Shaft Mucking Investigation PART 2

Jorge R. Delzo
A Thesis
Submitted to
Professor K. S. Stout

SHAFT MUCKING INVESTIGATION

by
Jorge R. Delzo

May 10, 1957
Montana School of Mines
Shaft Mucking Investigation

Part II

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Mr. Koehler S. Stout
Mining Department
Mont. School of Mines
Butte, Montana

Dear Mr. Stout:

In accordance with your instructions received on Sept. 27, 1956, I hereby respectfully submit the second part of my Thesis on Shaft Mucking, as partial fulfillment for my degree of Bachelor of Science in Mining Engineering.

In compiling information on shaft mucking, I have set a comprehensive progress pattern, beginning with hand mucking, following with different mechanical shaft-mucking devices, and concluding with predictions on what progress on this type of mining operation can be expected in the future.

I sincerely hope that if some day I may have to undertake some planning or carrying out any shaft-sinking operation, I will, by the knowledge and comparison of different devices and their performances, included on my thesis, have the necessary background to serve me as a guide.

Yours very truly,

Jorge R. Delzo
ABSTRACT

Of the four phases—drilling, blasting, mucking, timbering—making up the complete shaft-sinking cycle, mucking is perhaps the most tedious and time-consuming. For this reason miners have always considered shaft mucking as the most arduous and unwanted underground type of work. Many incentives have been used to attract them to do this type of work, but undoubtedly, the physical harness that shaft mucking evolves, is further aggravated by the heat, deficient ventilation, and falling water, that usually accompany this phase of shaft sinking.

Progress in mechanizing shaft-mucking work have been rather slow, chiefly because of the difficulties facing the designer in perfecting a loading machine simple in layout, but powerful and flexible enough to operate in the restricted space in shaft bottoms.

By the use of several digging principles, such devices as scrapers, clamshells, power shovel loaders, etc., have been perfected. The net results have been an almost complete elimination of hand mucking, an increase of loading speed, and a reduction of sinking costs. Moreover, the elimination of hand mucking has had a favorable psychological effect on the crew, as well as saving physical effort for the other phases of the shaft-sinking cycle.
Investigation on
VERTICAL-SHAFT MUCKING

PURPOSE OF THIS INVESTIGATION

This investigation represents the second part of my Thesis, which I will submit as partial fulfillment for the degree of Bachelor of Science in Mining Engineering.

SECTION I. MUCKING METHODS

A. Hand Mucking.

1. Sinking Buckets. At the Hope Mine, Clark Fork, Idaho, a 2-1/2-compartment shaft was sunk. The mucking was done by hand into 12-ft. sinking buckets. One bucket was loaded at the bottom of the shaft while the other was being hoisted and dumped. The buckets were suspended on two chains, 12 ft. long, from a conventional sinking cross head equipped with 9-tons. safety dogs. The safety dogs were standard saw-toothed eccentrics held away from the guides by a heavy spring suitably controlled and stressed by the tension in the hoisting cable.

An average of 50 man-hours was required to muck out a 5-ft. round; 95 to 110 buckets were mucked per round. The direct shaft-mucking cost was of $ 20.9 per foot (1946). Miners were paid either their regular wage, $ 1.02 per hour, or at the rate of $ 35 per foot of shaft sunk, whichever was larger.
2. **Mucking Pans.** In the sinking of the Spokane shaft in 1939, and the Turayog shaft in 1940, at the property of the San Mauricio Mining Company, in the Philippines, by the replacement of conventional shaft sinking buckets by mucking pans, increased monthly sinking speeds from 31 ft. to 118 ft. and 151 ft. respectively, were attained.

The hoisting was done in the end compartment of the 3-compartment shaft, where long sinking guides permitted lowering the cage below the last set of timber. The mucking pan was filled by hand mucking, then raised by the use of a hoist and pushed into the cage. A short chain attached to the pan was then hooked to the cage and the pan was raised into dumping position.

A bonus payment "in pesos", based on 3 shifts per day was introduced. Miners were paid $0.20 per foot; above 1.3 ft. but less than 1.6 ft. per day, $0.30 per foot; above 1.6 ft. but less than 2 ft. per day, $0.40 per foot; and above 2 ft. per day, $0.50 per foot. Rate of exchange: 2 pesos per dollar.

As much as 85 cars (19 ft.) were mucked per shift. The man power was composed of natives from several islands, speaking different dialects and having none, whatsoever, training on this type of work.
B. Mechanical Mucking.

1. Riddell Mucker. This mechanical shaft-mucking machine, shown in Fig. 1, page 4, was designed by J. Murray Riddell, professor of mining engineering at Michigan College of Mining and Technology, Houghton, Michigan. Its design is based on practically the same principles as the most familiar overhead traveling cranes, and it consists essentially of three principal parts: a frame, a carriage, and a clamshell bucket.

This shaft mucker was used by Polaris Mining Company of Wallace, Idaho, in extending the 1,500' Silver Summit shaft to the 3,000' level, in 1946. This shaft measured 9' x 18' and it was divided into three compartments.

During the mucking operation 2 men on the carriage operated 3 air motors. By actioning 2 air motors one man lowered and raised the 3/8-clamshell and the other moved the carriage back and forth, as required. Two shaftmen stayed in the bottom. One rotated the clamshell bucket when necessary, by means of a rope, and the other barred and picked down loose from the walls.

The clamshell bucket discharged into a conventional round, 32-ft. sinking bucket resting on the shaft bottom. The time required to fill the bucket varied from 1 1/2 min. to 2 min., according to the operator skill and the fineness of the muck. Loading the 25 to 30 buckets of muck resulting from each blast took from 2 to 3 hours, the time increasing as the hoisting distance grew. An average of 5.25 ft. advance was obtained in
each 24-hour period.

The frame and carriage were lowered one set at a time immediately after a timber set was installed. Before the machine is lowered, the clamshell bucket is first rested on the bottom of the shaft to relieve weight from the supports. The frame, and the carriage centered on it, is attached to the sinking bucket in the middle compartment by four cables hooking over the rim of the bucket. It is then hoisted just enough to enable the four U-shaped straps to be unhooked from the shaft timbers. When so released, the frame is lowered to its new position, the U-shaped straps are hooked over the next lower timber set, and the set up is ready for the next cycle.

By the use of the Riddell mucker hand mucking practically was eliminated, except for the clean-up work in the corners. Since handling of muck is one of the greater time-consuming factors in shaft sinking operations, the time saved by this mechanical mucker is reflected in the rapid progress made in deepening the Silver Summit shaft. Working three shifts per day during one month with 5 men per shift, 35 sets, or 183.75 ft. of timbered shaft were completed. This set a new record in the Coeur d'Alene district.

Miners who habitually work at shaft sinking have estimated that the Riddell mucker has reduced the expenditure of physical effort by as much as 50 percent.
The Riddell mucker was also used in sinking the Crescent mine's shaft, in Idaho, in 1953. This mine is owned by Bunker Hill and Sullivan Company.

In this mine a total of 2000.5 ft. of shaft was sunk, 7 stations excavated, and two pocket raises driven in slightly over 11 months. The rate of advance was 7.1 ft. of shaft per operating day and 8.4 ft. per shaft-sinking day.

2. Boskovitch Mucker. The problem of shaft mucking found a partial answer in the mechanical mucking pan and in the Riddell mucker already described, which although resulted in a speeding up of the mucking operations, distanced much from being the last word in mechanical devices used for the purpose of shaft mucking.

Working toward the end of designing a more complete and efficient shaft mucking device, Mr. M. Boskovitch of Midvale, Utah, constructed a machine which was first put into successfully operation in the Mayflower shaft of the New Park Mining Co., Keetley, Utah, 30 miles southeast of Salt Lake City.

The characteristics of the shaft where this new device was first used was a 3-compartment shaft, of hard rock, and making considerable water.

This device was installed in the center compartment after an advance of 5 ft. had been made. It features a power shovel dipper suspended beneath a mine cage, which has mesh screen's floor, for the purpose of enabling the operator to observe the shaft bottom. Fig. 2, page 7, is a detailed sketch of this mucker.
Fig. 2. Boskovich Mucker
Four air hoists and an air piston provide swinging, crowding, and horizontal motion of the dipper. A heavy "A" steel frame is suspended below the cage from which the digging and loading assembly is attached to the bottom of the cage.

The flexibility of this machine permits its use as a single mucking operation, as in the Mayflower shaft, or the loading into two buckets, spotted at opposite sides of the shaft.

For the operation of this mucking arrangement 2 men are necessary: One man from the cage operates the dipper back and forth through the rock, using levels controls from the two single-drum hoists, and providing crowding action with a foot-operated valve by the controlling of the air piston. The other man works on the shaft bottom, leveling the muck pile, spotting the buckets, switching the main hoist cable from empty to full buckets, operating a sponge pump, and mucking one or two buckets by hand every round, in the clean up of the shaft bottom.

The loading time per bucket varied with the rock fragmentation, but an average loading speed of this machine was found to be about 1 ton/min., The complete loading-hoisting-dumping-lowering cycle being completed in 3 to 4 minutes. This figure, of course, increased accordingly as the depth of the shaft increases.

The use of this unit was found to present the following advantages:
1. Positive and natural digging action at every point in the bottom of the shaft.

2. The machine can be operated by two men only. It will scrape and clean up the shaft bottom.

3. The machine may be lowered into position and set up for mucking in a few minutes, and after completion of mucking operations it may be hoisted instantly from the shaft bottom away from damage by blasting.

4. In bad ground, the machine may be operated with timbers close to the bottom of the shaft by leaving out bottom dividers temporarily.

5. Mucking may proceed with 2 or 3 ft. of water in the shaft bottom, thus saving important man hours, particularly in shafts making a large amount of water.

In the first part of the sinking shaft operation, when the shaft was hand mucked, the advance per manshift was of 0.16 ft., and after the installation of the machine the advance per manshift was increased to 0.28 ft. Buckets mucked per manshift increased 70 percent. Manshifts required to install one shaft set decreased 23 percent.

3. Cryderman Mucker. Since this new revolutionary air-powered-type of mechanical shaft-mucker was fully treated under the first part of this investigation, I will merely review it briefly this time, to emphasize its importance for the efficient mucking of
vertical and inclined shafts.

Positive action in this new mucker, shown in Figs. 3 & 4, page 11, and developed in Ontario, Canada, is achieved through finger-tip controls on the operator's deck of the sinking cage. Four air pistons, mounted beneath the cage, position the telescopic boom. Piston action of the boom then thrusts the clamshell toward the muck pile. Two-way air pistons enable the clamshell to pick up a bite and dump it into the sinking bucket.

4. Model 21 Eimco Rocker Shovel. This type of shovel, shown in Fig. 5, was successfully used for mucking the No. 2 vertical shaft at Quemont Mining Corp., Noranda, Quebec.

Fig. 5. Model 21 Eimco Rocker Shovel
Fig. 3. Cryderman Mucker Loading Shaft Bucket

Fig. 4. Loaded Shaft Bucket Being Hoisted
To secure an efficient performance a benching method was used, which consists in drilling, blasting and mucking each half of the shaft bottom alternately. The advantage of this method is that the rock blasted in one end is piled in the opposite end.

In order to make room at the toe of the pile for operating of the loader, several buckets (about 10% of rock from previous blast), must be loaded by hand-shoveling. Then, a welded section of track with extension slide rails is placed on the long axis of the shaft bottom and the loader is then lowered to the track. Six or seven men are used to swing the buckets into position behind the loader and to clean up on the side as the loader advances into the pile.

After its use, the loader is then hoisted to the sinking deck for storage and maintenance, and the cleaning of the bench is then completed by hand-shoveling.

Two 40-ft. buckets, hoisted in balance, were used. Loading performance increased considerably, as crews became familiar with the operation.

Shaft sinking data for seven months and three months respectively:

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<tbody>
<tr>
<td></td>
<td>tru Dec., '48</td>
<td>tru Dec., '48</td>
</tr>
<tr>
<td>Tons per foot of shaft</td>
<td>39.2</td>
<td>39.4</td>
</tr>
<tr>
<td>Men per shift on bottom</td>
<td>11.7</td>
<td>11.4</td>
</tr>
<tr>
<td>Shaft advance per working day</td>
<td>5.0</td>
<td>5.4</td>
</tr>
<tr>
<td>Tons hoisted per mechanical loading hour</td>
<td>18.2</td>
<td>19.9</td>
</tr>
<tr>
<td>Tons per man-hr., mech. loading</td>
<td>2.5</td>
<td>3.1</td>
</tr>
<tr>
<td>&quot;&quot;&quot;&quot;&quot;, all loading</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Percent of total man-hrs. on loading</td>
<td>40.7</td>
<td>38.6</td>
</tr>
<tr>
<td>Percent of muck loaded mechanically</td>
<td>75.2</td>
<td>76.1</td>
</tr>
</tbody>
</table>
5. Model 630 Eimco Crawler-Mounted Loader. This type of loader, shown in Fig. 6, page 14, has an overall length of 9 ft. 4 in. with the loading bucket down and 6 ft. 3 in. with the loading bucket up. It is 5 ft. 9 in. wide and weighs 5 tons. Power is provided by three air motors, one to operate the hoisting chain on the bucket and one attached to each crawler. A 2-in. hose supplies air for the motors.

Actual operation of this machine requires two men, an operator and a tail hose man. In loading, a shaft bucket is placed near the shaft wall. The mucker travels forward, crowding its shovel into the loose muck. When full, it turns, facing away from the empty shaft bucket, and then hoists the shovel up over the top to discharge the load into the bucket.

This rockershovel was successfully used for mucking the 37 x 14 ft. vertical shaft at the Pocahontas Fuel Co. in Virginia. It loaded into two buckets of 3 ft. high and 5 ft. in diameter. Buckets were hoisted alternately from their own headframe.

On the average it took about 14 hours to muck out the shaft and prepare the bottom for drilling. After cleaning the bottom, the loader was hoisted out of the shaft.

The effective use of this loader was primarily due to several design features as the shape of the bucket, the angle of the bucket lip and the powerful crowding action of the crawlers, which were operated independently, allowing the operator to maneuver the loader in tight places for maximum effectiveness in digging and loading.
Fig. 6. Model 630 Elmaco Crawler-Mounted Loader
The crawler-mounted loader was also successfully used in mucking a circular, 20-ft. diameter shaft at the Intermountain Chemical Co., at its Westvaco mine near Green River, Wyoming.

In this mine an average of 15 to 18 yd/hr. were loaded, depending of course upon the conditions, that is, whether muck loading on the shaft bucket was balanced with the time to make a round trip with the mine hoist.

Several methods of clamshell loading have been devised in the past. In every one of them some means of support must be provided down in the shaft. Men on the tag line, in many instances must work against the swinging weight of the clamshell for its proper loading into the shaft bucket.

Proper fragmentation is not too important when a clamshell is used, providing of course, that the largest pieces can be handled by the clamshell into the shaft bucket, although large pieces can slow up the operation because the clamshell tends to slide off big rocks and several passes may be necessary to pick them up. The Eimco 630 loads best when 80 to 90 percent of the fragments are 1 ft. or less in size, thus any oversized muck will result in a decreasing of the mucking speed.

An air-operated tugger on the closing line of a clamshell requires about 200 ft./min. of air at a pressure of 90 psi. An Eimco 630 requires about 750 ft./min. of air at a pressure of
115 psi. However, air should not be too much of a problem on a shaft job, because drilling equipment usually requires more air than is necessary to operate the Eimco 630 crawler-mounted loader.

Manpower varies according to the methods used and the policies of the contractor. At times a contractor uses what he believes to be a bare minimum of men for a given operation, but he may be sacrificing production and efficiency. For example, sometimes the two men working the taglines of the clamshell must hook and unhook the buckets; a good extra man hooking shaft buckets will increase the hoisting rate, even though tagline men could do the hooking.

A set-up with the clamshell remotely controlled could be worked with an operator and two tagline men. With the bridge crane or similar systems two operators and one man to change buckets could make up the crew. To use a clamshell with air-operated tugger, two tagline men are needed, a tugger operator, a signal-man who signals both mine hoist and crane, and a helper to hook buckets and spell the tagline men. With the Eimco 630, an operator, a hoseman, a helper for hooking and unhooking the buckets, and a signalman to the mine hoist are needed. Manpower on a shaft sinking operation is usually governed by the size of the drilling crew.

Comparison of rate of production and footage sunk at present time would be unfair, because the Eimco 630 has only recently been used and the figures obtained would not represent an aver-
age as a basis for comparison.

Restricted operating space is a problem, for either clamshells or loaders. The minimum operating space for a clamshell is 14 ft. in diameter. The minimum operating space for an Eimco 630 has not been yet determined.

It is believed that the Eimco 630 is much safer to operate than any clamshell method thus far introduced. This is due primarily to the absence of entangling lines between the mine hoist cable and cables supporting the clamshell. In addition, there are no supporting structures overhead in the shaft that could be fouled with the mine hoist and shaft bucket. With a clamshell, there is always the hazard of slipping and falling beneath the clam as it is lowering into the muck pile. Also, the clam could fall over if too much slack occurs in the load line. These hazards are eliminated by the crawler-type mucker, which remains firmly on the muck pile, where the crew can watch every operation without worrying about anything overhead.

7. Hydro-mucker. The high-head type of hydro-mucker, shown in Fig. 7, was manufactured by the Hydrocrane Division of Bucyrus-Erie Co., and used successfully in mucking the Mather "B" Shaft of the Cleveland-Cliffs Iron Co., in 1948.

It consists of a clamshell bucket of a capacity of 3/8 yds³ actioned by a vertically mounted hydraulic ram operating at oil pressures from 500 psi to 600 psi. By operating this hydraulic ram the clamshell jaws are opened and closed as it deems necessary. The raising and lowering of the clamshell bucket is done
Fig. 7. Hydro-mucker

by means of an IR-type hoist, and the swinging of the clamshell over the muck pile is done manually. The dumping is done into a 2 1/4-yd³ mine car lowered into the shaft on a cage, although a shaft bucket can be used instead.

Performance data shows hand mucking production with 10 men as 8 yds³/hr., up to the time the hydro-mucker was introduced. Four months later, the output had increased to 11 yds³/hr., and the number of men decreased to 7. Monthly average of shaft advance was also increased from 129 ft. to 151 ft.

When using the hydro-mucker, only a small percentage of the total mucking was required to be done by hand.
Some of the advantages in the use of a hydro-mucker for shaft mucking purposes are as follows:

1. Short preparation time for the start of the mucking cycle.

2. Maintenance and repairs are quickly done, consuming only a few minutes during the mucking cycle.

3. High mucking speed.

4. Simple to operate.

5. Economic.

Fragmentation is an important factor in the operation of the hydro-mucker, for a large chunk caught in the jaws will let all the fine material fall out.


The major units of the grab system are similar to those used in the Riddell system, that is: an operating platform suspended below the bottom set, a traversing carriage which propels itself along the operating platform and which mounts the hoist from which the grab id suspended, and the grab itself.

The grab, shown in Fig. 8, is suspended by a lifting eye which is immovably connected by guides to the head of a two-way air cylinder.

The two grab jaws rotate on pivot bearings fixed to the cylinder wall. A pin inserted in the upper end of the piston rod is housed on each end by G.M. shoes which ride up and down on the guides. The pin, in turn, transmits force to link arms which ac-
tuate the jaws. The cylinder is 30 in. inside diameter, and operating at a pressure of 80 psi, applies a force equivalent to 8 tons at the teeth of the jaws. This is sufficient to crush rock particles squeezed between the side plates on closing. The jaws have an open span of 7 ft. 4 in. and will normally gather a full load on closing. Stability is ensured by the low center of gravity and the grab will close and open in any position taken during loading position.

Two important design features are worth mentioning:

1. Because the link arms are most horizontal as the jaws close, maximum closing force is transmitted to the jaws at the instant of closing.
2. Use of the two fixed pivots on each side (instead of a common pivot) allows for wide opening of the jaws and for full loading with only a shallow bite.

Two air-powered jaws type of mucker were used in the 46.33 ft. by 10 ft., 7 compartments rectangular shaft; each grab controlled from its own carriage, at the operating platform suspended about 25 ft. above the bottom of the shaft.

At blasting time the grabs and the traversing carriages are hoisted and placed on trolleys.

Because of the small size of the shaft compartments, the size of the shaft bucket was limited to a maximum capacity of 3.75 tons, and great care had to be exercised during the lowering and raising of the units and grabs through the shaft. This of course limited the rate at which rock could be hoisted.

Each of the two mechanical grabs used mucked at an average speed of 1 ton/min., and the mucking of a 5-ft. round (approx. 275 tons) was accomplished in less than ¼ hours.

Comparison between grab-type mechanical mucking and hand mucking, over a period of ¼ months:

<table>
<thead>
<tr>
<th>Item</th>
<th>Western Holding No. 1 Shaft</th>
<th>Western Holding No. 2 Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft depth at start of test</td>
<td>3,850 ft.</td>
<td>3,820 ft.</td>
</tr>
<tr>
<td>Footage sunk during test</td>
<td>548 ft.</td>
<td>556 ft.</td>
</tr>
<tr>
<td>Development footage in stations</td>
<td>396 ft.</td>
<td>381 ft.</td>
</tr>
<tr>
<td>Tonnage excavated and hoisted</td>
<td>34,833 tons</td>
<td>35,942 tons</td>
</tr>
<tr>
<td>Total native labor shifts (machine and mucking)</td>
<td>14,782 shifts</td>
<td>25,942 tons</td>
</tr>
<tr>
<td>Total mucking man-shifts</td>
<td>4,961 shifts</td>
<td>19,260 shifts</td>
</tr>
<tr>
<td>Tonnage per overall shift</td>
<td>2.343 tons</td>
<td>1.365 tons</td>
</tr>
<tr>
<td>Tonnage per mucking shift</td>
<td>8.56 tons</td>
<td>1.87 tons</td>
</tr>
</tbody>
</table>

* Grab crews
9. "Cactus"-type Mechanical Grab. By the use of this new type of shaft mucker, a new world shaft sinking record of 585 ft. of advance per month was set in May 1953, at the No. 2 shaft of the Vlakfontein Gold Mining Co., in South Africa. The previous record, held by Virginia G. M. of the Orange Free State was 50\(\frac{1}{4}\) ft. advanced in April 1951, with the same type of mechanical grab.

This new type shaft-mucking device, shown in Figs. 9 & 10, page 23, consists of a multi-pointed grab operated by air compressed. It has a capacity of one ton, and it will load a 90-ft\(^3\), 5-tons bucket in about 3 minutes, and clean and hoist more than 100 tons per hour. Leaves of the grab are tipped with tungsten carbide. The grab is mounted so that it traverses the shaft on a radial arm riding on a monorail attached to the lowest deck of a three-deck sinking stage. The second deck carries the winch which lowers the forms used for concreting, and the top deck is used to extend pipes and control the proper distribution of the concrete. The complete set up is shown in Fig. 11, page 24.

For the maneuvering of the three-deck sinking stage and the four shaft buckets used in the 24-ft. diameter shaft, it is necessary to provide a 4-tons weight compensating tower, two friction drums, and two storage drums.

After the buckets are loaded they are hoisted in balance. Cross heads traveling on guides permit the proper hoisting of the shaft buckets, which upon reaching the top of the shaft are
Fig. 9. "Cactus" Grab Picking Up Load

Fig. 10. "Cactus" Grab Loaded
Fig. 11. Three-Deck Shaft Sinking Stage
tipped by means of a chain hook hanging from the headframe, dumping the rock into split chutes. These chutes feed a conveyor belt, which transports the muck and dump it into a 300-ton waste bin.

Sinking and lining operations are run on a three-shift basis. Two, 1-yr. concrete mixers, mounted in the headframe, discharge into a common launder feeding into a concrete bucket. The bucket is lowered and discharges into an "octopus" which feeds into the space between the walls and the forms. The concrete is poured during the drilling shift. The lining is broken on 12 ft. 6 in. centers with 18-in. spacings which will carry the permanent steel work of the shaft.

The average sinking cycle lasted about 6 hours, and it was divided in 1½ - 2 hours - drilling and cementing, and 3½ - 4 hrs-mucking.

The average cost per ft. of sinking and concreting was $310.

People engaged in the shaft sinking operations are subject to an enormous physical effort. It is thought that crews of 18 men working on a four-shift basis, would result in an increased performance.

The cactus-type mechanical mucker was also used in a 18 ft-diameter shaft by the Anglo-American Corporation of South Africa, in 1956. A monthly average of sinking and lining rate of 415 ft. was recorded.

This type of mechanical shaft mucker has never been used in the United States, but Anaconda Company is planning to use it in
sinking a 26 ft.-diameter shaft at the Ryan Mine site in Butte, Montana.

SECTION II. LOOKING INTO THE FUTURE

Present mechanical muckers have two basic flaws in common. First of all, they are not continuous flow machines; resultantly, there is no a continual flow of muck from the bottom of the shaft to storage bins or skips. Secondly, these muckers cannot completely clean the bottom of the shaft. I believe that by the use of pumps for shaft mucking purposes, these two basic flaws could be solved.

A. Dredge Pump. This type of pump, designed by Thomas Foundries of Birmingham, Alabama, was installed in the LaGarde gravel pit, near Anniston, Ala., in September 1948, operating successfully in a single lift ever since that time.

The special feature in the design of this pump was its casing, which was made of Ni-Hard liner surrounded by an outer casing of ordinary cast iron. Between these two casings a water jacket was provided, so that it served as a cushion, absorbing the shock and impact caused by heavy boulders, and also insuring that no damage could be done to the outer casing should the casing liner wear through.

The life of the wearing parts in the regular manganese pumps ranges from two to a maximum of four weeks, depending on the character of material currently being handled. The Ni-Hard wearing parts of the dredge pump have a minimum hardness
of 550 Brinell and a life from 5 to 7 times longer than the manganese steel parts.

The pump is driven by a 200-hp. Diesel engine at approximately 600 rpm through a V-belt drive, and on the average it pumps 2700 g.p.m.

The conditions under which the dredge pump was used were a pumping of mixture of slime-free sand, gravel and boulders up to 6 in. in diameter, and at the rate of 175 tons/hr. in one single-stage pump against a static head of 90 ft. and a total head of 140 ft., of which 20 were in the suction side.

I believe that by an increase in the suction and discharge sizes, larger and courser material could be handled, and that providing a good fragmentation, the dredge pump may prove feasible for shaft mucking purposes.

B. M. S. M. Investigation. Few years ago an investigation was undertaken by one of the undergraduate mining students in applying the venturi-suction principle, for shaft mucking. Experiments took place at the laboratories of the M. S. M., and the necessary tools for research were provided by the Research Dept. of the Anaconda Co.

The operation of the mucker, whose model is shown by Fig. 12, page 28, is as follows: High-pressure water is introduced through the nipple (A) and around the jet (B). When the water enters the throat of the venturi (C), this pressure head is then converted to velocity head. This conversion causes a suction, which operates the mucker by pumping the water and muck through
Fig. 12. Cross Section Of Venturi-Mucker Model

Fig. 13. Possible Set Up Of Venturi-Mucker
the jet. The combined streams of water and muck move up and through the venturi of the model, and the velocity head is then converted back to pressure head.

Four models were constructed. Several changes in design were undertaken in reaching for a practical model and several tests were run, the results being recorded and compared. The final model adopted is shown in Fig. 13, page 28, and it is hoped that when put it into practice will prove to result in a reduction in shaft mucking costs.

The advantages of the Venturi Mucker may be described as follows:

1. There will be a continual flow of the muck from the shaft bottom to skips or some other type of conveyance.
2. It could be used in the wettest or the driest shaft.
3. Only a few men will be needed to operate this mucker.
4. All of the muck will be removed from the bottom of the shaft.
5. The mucker has simplicity of design.

Proper fragmentation is one of the keys to the success of this type of mucker. It is hoped, however, that this system will prove of sufficient value to warrant the development of a shaft round which will consistently break all the muck to minus 6 in.

The Anaconda Company is at present using the venturi-suction principle for pumping slimes in its slime fill program.
CONCLUSION

In a shaft of sufficient depth to justify the original expenditure for equipment, mechanical mucking has been perfected to the point where it is quite efficient.

In comparing the performance of the different shaft mucking devices, care should be exercised in comparing data of one method with another, because of such variables as character of the broken rock, speed of hoisting, difference of cross section dimensions of shaft, shape of cross section (rectangular or circular), difference in number of men in mucking crew, etc. However, past performances have indicated that in general, broken rock is easier to handle in circular shafts than in rectangular shafts.
BIBLIOGRAPHY


BIBLIOGRAPHY (Continuation)


