Hydraulic Shaft Mucker

Frederick D. Owsley

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HYDRAULIC SHAFT MUCKER

by

FREDERICK D. CWSLEY

May 13, 1955
Montana School of Mines
Mining 68
Spring Semester, 1955
Mining Methods

Report
Submitted to
Professor K. S. Stout

26720
HYDRAULIC SHAFT
MUCKER

by
Frederick D. Owsley

May 13, 1955
Montana School of Mines
Montana School of Mines
Butte, Montana
May 13, 1955

Professor K. S. Stout
Mining Department
Montana School of Mines
Butte, Montana

Dear Professor Stout:

In compliance with your instructions received during February, 1955, I am submitting my thesis on the Hydraulic Shaft Mucker as partial fulfillment for the degree of Bachelor of Science in Mining Engineering.

The hydraulic shaft mucker was designed to provide a maximum of safety and to utilize a minimum of man power. Due to the lack of physical facilities this report can cover only the design of the hydraulic shaft mucker.

It is hoped that this report will bring forth a few new ideas on shaft mucking that will be useful in future designs and helpful in the move to mechanize mining operations.

Respectfully submitted,

Frederick D. Owsley
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INTRODUCTION

Until recent years mining has depended upon the muscles of men to supply the power required to obtain ore. With the rising cost of labor and the increased demand for metals, mine management has turned to machines to meet these demands. With the coming of machines, the mechanization of mining began, and a new era in mining developed. Great strides have been made in drilling, hoisting, haulage, etc; but the sinking of shafts still create a costly operation.

TIME STUDY OF SHAFT SINKING

Shaft sinking at the Hope Mine, Clark Fork Idaho.¹

<table>
<thead>
<tr>
<th>Operation</th>
<th>Man-Hours / ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling and blasting</td>
<td>6.346</td>
</tr>
<tr>
<td>Timbering</td>
<td>6.346</td>
</tr>
<tr>
<td>Hand Mucking</td>
<td>15.866</td>
</tr>
<tr>
<td>Misc</td>
<td>3.173</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>31.731</strong></td>
</tr>
</tbody>
</table>

The excavated rock section was 17x7 ft.

Shaft sinking at the Macassa Mine, Kirkland Land Ontario.²

<table>
<thead>
<tr>
<th>Operation</th>
<th>Man-hours / ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling and blasting</td>
<td>8.52</td>
</tr>
<tr>
<td>Hand Mucking</td>
<td>11.53</td>
</tr>
<tr>
<td>Timbering</td>
<td>2.61</td>
</tr>
<tr>
<td>Misc</td>
<td>1.58</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24.24</strong></td>
</tr>
</tbody>
</table>

The excavated rock section was 17.9 ft.
Shaft sinking at the Silver Summit Mine, Wallace Idaho, using a Riddell Mucker.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Man-hours / ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling and blasting</td>
<td>8.502</td>
</tr>
<tr>
<td>Timbering</td>
<td>5.586</td>
</tr>
<tr>
<td>Mechanical Mucking</td>
<td>8.670</td>
</tr>
<tr>
<td>Misc</td>
<td>3.251</td>
</tr>
<tr>
<td>Total</td>
<td>26.009</td>
</tr>
</tbody>
</table>

The excavated rock section was 18 by 9 ft.

At the Hope Mine 50% of the man-hours / ft was required for mucking and at the Macassa Mine 47.6% of the man hours / ft was required for mucking, but at the Silver Summit Mine, using a mechanical mucker, the man-hours / ft was reduced to 33.4%.

REQUIREMENTS OF A SHAFT MUCKER

1. Be compact, so that it can be transported in a shaft, compartment without being disassembled.
2. Use a minimum of man power to operate.
3. Utilize a simple control system.
4. Provide a maximum of safety.
5. Be designed so that it can muck a complete shaft with one set up.
6. Reduce the mucking time.
7. Be cheap and simple to build and economical to operate.

THE HYDRAULIC SHAFT MUCKER

Compactness

The hydraulic shaft mucker was designed so that by extending the lift cylinder the extension arms and clamshell will lie directly and vertically below the cage and can be transported in a shaft compartment without disassembling.
Man-Power Required

Operation of the hydraulic shaft mucker requires two men, one to operate the clamshell and one man to raise and lower the hydraulic shaft mucker as required during the mucking operation, and to raise and lower the mucking bucket.

Control System

All digging action by the hydraulic shaft mucker is accomplished by hydraulic cylinders. The controls for the cylinders are mounted in the cage (T-5). Only four control valves are required for the operation of the mucker. The raising and lowering of the mucking bucket and the hydraulic shaft mucking will be controlled by a bell system between the two operators.

Safety

During the mucking operation no men are required in the shaft bottom, and both operators are in well protected places so a maximum of safety is possible. The operator of the hydraulic mucker has an unobstructed view of the clamshell except when mucking directly beneath the cage.

Mucking From One Position

During the mucking operation the hydraulic shaft mucher has to be turned 180° by hand in order to muck both sides of
the shaft. This is accomplished by removing a pin (T-4) in the cage deck; swinging the mucker \(180^\circ\) and inserting the pin in its new position.

Mucking Time

Being the mucker could not be constructed, the mucking time could not be determined.

Construction

The mucker is of welded construction, except where it is required to have removable parts. In drawing T-4 the design for the suspension column attachment for the lift cylinder is in error; please refer to drawing T-6 for the correct design.

The clamshell, hydraulic cylinders, pump, and control system may be obtained from the Shawnee Manufacturing Company Inc, 1947 North Topeka Avenue, Topeka, Kansas.

The clamshell may be obtained in \(1/3\), \(1/4\), and \(1/5\) cubic yards and is of welded construction. The hydraulic cylinders are double-acting, heavy duty cylinders equipped with adjustable packing. All parts are interchangeable except the case and the rod, which determine the length of the cylinder. The pump is capable of pumping 25 gpm at 1200 psi. The control system utilizes piston type, silent by-pass valves. The recommended hydraulic hose is of wire braid construction with at least a 3800 lb test.
**Miscellaneous Data**

<table>
<thead>
<tr>
<th>Cylinders required</th>
<th>maximum</th>
<th>Length (in.*</th>
<th>minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 extension cylinders</td>
<td>103.08</td>
<td>55.39</td>
<td></td>
</tr>
<tr>
<td>2 lift cylinders</td>
<td>85.0</td>
<td>46.35</td>
<td></td>
</tr>
<tr>
<td>1 turn cylinder</td>
<td>25.4</td>
<td>15.2</td>
<td></td>
</tr>
</tbody>
</table>

*The length of the cylinders is measured from the center of the connecting rings.*

Weight of extension arms and cylinders = 533.10 lb
Weight of 1/3 yd³ clamshell and ore = 1784.40 lb
Maximum length of extension arms = 103.08 in.
or 8.6 ft
Minimum length of extension arms = 61.75 in.
or 5.23 ft
Horizontal swing for extension arms extended* = 23.2 ft
Horizontal swing for extension arms not extended* = 9.26 ft

*Width of clamshell was considered in the swing.*

**Calculations**

Cylinder thrust:
- Diameter of piston = 3.1 in.  
  Area = \(7.525 \text{ in.}^2\)
- Diameter of rod = 1.25 in.  
  Area = \(1.225 \text{ in.}^2\)

\(1200 \text{ psi} \times 6.30 \text{ in.}^2 = 7,560 \text{ lb}\)

**Forces involved:**

\[\begin{align*}
\text{A} & -59.33'' & \text{B} & -51.54'' \\
533.10 \text{ lb} & & & 1784.4 \text{ lb} \\
59 & & & 103.08'' \\
-6- & & & \\
\end{align*}\]
\[
\text{Tan} = \frac{26.0}{59.33}
\]

\[
\text{Tan} = 0.44
\]

\[
\text{Sin} = 0.403
\]

Moments about A:
\[
59.33x = 51.54 \times 533.10 \neq 103.08 \times 1784.6
\]
\[
x = 3,560
\]
\[
\text{Sin} = \frac{3.560}{Y}
\]
\[
Y = 8,330
\]

Safety factor for lift cylinders:
\[
\frac{15,120}{8,330} = 1.73
\]

Connecting pins for lift cylinders:
\[
S = \frac{P}{A}
\]
\[
S = \text{Shear}
\]
\[
P = \text{Force exerted}
\]
\[
A = \text{Area}
\]
\[
S = \frac{4,415}{\pi \times 0.625^2} = 3,600
\]

Safety factor for connecting pins:
\[
\frac{15,000*}{3,600} = 3,600
\]
*Shear value taken from "Strength of Materials" by Poorman, page 310, Table III

Connections for lift cylinders:
\[
S = \frac{P}{2A} = \frac{4,415}{2(2 \times \frac{1}{2})} = 2,207
\]

Safety factor for connections:
\[
\frac{13,000}{2,207} = 8.09
\]
Drawings

Extension Arms (T-3) and Turn Assembly & Suspension Column (T-4)

1. Support ring.
2. Turn circle.
3. Turn cylinder.
4. Turn cylinder attachment to suspension column.
5. In error, refer to drawing T-6 for correct design of suspension column attachment for lift cylinder.
7. Small extension arm.
8. Large extension arm.
9. Pins for extension arms, welded to suspension column.
11. Supports for extension arms.
12. Large cylinder for suspension column.

Conclusion

It is hoped that this report will be an aid in reducing the cost of shaft sinking. Although the design of the hydraulic shaft mucker may not be perfect in every respect, it does provide a maximum of safety, a minimum of manpower, an ease of transportation, and a simple control system.

Due to the lack of physical facilities a working model of the hydraulic shaft mucker could not be constructed, and actual tests could not be carried out.


HOSE INSTALLATION FOR HYDRAULIC SHAFT MUCKER

HYDRAULIC CYLINDER

1. OPERATES EXTENSION ARMS
2. OPERATES SWING CYLINDER
3. RAISES & LOWERS CLAM SHELL
4. OPERATES CLAM SHELL

OIL TANK

CONTROL PANEL

PUMP

GEAR BOX

MOTOR

1/2"

1/2"

3/4"

1/2"

1"

1/2"
T-1
HYDRAULIC CLAM SHELL
SCALE: 1 in. = 6 in.
TURN ASSEMBLY &
SUSPENSION COLUMN

T-4
SCALE: 1 IN. = 4 IN.
SUSPENSION COLUMN
ATTACHMENT FOR LIFT CYLINDERS

EXTENSION ARM
ATTACHMENT FOR LIFT CYLINDERS