introduced a semi-automatic, pneumatically-operated roof bolter. This machine had an auger drill, with an in-line magazine, containing ten bolts and was as previously stated, air-operated. The machine appeared to meet the requirements of one-man operation and have an auger drill, but it had to be mounted on a vehicle which would allow us to take the drill up to the high back.

An Austin-Weston Model 409 hydraulic crane, used during the installation of the underground crushing and screening plant and, subsequently, but not too successfully, used as a roof scaler, was available for this purpose.

The semi-automatic bolter and crane were assembled and the necessary compressed air for the unit supplied from the air compressor formerly used with the stoper-giraffe combination. The operations of the crane boom being supplied hydraulically as it was when used as a crane, gave us a one-man operation from floor level and it was planned that a hydraulically or diesel driven air compressor could be mounted on the crane unit should the tests prove successful. We would then have a self-contained roof bolter suitable for one-man operation and not dependent upon an electric power supply.

Unfortunately, the bolting machine had several serious built-in problems. The piston-type air motor on the drill unit did not provide sufficient torque for efficient drilling and was very susceptible to the corrosive effects of water and salt dust in the air supply. The bolt magazine contained a number of small spring loaded pawls which were also subject to corrosion and caused malfunction of the bolt feeding sequence. In addition, time was wasted in lowering the machine to refill the magazine with bolts and the operator, being at ground level, had some problem in locating the drill.

For short periods the performance of the bolter was very encouraging but over the testing period it required far too much maintenance to be considered a production machine. The manufacturer was requested to supply a hydraulic motor for drilling and a means of lubrication for the pawls and springs in the magazine. It appeared that the field of hydraulics was beyond their normal scope and, consequently, we were reluctantly obliged to discontinue our tests and return the machine.

Our enquiries then led us into the field of existing hydraulic bolters of the type used in coal mining which would require us to put a man up with the bolting machine. We finally settled on a bolter manufactured by The J.H. Fletcher Company which was suitable for drilling a 1-5/8 inch in diameter, six foot long hole.

To accommodate this bolter we designed a structure to mount on the boom of our crane which would carry the bolter, operator and a supply of five foot roof bolts. The original crane hydraulic pump was replaced with a tandem pump rated at 35 gpm and 10 gpm: the large volume section of the pump being used to supply the drill motor while the small volume section was to position the crane boom and drill, as well as the operator's basket, at a safe smooth speed and with a minimum amount of jerkiness which may have alarmed the operator.

We again had a machine which was self-contained, self-propelled and operated by one man.

The operator can place four rows of 5/8 inch dia. X 5 foot long bolts, at 5 foot centres, across half the width of the 60 foot room without descending from the basket. The placing of bolts was

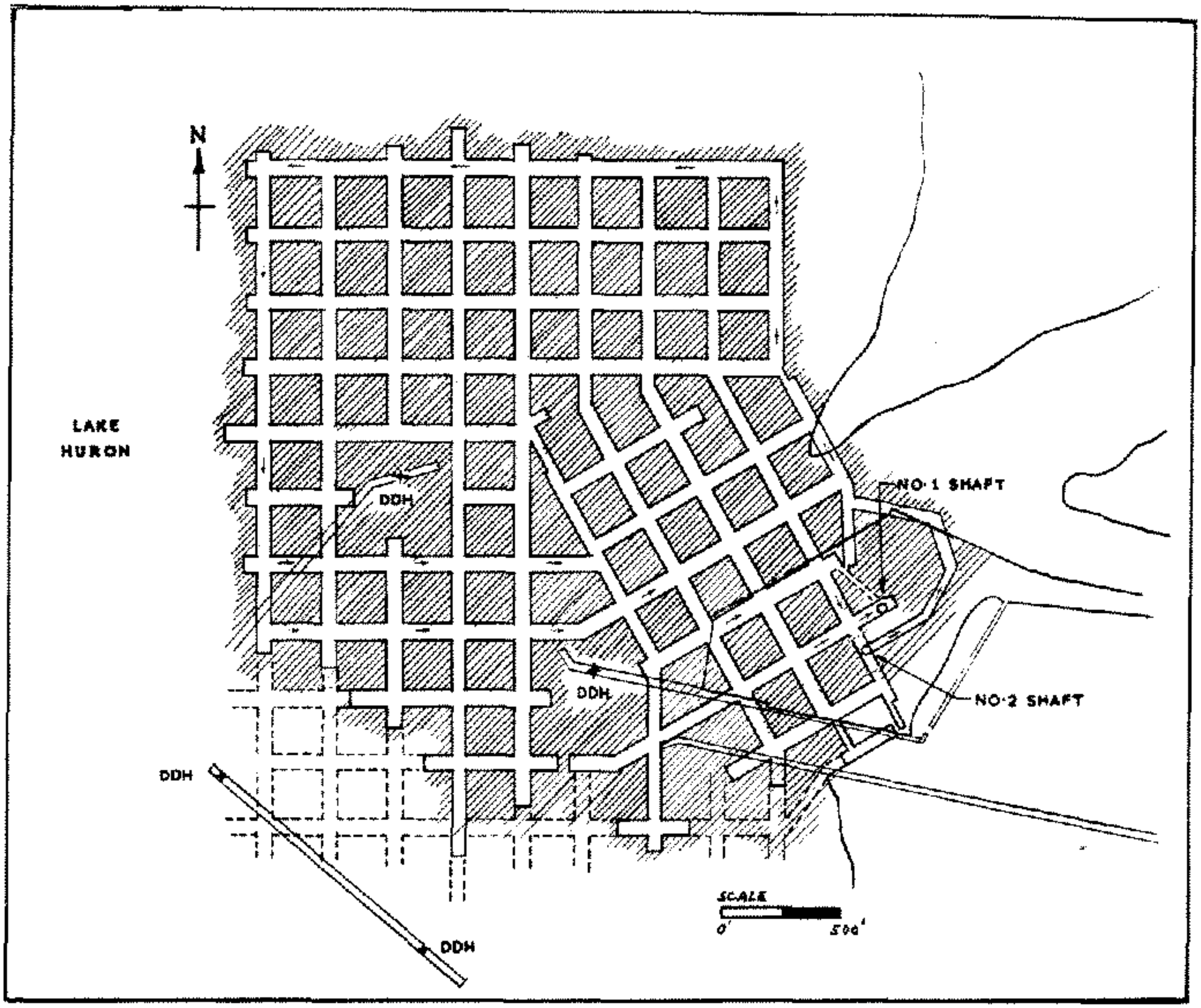

Figure 4.

more than double that of the giraffe-stoper arrangement with half the man power. With this unit we are averaging approximately one hundred bolts on each shift.

This arrangement is quite efficient and after a short period on the job the operators have full confidence in the machine and become accustomed to working thirty-five to forty feet above the floor.

When it became necessary to start bolting with 14 foot bolts, at the intersections in particular, we used the same machine with a six, twelve and fifteen foot auger. Having to use three different lengths of steel for each hole slowed down the placing of bolts to such an extent that the whole roof bolting program fell behind and even using two men on the machine only made a minor improvement in the performance.

It was now time to start on another machine which would have the ability to drill a 15 foot hole in one operation and, of course, be managed by one man. To allow drilling for the blasting of stockpiles it was decided that the new unit should also be able to drill horizontally, or close to the horizontal position.

The Austin-Weston, Fletcher combination had proved to be successful and it was decided to continue this arrangement particularly as we already had a stock of spare parts on hand.

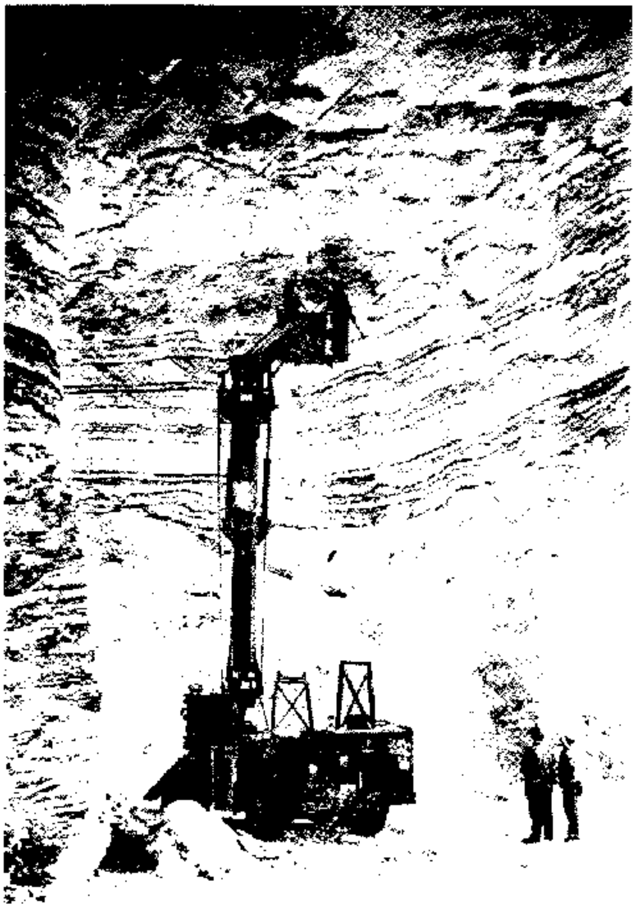

Figure 5. "TRUMP GIRAFFE" when used with a stoper was the original roof bolting machine.

Now we would need to mount the drill and operator's platform as separate units since the drill had to swing to the horizontal position. This was accomplished by making a double upper boom in the shape of a tuning fork and pivoting the drill between the two ends of the forks. The operator's basket was hung alongside the drill but on the outside of the forks, while provision was made for a basket on the opposite side should a second operator be required in the future.

The new drill unit, being much longer, was, of course, considerably heavier than the old unit and the split top boom also added its quota to the additional weight. This weight was no problem with the drill in the working position but with the boom down for travelling the front tires and axle would be considerably overloaded. To correct this situation the vehicle frame was lengthened and an additional steering axle and pair of wheels added to the front end of the machine while counterweight was added at the rear of the vehicle and the crane boom.

In the previous bolter some 13 hydraulic hoses were required between the operator's basket and the vehicle. To reduce the number of hoses all crane movements were to be controlled by pilot operated solenoid valves from switches located in the operator's basket while again retaining the existing manual controls at the driving position. This arrangement reduced the hydraulics to 4 hoses and 1 multi conductor cable running up to the operator's position and also helped to reduce the weight on the boom. It also had the effect of decreasing some of the oil leak problems inherent in the multiplicity of hose connections used on the previous bolter.

The electric power required for the solenoid valves is supplied from the vehicle generator-battery system.

With this new version of bolter we are now able to obtain on each shift forty to fifty 15 foot holes complete with bolts and still continue to operate with one man.

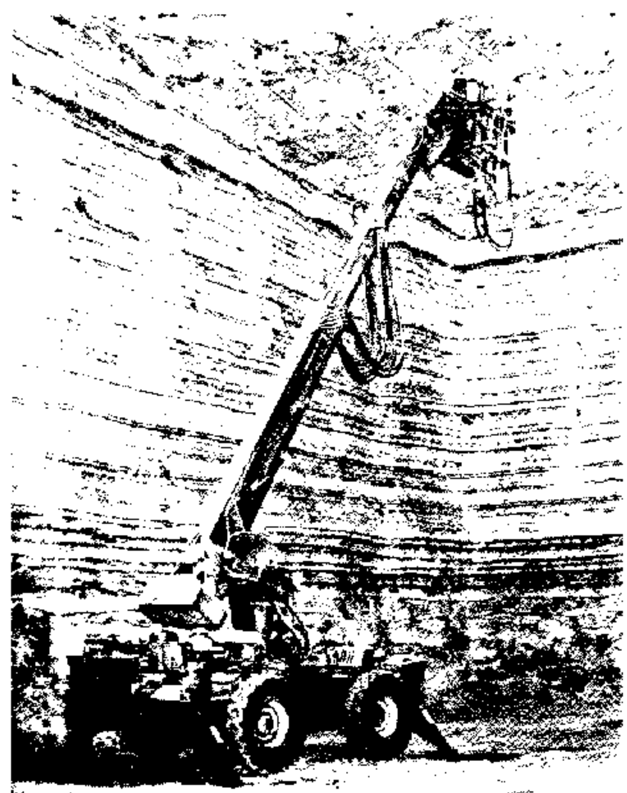

Figure 6. Six foot Fletcher drill mounted on the Model 100 crane.

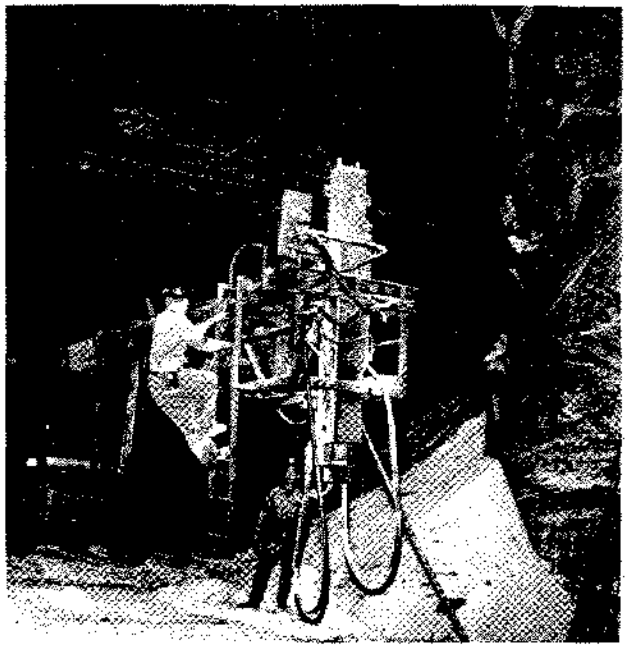

Figure 7. Six foot drill and operator's platform in the lowered position.

Due to the length of the fourteen foot bolts a change in operating procedure was required. With the five foot bolt length sufficient bolts could be accommodated in the basket for the operator to drill the hole, then insert and tighten the bolt and continue to do this within the operating range of the machine, when located in one position. Now the operator drills all the fifteen foot holes in the operating range, descends, loads the required bolts then places and tightens each one in the pre-drilled holes.

Both machines are stabilized by hydraulic outriggers during the bolting operations and the boom movement is limited to a 40° swing on either side of the centre line as a safety precaution. In the original machine the limits are mechanical stops while in the second machine limit switches cut out the solenoid valves controlling the boom swing. The limit switches in turn are backed up by mechanical stops as an added safety precaution.

In conclusion, it is appropriate to express some thoughts for the future since in the business of mining nothing ever remains static and the emphasis is on more efficiency from every one of the individual operations which made a successful mine.

In this particular operation I would like to see a completely custom-built machine capable of drilling holes faster and with an automatic cycle in which a bolt magazine is incorporated. The drilling, bolt placing and bolt tightening sequence would be automatic leaving the operator to locate the position of the hole and continuously recharge the bolt magazine during the drilling-bolting cycle.

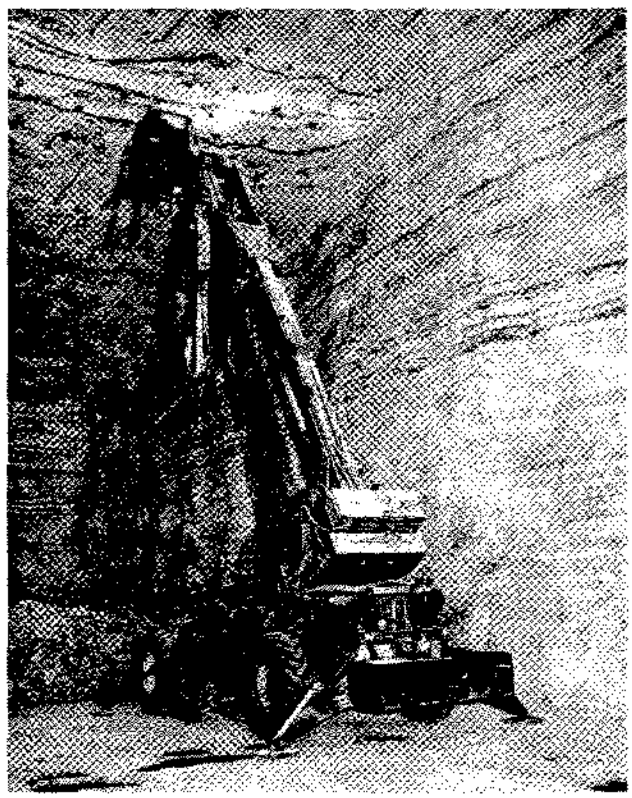

Figure 8. Fifteen foot drill & bolter in the operating position.