HANDBOOK OF STEAM SHOVEL WORK

FIRST EDITION

A REPORT BY THE
CONSTRUCTION SERVICE CO.
TO THE
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TABLE OF CONTENTS

				Page
CHAPTER I. NATURE OF THE PROBL	EM			5
Process of Loading				6
Steam Shovel versus Hand Loading				6
Cost of Work by Human Power .				7
Great Variation in Steam Shovel Effic	iency			7
Trained Labor Necessary				8
Co-operation of Other Processes .				8
Work Economically Justifying a Steam	n Sho	vel	•	8
CHAPTER II. GENERAL CONDITIONS A	ND F	ORMUI	LAS	10
Repairs				10
Depreciation				10
Interest				11
Height of Bank				11
Standard Rates				11
Formulas and Diagrams				12
Mathematical Analysis				I 2
Standard Assumptions				16
Uses of Cost Curves				16
Cost Curve Diagrams	•	٠.		20
CHAPTER III. FIELD CONDITIONS				28
Equipment				28
Superintendence				29
General Arrangement				29
Lost Time				30
Kind of Labor				32
Kind and Condition of Material .		•		33
CHAPTER IV. Estimating				35
Standard Classification of Expenses				35
Diagram Showing Cost in Cents per C	ubic	Yard		37
Table of Rates of Wages				37
Diagram Showing Time in Seconds	for	Compl	lete	
Dipper Swing				38

CHAPTER IV—Continued
Diagram Showing Idle Time of Shovels Due to Waiting for Cars
Diagram Showing Actual Shovel Working Time .
CHAPTER V. SHOVEL WORK IN SAND AND GRAVEL
Report No. 1, Shovel No. 612, in Sand Pit at Dune Park, Ind.
Report No. 2, Shovel No. 1118, on W. & L. E. R. R.,
Relocation at Kent, Ohio
ment at Gary, Ind.
Report No. 4, Shovel No. 166, in Gravel Pit at South Bend, Ind.
Report No. 5, Shovel No. 58, in Gravel Pit at Janes-
ville, Wis
CHAPTER VI. STEAM SHOVEL WORK IN EARTH AND
GLACIAL DRIFT
Yard at Long Island City, New York Report No. 9, Shovel No. 1121, Excavating Sewer
Trench, Chicago, Ill.
CHAPTER VII. STEAM SHOVEL WORK IN CLAY .
Report No. 11, Shovel No. 1119, on Relocation of
W. & L. E. R. R., at Kent, Ohio
Report No. 12, Shovel No. 843, on the L. S. & M. S. Cut-off, at Cleveland, Ohio
Report No. 13, Shovel No. 666, on Relocation of the
W. & L. E. R. R., near Kent, Ohio
Report No. 14, Shovel 1128, Stripping the Grant
Mine at Buhl, Minn
Report No. 15, Shovel No. 650, Digging Slag at
South Deering, Ill
Report No. 16, Shovel No. 980, Excavating Clay at
Chicago, Ill.

CHAPTER VII-Continued

Report No. 17, Shovel No. 424, Excavating Clay at	Page
Riverdale, Ill	143
Report No. 19, Shovel No. 517, Stripping in the	_
Grant Mine at Buhl, Minn	I 54
Explanation of Time Study of Report No. 19	164
Explanation of Tables of Shovel No. 517	164
Table Showing Time of Different Parts of Dipper	
Action, Shovel No. 517	167
Report No. 20, Shovel No. 727, Excavating in Clay	
Pit at Chicago, Ill.	169
CHAPTER VIII. STEAM SHOVEL WORK IN IRON ORE	174
Description of the Mesabi Range	174
General Remarks, Oliver Iron Mining Co., Hibbing,	•
Minn	188
Report No. 21, Shovel No. 710, in Stock Pile Work	
at Chisholm, Minn.	191
Report No. 22, Shovel No. 719, in Stock Pile Work	-
at Amasa, Mich	198
Report No. 23, Shovel No. 707, in Stock Pile Work	
at Negaunee, Mich.	205
Report No. 24, Shovel No. 1127, in Stock Pile Work	
at Ironwood, Mich	212
Report No. 25, Shovel No. 1142, in Stock Pile Ex-	
cavation at Stambaugh, Mich	220
Report No. 26, Shovel No. 1124, in Open Pit Mining	
at Michigamme, Mich	225
Report No. 27, Shovel No. 1074, in Stock Pile Work	
at Ishpeming, Mich	231
Report No. 28, Shovel No. 1083, Excavating Soft	
Ore at Seller's Pit, Hibbing, Minn	236
Report No. 29, Shovel No. 866, in Stock Pile Work	
at Princeton, Mich	245
Taking Down Boom and Dipper of Shovel No. 700	
at Chisholm Minn	252

HANDBOOK OF STEAM SHOVEL WORK

	Page
CHAPTER IX. STEAM SHOVEL WORK IN ROCK .	254
Report No. 30, Shovel No. 1108, on D., L. & W.	
Cut-off at Hopatcong, N. J.	255
Report No. 31, Shovel No. 1138, Excavating Lime-	
stone at Thornton, Ill	265
Report No. 32, Shovel No. 1073, Excavating Lime-	
stone at Thornton, Ill	278
Report No. 33, Shovel No. 1096, on D., L. & W.	
Cut-off near Johnsonburg, N. J	286
Report No. 34, Shovel No. 1097, on D., L. & W.	
Cut-off near Johnsonburg, N. J	301
Report No. 35, Shovel No. 795, on D., L. & W.	
Cut-off near Columbia, N. J	312
Report No. 38, Shovel No. 1137, on D., L. & W.	
Cut-off near Hopatcong, N. J	323
Report No. 42, Shovel No. 350, on D., L. & W.	
Cut-off near Netcong, N. J	331
Report No. 43, Shovel No. 1106, Excavating U. S.	
Ship Canal on Soo St. Marie, Mich	347
Report No. 45, Shovel No. 875, on D., L. & W.	
Cut-off near Columbia, N. J	357
CHAPTER X. Directions for Moving Shovel .	364
Economic Hints	364
Economic Hints to Superintendents	365
Advantage of Whistle or Bell Signals Over Hand	
Signals	370

CHAPTER I

NATURE OF THE PROBLEM

The steam shovel effected a revolution in the cost of loading earth and other excavated material from the date of its introduction, and it is to-day the standard machine for handling economically such materials in large quantities. It is a highly specialized machine, requiring many accessories in the way of plant for the transportation process. Its efficiency depends upon the skill of its operators, the co-operation of many different men, and the ability with which the general operating scheme of which it is a part, has been designed.

Many a steam shovel has been considered inefficient when it had not half a chance to do its work, and many excavating jobs could have been handled advantageously with steam shovels instead of by hand had the contractors known how to bring them into play. Up to this time no effort has been made, within our knowledge, to put into available shape for ready reference the various quantities and factors which go to make up the cost of steam shovel work, so that it may be determined whether a particular shovel is doing its full duty, and whereby, with careful study of daily performance, a losing contract may be turned into a paying one. To set before the man interested in steam shovel work the necessary data to enable him to work out the economics of his shovel work at the least cost is the problem that we have attempted to solve in this volume. There are so many factors entering into the work that the problem seems at first highly complex; but systematic analysis has resulted in so simplifying it that any man of field experience ought to be able, with the help of the data contained in these pages, to put his shovel work on a scientific To determine what work is costing day by day is half the problem; to determine what it ought to cost 238181 is the other half.

To establish these factors it was necessary to observe a large number of shovels in operation, and an elaborate description of the work observed has been necessary in order to afford an adequate statement of the result. These appear in Chapters V to IX inclusive. Wherever possible, the observations have been made by our men. On questions of coal and oil consumption and the like we have had to take the statements of shovel runners, checked more or less by our own observations, and in the items of repair cost, etc., we have had to rely on the statements of others. Where such statements have seemed not to be accurate, we have discarded them.

PROCESS OF LOADING

The process of loading consists in seizing the material

after it has been reduced to a fit condition and placing it either in its ultimate position or upon a vehicle for the purpose of transportation. With hand shovels, unless the material be sand or gravel or very soft loam, it is essential that it be broken in order that the workmen may be able to handle it. With a steam shovel, however, much of the breaking can be done by the power of the shovel itself aided by teeth which are fastened to the dipper, so that, in many instances, rock which has been imperfectly blasted is further reduced by the crushing and tearing up of the teeth driven by the steam power of the shovel's mechanism. The steam shovel then is frequently called upon to perform not only its proper function of loading, but to a large extent the other process of breaking the material.

THE STEAM SHOVEL VERSUS HAND LOADING

It needs no argument to establish the superiority of machine work over hand labor wherever the amount of work to be done justifies the use of the plant. It is a general rule that, if many foot pounds of work have to be performed, the horse is more economical than the human engine, and the steam engine far more than the horse. Thus, loading into wagons by teams and scrapers may be done a little more economically than by hand, while the efficiency of a steam shovel above that of a horse team is far more than that of the horse team above that of the man with the hand tool.

COST OF WORK BY HUMAN POWER EXPENSIVE IN PROPORTION TO THE UNITS OF WORK TO BE DONE

The unit cost of loading by hand will be nearly the same, field conditions being equal, whether the job is a large one or comparatively small, the so-called preparatory costs, which will be referred to later, being almost negligible. Thus we know that a man can load by hand into an ordinary wagon, at a cost of from 10 cents to 20 cents per cubic yard, on the basis of 15 cents an hour for wages, the cost varying between these limits according to the condition and weight of the material and the size and kind of shovels and the efficiency of the organization. This performance ought to be feasible whether digging cellars, building a railroad embankment, dam, or any other general type of work, small or large.

GREAT VARIATION IN STEAM SHOVEL EFFICIENCY

In contrast to the above, the steam shovel is dependent for its work upon so many factors, any one of which may very greatly help or hinder it, that there is a far greater diversity of results than in the case of the hand work. Thus, on the standard basis for labor that we have assumed in this report, the direct labor cost alone for loading varies from ½ cent to nearly 13 cents per cubic yard, as observed.

TRAINED LABOR NECESSARY ON STEAM SHOVEL WORK

For the most economical operation it is necessary not only

that the shovel runner and craneman be skillful men, but that they shall have been accustomed to work together, and that the other men on the work who are engaged in co-ordinate processes be properly trained to work with the shovel crew; otherwise the work will not run smoothly and the cost will be correspondingly high. Bad co-ordination on such work will inevitably cost more than correspondingly bad co-ordination in hand work.

CO-OPERATION OF OTHER PROCESSES When a show-WITH THE STEAM SHOVEL WORK el is loading rock, for in-

stance, its own efficiency is very dependent upon the manner and thoroughness with which the rock has been broken. The blasting must be of such quality as to break up the rock so that the shovel can easily handle it without leaving ridges that prevent the laying of the shovel track to grade. We have had experience with work where, because the blasting charge was not concentrated in the bottom of the holes, the ridges were so pronounced that the shovels were unable to operate more than 50 per cent of the working day, the rest of the time being spent in waiting while the rock was "mud capped." Here inefficiency of shovel work was due entirely to improper blasting.

HOW MUCH WORK MUST THERE BE TO ECONOMICALLY JUSTIFY THE USE OF A STEAM SHOVEL?

This question is vital on a large percentage of all excavation contracts. To answer it, simply calculate the total cost, including the cost of installing the plant,

and divide this total by the cubic yards of material to be handled. A comparison of the quotients for the different methods will indicate which one should be followed. A list of the various items that are usually included in a contractor's cost is given in Chapter IV.



Fig. 1. 95-Ton Bucyrus Shovel Digging Ore on the Mesabi Range See page 236

CHAPTER II

GENERAL CONDITIONS AND FORMULAS

The cost of repairs should be apportioned REPAIRS to the work turned out rather than considered as a function of the age of the shovel. It will be higher for rock than earth work and higher for badly broken rock than for well blasted material. Thus, in a given material, the repair bill for a season's output of 500,000 cubic yards may be expected to be twice that in which the shovel loaded only 250,000 vards. Time alone does not affect the unit cost of repairs. The reverse of this proposition obtains in the case of

DEPRECIATION If the machine be kept in proper repair the depreciation in its value is affected by time alone, regardless of the work that it is doing. Many concerns class the depreciation and repairs under one account, but this practice is inaccurate and misleading. There is great disagreement among accountants as to how depreciation should be figured, and there are many so called depreciation formulas and "curves." The simplest to use, and one which for steam shovel work is satisfactory if proper allowance be made for repairs, is the "right line formula." which is as follows:

$$X = -\frac{(a - b)\frac{c}{d}}{a}, \text{ where } a = \text{ original value,}$$

b = value on removal or sale, c = time in use.

d = estimated life.

X = % of depreciation.

Then X divided by the output for the period c will be the cost of depreciation per unit of performance.

The working life of a steam shovel may safely be assumed at 20 years, and taking the first cost at, say, \$150 per ton, and its scrap value at \$10 per ton, the value for X, with a ten-year old shovel, would be

$$\frac{(\$150 - \$10)}{\$150} = 46.67\% \text{ in the ten years, or } 4\frac{2}{3}\% \text{ per year.}$$

To estimate the depreciation per unit of output it is necessary to distribute this amount over the working time. The method of doing this is indicated in the latter part of this chapter, under typical Standard Steam Shovel Work

INTEREST The interest on all the money invested in this work must be included as part of its cost. We have assumed this at the uniform rate of 6 per cent.

HEIGHT OF BANK In different classes of steam shovel work, the height of the face to which the shovel can work has an important bearing upon costs. The reason for this is that the higher the bank, the larger the amount that the shovel can load without moving up.

STANDARD RATES

Jones how much contractor Smith paid his men, or for his coal a year or two ago, and Smith usually dislikes to have these exact rates published, on account of possible trouble within his own organization; but it is of importance to be able to compare the efficiencies of different methods in different places, so that any contractor using this volume may be able to estimate the value of any special methods herein described. Such comparison is valuable for making estimates on future work, and it is greatly

facilitated by giving the data observed in terms of an assumed standard rate of pay for each class of men and materials. We have therefore given our cost data in these "standard" figures.

FORMULAS AND DIAGRAMS

TYPICAL STANDARD STEAM SHOVEL WORK

MATHEMATICAL ANALYSIS
AND CURVES OF COST of steam shovel work and the accompanying

curves of cost are useful in enabling a rapid estimate to be made of the approximate cost of steam shovel work in progress or proposed.

d = time in minutes to load 1 cubic foot with dipper (place measure).

c = capacity of one car in cubic feet (place measure).

f = time shovel is interrupted while spotting one car.

e = time shovel is interrupted to change trains.

g = time to move shovel.

 \ddot{L} = distance of one move of shovel.

N = number of shovel moves.

M = minutes per working day less time for accidental delays.

A or B = area of shovel section excavated in square feet.

R = cost per cubic yard on cars in cents, for shovel work only (place measure).

L A N = cubic feet excavated per day.

C = shovel expense in cents, one day, not including superintendence and overhead charges and not including preparatory charges.

n = number of cars in train.

(1) Time to load one car = d c.
 (2) Time to load one train = n d c + n f + e.

(3) Number of trains for one shovel move = $\frac{L A}{n c}$.

(4) Time between beginning of one shovel move and beginning of next

$$(ndc + nf + e) \frac{L A}{n c} + g.$$

(5)
$$N = \frac{M}{\left(dc + f + \frac{e}{n}\right) \frac{L A}{c} + g}.$$

(6)
$$R = \frac{27 \text{ Cd}}{M} + \frac{27 \text{ C}}{M} \left(\frac{f}{c} + \frac{e}{nc} + \frac{g}{LA} \right)$$

This is the equivalent of the equation R = md + b.

(7) Where
$$m = \frac{27 \text{ C}}{M}$$
, and

(8)
$$b = m \left(\frac{f}{c} + \frac{e}{nc} + \frac{g}{LA} \right)$$

We have assumed for the typical example a shovel valued at, say, \$14,000, and the following daily expense:

									P	er Year
Depreciation	$4^{2}/3$	ć							. \$	653.34
Interest, 6%	•									840.00
Repairs, whe	n wo	rking	one	shift					. 2	00.00
									\$3	493-34
Per year of 1		vorki	ng da	ays, o	r \$23	.29 p	er wo	rking	day,	\$23.29
Shovel runn	er			•						5.00
Craneman										3.60
Fireman						•				2.40
One-half wat	chma	n at	\$50]	per m	onth					1.00
6 pitmen at \$	81.50		•	•						9.00
ı team hauli	ing co	al, w	ater,	etc.,	half	day,	say, a	at \$5		2.50
2 1/2 tons coal	l, at \$	3.50								8.75
Oil, waste, et				•	•				٠.	1.50
										\$57.04

It appears that the equation: R=md+b, is that of a straight line. Now since in this equation $m=\frac{27\ C}{M}$ and $b=m\left(\frac{f}{c}+\frac{e}{nc}+\frac{g}{LA}\right)$ all quantities

involved in the equation excepting d are, or are assumed to be, constant. The data upon the value of these quantities furnished by the accompanying

^{*}For various reasons, such as weather, lack of continuous work, transportation of plant, etc., we have assumed the average working year as composed of 150 working days. This, of course, will be greatly affected by local conditions.

reports have been presented in graphic form with all influencing factors noted on the five plates, A, B, C, D and E, bearing the heading for use with cost curves. See pages 20 to 24 inclusive.

Plate A indicates the time to load one cubic vard. place measure, in various kinds of material. deals with the quantities e, average time shovel is interrupted to change trains. For use in plotting the equation above, those average values of e, n, c and f, involved in ordinary contracting work where side dump cars are used, have been tabulated separately on plate C. It will there be seen that the average value for e, the time between trains, is 4 minutes. The average number of cars per train, or $n_1 = 10$. The commonest form of contractors' side dump car is of 4 yards water measure, or 2.5 yards place measure capacity*, and we therefore take c = 67.5 cubic feet. The ordinary value of f is zero, since the cars are almost invariably spotted while the shovel is swinging and digging. Plate D deals with the values of M or the working time, including actual shovel time, waiting for trains, and moving up, but not accidental delays. Plate E deals with the time of moving up, an average value for which is 8 minutes.

The constants having been thus established, three sets of curves have been plotted on the plates headed cost curves, I, II and III, one for each of the three values of L A 1500, 3000 and 6000 cubic feet (L being the average shovel move, 6', and A the area of the dug section in square feet). Each of these sets of curves has been plotted for values of M, ranging from two hours to ten hours by hourly intervals, between which intervals our observed values (see plate C) fall.

We have found it much more convenient to make use of our data when arranged in this manner, both for field work and for the purposes of the estimator,

^{*}This is a general average. It varies a good deal with the character of the material handled.

than when expressed in long tabulations. Moreover, when cost data are presented in the detailed form contained in this volume they are applicable to a far wider range of new conditions than when simply given in totals as records of cost. Attempts have been made to discredit cost data on the ground that they are of no use to anyone except him who did the work or made the original observations, or on the ground that to a reader who has perhaps never seen the job at all there will be so many unknown conditions, that when applying the data to his own work he cannot be sure of having conditions sufficiently similar to make comparisons safe. Moreover, skill in management varies greatly with different organizations, and a reader may not have the same ability in organizing or handling work as some of the people whose performance has been herein described. This is very true, and if the reader can do as well as any one of several of the managers whom we met in getting up these data, he may be proud, as well as wealthy; but cost data on any work, if presented in sufficient detail and with clearness, will be useful to any man, good, bad, or indifferent, who will intelligently study them. If he attempt to proceed with improper study of the data or of the work that he is trying to do himself, he will fail just as he would without the data, which in all cases must be taken with intelligent discrimination.

In the formula for steam shovel loading cost are some ten quantities that vary on different pieces of work. Some of these are dependent on the kind of material and equipment, some depend on the efficiency of the management alone, and some few are affected by conditions beyond control or foresight, such as weather. The first two can be "standardized" and the other must be estimated by us for purposes of illustration and by the reader for his own use. Even in the case of weather, there is not as much uncertainty as

would at first appear, for over a long working season the number of days suitable for operating may be pretty well estimated in most climates by going over the Weather Bureau records for the neighborhood.

Because the meaning and general bearing of a mass of data can be grasped by looking at charts much more readily than by any other method known to us, we have used them in this volume.

STANDARD ASSUMPTIONS 7

These have been made to facilitate the chart

work, and because from our experience they are entirely justified in practice. When, for example, we assume that the time to move a shovel is four minutes, though some men take fifteen, and a few two or three, we are justified by a vast number of cases in which the moving was actually done in four minutes. If the reader find that his men are taking eight or ten minutes, an application of the rules given in Chapter X, will save him some money. The assumptions for "A" depend upon the field conditions, and the reader must use the particular plate that most nearly represents the section area of his job, or else must make up his own chart, not a difficult or laborious operation in any event.

USES OF COST CURVES

There are two important uses to which these curves of cost can conveniently be put.

- 1. Estimating the cost of proposed work.
- 2. Checking up the cost of work under way.

In estimating we may proceed as follows:

Assuming that the proposed work is to be a railroad cut in rock, with average equipment, there are then only three quantities to decide upon, namely, L A, 27d and M. The area of the shovel section being assumed at 250 square feet and the average distance

of move being 6 feet, L A will equal 1500 cubic feet. Now refer to plate A and select a fair value for the time of loading one cubic yard in rock work. Suppose 30 seconds be chosen. Next refer to plate D for the proper value of M to use for rock work. The average value is 8 hours (80 per cent. of 10 hours). The cost per yard in cents can now be read directly on cost curves, plate 1. With abscissa (27d) as 30 seconds glance upward till the vertical line through 30 seconds intersects the 8 hour, M line. Then on the left opposite this point of intersection read $9\frac{1}{2}$ cents as the cost per cubic yard loaded, place measure.

It may be noted here that with respect to the two important items of time to load I cubic yard with dipper and values of M, the cost curves are perfectly flexible. Variation in the value of the constants may be allowed for by proper choice of M. In connection with the formula it is interesting to note the effect of decreasing the carrying capacity of each train, other conditions remaining the same. Suppose the carrying capacity to be decreased from the average, 10 x 2.5 yards = 25 cubic yards to 8 x 2 yards = 16 cubic yards, place measure, what would be the effect upon the cost per cubic yard? The new cost per cubic yard, place measure, would be 10.6 cents against the former 9.5 cents, an increase of 1.1 cent per yard, or 10 per cent.

To use the curves for checking the cost of work in progress proceed as follows: The field operations are few and simple. Find the average time per dipper swing. Knowing the rated capacity of the dipper and the character of the material, a glance at the tabulation near the top of plate A will give the ratio of dipper capacity, place measure, to dipper capacity, water measure, and by using this factor the average capacity of dipper, place measure, can be obtained, and thence the time to load I cubic foot or yard. Suppose for instance the average

time per swing to be 25 seconds, material earth, and capacity of dipper 2¹/₄ yards. On plate A, under heading "Ratio of place measure water measure" we find for earth

the average value for $\frac{\text{place measure}}{\text{water measure}}$ given as 0.53.

Therefore $2\frac{1}{4}$ x 0.53 = 1.2 yards per swing or 2.88 yards per minute, or .35 minute per cubic yard. Make some rough measurements to determine the approximate area of the shovel section and multiply this area by the length of move up and get L A, say 3000. Then, from previous observations or by an estimate of M, get the time worked per day, less accidental delays, say 9 hours. Now take cost curves, page 26, and with .21 as abscissa read opposite the line for M = 9 hours, 6 cents as the cost per yard place measure. If the constants in the formula do not agree closely enough with actual conditions, allow for this by choosing a suitable value of M. or substitute directly in the equation for cost.

Note that the above costs do not include superintendence or overhead charges, and cover only the cost of loading. Transportation, dumping, spreading and preparatory costs are not included.

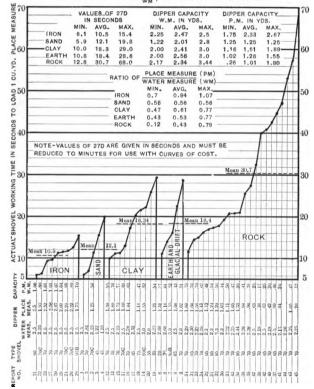
These plotted charts have been given to assist the man who is accustomed to charts to use the observed data contained in this volume. By their use it is much easier to pick out the conditions that fit any particular piece of work, or a particular example to fit the conditions of the work to be done, and thus make the data available with less time than would be necessary if all the figures were given in tables.

It should be particularly noted that for plotting the two co-ordinates certain assumptions are necessary because there are a large number of variables in the theoretical steam shovel formula. Thus, we have made three plates—one where the expression L A is 1500

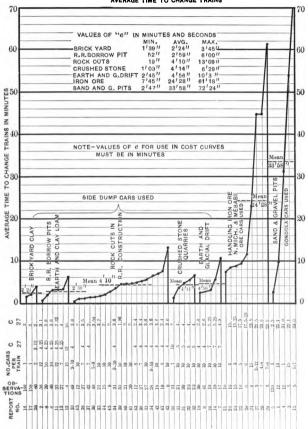
cubic feet, one where it is 3000, and one where it is 6000. We have also made an assumption of \$57.04 for the value of C. Where the shovel differs very much in type from the one mentioned or where the rates of labor are very different from those assumed, it will be necessary to compensate for the difference between the new value of C and the one that we have used in the diagrams. The easiest way to do this is to multiply the figures taken from the diagrams by the ratio between the new value of C and the assumed one. Thus, if the shovel costs per day turned out to be \$65 instead of \$57.04, and the diagram should give a cost per cubic yard for loading of 12 cents, we would have for our charge 12 cents multiplied by \$65 and divided by \$57.04, or 13.67 cents per yard. As heretofore indicated, this does not include the cost of overhead charges, superintendence, and preparatory charges, which in all cases must be added for purposes of estimating. It will be well worth while for the man who contemplates doing shovel work to give these diagrams and the formulas most careful study, and to make up for his own work, substituting in the formula the constants that he expects to obtain, diagrams that will be exactly suited to his particular case.

FOR USE WITH COST CURVES PLATE "A"

VALUES OF 27D 8HOWN GRAPHICALLY BY BROKEN LINES BELOW. FOR VARIOUS RATIOS OF $\frac{PM}{WM}$, IN DIFFERENT KINDS OF MATERIAL



FOR USE WITH COST CURVES PLATE "B" VALUES OF "e" SHOWN GRAPHICALLY AVERAGE TIME TO CHANGE TRAINS



FOR USE WITH COST CURVES PLATE "C"

Values of e, n, c, f, involved in ordinary contracting work with side dump cars.

e = Average time shovel is interrupted to change trains.

n = Number of cars per train.

c =Capacity of cars in cubic feet (place measure).

f = Time to spot one car. c' = Capacity of cars in cubic feet (water measure).

	V:	alues of	n	Va	alues o		c'	
	Min.	Avg.	Max.	Min.	Avg.	Max.	7	<i>\</i>
Brick yard clay .	I	1-2	2	54	72	81		
R. R. borrow pits	7	11	15	83.7	126	270		151
Rock cuts	7	9	12	54	7.5	97.2		188
Crushed stone		•				*		
quarries	I	10	10	108	124	189	9	162
Earth and glacial							Zero	
drift	10	10-11	13	70	108	141		1 57
Iron ore	3	7	12	270	540	675		1 57 540
Sand and gravel	"				•			•
pit	I	7	15	67.5	598	891		

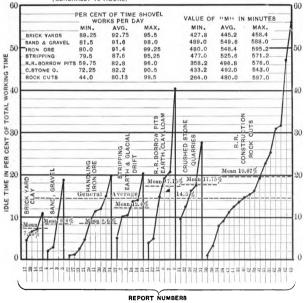
General average of e, n, c, f, c', as follows

	No. of Obs.	Minimum	Average	Maximum		
e n f	35 35 0	.25 min. 5.0 cars	4.00 min. 10.00 cars	13.5 min. 15.0 cars		
c c' c/c'	35 27 27	2 yards 4 yards 0.5	4.00 yards 5.00 yards 0 8	10.00 yards 12.00 yards 0.95		

FOR USE WITH COST CURVES PLATE "D" AMOUNT OF IDLE TIME SHOWN GRAPHICALLY IN PER CENT OF TOTAL TIME WORKED EACH DAY

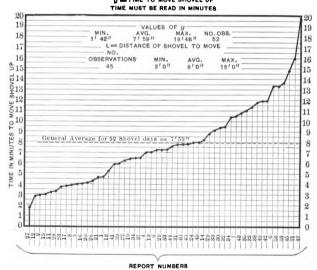
VALUES OF "M" TO BE TAKEN FROM THIS TABLE
"M" == ACTUAL WORKING TIME OF SHOVEL

TO FIND "M" TAKE VALUE PLOTTED BELOW, SUBTRACT FROM 100% AND MULTIPLY RESULT BY TOTAL WORKING TIME PER DAY. (GENERALLY 10 HOURS)



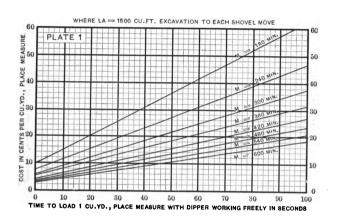
Report No. 15 Worked in Slag Report No. 43 Rock Cut on Soo Canal Widening

FOR USE WITH COST CURVES PLATE "E" VALUES OF "g" SHOWN GRAPHICALLY AS TAKEN FROM THE VARIOUS REPORTS g = TIME TO MOVE SHOVEL UP



Note-Shovel on Report No. 9, Engaged in Sewer Excavation, Averaged 33'

COST CURVES



FORMULA

$$R = \frac{27Cd}{M} \quad \frac{27C}{M} \left(\frac{f}{c} + \frac{e}{nc} + \frac{g}{LA} \right)$$

= 0, interruption of shovel while spotting cars.

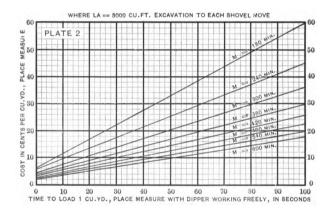
Assume

| T = 0, interruption of shovel while spotting cars. e = 4 minutes of time between trains. n = 10, number of cars per train. c = 2.5 yards place measure = 67.5 cubic feet. C = 5704 cents, daily cost. M = Actual working time of shovel. g = 8 minutes, see Plate D. d = Minutes to load I cubic foot, place measure.

COST CURVES

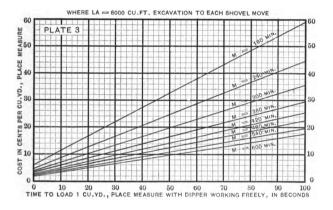
DAILY COST "C" AS FOLLOWS

Plant dep										
										\$ 653.34
Interest,										840.00
Repairs	•	•	•	•	•	•	•	.•	•	2000.00
										\$3493.34



						Per Day
\$3493.34 ÷ 150 da	ays eq	uals				\$23.29
Shovel runner						5.00
Craneman .						3.60
Fireman						2.40
½ watchman .						1.00
6 pitmen, at \$1.50						9.00
Teaming one-half	day					2.50
2½ tons coal .	,•					8.75
Oil, waste, etc.						1.50
						\$57.04

COST CURVES



Values of f Values of e Values of n Values of c Values of C Values of M

Values of g Values of d Same as used on Plates 1 and 2.

CHAPTER III

FIELD CONDITIONS

EOUIPMENT To do work economically in the field, it is an axiom that the equipment must be proper in condition and suitable in design. need not necessarily be of the very latest model, with all the new improvements, for it sometimes happens that the high cost of new equipment may render its purchase inexpedient. But, and this point must receive emphasis, the equipment must be of the right kind and in the right condition. Sand is dug with a large dipper and a sand lip, and rock with a smaller dipper and the best of teeth. We had occasion to reorganize a job on which were working a Bucyrus Shovel of a certain size and one of another make that weighed a good many tons more than the Bucyrus. The work was in rock, badly blasted, and taxed both shovels to the utmost. It happened that because of greater power in the lifting and crowding motions the Bucyrus, which was by far the lighter shovel, was able to do more efficient work in the rock, while there was no appreciable difference in performance in clay and loam, for which materials the other shovel was amply strong. It was entirely capable of carrying a dipperful of rock to the car, but it often stopped when attempting to break rock with the teeth. Experience with another shovel in narrow trenches, demonstrated that it was effecting no saving over hand labor. digging cellars, or trenches of twice the width of those that it had to excavate, or for clay material free from boulders, it would have been highly economical.

For each piece of work there is economically one

For each piece of work there is economically one best type (not necessarily one best manufacturer) of equipment, and to handle the job cheaply it is necessary to have that type. SUPERINTENDENCE The quality and amount of the superintendence will greatly

affect the unit costs on the work; and by superintendence we mean not only the man in charge, but his whole directing organization. The work in the iron ore country is an example of what may be accomplished in the way of skilled organization. It is with increasing force coming to the attention of managers that superintendence is a many sided art, requiring study as well as experience, and trained helpers in addition to a time-keeper. Special appliances, such as a stop-watch, record blanks and tally machines, are also necessary for the best of control over the daily conditions. Cost keeping on the job must be applied immediately after performance, or else it is too late to take advantage of the lessons of cost and to economize the work.

Pure observation alone without actual timing, will not show a superintendent whether it is more economical for him to use nine-car or ten-car trains to haul material away from his shovel. Logic alone will tell him whether the shorter or the longer train is the better to use. He will generally favor the use of long ones if his engines will haul them. Yet money has been saved by shortening trains even when the engines could easily haul the longer ones. In this case the key to the situation was the time required to dump and transport.

So many conditions of management enter into efficient steam shovel work, that it is most sensitive to variations in the superintending organization.

GENERAL ARRANGEMENT This feature always receives great attention

from skillful managers. The "old line" contractor comes upon the job and looks it over from the seat of his buggy, deciding on the ground where he will begin operations and how he will remove the material from the

shovels. The modern manager undertakes it much in the manner of a German professor attacking a mathematical proposition. Sometimes there is only one place to "cut in" and only one way to handle the earth or rock; but generally there are several places to cut in and many, many ways available for handling the material. If there were only three ways, and there are seldom less than twenty-three, he is a bold man who would decide off hand which is unquestionably the best of the three. until an economic study has conclusively established To do this it is necessary to consider methods in use in other places and often in other lines of work. It happened that the subaqueous drill operators developed the fact that pumping a jet of water under high pressure into a drill hole would greatly decrease the cost of drilling rock; and they were led to try the plan because water was just over the side and good force pumps were on board the drill boats. This device in the subaqueous field has saved large amounts of money when applied to drilling on land.

Steam shovel operation is rarely a contin-LOST TIME uous performance, so far as concerns the There are always delays, some of which shovel itself. are due to breakages on the shovel itself and some to interruptions of one of the collateral processes, breaking or transportation. The most costly of these, in our experience, has been where the shovel was loading blasted rock, and because of imperfect breaking the shovel had to stop from time to time to allow drilling and blasting under the dipper. In one case the interruptions from this cause amounted to nearly 50 per cent, which in an eight-hour day allowed the shovel only four hours for actual work. Under such conditions the transportation facilities must be adequate to keep the shovel working full time, so that delays to the shovel increase the cost of transportation correspondingly.

Accidents to the transportation department, due to bad condition of the equipment, rolling stock, or track, cost just as much as delays of the same duration caused by shovel break-downs. Reserve equipment will often save money in such a situation, but the best safeguard is to give to one man the facilities and responsibility for seeing that all equipment be kept in first class repair. It is customary for shovel crews to make their repairs to the shovel out of working hours and on Sundays whenever possible. On heavy rock work, where many repairs are needed, the crews often have to work nearly every Sunday for an entire season, and the consequent lack of rest and recreation is likely to tell on the men's working efficiency.

Stopping to "chain out" boulders on heavy rock work in shale or the schist of Manhattan Island is likely to account for a lost time bill of 20 per cent or more, and presents a most aggravating and discouraging obstacle to good work. In such cases several extra chains should be provided, and two or three men constantly employed in putting them on the boulders as fast as possible while the shovel is working. Even if these men are often idle for several minutes at a time, the result, in shovel output, of their services is worth more than their pay. After estimating how many cents each dipper swing is worth in pay yardage, it is a simple matter to calculate how much should be spent in keeping the dipper working. Mud-capping the boulders, to save "chaining out," is desirable if it can be done without too much delay. Usually it will be found cheaper in the end to keep a man or two drilling block holes, especially if the facilities permit the use of a small power drill. When thus drilled the boulders can be cracked with small charges and with almost no interruption to the shovel work. With the small drill (like a riveting gun) the holes may be put in on the side of the boulder away from the shovel, if that side can be reached, drilling about 6 to 10 inches deep, tamping with blue clay forced in with the thumbs and fired with a fuse. Very small charges of a rather high powder (50 or 60 per cent) should be used.

A list of the various causes of delay should be kept by the shovel runner, and reported daily, with the duration of each, so that the relative importance of the different causes may be known, and a standard remedy adopted. Whenever such a remedy is needed, the shovel runner can call for it by a whistle signal. The following is a convenient code for these signals, a long toot being indicated by a dash, a short one by a dot:

maicute	by a dash, a short one by a dot.
	Pit crew get ready to move shovel.
	Get ready to mud cap.
	Get ready to block hole.
	We need coal.
	We need water.
	Waiting for cars (useful to help in spotting cars when dinkey man cannot see hand signals).
-	Stop.
	All ready to blast.
- -	Fire.
	Cars off the track.
	Back up.
	Shovel has broken down.
	Superintendent's call.
A code	e of these signals in the shovel cab, and one

A code of these signals in the shovel cab, and one in the hands of each foreman, will be sure to save money by the elimination of the preventable delays.

KIND OF LABOR and a highly paid specialty, and as a general thing shovel runners are intelligent and conscientious, but a good deal depends on the way in which a runner and his craneman work together. If they should be of incompatible dispositions it is often better to move one of them to some other shovel than to have

them work badly together. They must have considerable confidence in each other in order for the attainment of the highest efficiency.

We cannot too strongly emphasize the importance of selecting the most skillful shovel runners and cranemen. The loss of money caused by indifferent ability in these positions may easily be several times as much as the wages of the men themselves.

We have elsewhere shown the economic effect of efficiency in moving the shovel. For this reason the pit crew should be made up of picked men, one of them getting a little more pay than the others perhaps and having authority over them. Thorough organization here may be worth half of the wages of the pit crew. Of great importance in many classes of work is the dump gang, which usually receives but scant attention. In sandy material there should be no difficulty in dumping the cars with great regularity and returning them to the shovel on time, but with clay mixed with boulders a good dump foreman and a lively gang are necessary for good work. The men must realize that they are part of a large machine and that their own delays will impede their fellow workmen. For this reason it is often well to alternate the foreman and some of the men between the different positions. A foreman on the dump will better realize what is expected of him after he has had experience in the pit and on the track laying. Some of the more intelligent men will also be benefited in like manner, while others of less intelligence will not.

KIND AND CONDITION OF MATERIAL The kind

of material

greatly affects the shovel output, as will be seen from the reports which follow. Rock work will generally cost much more to load than earth, and rock that is badly broken may cost three times as much to load as properly blasted rock. In this case, its condition, which affects the cost, may be due to the degree of skill used in the preceding process. Clay will vary much in consistency and in the ease with which it can be handled. The higher the face to which the shovel can work, the greater the efficiency, as indicated elsewhere, if other conditions be equal. The safe height of bank, however, is limited by the condition of the material, heavy slides being dangerous. Some banks are too high to be economically workable on account of slides.



Fig. 2. Shovel No. 1108 Cutting-in on D., L. & W. Cut-off. See page 255

CHAPTER IV

ESTIMATING

For purposes of estimating, in order not to forget anything and to facilitate a logical arrangement of the various costs that occur on the work, it is important to have some standard classification of expenses. The ordinary costs are included in the following list, which is used by the Construction Service Company as a standard guide, and which will be found useful as a guide to properly subdivide the cost keeping in the field, and as an aid to the bookkeeper. By using the symbols opposite each name they can be readily and easily referred to. We have found that the mnemonic method is much easier to remember and more satisfactory in operation than a numerical system. It has been in use for some time and it is proving very satisfactory.

STANDARD CLASSIFICATION OF EXPENSES

Classification I. Main Classification of Expenses.

 $X \longrightarrow X$ Miscellaneous $X \longrightarrow X$ Overhead.

U Sub-contract

Classification II. Distribution of Classification I.

L Labor directly productive.

Lh Hourly labor.

Lw Weekly labor. Lm Monthly labor.

Li Incidental labor.

Labor superintending.

M Material.

Supplies.

Miscellaneous.

Classification III. Distribution of Classification II.

Depreciation Maintenance.

Interest

Storage

- H Hire or rent T Transportation
- O Organization or preparatory
- X Miscellaneous
 - Charity or accidents
- B Bonus or discounts
- Legal and medical
- Publicity or advertising
- A Accident insurance
- Fire insurance
- O Theft insurance
- G Bond to guarantee contract

Incidental.

Classification IV. Application of Classifications II and III.

- Equipment or plant.
- Т Tools.
- B Buildings.
- Cash capital.
- X Miscellaneous.

Classification V. Field Processes.

- B Breaking (loosening).
- Construction.
- D Dumping.
- G Grubbing.
- L Loading.
- M Mixing.
- P Protection. R Ramming and rolling.
- Spreading.
- T Transportation.
- X Miscellaneous.

Classification VI. Type of Work.

- C Concrete masonry.
- Е Earth.
- L Liquids.
- M Brick and mortar.
- R Rock.
- W Woodwork.

We also give in this chapter some charts made up from our observations, which will be useful in helping to estimate the costs on steam shovel work. Rates of wages must be ascertained for the particular locality in which the work is to be done, and with reference to the condition of the labor market. It may be noted that certain report numbers are quoted in those charts, the corresponding reports not being found elsewhere in this volume. In such cases the information is on file, but is not published in detail, owing to objection on the part of the company or individual operating the shovels.

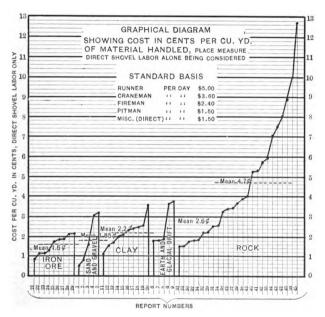
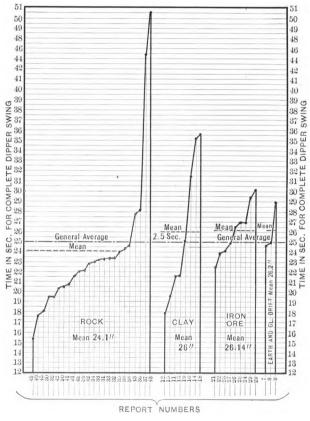
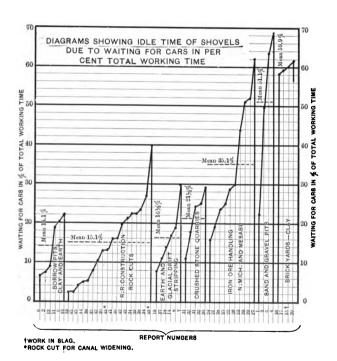


TABLE OF RATES OF WAGES. DIRECT LABOR BUCYRUS SHOVELS

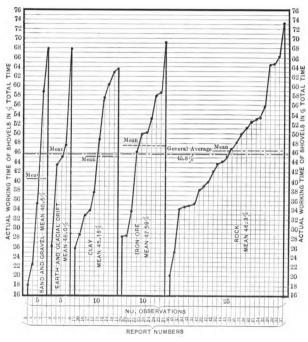
Occupation	No. Obs.	Minimum	Average	Maximum
Runner	41	\$75.00 per mo.	\$135.00 per mo.	\$175.∞ per mo.
Craneman	41	55.00 per mo.	96.00 per mo.	125.∞ per mo.
Fireman	38	50.00 per mo.	62.00 per mo.	87.∞ per mo.
Coalman	8	1.40 per day	1.47 per day	1.50 per day
Pitman	39	1.40 per day	1.90 per day	3.50 per day



Diagrams of Time in Seconds for Complete Dipper Swing



DIAGRAMS SHOWING ACTUAL SHOVEL WORKING TIME IN PER CENT OF TOTAL TIME



Material	Min.	Avg.	Max.	No. Obs.
Sand and Gravel	18.2	40.5	67.6	5
Earth and Drift	26.5	46.0	67.8	5
Clay	26.0	45.16	63.4	10
Iron Ore	28.4	47 59	69 3	10
Rock	20.4	46.3	73.3	25

CHAPTER V

STEAM SHOVEL WORK IN SAND AND GRAVEL

Most of this work is likely to be in a borrow pit, where a large area is to be excavated, and where the installation is of a semi-permanent nature. Many of the banks are very high, requiring few moves of the shovel, and in some cases, especially where there is some cementing material mixed with the sand or gravel, or when the cementing is done by ice in the spring or fall of the year, heavy and dangerous land slides are possible.

From an operating standpoint sand is an ideal material to handle, except when very fine and in heavy winds, in which cases a high pressure stream of water from a hose with spray attachment, if water be plentiful, will greatly help to keep the sand out of the eyes of the men. Sand in a freshly dug bank is quite often naturally moist. In railroad work a good deal of this material is loaded on flat cars with or without sideboards, and it is often difficult to make close estimates of the amounts handled. We have found it an excellent method to weigh the amount of material that will fill a half cubic yard box, at average dryness, and then weigh several trains of cars of the material, which can easily and conveniently be done. From records obtained in 1898, average gravel used for railroad ballast, fair quality, moderately clean, weighed 3248 pounds per yard, rather dry, and the average flat car without sideboards contained 9.4 cubic yards. The length in a train of such average cars was 36 feet center to center of couplers, so that when dumped from the train the ballast averaged 0.26 cubic yard per foot of track. This was sufficient to raise one track 5 inches.

Free running dry sand will not stand up so high in the bucket or on the cars as when it is quite wet or

contains some little cementing material. Therefore, the best performance can be looked for where there is a little cement or water evenly distributed in the bank.

REPORT No. 1 — SHOVEL No. 612

INSPECTED SEPTEMBER 11, 1909

DUNE PARK, IND.

GENERAL CONDITIONS The Knickerbocker Ice Company have this shovel working on some 100 odd acres of sand land at Dune Park, Ind. A large part of this tract has been leveled already. No washing of the material is needed, for it is all of uniform size and exceptionally clean, sharp, white and rather small grained. The bank against which the shovel worked was fully 60 to 70 feet high and sloped at about one on two.

The material was loaded upon gondola cars supplied and spotted by the Lake Shore & Michigan Southern Railway.

TYPE OF SHOVEL The shovel is of the usual 70-ton type with all steel dipper handle and boom, the latter being of the truss type braced on the sides. A 2½-yard dipper is used. This, instead of teeth, has a long steel lip or "cutter blade," so that when filled its capacity is increased to about 3¼ yards. Water is taken from the ground by means of a pipe sunk therein and a pump on the shovel, which is digging to water level only.

COST KEEPING The time sheet is made in duplicate and is sent to the main office, where the payroll is made up and the total amount charged to the job. The steam shovel report also goes to the main office every day. This is made out by the steam shovel engineer, but is copied by the clerk to obtain a clean sheet. A facsimile of such a report blank is given on page 46.

At this place is a car repair shop and the work recorded by the use of a system of cards which are made out in duplicate. At the field office the only way to obtain the cost of the repairs for any one car is to go over all the slips and select those pertaining to the

car in question.

The requisition blank consists of a form about 6 x 8 inches, similar to that given in "Field System," by Gilbreth. This is in triplicate, one copy for the main office, one for the field, and one for the mechanical engineer at the shop. If the latter have the material wanted on hand he sends it to the job, but if he lack it he copies the requisition, sending it to the purchasing agent, who obtains and ships the goods.

OBSERVATIONS

Weight	70 t	ons, s	hippi	ng we	ight v	with	out co	al an	d water
Gauge	٠.		• • •	٠.	٠.			St	andard
Capacity of dippe	r.				3.27	cu.	yds.,	inclu	ding lip
Height of lift					٠.				91/2'
Kind of teeth				None	e, but	stee	l lip	exten	ded 31"
Number of pitmer	n				· .		٠.		. 4
Height blocked u	р								. 6"
Length of boom	٠.								28'
Length of dipper	han	dle							18' 6"
Height of boom a			vel tr	ack					24'
Horizontal reach									20′
Farthest dipper c			to du	ımp					27
Highest dipper ca									16'
Diameter of swin									7' 6"
Height of dinkey			bove	shove	l trac	ks			' 1'

OBSERVATIONS—Continued

Distance inside dinkey track to inside shovel track Depth of dipper including lip	tes
beginning of next	tes
Number of cars to one shovel move	
Area of section	ft.
Cubic yards per car (place measure) . average 21.2 ya Coal cost \$3.00 per ton (Hocking Vall Weather clear.	rds

TIME STUDY

	r orenoon	Atternoon	
Started work	7:06	1:19	
Stopped work	11:48	4:38	
Total time worked,	282 + 199 =	481 minutes =	8 hours
I minute			

	Minutes	Seconds	Per Cent.
Actual working	325		67.6
Spotting cars	3	30	0.7
Waiting for cars	108	45	22.6
Moving shovel	32	45	6.8
Miscellaneous delays, including			
8 minutes clearing track .	1 I	• •	2.3
Total time under observation	481		100.0

HANDBOOK OF STEAM SHOVEL WORK

Direct Labor	r D	isti	ribu	tio	n		Standaı	d Basis	
Per	D	ay				Loading	Spreading	Incidental	Total
I runner .						5.00			
I craneman						3.60			
ı fireman .						2,40			
3 pitmen .						4.50			
3 spreaders							4.50		
Watchman								1.50	
Timekeeper								2.00	
Shop enginee	r							2.00	
1 machinist								3.00	
ı car repairer		٠	٠	•				2.00	
Total cost of	la	boı	p	er	day	\$15.50	\$4.50	\$10.50	\$30.50
Cost per cu. y	d.,	ct	s.			0.47	0.14	0.32	0.93
Per cent .						50.6	15.0	34.4	100.0

Process Analysis	Ti	me	Per	Cost per Yard in	Total Cost
Frocess Analysis	Minutes	Seconds	Cent	Cents	Per Yd.
Charge to loading 1. Actual loading	325		67.6	0.318	
2. Delays (a) Moving up	32	45	6.8	0.032	 0.350
Charge to transportation and dumping					
1. Waiting for cars .	112	15	23.3		
2. Miscellaneous delays	II		2.3	0.011	0.120
Charge total	481		100.0		0.470

Incidental labor
Direct labor = 0.525

Form 103-3m-CG&Co-8137

KNICKERBOCKER ICE COMPANY.

Number Men Worked Shovel Number

STEAM SHOVEL REPORT.

ž	umber Fe	et Moved	Number Feet Moved						Du	ine P	ark,		Dune Park,190
	E	ENGINE			Number	TIME	-	LIME		DELAYS	AYS		
ENGINE	ARR	ARRIVED	DEP.	DEPARTED	Cars	LOADING SWITCHING K.I.CO.	WS 0	TCHING	X.	9	R.R.CO.	9	REMARKS
NUMBER	A.M.	P.M.	А.М.	P.M.	P.M. Loaded Hrs. Min. Hrs. Min. Hrs. Min. Hrs. Min.	Hrs. Mi	ı. Hrs	Min.	Hrs	Min.	Hrs	Min.	
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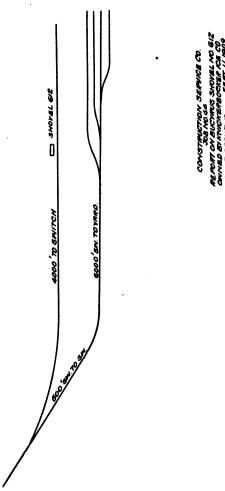




Fig. 3. Bucyrus Shovel No. 612 at Dune Park, Ind.



Fig. 4. Bucyrus Shovel No. 1118 at Kent, Ohio.

REPORT No. 2 — SHOVEL No. 1118

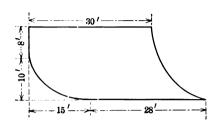
INSPECTED JULY 16, 1909

KENT, OHIO

GENERAL CONDITIONS This work was part of that undertaken in the relocation of the Wheeling & Lake Erie R. R., at Kent, Ohio, and was done by John B. Carter, under contract, and under the personal direction of R. G. Hengst, manager, who may be congratulated on the highly efficient management of this work. The material was uniform in quality, and there was every opportunity to keep the output at its maximum by competition among the men, produced by offering substantial prizes. On the day of inspection a five dollar Panama hat was offered as a prize to the dinkey runner who should average the best time for spotting cars during the afternoon's work. The time was computed from the dumping of the first dipperful into an empty train until the latter started on its way to the dump. This of course included the time of loading by the shovel, and the shovel runner could have "pulled" the race by favoring one of the dinkey As far as could be observed, however, every man did his utmost to make the contest fair and to let the best man win. After five hours' work one of the runners was declared winner of the hat by less than 30 seconds, while the actual loading done was far in excess of what would have been accomplished without such incentive.

The general result of occasional competitions of this kind was to develop an exceedingly efficient field force.

REPAIRS Repairs are anticipated and important parts are kept in duplicate in the storeroom. This shovel and No. 1119 (see page 104) are exactly alike.



Typical Cross Section

OBSERVATIONS

Material is fine gravel with occasional strata of sand. Ideal material to handle. Weather fair after heavy rain during night.

•
Type of shovel Standard gauge 70 C
Type of shovel
Height of lift
Size of ties under shovel 6" x 8' x 8'
Size of bucket
Age of shovel New April 1, 1909
Duration of job
Length of shift
Number of shifts per day
Water pipe from pumping station
Coal hauled by teams and shoveled into bunkers.
Repairs are made by crew, between shifts, or whenever neces-
sary.
Coal used
Water used 300 gallons per hour
Boiler is cleaned every 3 or 4 weeks Very clear water used
Contract price
Contract includes embankment.
Narrow gauge track 3', 55-pound rails for cars.
77' 1 1 ' C 1 1 77 0 T 1
Kind and size of cars used K. & J., 4 yards
Train is braked by steam on locomotive; by hand on cars.
Train is braked by steam on locomotive; by hand on cars. Kind of signals used, hand by brakeman standing on shovel.
Train is braked by steam on locomotive; by hand on cars. Kind of signals used, hand by brakeman standing on shovel. Kind and size of dinkey Vulcan, 16-ton
Train is braked by steam on locomotive; by hand on cars. Kind of signals used, hand by brakeman standing on shovel. Kind and size of dinkey
Train is braked by steam on locomotive; by hand on cars. Kind of signals used, hand by brakeman standing on shovel. Kind and size of dinkey Vulcan, 16-ton

TIME STUDY

 Started work
 Forenoon 9:32:40
 Afternoon 12:02:30

 Stopped work
 11:32:40
 5:02:55

						Minutes	Seconds	Per Cent
Actual working						247	12	58.9
Waiting for cars						31	14	7.4
Moving shovel						55	20	13.2
Miscellaneous dela	Lys					(86	39)	(20.5)
Coaling						5		1.2
Repairing track						4	45	I.I
Repairing track						3	50	.9
Pulling track on						72	04	17.1
Minor repairs						I		. 2
Total time under o	bs	erv	vati	ion		420	25	100.0

Average number of cars loaded per day (average of 85 days) = 516 (9) 41/4 yards.

Average number of cubic yards loaded per day (average of 85 days) = 2193.

Direct Labor Di		:1				Sta	ndard Bas	sis	
Per Da		1Du	non		Loading	Trans- portation	Dump- ing	Inci- dental	Total
I runner					\$5.00				
i craneman .					3.60				
ı fireman					2.40				
11 1						\$7.80			
3 brakemen .						4.50			
4 pitmen					6.00				
9 dumpmen .							\$13.50		
i dump foreman							2.00		
ı pipeman . :								\$1.50	
smith								2.50	
								1.50	
I watchman .								I.50	
Cost of labor pe	rc	lay			\$17.00	\$12.30	\$15.50	-	\$51.80
Cost per day				ic			5.5		
1					0.78	0.56	0.70	0.32	2.36
Per cent					33.0	23.7	29.7	13.6	0

D 4 1 1		Ti	me	Per	Cost per	Total
Process Analysis		Minutes	Seconds	Cent	Yard in Cents	Cost Per Yd
Charge to loading 1. Actual loading 2. Delays		247	12	58.9	0.459	0.573
(a) Moving up(b) Miscellaneous .		55	20	13.2	0.103	575
Charge to transporting and dumping	nd					
 Waiting for cars . Miscellaneous . 		31 80	14 39	7·4 19.1	0.058 1	0.207
		420	25	100.0		0.780

Time Study Reductions	Number	Mini	mum	M	ean	Maxi	Maximum	
Time Study Reductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.	
Time for moving up, shovel idle	19	I	20	2	54	5	45	
Time between moves, shovel working	20	7	35	12	23	14		
Time between trains .	21		55	I	29	2	05	
Time per train loading	36	6	07	6	52	8	10	
Time per dipper	21		16		17		19	
Number of dippers to move	20	24			42.3		48	
Number of dippers per	20	24			42.3		40	
train	36	24			24.2		26	
car	432				2.02			

Very interesting light upon one of the competitions, as demonstrating what can be done in uniform material, is given by the following detailed analysis of the above time study.

	TIME ST	'UDY	
	Forenoon	Afternoon	
Started work	9:32:40	12:02:30	
Stopped work	11:32:40	5:02:55	
Total time worked	Hrs. Min. Sec. 2 00 00	Hrs. Min. Sec. + 5 00 25 =	7 hours

HANDBOOK OF STEAM SHOVEL WORK

(Read from left to right)

Moving Up Shovel Idle		Time per Train	Dippers to Train	Shovel Working Between Moves	Dippers to Move	Time per Dipper	Time Between Trains		Miscellaneous Delays
Min. S	ec.	Min. Sec.		Min. Sec.		Sec.	Min. Sec.	Min.	Sec.
		7 35	24	7 35	24	18.90	*		
5	45	7 50	25	7 50	25	18.75	*	1	
5	30	7 40	26	13 15	43	18.50	2 05		
2	20	8 10	26				I 40		
Contest begi		6 07	24	12 07	44	16 50	1 13		
I	30	7 25	26	8 20	20	17.20	1 35		
1-	40	7 20	24	10 05	33	18.30	1 50	100	
2	00	7 05	24				0 55		
		6 55	24	10 50	38	17.10	I 25		
1	20	7 07	24				I 23	5	oo coaling
		6 42	24	9 54	35	16 9	1		oo couring
1	53			utes 50 se		,	*		
		6 30	24				I 20	1	
		6 30	24	13 00	48	16.20	0 55		
2	40	6 25	24		40		1 30		
	40	6 55	24	13 20	48	16.65	*	4	45 track
2	00	6 25	24				I 20	4	45 1111011
		7 15	24	13 40	48	17.05	*	1	
3	05	6 25	24		40		I 35	1	
		6 51	24	13 16	48	16.55		3	50
		6 32	24		40		1 13	72	04 throw
		6 32	24	13 04	48	16.30	*	1-	ing track
2	58	6 21	24		40	10.30	I 29		on dump
	50	6 40	24	13 01	48	16.24	‡0 15	1	oo misc.
3	25	6 20	24	13 01	40	10.24	I 20		oo mise,
	-3	6 42	24	13 02	48	16.27	‡0 22		
2	53	7 08	24	13 02	40	10.2/	1 30		
		6 39	24	13 47	48	17 20	*	1	
2	54	6 17	24	13 4/	40		1 18	1	
		7 07	24	13 24	48	16.72	‡0 15		
3	15	6 36	24				1 28		
			24	12 52	48	17 24	*		
3	39	7 17 6 48	24	13 53	40	17.34	I 27	1.	
3		7 12	24	14 00	48	17 50	‡0 15	1	
3	33	6 24	24	14 00	40	17 50	1 21	1.	
		7 00	24	13 24	48	16.72	‡0 15		
3	00	6 25	24	† 6 25	124	16.05	+0 15		
	_		_		-		-	-	
Total 55 Average 2	20	247 12 6 52	871 246	247 12	871		31 14 1 25	86	39

¹² cars to train. Total cars, 432.

[†]Left out of averages, because not a full move worked.

^{‡*}Train up during move or at noon or shortly after. Therefore not used in averages.

RESULTS OF CONTEST

As before stated this contest was for the price of a Panama hat to be given to the dinkey engineer who averaged the best time for loading a train, i. e., "loading time."

Di Lo	inkey No. ading Tin	7 ne		inkey No. ading Tin		Dinkey No. 3 Loading Time			
Minutes	Seconds	Dip'rs	Minutes	Seconds	Dip'rs	Minutes	Seconds	Dip'rs	
6	07	24	7 6	25	26	7	20	24	
7	05	24		55	24	7	07	24	
6	42	24	6	30	24	6	30	24	
6	25	24	6	55	24	6	25	24	
7	15	24	6	25	24	6	51	24	
6	32	24	6	32	24	6	21	24	
6	40	24	6	20	24	6	42	24	
7	о8	24	6	39	24	6	17	24	
7 6	07	24	6	36	24	7	17	24	
	48	24	7	12	24	О	24 (10)	24	
7	00 (11)	24	6	25 (11)	24				
T'1 74	49		T'1 73	54		T'1 67	14	j.	
Av. 6	48		Av. 6	43.09		Av. 6			
Cars Dip'rs	1 32 264		Cars Dip'rs	1 32 266		Cars Dip'rs	120 240		

			Minutes	Seconds	Per Cent.
Actual working			215	57	72.0
Waiting cars			27	29	9.2
Moving shovel			41	45	13.9
Miscellaneous delays		•	14	35	4.9
			299	46	100.0

NOTE—In the above ratio, the 72 minutes 4 seconds delay due to pulling track on dump is omitted.

The material was ideal for steam shovel work, and as the time study shows, the machine worked with clocklike regularity.

The total loading time of the contest was 215 minutes 57 seconds, and in this time 770 complete dipper swings were made, and 384 cars at 4 cubic yards each were loaded.

Special attention is called to the remarkable closeness of the averages.

It is our understanding that the output shown on page 56, in cars of 4½ cubic yards capacity, was accomplished during the months designated.

Shovel No. 1118 was moved back on standard rails 30 feet in length, only 6 rails being used, and the method

employed was as follows:

When the shovel had finished its cut, a track 90 feet long was laid behind it joining the regular shovel track made up of short sections. The shovel was then backed to the end of this track, and as soon as it had passed off the first rail-length the rails were picked up by four men and thrown over the loading track. On this track stood a dinkey with a 6 by 8-inch piece fastened to its front end, and long enough to extend about 6 feet from the side of the dinkey on the shovel side of the track. At the end of this was a piece of ¾-inch cable, wrapped securely around the timber, and with a loose end about 10 feet long. At the loose end of the cable was a hook made of material small enough to be inserted in the bolt holes in the rail.

When a rail was moved over toward the loading track this hook was fastened to the rail and the dinkey then dragged the rail to the rear of the shovel. While the four men were moving the rails and the dinkey was dragging them, three other men were gathering up the ties and putting them in piles of three or four each, fastening them with chains. The ties were dragged by mule team to a place in rear of the shovel where they

HANDBOOK OF STEAM SHOVEL WORK

No.	April	May	June	July
· 1	173	166 dug out	564	552
2	7.5		516	108 dug out
3		688	516	312,3 hrs cos
4		720	492	• •
5	136 starting	800	264	
		752		612
7 8	387	732	576	552 612
8	426	752	552	612
9	420	. •	516	600
10		496	moving back	552
11		128 dug out	552	• ;
I 2		672	624	516
13	150 dug out	640		504
14	324 moving back		468	492
• •	5 hours	624	492	84 dug out
15	522	• •	564	
16	66o	528	408	
17	708	624	576	
18	• •	;;		
19	408	636	468	
20	336	264 dug out		
2 I	720	300	516	
22	708	564	216 dug out	
23	300	540	336	
24	732	660	588	
25	• •	612	588	
26	708	624	588	
27	780	504		
28	696	564	552	
29	416	264	564	
30	640		552	
31		408	· ·	
	10,350	14,918	12,648	

were spaced by two men and made ready to receive the rails. As soon as sufficient ties for a rail length of track were laid, the rails that had just been brought back by the dinkey were placed upon them and fastened to the rails on which the shovel stood, and were connected and spaced by four regular track bridles. The shovel then moved back one rail length and so left a rail length in front of its position uncovered, this being then torn up and moved back—the rails by the dinkey and the ties by the mules.

The force engaged included the

Shovel engineer Craneman 1 Mule team and driver8 Men moving rails5 Men moving ties

Fireman Dinkey engineer Dinkey brakeman

4 Pitmen bolting track, etc.

1 Foreman

at a total labor cost of \$46.60 per day.

It took I hour 10 minutes, to move the shovel back 300 feet in this manner or 1167 of a day.

 $0.1167 \times $46.60 = 5.44 to move 300 feet or 1.81 cents per foot.

Preparatory cost was \$1500; includes moving shovel 2500 feet from railroad tracks on practically same grade as bottom of pit.

Distance of move in pit laterally for each bank averages 30 feet for eleven moves.

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{60,000}{7,500} = 8.00.$

REPORT No. 3 — SHOVEL No. 611

INSPECTED SEPTEMBER 14, 1909

GARY, IND.

GENERAL CONDITIONS

The Pennsylvania Railroad, as part of the improvement of its lines west of Pittsburgh, is abolishing grades at South Chicago. The contract for excavating and placing the earth for this embankment is in the hands of P. T. Clifford & Sons, of Valparaiso, Ind., while everything else, including concrete and timber work, is being done by the Brownell Improvement Company of Chicago, Ill.

Sand is used for the filling and is taken from a sand pit owned by Mr. Clifford and located at Gary, Ind., and steam shovel Bucyrus No. 611 is occupied in loading this sand into cars supplied by the Pennsylvania Railway and transported by them a distance of 15 miles over their main line to the fill at South Chicago.

The steam shovel itself has no features that would distinguish it from any of the others of the 70-ton class, but the method of blocking up the rear trucks is different from the usual practice. These are raised 20 inches while the front ones are elevated only the usual 6 inches. The reason given for this by the runner was that the boom "swung better." When it is swung loaded over the cars it can be stopped more quickly and will swing back in less time than when blocked evenly. The boom is of the truss type with lattice side bracing, and both it and the dipper handle are made entirely of steel. Water was taken from the locomotive.

PLANT ARRANGEMENT
As indicated by the sketch, the Pennsylvania Railroad maintains a small yard at this point. The arrows show

the direction taken by loaded and empty cars. Two large freight locomotives were kept in this yard to haul the trains to the main line. Two road locomotives hauled from the siding to the fill in South Chicago. A small shop containing a boiler to supply steam for the pump that forces water into the tank, a drilling machine, and a few hand tools are also maintained here by the railroad.

At the fill in South Chicago the sand is shoveled from the cars by some 50 Italian laborers, and after the train pulls out, a side scraper levels off the bank.

OBSERVATIONS

Type of shovel	n
Gauge track standard	
Capacty of dipper 3 cu. yd	S.
	7′
Kind of teeth Extended 1	ip
Number of pitmen	4
Height blocked up rear trucks, 20"; front trucks	6'n
Length of boom	o″
Length of dipper handle	6"
Height of boom above pivot	
Height of boom above shovel track	8"
Horizontal reach of boom 21'	6"
	81
Highest dipper can reach to dump	6′
Diameter of bull wheel	,,
Height of dinkey tracks above shovel tracks	§″
Distance inside dinkey tracks to inside shovel track 20	o′
Depth of dipper (water measure) 501/2	٤"
Depth of dipper, including lip	ī″
Total distance moved forward during day 44	
NT	7
Maximum distance moved forward in one move 7'	ı″
Average time between beginning of one shovel move	•
and beginning of next 60.7 min	n.
Number of cars to one shovel move	
Time shovel is interrupted to change train 267 min	
Area of section	
Height of face	o
Cubic yards per car 21.1 place measure (average	
Weather, clear	′

TIME STUDY

	Forenoon	Afternoon
Started work	7:09	12:48
Stopped work	12:00	5:04

Total time worked . . 291 + 256 = 547 minutes = 9 hours 7 minutes.

	Minutes	Seconds	Per Cent
Actual working	193	30	35.4
Spotting cars	I	30	0.3
Waiting for cars	267	00	48.8
Moving shovel	28	00	5.1
Miscellaneous delays	7	00	1.3
Idle-engineer looking after fire	21	00	3.8
Pitmen loosening bank	I	00	0.2
Waiting for cars to pull out .	2	00	0.4
Fixing valve on crane engine	6	00	1.1
Taking water	10	00	1.8
Taking coal	10	00	1.8
Total time under observation	547	00	100.0

THE SHOVEL CREW PAY ON STANDARD BASIS

Runner .								\$5.00
Cranemen								3.60
Firemen								2.40
4 pitmen								6.00
6 trackmen								9.00

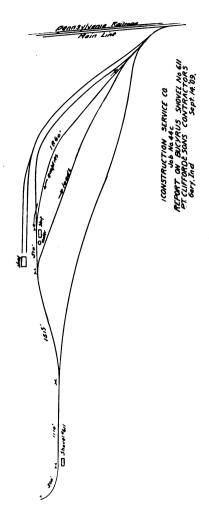
Cubic yards loaded on day of observation 1602 Cost of loading per cubic yard (direct labor only), $\frac{$26.00}{1602} = 1.62$ cents per cubic yard.

HANDBOOK OF STEAM SHOVEL WORK

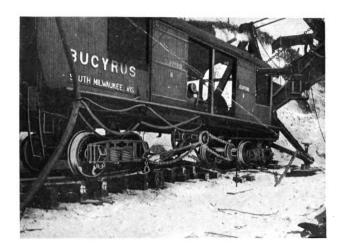
P A1i-	Time		Per	Cost per	Total Cost per Yard
Process Analysis	Min. Sec		Cent	Yard in Cents	
Charge to waiting for blasters	ı		0.2	0.003	0.003
Charge to loading 1. Actual loading 2. Delays	193	30	35.4	0.574	
a Moving up b Repairs c Miscellaneous .	28 6 41	::	5. I I. I 7. 5	0.083 0.018 0.121	0.796
Charge to transportation and dumping	4.		7.3	0.121)	
1. Waiting for cars 2. Miscellaneous	270	30	49.4	0.800 }	0.821
z. miscenaneous	7		1.3	0.021)	
	547	00	100.0		1.620

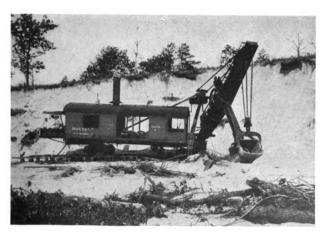


Fig. 5. Dipper used on Shovel No. 611



HANDBOOK OF STEAM SHOVEL WORK





Figs. 6 and 7. Two Views of 70-ton Bucyrus Steam Shovel on Pennsylvania Railroad Improvement, South Chicago

REPORT No. 4 — SHOVEL No. 166

INSPECTED SEPTEMBER 12, 1909 SOUTH BEND, IND.

LOCATION OF WORK about 5 miles outside of South Bend, Ind., at what is locally known as Ruple's Pit. This is a gravel pit and was originally worked by the Lake Shore & Michigan Southern Railway, having been bought by them from Mr. Ruple at a cost of \$115 an acre for 140 acres, 125 of which are estimated as sand, the remainder being swamp land. The pit is now leased by the Knickerbocker Ice Company. It is an uncemented gravel, similar to that found in dunes throughout New York state. It contains a sharp sand that is very clear, leaving practically no dirt when rubbed in the palm of the hand.

THE SHOVEL The shovel is of a very old 45-ton crane type. The boiler is vertical. The swing circle is located at the top instead of the bottom of the boom mast and is to feet in diameter, the swinging chain passing over the roof and through it to the drum. The crane is a triangular truss, the mast consisting of a solid casting 9 1/2 feet high. The lower and upper chords of the crane are composed of channels 3 x 10 inches braced vertically by angles. There is no thrusting engine on this machine, the dipper being held to the face by the hoisting engine and by a foot friction brake on the large gear wheel at the shipper shaft. is operated by the craneman, who releases the brake when the dipper is in position to begin digging, and applies it a soon as the dipper touches the ground, holding it there while the hoisting chain draws it through the bank. This arrangement is more fatiguing to the craneman than is the crane engine, but in spite of this fact, and notwithstanding that the craneman was just learning to operate the shovel, good time was made. The dipper is correspondingly small, holding 1.25 cubic yards water measure, but as the lip projects out 18 inches and consists of a plain piece of 1 ½-inch steel extending half way up the side of the dipper, the capacity is increased to about 1.9 cubic yards.

PLANT, ARRANGEMENT, Only half the plant is being operated, the labor force consisting of 16 men

with but one locomotive and a 45-ton shovel.

The sketch shows the storage yard and the method of hauling to the washer. The track is all standard gauge and the length of haul is about 2100 feet. A 50-ton locomotive was used and hauled one bottom dump car of 31 cubic yards capacity. There was no alternate train and consequently the shovel was idle a large part of the time.



Fig. 8. Shovel No. 166 at South Bend, Ind.

ADDITIONAL NOTES Water is obtained by driving a pipe with the usual point and filter to a depth of about 6 feet and drawing the water up by means of a pump on the shovel, which is digging to the water level only. Pools of water sometimes form in front of it, but these are filled with sand as fast as they appear.

The hinge of the dipper is at its side.

OBSERVATIONS

Gauge Standard	t
Height of lift	
Kind of teeth None—extended lip)
Height blocked up	,
Length of boom	,
Length of dipper handle	
Height of boom above pivot	
Height of boom above shovel track	
Horizontal reach of boom	
Farthest dipper can reach to dump	
Highest dipper can reach to dump 13', plus or minus	s
Diameter of swing circle	
Height of dinkey tracks above shovel tracks	,
Distance inside dinkey tracks to inside shovel tracks . 15' 7'	7
Depth of dipper (water measure)	
Depth of dipper, including lip	,
Depth of dipper, including teeth No teeth	
Height of boom post 9' 4'	,
Number cars loaded	
Cubic yards excavated (place measure) 373	Ł
Total distance moved forward during day 29	
Number of times moved forward in one move	,
Average time between beginning of one shovel move and be-	
ginning of next	
Number of cars to one shovel move 2.4	
Time shovel is interrupted to change train 3791/4 minutes	
Area of section about 450 square feet	
Height of face	
Average yardage, place measure, per car	
Coal costs \$3.00 a ton at shovel and is Hocking Valley.	
Weather cloudy.	
···	

HANDBOOK OF STEAM SHOVEL WORK

TIME STUDY

	F orenoon	Atternoon	
Started work	7:54	12:30	
Stopped work	11:31	6:01	
		minutes = 548 minut	es =
9 hours 8 minutes.			

	Minutes	Seconds	Per Cent
Actual working	123	15	22.5
Spotting cars			
Changing trains	379	-15	69.2
Moving shovel	35		6.4
Miscellaneous delays	8		1.4
Idle-Setting key in shipper			,
shaft	2	30	0.5
Total time under observation .	548		100.0

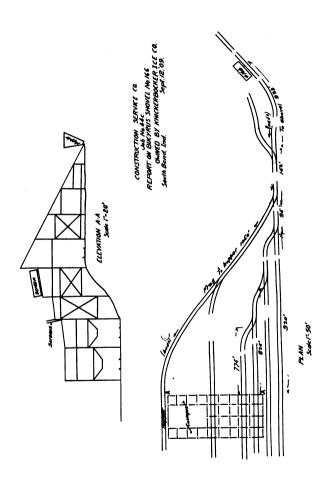
Dinast Labor Distribution	Standard Basis					
Direct Labor Distribution Per Day	Loading	Trans- porting	Spread- ing	Inci- dental	Total	
Runner	\$5.00					
Craneman	3.60					
2 pitmen	3.00					
I washer runner			\$2.00			
I man at locomotive hopper			I 50			
I man at washer			1.50			
3 carmen		\$4.50				
I car patcher		1.50				
I pumpman				\$1.50		
I watchman	1			1.50		
I locomotive engineer .		2.60				
Total cost of direct labor per day	\$11.60	\$8.60	\$5.00	\$3.00	\$28.20	
Cost direct labor, cubic				. 0.	6	
yard, cts	3.11	-		0.80	, - 5	
Per cent	41,1	30.6	17.7	10 6	100.0	

Note.—By the locomotive hopper is meant the hopper into which the material is dumped from the cars. The bottoms of the cars are lined with hay to hold the sand.

D A	Ti	me	Per	Cost per	Total
Process Analysis	Minutes	Seconds	Cent	Yard in Cents	Cost
Charge to waiting for blasters	3		0.5	0.016	0.016
Charge to loading 1. Actual loading 2. Delays	123	15	22.5	0.700	
a Moving up b Repairs	35	30	0.5	0.199 0.016 0.028	0.943
Charge to transporting and dumping 1. Waiting for cars .	379	15	69.2	2.151	2.151
	548		100.0		3.110



Fig. 9. 11/4-yard Bucket with 18-inch Lip added, Increasing Capacity to about 2 Yards, 45-ton Type, near South Bend, Ind.



REPORT No. 5 — SHOVEL No. 58

INSPECTED SEPTEMBER 24-25, 1909 JANESVILLE, WIS.

LOCATION In addition to its plant at South Bend, Ind. (see p. 64), the Knickerbocker Ice Company has a gravel pit and washer at Janesville, Wis. These two plants present several points of difference, in some instances the conditions being exactly reversed.

The pit is located about two miles east of Janesville and on the line of the C., M. & St. P. Railway, which has a siding to the washer. The material consists of a clean coarse cemented gravel containing considerable sand. This is excavated by a 45-ton steam shovel and loaded into three-yard standard gauge steel cars which are hauled to the bottom of an inclined plane by means of horses. Two cars only are used. From the bottom of the incline they are hauled by cable to the hopper in the tower at the top, where the material is dumped from the car automatically. The car is then lowered and hauled back to the shovel by the horse.

THE SHOVEL The material is easy to dig, and the shovel had no difficulty in making rapid progress. It is of a very old type, the number 58 indicating that it was one of the first put on the market by the Bucyrus Company. It is now twenty-two years old, but is in good condition and is well adapted for this light work. Like No. 166 at South Bend, the swing circle is at the top of the boom post and the crane consists of a triangular truss.

The shovel was not worked to its full capacity, as will be understood when it is stated that it spent but 18 per cent. of the day in actual loading, the remainder,

82 per cent., being in waiting for cars and making repairs to the washer.

COST KEEPING The time cards used here are like those used at Dune Park. The superintendent stated that every Sunday during the season is spent in making repairs to the plant and shovel. The labor cost would therefore be very great, although the material cost is not excessive.

GENERAL The operation of turning the hoisting cable on the inclined runway end for end occupied 6 men for 38 minutes at a cost of 69 cents, but the entire plant was shut down in the meantime.

OBSERVATIONS

Weight	•						•				5 tons
Gauge											ındard
Capacity of dipper, 1.22 cul	bic	yar	ds,	w.s	itei	m	eas	ure	;	134	yards
including lip.											
Height of lift											6′
Kind of teeth	Ste	el 1	plat	e l	ip	squ	are	at	tŀ	ie c	orners
Number of pitmen					-	-					2
Height blocked up											6"
Length of boom											22' 6"
Length of dipper handle .											13'
Height of boom above pivo	t										15'
Height of boom above show	el t	rac	k					•			15' 18' 8"
Horizontal reach of boom											16′
Farthest shovel can reach to	o du	ımp)								22'
Highest shovel can reach to	du	mp									13'
Shovel can cut below track											3½′
Diameter of swing circle											9'
Depth of dipper (water mea											401/2"
Depth of dipper, including l											651/2"
Height of boom post											8' 6"
Number of cars loaded .											120
Cubic yards excavated .											ut 360
Total distance moved forwa	rd d	Inri	in or	ďa	37	•	•	•			
Number of times moved for			5			:	:	:	:	:	None

OBSERVATIONS—Continued

Area of sectio	n					a	bοι	it :	1300 square feet
Height of face	е								· · · 55'
Coal used .									about ½ ton
Water used .									74 cubic feet
Coal cost .									\$1.85 at mines

TIME STUDY

	Forenoon	Afternoon
Started work	7:08	12:50 1/4
Stopped work	11:57 🌠	4:50

	Minutes	Seconds	Per Cent
Actual working	96	15	18.2
Spotting cars			
Waiting for cars	334	30	63.2
Moving shovel			
Idle			
Repairing broken strand in hoisting cable on inclined			
plane	9	15	1.8
Repairing harness	9 1		0,2
Turning cable on inclined			l
plane end to end	37	45	7.1
Repairing broken strand in hoisting cable on inclined			
plane	35	45	6.8
Putting car on track		l''	0.9
Repairing car	5 9	30	1.8
Total time under observation .	529		100.0

Discount 1 - Discount and an		Sta	andard Ba	ısis	
Direct Labor Distribution Per Day	Loading	Trans- porting	Spread- ing	Inci- dental	Total
Superintendent				\$6.00	
Timekeeper				2,00	
Night watchman				1.50	
Runner	\$5.00				
Craneman	3.60	. . .			
ı car loader	1.50				
ı bank caver	1.50				
Track boss		\$2.00			
Crusherman			\$1.50		
Towerman			1.50		
2 drivers		3.00			
Fireman			1.50		
Screenman			1.50		
3 horses		4.50			
Total cost direct labor		l			
per day	\$11.60	\$9.50	\$6.00	\$9.50	\$36.60
Cost direct labor per	1				
cubic yard	3.22	2.64	1.67	2.64	10.17
Per cent	31.6	2,60	16.4	26.0	100.00

D 4 1 :	Ti	me	Per	Cost per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost per Yard
Charge to loading 1. Actual loading	96	15	18.2	o. 586	0.586
Charge to transportation and dumping					
 Waiting for cars Repairs for cars Miscellaneous for cars 	334 55 42	30 30 45	63.2 10.6 8.0	0.338 0.261	2.634
	529	00	100.0		3.220

DAYS WORKED AND CARS LOADED DURING LAST SIX MONTHS

	Month													Days	Cars	
April														.	23	303
May*														.	22	303 278
June														. 1	26	354
July															26	349
August	t													.	26	346
Septen	ıbe	er	ıst	to	24	th	inc	lus	sive	;					18	286
Total (av	era	age	, I	3.6	ca	rs	per	· da	v)					141	1916

^{*}There were several washouts during this month, part of the time being spent in making repairs due to this cause. The cars were freight gondolas loaded ready for transportation, and averaged about 20 cubic yards capacity.

	Loading	Trans- porting	Spread- ing	Inci- dental	Total
Cost direct labor per day (average, six months)					
per cubic yard, cents .	4.27 31.7	3.49	2.02	3.49	13.45
Percentage (six months) .	31.7	25.95	16.4	25.95	100.0

Process Analysis	Ti	me	Per	Cost per Yard in	Total
Average of Six Months	Min	Sec.	Cent	Cents	Cost per Yard
Charge to loading 1. Actual loading Charge to transportation	96	15	18.2	0.778	0.778
and dumping 1. Waiting for cars 2. Repairs for cars 3. Miscellaneous for cars	334 55 42	30 30 45	63.2 10.6 8.0	2.698 0.452 0.342	3.492
	529	00	100.0		4.270

TRANSPORTATION

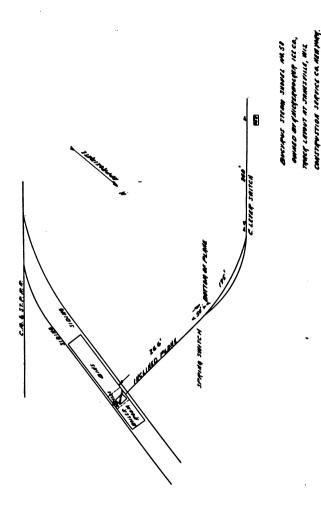
	Obs.	Bo	novel ottom Plane	of		Bott f Plai		P	ottom lane o of F	to	At Top of Plane		
	0	Min.	Ave.	Мах.	Min.	Ave.	Мах.	Min.	Ave.	Мах.	Min.	Ave.	Мах.
Time (seconds) Distance (feet) Speed (feet per	8 8	69 435	72 435	75 435	23	36.6	50	39 275	42.7 275	55 275	. 3.	4.2	6
second)	8	5.8	6.1	6.3				5.0	6.4	7.0		٠.	

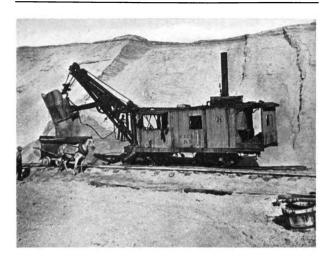
	Obs.	to	p of P Botto of Plan	om	At	Botte Plar			ottom Plane Shov	2	Time for Round Trip		
	_	Min.	Ave.	Max.	Min	Ave	Max.	Min.	Ave.	Max.	Min	Ave.	Мах
Time (seconds) Distance (feet) Speed (feet per second)	8 8 8	17 275		25 275 16.2	2 0	5 9 .9	85 	70 435 5.0	78.1 435 5.5	87 435 6.2	M.S. 4·53	M.S. 6,20	

Average time for round trip from daily log, 7 minutes 20 seconds (120 obs.)

ACTUAL RATIOS

 $\frac{\text{Superintendence}}{\text{Direct labor}} = 0.150 \quad \frac{\text{Incidental labor}}{\text{Direct labor}} = 0.145$ $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{4625}{1000} = 4.625$







Figs. 10 and 11. Shovel and Inclined Plane at Janesville, Wis.

CHAPTER VI

STEAM SHOVEL WORK IN EARTH AND GLACIAL DRIFT

The peculiarity of this material for steam shovel work is that it varies much more in consistency than sand and gravel, may be difficult to break up, and often contains boulders of considerable size. It is the usual practice to attack it with teeth instead of a steel lip on the bucket. When wet, the material is likely to stick to the bucket, and particularly to the bottoms of dump cars, making it difficult to remove in dumping, and being likely to dry or freeze into a hard cake. For this reason it is important to clean and scrape car bottoms at night.

Because of the prevalence of boulders, which cause irregular loading of the bucket and of the cars, this material will not be likely to average quite as many yards, place measure, per car of the same size as will sand or "good" gravel.

When the large boulders occur, necessitating the use of chains and hooks, or even mud capping with dynamite to reduce their size, the work is necessarily much delayed and the cost becomes excessive.

Sometimes a good sized boulder may roll down the slope and injure one of the pitmen, who are therefore more cautious than when working in sand, and consequently slower.

In estimating upon this material the ground should be gone over with care by the man who is to make the estimates, and a computation made of the number of boulders above the limiting size that are likely to be encountered. A shovel with large bucket is advisable for this work, since the delays from boulders are thus minimized.

REPORT No. 6 — SHOVEL No. 893

INSPECTED JULY 14 and 15, 1909 LONG ISLAND CITY, N. Y.

GENERAL CONDITIONS

The Pennsylvania Railroad is building a large storage yard about 1000 feet wide by 8000 feet long at Long Island City to be used for passenger cars only. This is the so-called "Sunnyside yard" and connects with the main terminal at 34th Street, New York City, by means of tunnels under the East River and Manhattan Island.

The excavation required to make this area level has been through the same glacial drift that is found over Long Island, and has necessitated the removal of thousands upon thousands of yards of material. Three and four steam shovels have been employed on this work, which is being done by the Degnon Realty and Terminal Improvement Company, of 60 Wall Street, New York City.

At the time of the inspection of Bucyrus Shovel No. 893 the work was nearing completion, the stone crusher was being dismantled, the machinery overhauled and only one shovel (No. 893) was working. Two days were spent in timing the different operations and collecting miscellaneous data.

DESCRIPTION OF SHOVEL AND METHODS OF OPERATION

Shovel No. 893 has standard gauge railroad car wheels,

weighs seventy tons, and is about three years old. It has been overhauled several times and is in good condition. It happened, however, that at the time of the inspection considerable repairing was necessary. When first observed the shovel was laid up for 45 minutes because of the breaking of the valve stem on the hoisting engine, and the next day I hour was spent in replacing

the U-bolt on the dipper handle. Both these parts are likely to break on any machine, particularly when the nuts are not screwed up tight. The machine is equipped with an all-steel boom and dipper handle.

The dipper has been remodeled, so that it now has a capacity of 2.66 cubic yards water measure. It is of the usual design and is provided with removable manganese teeth. Shortly before closing down on the first day of our observation one of these teeth broke at its base. The breakage did not delay the shovel, but it required five men 3 hours (overtime) to make the necessary repairs.

It will be noticed under the "Labor Distribution" table that there are two more pitmen than is usual. The duties of the engineer consist in superintending everything about the shovel in a general way and, in co-operation with the craneman, running the shovel. His word is law in anything connected with the shovel. The craneman operates the dipper engine and dumps the dipper. He also directly supervises the operation of moving forward, but on this shovel did none of the actual work. The pitman receiving \$1.75 is a general handy man and is foreman of the pitmen, although he does the same work as they.

While the shovel is operating, the pitmen are engaged in taking up the rails and ties behind it and carrying them to a convenient place ahead, so that they can be readily laid. The ties are thrown in front of the forward trucks, and as soon as the dipper digs high and far enough away, the pitmen lay the stringers and then roll the ties into place so that as soon as the shovel is ready to move, all that remains to be done is to place and clamp them to the rails, and set the jacks. Under the head of "Time Study" will be found the percentage of the total time consumed in moving forward.

As has been explained, moving the shovel forward is an intermittent process. So far as is possible, however, the move back to enter a new cut is made continuous. This necessitates an unbroken track behind the shovel. In this particular case it took all morning and part of the afternoon to thus clear the way and lay the ties and rails. The time required for such a process is of course dependent on the distance the shovel must be moved back and also upon the number of curves encountered. Great care should always be exercised in having the bridle rods in proper adjustment, especially on the curves, for otherwise the shovel will be likely to leave the track, causing annoying delays. Here, as will be seen in the "Time Study," the actual moving back occupied 106 minutes, and 48½ minutes were necessary to get things into running order after the backward journey.

SUPPLIES Coal for the shovel was brought in by the dinkeys, dumped near by, and carried from the dump by a laborer. For this purpose an ordinary nail keg was used, and by having the man keep count of the number of kegs, the consumption to within a tenth of a ton was obtained. On the first day this amounted to 2.2 tons and on the second to 2.7 tons.

Water was supplied through a pipe carried from the city mains at a distance, and there was no method of measuring it.

The amount of oil and cotton waste used was also indeterminate.

GENERAL METHODS EMPLOYED BY THE CONTRACTOR

In order to be able from time to time to tell wheth-

er any part of the work was costing more that it should, the engineer in charge has kept very close cost accounts, and he very kindly explained his methods.

The time keeper on this work has two books, using them alternately. He does not write in the names or the numbers of the men before leaving the office, but as he finds the men on the work he jots their numbers or names one below the other just as he comes to them, starting with a new page every day. The following day this book is left in the office and the clerical force compares the timekeeper's record with the foreman's reports. If there is any discrepancy it is called to the timekeeper's attention and he looks into the matter.

From these records the office force makes up a daily statement showing the labor employed, the rate of wages, the amounts, and the nature of the work. Material used is kept account of by the amounts delivered to each machine or foreman, as shown by the storekeeper's daily report.

From these reports the engineer himself makes up the distribution. This, however, does not follow any definite scheme such as the schedule employed by the Construction Service Company, but consists in crediting to each item, such as grading, surfacing, mixing concrete. shovel No. 1, etc., its quota of labor and materials used, and from these data the unit costs are computed by the engineer, so that no one else has access to them. Superintendence, insurance, interest, and other items that cannot be charged directly to any one operation are distributed according to the percentage of the total labor cost involved. Superintendence has been found to be about 6 to 61/2 per cent of the labor cost. The cost and amount of coal, oil, and cotton waste supplied to any machine over a definite period is divided by the number of working days and by the number of yards excavated or hauled to find the unit quantities and costs. Depreciation is not considered until the end of the job. With the exception of the foreman's reports and the daily statement of the timekeeper, no printed forms are used for this work.

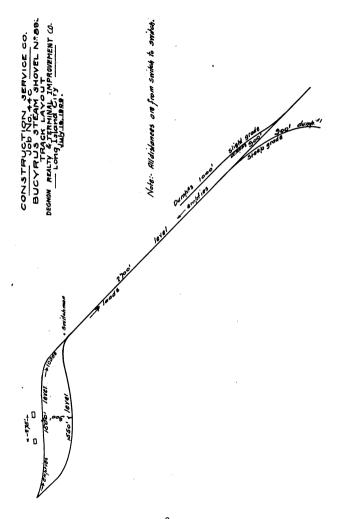
The general plan of the track layout, shown on page 84, is the ideal arrangement for feeding cars to a

shovel, as, with wideawake signalmen and dinkey engineers and plenty of cars, there should be no more reason for losing time in spotting trains than in spotting cars, for as soon as a train is loaded and pulls out another follows right into its place, and by loading the end car first no time need be lost. With the exception of not always having enough trains on hand, this is what happened on this work, and when the trains did follow one after another very little time was lost. This arrangement is particularly suitable when the number of moves of the shovel is a minimum, for then the idle time of the dinkeys would be a minimum also.

The total "runaround" was 7300 feet, 6600 feet and 6300 feet, depending upon the dump, as indicated in the sketch. The dinkeys weighed 18 tons each and the cars were the usual 4.17-yard side dump cars, as shown in the various illustrations. These cars hold about 3.6 cubic yards when heaped full, according to the engineer's estimate. No method of braking was provided or needed, as the only steep grades were those leading to the various dumps, and these were very short. The act of dumping these cars was performed by the laborers placing their shoulders to the under side and tilting them over.

TIME STUDY A minute and accurate record of the working of the shovel was kept for two consecutive days, and, because of certain features of the work, it furnishes some interesting data and comparisons. The times required for all the movements of the shovel and for all delays, the amount of coal used and the number of men employed, were recorded. For the sake of brevity this has been set down in tabular form.

The material consisted of glacial drift, part of which was very loose and part comparatively well cemented. Those illustrations showing the face of the bank distinctly



indicate a pebbly layer about ten feet wide with sand on the top and bottom. This stratum in places was very hard, but the sliding of the ground above it several times obviated the necessity of moving forward.

A feature of the data given in a following table is the large percentage of time required for handling boulders. The superintendent explained that, as the material was being used for dressing and one of the dumps was along-side the main line tracks, the boulders could not be loaded. On the previous run they had been cast behind the shovel and lined the foot of the embankment, as shown very clearly in Fig. 13. There were some seventy-five of these in front of the shovel after it was moved back, and they, of course, all had to be moved again on the new run.

Under "Time Study," second day, is an item of $36\frac{1}{2}$ minutes for clearing track after a blast. The cause of this is distinctly shown in Fig. 15, where it is seen how the blast loosened the earth so that it slid down upon the dinkey tracks.

The time for a round trip, given under "Observations," is an average as indicated by the difference in time between the departure of the train and its return to the shovel. In some instances this includes "waiting on the shovel" and in some it does not, but the average will be very nearly the time for a round trip.

There are no important grades on this work, the whole area having previously been leveled by steam shovel. At dump No. 1 it was necessary to break the train, leaving half the cars at the switch, but this was the only place at which any difficulty was experienced.

Under "Observations" it will be noted that the average time for one move and to move forward one foot are twice as great on the second day as on the first. This is doubtless due to the fact that the machine was moved further on each move on the first day and that the moves were so frequent that the men moved more

rapidly, and that there was also less clearing of the tracks, so that more pitmen could stay in the pit. The effect of these frequent moves is shown in the number of cars for one shovel move. On the first day it was only 8.6 (average), while on the second day, with two blasts and the bank caving, it was frequently 49.5, or one move for about every five trains. The rate of transportation was about a mile in 16 minutes.

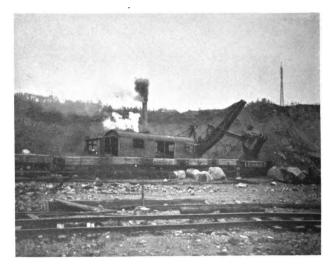


Fig. 12. View of Shovel at Work on the New Passenger Storage Yards of the Pennsylvania Railroad at Long Island City

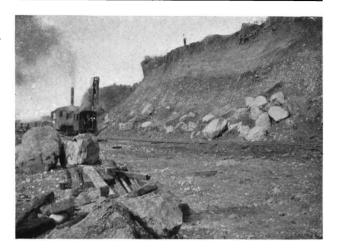


Fig. 13

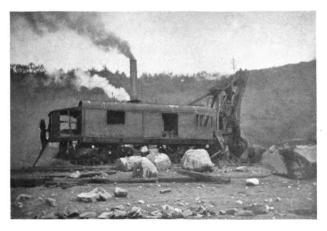


Fig. 14. Views of Shovel at Work on the New Passenger Storage Yards of the Pennsylvania Railroad at Long Island City



Fig. 15. Slide Blocking Dinkey Track

OBSERVATIONS

Weight																	70	ton	s
Gauge																	4	81/2	"
Height o																			
Capacity																			
Kind of																			
Height b																			
Capacity																			
Capacity																			
Number																			
Height o																			
Length o																			
Length o	of r	una	roi	ind.	. a	ppr	OX	ima	telv	•	Ċ	Ĭ.	Ī				Ť	0000	'n
Weight	of d	link	ev	s	, -	·PP.	٠		,		•	•	•	•	•	٠	. 18	ton	ė
Carle of			٠,٠	,	•	•	•	•	•	•	٠,	. i .	.i.	•	•	i	- 41.		
Style of																			
Gauge of	ftra	ack															N	arrov	N
Number	of	trai	ns															•	3

Average time for a round trip . 27.3 min. (11 observations)
Grades, level except slight ones near dumps; on one grade the
train was broken
Time traveling to dump No. 1 8 minutes. (See sketch)
Time traveling to dump No. 2 6 minutes
Time traveling to dump No. 3
Time to dump cars No 1, broke train, 14 minutes for nine cars
Time to dump cars No. 2 6 minutes for ten cars
Time to dump cars No. 3 3 minutes for ten cars
Time traveling from dump to shovel No. 1 8 minutes
Time traveling from dump to shovel No. 2 8 minutes
Weather, clear

		-
	First Day	Second Day
Number of cars loaded	190	396
Average time to load one car .	50 sec.	39 sec.
Cubic yards excavated	684	1426
Total distance moved forward		
during day	130′	51'
	22	8.
Total time moving forward .	158½ min.	107 min.
Average time for one move .	7.2 min.	13.4 min.
Average time to move forward		
one foot	1.2 min.	2.1 min.
Maximum distance moved for-		
ward in one move	8′ 3″	8′
Average distance moved forward each time	-	(1 - / "
	5′ 11″	6' 4 1/2"
Swings per minute	3.7(1)	3.7(1)
Average time for one swing	16.3 sec.	16.3 sec.
Time to load I cubic foot with		
dipper	. 52 sec.	.40 sec.
Minutes per working day, less		
times for accidental delays .	540 ½ min.	574½ min.
Area of section	87 ½ s. f. (a. m.)	1
Area of section	500 s. f. (p. m.)	{ 500 s. f.
TT-i-ba of for-	3½' (a. m.)	j
Height of face }	25' (p. m.)	25'
Number times blasted bank	None	′ 2
	2.16 short tons, at)
Coal used	42 lbs. per cu. ft.	2.7
(4 For our re	_′

	First Day	Second Day
Pounds of coal per cubic yard excavated	6.32 (3)	3.8
Total cost to excavate, transport and spread one cubic yard	16.1 cents (2)	10.81 cents
Number of cars for one shovel move	8.64	49.5
of one shovel move and beginning of next	16.94 min.	80.3 min.

⁽¹⁾ The two days were averaged, 57 observations taken at different times.

(3) No deductions made for moving back.

First Day

Started work

Stopped work

Total time under observation

TIME STUDY Forenoon

6:58

11:58

Afternoon

12:49

30

100.0

5:42 1/2

Min. Min. Total time worked $300 + 293\frac{1}{2} =$	Min. 593½=9	hours 53½	≨ minutes.
	Minutes	Seconds	Per Cent
Actual working	157	15	26.5
Spotting cars		30	0.1
Waiting for cars	38	30	6.5
Moving shovel (158½ minutes		Ü	
forward, 106 minutes back .	264	30	44.5
Idle, repairing boom	53	·	44·5 8.9
Miscellaneous delays	30	İ	_
Loosening bank	5	. .	0.8
Clearing track	ΙĬ	·	1.9
Handling boulders	15	15	2,6
Setting up, shifting track, etc.,	3		
after moving back	48	30	8,2

593

⁽²⁾ Does not include cost of moving back. This should be charged to amount taken out before the next move back is made.

Direct Labor			Standard	Basis-	First D	ay		
Distribution per Day	Prep. Charge	Load- ing	Trans- porting	Dump- ing	Break- ing	Inci- dental	Total	
Runner		\$5 00						
Craneman .		3.60						
Fireman		2,40						
ı pitman		1.75						
7 pitmen		10.50						
i coalman .		1.50						
3 locomotive		3				1000		
engineers .			\$7.80			12.50	1000	
3 locomotive				3.04.5				
brakemen .			4.50					
Switchman			1.50					
2 drillers, ½ day			1.30		\$1.50			
16 laborers.					#1.50			
moving back								
I foreman, mov-								
ing back			B 14 5					
29 laborers,								
moving back.								
1/2 day .	21.75							
2 foremen, mov-								
ing back, 1/2								
day	2.00			7				
35 laborers,								
on 3 dumps,								
				o-6				
½ day .				\$26.25				
3 foremen, on 3 dumps, ½ day								
				3.00				
superintend-						dr		
						\$6.00		
*4 blacksmiths'								
helpers . *1 foreman						10.00		
blacksmith .								
blacksmith .		9 4 4				3.50		
Total cost of								
labor per day	\$49.75	\$24.75	\$13.80	\$29.25	\$1.50	\$19.50	\$138.5	
Cost direct la-	.,,,			, ,	3	, ,	3-13	
bor per cubic								
yard, cents	7.27	3.62	2 02	4.28	0.22	2.85	20.20	
Percent	35.9	17.9	10.0	21.1	I. I	14.0		
	33.9	11.7	10.0		4.4	14.0	100.0	

^{*}This large blacksmith force was due to the extra work caused by overhauling machinery as contract neared completion.

Process Analysis. First Day	Ti	me	Per	Cost per Yard in	Total	
Process Analysis. First Day	Min.	Sec.	Cent	Cents	Cost per Yard	
Charge to waiting for blast-						
ers	20	15	3.4	0.123	0.123	
Charge to loading						
1. Actual loading	157	15	26.5	0.960)		
2. Delays	3,	5				
a Moving up, 1581/2';				1		
back, 106'	264	30	44.5	1,610	3.189	
b Repairs	53		8.9			
c Miscellaneous	48	30		0.297		
Charge to transporting and dumping	40	30	0.2	0.297)		
I. Waiting for cars .	39		6.6	0.239)		
2 Miscellaneous	11			0.069	0.308	
2 Miscenalieous	11		1.9	0.009		
	593	30	100.0		3.620	

TIME STUDY

Second Day	Forenoon	Afternoon
Started work	7:00	12:40
Stopped work	11:48 1/2	5:50

Min. Min. Min. Min. 288½ + 310 = 598½ = 9 hours 58½ minutes

					Minutes	Seconds	Per Cent
Actual working				•	259	30	43.4
Spotting cars					Negli	gible	0.0
Waiting for cars .					122	് ം	20.4
Moving shovel					107	00	17.9
Idle time-Rain					7	00	I.2
Repairing boom .					17	00	2.8
Clearing track after	· bl	ast			36	30	6.1
Misc. time—Clearing	bai	nk			14	oo	2.3
Blasting					2	30	0.4
Moving boulders					18	00	3.0
Boulder on track					9	00	1.5
Loosening bank .					4	00	0.7
Jacking up					2	00	0.3
Total time under obse	erva	atio	n		598	30	100,0

D' at I day	Standard Basis-Second Day									
Direct Labor Distribution per Day	Load- ing	Trans- porting	Dump- ing	Break- ing	Inci- dental	Total				
Runner	\$5.00									
Craneman	3.60									
Fireman	2.40									
ı pitman	1.75									
8 pitmen	12.00									
ı coalman	1.50									
3 locomotive en-										
gineers		\$7.80								
3 locomotive brake-				ļ	1					
men		4.50								
ı switchman		1.50								
4 laborers, blasting.				\$6.00						
I foreman, blasting.				2.00						
35 laborers, 3 dumps			\$52.50							
3 foremen, 3 dumps			6.00							
I superintendent .					\$6.00					
Total cost of labor					1					
per day	\$26.25	\$13.80	\$58.50	\$8.00	\$6.00	\$112.55				
Cost of labor per					1					
cubic yard, cents .	1.84	0.97	4.10	0.56	0.42	7.89				
Per cent	23.3	12.3	52.0	7.1	5.3	100.0				

Process Analysis	Ti	me	Per	Cost per	Total
Second Day	Min.	Sec.	Cent	Yard in Cents	Cost per Yard
Charge to waiting for blasters	38		6.4	0.118	0.118
Charge to loading 1. Actual loading 2. Delays	259	30	43.3	0.796	
a Moving up . b Repairs c Miscellaneous .	107 17		17.9 2.8 1.5	0.329 0.052 0.028	1,205
Charge to transporting and dumping					
 Waiting for cars . Miscellaneous . 	122 45	30 30	20.5 7.6	0.377 (0.517
Total	598	30	100.0		1.840

From the record which follows:

Average cubic yards excavated per

day during 1908

Average cost direct labor per day 1705

 $\frac{$24.75}{}$ = 1.45 cts. per cu. yd.

Number cubic yards per day . 1705

Process Analysis	Ti	me	Per	Cost per	Total Cost per
Second Day's Observation as Basis	Min.	Sec.	Cent	Yard in Cents	Yard Cents
Charge to waiting for blasters	38		6.4	0.093	0.093
Charge to loading 1. Actual loading 2. Delays	259	30	43.3	0.628	
a Moving up b Repairs	107 17 9		17.9 2.8 1.5	0.259 0.041 0.022	0.950
Charge to transporting and dumping 1. Waiting for cars.	122	30	20.5	0.297	
2. Miscellaneous	45	30	7.6	0.110	0.407
Total	598	30	100.0		1.450

It is our understanding that the following represents the output in cubic yards for the year 1908:

Day	Actual Number Hours Employed	January	Actual Number Hours Employed	February	Actual Number Hours Employed	March	Actual Number Hours Employed	April	Actual Number Hours Employed	May	Actual Number Hours Employed	June
I	9	2164			Sun.		10	2765	91/2	2060		
2	4	1051			9	2419	10	2765	6	1224	3	587
	8	1543		1490	9	2207	91/4	2549	Sun.		91/4	1721
3 4 5 6	Sun.	547	7 8	1872	81/2	1678	10	2895	10	1440	10	2052
5	Sun.		8	1699	4	771	Sun.		51/2	1138	10	1800
6	9	1591	7 8	1476			10	2794	9 rain	1685	10	1483
7 8	9 5 6		8	1843	10	1469	9	2462	rain		Sun.	
	6	1455	71/2	1728	Sun.	1000	41/4	1210	91/2	1930	10	2268
9	8	2031	Sun.		rain		10	2704	10	1908	2	216
10		2160	7	1498	9	2189	81/2	1224	Sun.		10	1462
II	Sun.	2160	7 7 7½ 8	1570	10	2880 2808	rain	86	10	2092	10	2203
12	Sun.		71/2	1451	91/4	2808	Sun.		91/2	2333	10	2020
13	6	1570	8	1804	83/4	2462	10	2048	10	2394	10	1894
14	9	2171	7	1440	10	2776	10	2290	71/4	1732	Sun.	130
15 16	9	2534	Sun.	414	Sun.	0.4	9.	2160	5	1199	8	1422
10	5	1354			9½	2862	71/2	1836	10	2167	6	1181
17 .	9 5 8 9 Sun.	2354	4	558		1191	91/2	2520	Sun.		10	1976
	9	2448	9	1703	rain		10	2491	9	2034	8	1460
19	Sun.		snow		rain		Sun.		10	2114	10	1829
20	8	391	9	2203			10	2444	9	2106	10	1728
21	8	391 1868	81/2	2232	Sun.	2056	9	2524	10	1987	Sun.	
22	3 8	371 1080	81/2	2153	Sun.		71/2	1980	4.	770	10	1800
23		1080	Sun.		8	2016	9	2419	10	1915	8	1600
24	snow		9	2023	10	2794	71/2	1987	Sun.		10	1584
25 26	Sun.	986	9	2160	10	3000	7	1930	91/2	2028	9	1663
26	Sun.		2	461	10	1836	Sun.		10	2005	10	1714
27 28	8	1548	7½ 5½ 6	1854	10	241	81/2	1552	10	2081	91/2	1512
	6	1591	5 1/2	1195	10	1814	3	900	10	2038	Sun	
29	8	2002	6	1620	Sun.		10	2318	10	1908	10	1422
30	9	2034			91/4	2635	7	1213	_3	173	10	1584
31	7	1714			9	2419			Sun			
Γotal		41798		36447		44613		54066		44461		40190

Day	Actual No. Hrs. Employed	July	Actual No. Hrs. Employed	August	Actual No. Hrs. Employed	September	Actual No Hrs. Employed	October	Actual No. Hrs. Employed	November	Actual No. Hrs Employed	December
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 31	10 1½ 1½ 10 Holl Sun. 10 9½ 8 8 3½ Sun. 10 10 8 8 10 8 10 9½ 8 10 9 14 10 8 8 8 10 8 8 8 10 10 8 8 8 8 10 10 10 10 10 10 10 10 10 10 10 10 10	1512 205 1392 1494 1739 1526 1426 1685 1685 1743 2145 2149 2162 2149 2315 1937 2189 1692 709 1623 1744 1851 1744 1811 1260	Sun. Sun. Sun.	1591	Sun.		9¼ Sun. 7½ 8 8 8½ 6.43 7 6.4 Sun. 6 7½ 8½ 8 Sun. 7½ 7½ 7½ 7½ 7½ 7½ 7½ 7½ 7½ 8 8.10 9 7.20 6 8 8 7½ 5¾	1246 1250 1323 2870 1533 1287 1354 1701 1708 1704 1694 1460 1641 1505 1537 1407 1650 1235 1393 1680 1680 1680 1680	Sun. 7¾4 2½2 7 6 6½2 7 7 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1351 674 1519 1337 1029 1365 952 1148 1239 1015 1204 1386 891 1434 1365 1614 1885 1620 1881 1590	8¾4 9½8 7¾8 8 7¾8 8¼46 6¾46 6¾46 6¼46 7½2 2½2 8¼4 7½2 7 7 8 8 8 8 8 7 7	1379 1173 1114 1322 1278 1728 1872 1683 1683 711 2133 1944 1422 1683 2088 2088 2088 224 224 234
Tota M	onth		al Day: orked		tal Day Month	vs S	Number stormy D	of avs W	o. of lould h	Sun.	Act No. I Worke	Days d less
Feb Marc	ruary . h		26 23 21		31 29 31		1 1 3		26 25 23		21. 18. 18.	73

Month	Total Days Worked	Total Days in Month		could have Worked Sun. Holiday inc.	No. Days Worked less all Delays
*January .	26	31	1	26	21.10
*February .	23	29	1	25	18.17
March	21	31	3	23	18.73
April	25	30	I	25	20.65
May	25	31	1	25	21.58
June	25	30	0	26	23.28
July	26	31	0	27	22.38
August	1	31		26	
September.	0	30	0	26	
October	25	31	0	27	18.64
November.	25	30	0	25	13.92
*December	24	31	0	27	17.35
Total	246	366	7	308	195.80

^{*9-}hour days during January, February and December

REPORT No. 9 — SHOVEL No. 1121

INSPECTED SEPTEMBER 4 AND 7, 1909 CHICAGO, ILL.

Avenue and Thirty-fifth Street, Chicago, Ill., owned by John W. Farley, and employed in digging a sewer trench. It is new and of the latest design. Its distinguishing features are the location of the operating levers, those being placed about five feet outside the shovel housing, as shown in the sketch; the long dipper handle; and the support upon which the shovel rests. The operating levers are placed outside of the shovel house, in order that the operator may have an unobstructed view of the bottom of the trench. The



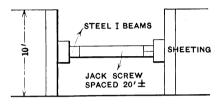
dipper handle is 54 feet long, so that it can reach into the deep trench, which was 26x16 feet. Both it and the boom are made of wood and are steel plated. The supporting structure consists of the truss arrangement shown in the Bucyrus catalog. The shovel is taken off its trucks and

placed on this structure, rollers being used to move it backward and forward.

The shovel crew consisted of engineer, craneman, fireman and seven rollermen. There were also employed six trimmers, six bracers and one foreman following the digging.

To move the shovel backward or forward, a cable, hauled on by the main engines, was led out to a "dead man." By actual timing the shovel was moved back 416 feet in $3\frac{1}{2}$ hours.

Two days were spent in observing this shovel. On the first day the top soil to a depth of 10 feet was removed and on the second day the remaining depth of 26 feet was taken out. As the shovel excavates the trimmers follow it, trimming down the sides for the bracers who follow with the sheeting. Two I-beams about 50 feet long are placed as shown in the



sketch, so that when the next bench is taken out and it is necessary to draw the braces the I-beams hold the sheeting and the shovel works

between the jack screws. When the shovel moves forward the jack screws are slightly loosened and the I-beams are attached to the shovel and hauled forward with it, the wooden bracing being placed behind the I-beams. This being a new shovel there have been no repairs.

PLANT ARRANGEMENT The sketch shows the arrangement. Some cars were

hauled out on the main line to a dump some distance away. Therefore both narrow and standard gauge tracks were necessary. On both days of the observation the dump was as indicated on the sketch, this being backfilling. Eighteen-ton dinkeys were used and standard gauge and narrow gauge cars of six and four-yard capacity respectively. The average time for a round trip on the first day was 19.8 minutes (28 observations), and on the second day was 16.8 minutes (22 observations).

The concrete mixer was on a platform similar to that upon which the shovel was placed. This follows behind the shovel. COST KEEPING The contractor keeps accurate unit costs but does not give outside information, so that these could not be obtained.

OBSERVATIONS

TIME STUDY

		Foren	oon	Afternoon
Started work		7:0	00	12:57
Stopped work		12:0	00	5:59
	M:	M:	341	

Total time worked, 300 + 302 = 602 = 10 hours 2 minutes.

STEAM SHOVEL WORK HANDBOOK O F

	Minutes	Seconds	Per Cent
Actual working	270	30	44.9
Spotting cars		30	0.3
Waiting for cars			22.9
Moving shovel			22.4
Time idle Boulder in bucket			0.3
a little on sides			0.8
Repairing braces			0.3
Removing bracing	. 32		5.4
Miscellaneous delay, moving cross bracing			2.7
Total time under observation	602		100.0

Cost of Direct Labor (Loading)													Standard Basis Per Day	
Runner														\$5.00 3.60
Craneman.														3.60
Fireman .														2.40
7 rollermen														10.50
'					_									\$21.50

Cubic yards loaded on day of excavation, 569.

Cost of labor per day _____\$21.50___2 78 c $\frac{$21.50}{569} = 3.78$ cts. per cubic yard.

Number cubic yards per day

D. A. L. I.	Ti	ne	Per	Cost per Yard in	Total Cost	
Process Analysis	Min.	Sec.	Cent	Cents	Cents	
Charge to loosening and breaking	55*		9.2	0.348	0.348	
Charge to loading 1. Actual loading	270	30	44.9	1.698		
2. Delays	135		22.4	0.846	2.555	
b Miscellaneous .	2	00	0.3	0.011		
Charge to transporting and Dumping 1. Waiting for cars	139	30	23.2	0.877	0.877	
	602		100.0		3.780	

^{*}Fifty minutes of this time was required for the braces. utes); to remove (32 minutes); and to arrange (16 minutes). Repairing (2 min-

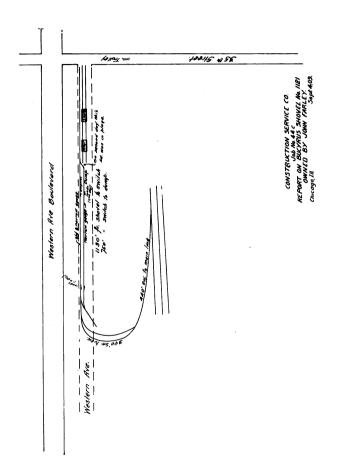
Dipper Performance	Mini- mum	Average	Maxi- mum	Number Obs.	No. Attempts
Digging Swinging loaded . Swinging empty . Falling empty .	3½ 4¾ 3 4	9.7 6.5 7.9 5.1	18 12 11 7	15 13 10 9	15
Time to fill and load one dipperful	151/4	29.2	48		

Time for a complete swing

Seconds					Minimum	Average	Maximum	No. Obs.
Seconds	•	•	•	•	231/2	28.9	35	9



Fig. 16. Shovel No. 1121







Figs. 17 and 18. Bucyrus Shovel on Western Avenue Sewer, Chicago, Ill.

CHAPTER VII

STEAM SHOVEL WORK IN CLAY

Clay is more susceptible to moisture than any of the other materials considered in this volume. It will stand with a nearly vertical face before excavation and can be dug very readily when fairly dry. When rather wet it is sticky and offers great resistance to the lifting motion of the bucket. With a powerful engine this is of no great disadvantage, since the resistance is smooth and does not rack the boom and shipper shaft. In the pit, however, the discomfort attendant upon working in this wet material is very considerable. To handle it wet with hand shovels is laborious, as it sticks to the bowl of the shovel and tries to take the shovel and the shoveler with it when cast. A hole or two punched in the bowl will often afford much relief to the men. This material containing practically no voids, is very heavy, and, owing to its stiffness, a large amount in comparison with sand or gravel can be loaded upon a car. Ton for ton, it is economical to transport for this reason. In wet weather it is apt to cling like flypaper to the car and delay the dumping operation. When handled with a toothed dipper it is liable to get between the teeth in chunks and cling to them when dumping into the car, so that only a portion of the dipper load is released for each swing. This is very irritating to the men and expensive to the management.

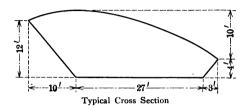
REPORT No. 11 — SHOVEL No. 1119

INSPECTED JULY 15, 1909 KENT, OHIO

GENERAL CONDITIONS
This shovel was working less than a mile from No.

1118,* on the same contract, with, however, some
*See page 49.

difference in the nature of the material handled. The same general methods were in use by Mr. Hengst and the same general efficiency was observable.



OBSERVATIONS

Material—Clay mixed with sand with occasional sand pockets. When dry could be handled easily but when wet it was very gummy and stuck in dipper badly. Some quick sand.

Type of shovel					•		٠.					70	C	В	acyrus
Distance of move	•														6′
Kind of teeth			•												Rock
Height of lift	•							•	•				•		8′
Size of ties under	r sl	or	/el										6 "	xξ	3" x 8'
Size of bucket						•							2	2 1/2	yards
Age of shovel Duration of job Length of shift													:	2 m	onths
Duration of job													41/2	'n	onths
Length of shift														10	hours
Number of shifts	рe	er d	lay												. 1
Coal is handled b	οÿ 1	tea	m˙;	wa	ter	pi	ped	di	rect	: to	sh	ove	el.		
Repairs are mad															
repair parts	ke	рŧ	in	sto	ck	for	eı	mei	rger	ıcy.		Ma	de	by	crew
and boilerma										-					
Coal used .											3 to	ons	in	10	hours
Water used .								٠.	350	o g	allo	ons	in	10	hours
Boiler is cleaned	on	ce	a n	non	th.										
Cost of repairs								•		Rej	oai	rs r	nac	le o	on job

OBSERVATIONS—Continued

Contract price 25c. per yard in embankment (which includes embankment)
Narrow gauge 3' track, 55-pound rail.
Kind and size of cars used K. & J., 4-yard
Dinkey braked by steam; cars by hand.
Hand signals used; brakeman standing on shovel.
Kind and size of dinkey Vulcan, 16-ton
Length of haul Max. 2700', min. 2000'
Number of trains 2-12 cars
Age of cars and dinkey 4½ months
Weather, fair

Cars figure 41/4 yards each according to this record and monthly estimate for first three months.

This shovel cut into right of way for several days and was then turned into borrow pit. The preparatory cost of cutting into right of way was \$400 and to cut into borrow pit \$1200 more. Shovel was delayed from May 19th to May 26th, on account of right of way difficulties. Total preparatory costs and cost of delay were said to be \$3000.

In general, remarks on No. 1118 will apply to No. 1119, as they are managed in exactly the same way.

TIME STUDY

	Forenoon	Afternoon
Started work	10:25	11:57:00
Stopped work	11:27:45	4:56:30
Total time worked	$62\frac{3}{4} + 299\frac{1}{2} = 36$	$2\frac{1}{4}$ minutes = 6 hours
2 ¼ minutes.		

	Minutes	Seconds	Per Cent
Actual working	229	42	63.4
Spotting cars			
Waiting for cars	69	20	19.1
Moving shovel	49	18	13.6
Miscellaneous delays	13	55	3.9
Total time under observation .	362	15	100.0

From the records which follow:

Number of carloads excavated per day (average of 36 days) 380 @ 4½ yards.

Cubic yards loaded per day (average of 36 days) 380 x 4.25 x 90* = 1450 cubic yards.

*0.90=ratio of Place measure Water measure

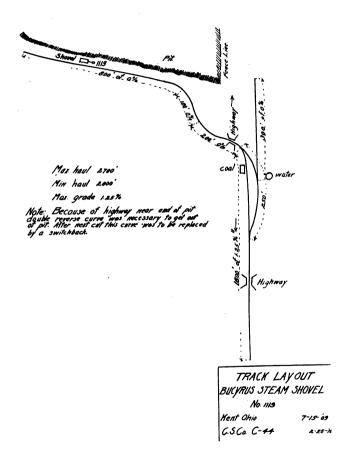
D: . T 1		D	.,		Standard Basis											
Direct Labor Distribution Per Day				Loading	Trans- porting	Dump- ing	Inci- dental	Total								
Runner .					\$5 00											
Craneman					3.60											
Fireman .					2.40											
4 pitmen .					6.00											
Dump forem	an						2.00									
7 dumpmen							10.50									
2 brakemen						3.00										
2 dinkeymen	ı					5.20										
								I.50								
1 watchman								1.50								
					\$17.00	\$8.20	\$12.50	\$3.00	\$40.70							
Cost per da yard (cts)		ре)1C	1.17	0.57	0.86	0.21	2.81							
Per cent .					41.6	20.3	30.6	7.5	100.0							

Process Analysis	Ti	me	Per	Cost per Yard in	Total Cost
Process Analysis	Min.	Sec.	Cent	Cents	
Charge to loading 1. Actual loading 2. Delays	229	42	63.4	0.742	
a Moving up b Miscellaneous .	49	18	13.6	0.159	0.946
Charge to transporting and dumping 1. Waiting for cars	69	20	19.1	0.224	0.224
	362	15	100.0		1.170

Time Study Deductions	Number	Mini	mum	Ave	rage	Maximum	
Time Study Deductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec
Time of moving up, shovel idle	16	2	15	3	5	4	25
Time between moves, shovel working	16	10	10	13	29	15	25
Time between trains, idle	16	3	30	4	20	5	15
Time per dipper	14		19		21		23
Number of dippers per move Number of dippers	16	2	6	3'	6	4	2
per train	23	2	5	2	7	3	0
per car	230				21/4	-	

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{29,160}{6,000} = 4.86$







Figs 19 and 20. Bucyrus Shovel Loading Clay and Sand on W. and L. E. R. R. Kent, Ohio

REPORT No. 12 — SHOVEL No. 843

INSPECTED JULY 10, 1909 CLEVELAND, OHIO

LOCATION Shovel No. 843 was working during July on a deep cut on the L. S. & M. S. cut-off south of Cleveland, Ohio, where the line runs through Brooklyn.

GENERAL CONDITIONS

The finished cut is to be for a four-track line and the bench on which the shovel was working at the time was within 3 feet of finished sub-grade. On the south side of the cut the excavation was to grade and one cut more was needed on the middle bench to finish the work. The remaining 3 feet to the sub-grade, on the north side was to be taken out by hand. A complete cross section at the time of observation is given in the illustration.

The shovel was to go through the cut once more on the center line, or a little to the left of it, so as to take the 7-foot heading to grade, and as much of the 3-foot cut on the north side as possible.

CREW The entire shovel force consisted of the shovel engineer, craneman and fireman, six pitmen, and one coal passer. Transportation force consisted of three crews of three men each. There were no extra men engaged in any capacity about the shovel, no pipe men, extra pitmen to look after drainage, drillers or blasters.

MATERIAL The material was dry clay and disintegrated shale. When the dipper was run into the bank the material broke up into fine flake spalls almost like small shells, and as it was perfectly dry it could be handled with the utmost ease. When

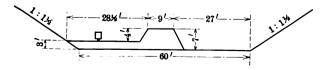
the shovel was near the bank after moving up, the dipper could penetrate to half its depth by inertia alone before the crowding engine was started, thus insuring a full dipper at every swing even though it might be brought but half way up by the hoisting engine. The dipper was dumped easily and was completely emptied at each dumping. When an attempt was made to heap a car, material was almost sure to be lost, as it was so light and flaky and so lacked cohesion that it would run over the side. For the same reason the dipper had to be spotted very carefully before it was dumped.

In spite of whatever care the shovel runner exercised in dumping his dipper and the brakeman in spotting his cars, the track had to be cleaned after each train pulled out. This, of course, was done by the pitmen, and often, when moving up occurred between trains, they were able to get the track clear and look after their regular duties as well

MOVING UP When moving up the shovel, a 2-inch pipe was used to swing the jack blocks clear of the ground instead of the ordinary wooden pole. This pipe was held in a bracket attached to the jack arm and had a collar about 4 inches from its end, which kept the chain that suspended the jack block from slipping along the pipe. This pipe was held by the bracket and was always in place, there being little danger of its breaking or splitting, as is often the case with wooden poles.

All supplies were brought to the shovel by SUPPLIES dump trains. Water was carried in the tender (the dump engines were standard railroad locomotives) and a 4-inch rubber hose was run from the tender to the water tank of the shovel and the water siphoned over. This always caused some slight delay with every second or third train. Coal was shoveled by hand to the pit behind the shovel. Thence it was carried in bushel baskets by a laborer who had rigged a gang plank with cleats at the back of the shovel. He dumped the coal on the extension platform back of the boiler.

TRANSPORTATION The average haul was three miles over very rough track. Three standard railroad locomotives were used. The cars were the most modern type of Western "air dumps" of 12 yards capacity. They were built in two sizes, there being 40 cars with bodies 18 feet o inches long and five cars with bodies 26 feet in length. All were double truck, two-side dumps with wooden bodies. Trains were composed of 15 cars each. Ten men worked on the dump. The material was unloaded on one side over a bank about 40 feet high. track was not near the edge of the bank a spreader was used. This consisted of a steel scraper plate with one end hinged on the trucks of a flat car and the outer end supported by a line from a block on the floor The spread and depth of cut could be of the car. regulated by one man on the car, but often the operator of the spreader was helped by the brakeman of the train. The regular dump train engine was used in operating the spreader.



Typical Cross Section

OBSERVATIONS.

Shovel
Distance of move 6'
Kind of teeth Standard earth Height of cars above rail, 7' and 7' 6"
Height of cars above rail 7' and 7' 6"
Shovel track to load track
Shovel track to load track
Size of bucket
Age of shovel
Age of shovel
weeks from July 10, 1909.
weeks from July 10, 1909.
Length of shift 10 hours
Number of shifts per day
Repairs are made on shovel as needed.
Coal used $2\frac{1}{2}$ to $2\frac{3}{4}$ tons per day
Water used 6000 gallons per day
Boiler cleaned every two weeks.
Standard gauge track; 55-pound rails.
Train is braked by air.
Hand signals used; brakeman on top of loaded car.
Kind and size of dinkey Standard locomotive
Length of haul Said to be 3 miles
Number of trains 3 of 15 cars each
Weather, fair, very warm

Note.—The bank was dry and the pit seemed to need no draining. Material was easy to handle, and a much larger dipper could have been used. Four-yard cars had been employed previous to the 12-yard cars and it was found that two swings of a 2½-yard dipper filled these cars completely; seven swings of a 2½-yard dipper filled the 12-yard cars completely Pit crew was composed of rather green men. The runner said he could move up in 1 or 1½ minutes in such a pit with a good crew.

TIME STUDY

	IIIII ()	IUD	•					
	Foren	oon						
Started work	9:25	:30	12:30:15					
Stopped work	11:35	:00	4:57:25					
	Min. Se	c.	Min.	Sec.				
Total time worked		0 +	267	10	= 6	hours		

		Minutes	Seconds	Per Cent
Actual working	•	228	5	57 · 5
Spotting cars				1
Changing trains		36		9.1
Moving shovel		112	20	28.3
Shovel taking water		8	50	2.2
Miscellaneous delays		ΙΙ	25	2.9
Total time under observation	1.	396	40	100.0

	Cost	of	Di	rect	Lal	bor	(Lo	adiı	ng)	Per	Da	у		Standard Basis
Runner											-	_		\$5.00
Cranemai														3.60
Fireman														2.40
6 pitmen														9.00
ı coal pas	sser			•							•			1.50
														\$21.50

Number of carloads excavated on day of observation . . 90 Cubic yards loaded on day of observation, 90 x 12 x 0.83 = 900 Based on the performance observed the cubic yards loaded per 10-hour day = 900 x 600 minutes = 1360 cubic yards.

396²/₃ minutes

Cost of labor per day . . . Per cubic yards per day = 21.50 = 1.58c. per cubic yard.

Process Analysis	Ti	me	Per	Cost per	Total Cost per Yard
Frocess Analysis	Min.	Sec.	Cent	Cubic Yard in Cents	
Charge to loading 1. Actual loading 2. Delays	228	5	57 - 5	0.908	
a Moving up b Miscellaneous	112 20	20 15	28.3 5.1	0.447	1.436
Charge to transportation and dumping 1. Waiting for cars .	36		9.1	0.144	0.144
	396	40	100.0		1.580

Time Study Deductions	Number	Min	imum	Ave	rage	Max	imum
Time Study Deductions	Obser- vations	Min	Sec.	Min	Sec.	Min.	Sec.
Time of moving up, shovel idle	31	2	10	2	51	3	50
Time between moves, shovel working .	37	3	20	6	16	13	55
Time between trains.	6	2		6		9	30
Time per train loading	6			38	10		
Time per dipper	26		14.2		17.9		22.2
Number of dippers to move	31	1	12	18	8.7	2	23
Number of dippers to				100			
train	6	1		II.	4.5		
car	90				7.6		
loaded				- 1	6.		
Number of cars loaded				9	ο.		
Cars per train				I	5.		

ACTUAL RATIOS

$$\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{50,000}{5,000 \text{ to } 5,500} = 10.0-9.1$$



Fig. 21. Bucyrus Shovel at Work in Deep Cut on the L. S. and M. S. R. R. South of Cleveland



Fig. 22. View of Spreader Used for Pushing Material over Bank

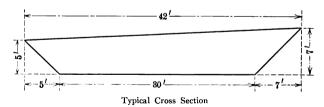
REPORT No. 13 — SHOVEL No. 666

INSPECTED JULY 17, 1909 KENT, OHIO

This work is part of that undertaken for correction of line on the W. & L. E. R. R. near Kent, Ohio, J. R. Dewitt, Manager.

GENERAL CONDITIONS The shovel had been working only three days and on the day of inspection was still cutting in. The cut was a "through," and for the purpose of getting material for a large fill on the job. At this point the ground had been wooded and because of old stumps, tree roots, etc., digging was rather slow. The inexperience of the pitmen also caused some delays.

MOVING SHOVEL Before cutting in, this shovel was moved 1600 feet. The shovel crew, 16 men, foreman and 1 team were engaged in this work for 8 hours, at a total cost of \$34.00 or 2.12 cents per foot moved.



OBSERVATIONS

Material, cla	ιy	and	lo	am	wi	th	mai	n y	stu	mp	s.					
Shovel .	٠.							٠.		·		7	o-t	on	Βı	acyrus
Distance of	m	ove														6
Kind of teet	th												H	[ea	vv	earth

OBSERVATIONS-Continued

Height of lift, cars 6' o"; shovel track to loading track, 6' 6"; total 12' 6".
Size of ties under shovel $6'' \times 8'' \times 8' \times 9''$
Size of bucket
Age of shovel 5 years
Duration of job 60,000 yards to be excavated
Length of shift
Number of shifts per day
Supplies are handled as follows: coal, by wagon; water, piped.
Repairs are made as needed.
Coal used 3½ tons per shift
Cost of repairs not known, but \$4000 to \$5000 should be spent,
as condition is bad.
Contract price 40c. for excavation
Contract including excavation.
Contract including excavation. Three working days; no rainy days since starting.
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30-pound.
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30-pound. Size of car used 4 yards
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30-pound. Size of car used 4 yards Car is braked by hand; dinkey by steam.
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30 pound. Size of car used 4 yards Car is braked by hand; dinkey by steam. Hand signals used.
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30 pound. Size of car used 4 yards Car is braked by hand; dinkey by steam. Hand signals used.
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30-pound. Size of car used 4 yards Car is braked by hand; dinkey by steam. Hand signals used. Kind and size of dinkey Vulcan, 16 tons Length of haul
Contract including excavation. Three working days; no rainy days since starting. Track, narrow gauge, 36", 30 pound. Size of car used 4 yards Car is braked by hand; dinkey by steam. Hand signals used.

TIME STUDY

	r orenoon	Aiternoon
Started work	9:00:35	12:30:00
Stopped work	10:47:35	5:04:22

Min. Min. Sec.

Total time worked 107 + 274 22 = 6 hours 21 minutes 22 seconds.

						Minutes	Seconds	Per Cent
Actual working .						143	24	37.6
Waiting for cars .						83	31	21.9
Moving shovel .						97	57	25.7
Pulling track						51	4.5	13.6
Miscellaneous dela	ys					4	45	1,2
Total time under o	bs	eı	va	tior	ı ,	381	22	100.0

, с	ost	of :	Dire	ect I	Labo	or (I	Coa	ding) Pe	er I)ay		Standard Basis
Runner wo	rki	ng								•			\$5.00
Craneman													3.60
Fireman .													2.40
6 pitmen			•				٠				•		9.00
													\$20.00

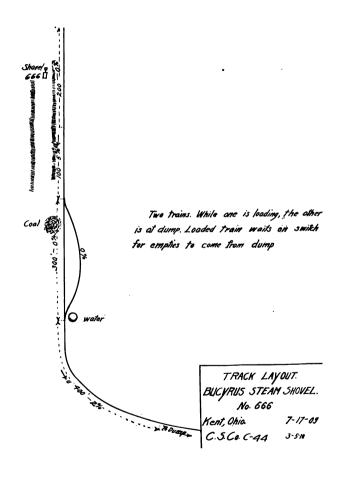
Number of cars loaded on day of observation . 189A 4 yards. Cubic yards loaded on day of observation . 189 % 4 = 756. Based on performance observed, the cubic yards loaded per 10-hour day = 756 $\times \frac{600 \text{ min.}}{381' 22''}$ = 1190.

Cost of labor per day . . . = \$20.00 | 1190 = 1.68c. per cubic yard.

Process Analysis	Tin	ne	Per	Cost per	Total Cost	
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cents	
Charge to loading 1. Actual loading 2. Delays	143	24	37.6	0.632		
a Moving up b Miscellaneous delays	97 4	57 45	25.7 I.2	0.432	1.084	
Charge to transportation and dumping						
1. Waiting for cars .	83	31	21.9	0.368	0.596	
2. Miscellaneous delays	51	45	13.6	0.228 \$	0.390	
	381	22	100.0		1.680	

TIME STUDY DEDUCTIONS

	Number of	Mini	imum	Ave	rage	Maxi	mum
	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle Time between moves,	14	3	15	7	00	12	5
shovel working	16	6	50	8	58	11	5
Time between trains.	19	2	10	4	24	6	45
Time per train, loading	27	4	5	5	19	8	55
Time per dipper	1.6	0	19.0	0	21.6	0	31.2
Number of dippers, per move Number of dippers,	16	2	0	25		3	3
per train Number of dippers,	27	I	4	14	.8	I	7
per car	••			2	.11		
loaded					7		
Number of cars loaded				18	9		
Cars per train					7		



REPORT No. 14 — SHOVEL No. 1128

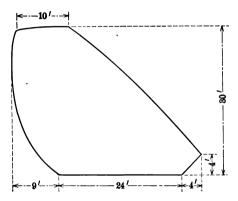
INSPECTED OCTOBER 4, 1909

BUHL, MINN. IN THE ORE REGION

LOCATION No. 1128 is a 95°C Bucyrus shovel, owned by Butler Brothers, stripping contractors. At present it is engaged with No. 517 in stripping in the Grant mine (see p. 154).

GENERAL CONDITIONS The character of the stripping was such that no machine, however powerful, could handle all of it without some hesitation and straining. The cut was a side one . and some 30 feet in height, of which the upper 17 feet were composed of a mixture of earth and clay containing just sufficient moisture to cause it to stick like molasses candy to the inside of the bucket, filling up the spaces between the teeth and decreasing their penetrative power, at the same time reducing the capacity of the dipper to such an extent that frequent stops had to be made to clean out the bucket. This was done by two of the pitmen equipped with small scraper and shovel. was the character of the upper part of the cut. This was very discouraging material to work in, but caused no straining on the part of the shovel. The lower part of the cut was a nearly solid mass of boulders, which were imbedded in the clay. Being round in shape, they offered scant grip for the teeth of the dipper, which would slide over them and bury itself in the softer material above. As might be expected, this strain on the shovel was severe. Frequently nests of large boulders were encountered, which were picked up and tossed to one side to be later broken with powder. In such material the teeth had to be replaced weekly and sometimes semi-weekly.

SHOVEL This shovel was equipped with tandem hoisting sheaves. The jacks could be swung inward, and the screws were operated, one by a wheel and the other by a bar passed through a hole in the top of the screw. In the afternoon the large pin that fastens the upper portion of the dipper to its handle failed as a result of the hard usage due to the boulders. Four men and the runner replaced it in 11 minutes and 15 seconds.



Typical Cross Section

OBSERVATIONS

Distance of move															5½′
Kind of teeth .															
Size of ties															6" x 7"
Height of lift .															11' 3"
Size of bucket .															3 yards
Age of shovel .											Ī	Nе	w	Ma	y, 1909
Length of shift .														I	o hours
Number of shifts,	per	da	ay												2
Coal is dumped f	ron	n c	ne	of	tŀ	ıe	du	mp	ca	ırs	ar	ıd	th	en	carried
onto the show	el l	Эy	a w	orl	km	an		_							

OBSERVATIONS-Continued

Water is supplied from a tank on a low hill near by. Repairs are made by the day crew on Sunday, who get no extra money.
Coal used 2½ and 3 tons in 10 hours
Coal used 2½ and 3 tons in 10 hours Black, 5 gallons in 24 hours Cylinder, 5 gallons in 24 hours Kerosene, 2½ gallons a night Gasolene, 20 gallons a night
Lighting is furnished at night by four gasolene torches, each holding 2½ gallons, and by eight kerosene oil burners or torches.
Water used 12,800 gallons in 24 hours Boiler is cleaned every second Sunday.
Standard gauge track; 55-pound rails. Russell Wheel and Foundry 7-yard dump car used; water measure.
Engine braked by air.
Kind and size of dinkey Baldwin locomotives, 50-ton ± Length of haul about ½-mile Number of trains
The locomotive new July, 1909. Shovel has been on the present work since coming out of shop.
New May, 1909. Moved forward 33 feet during day. Height of car above rail
Slope is slightly under cut and overhanging at top. Side cut. Teeth have to be replaced once a week and sometimes more often.
Extra small parts such as bolts and nuts are kept on the shovel. Larger duplicate parts are kept on hand at the Butler Bros. shops about o miles away.
Shovel was working down hill but cut was dry. The track layout for this shovel and No. 517 will be given together under No. 517 (p. 154). Weather, clear and cool.
TIME CTILLY

Forenoon

Afternoon

Started work Stopped work	6:56:00 12:01:00	12:53:45 5:56:25
Бъррод жен	Min. Min. Sec.	J.JJ
Total time worked	305 + 302 40 =	= 10 hours 7 minutes

40 seconds.

	Minutes	Seconds	Per Cent
Actual working	367	35	60.4
Waiting for cars	103	45	17.1
Moving shovel	49	40	8,2
Miscellaneous delays	.,	·	
Oiling 1 man	I	45	0.3
Oiling I man Clearing bucket . 2 men	6	20	1.0
Clearing bucket . 2 men	5	40	0.9
Clearing bucket . 2 men	4	35	0.8
Replacing heel pin 5 men	2 I	15	3.5
Rock between teeth I man	I	25	0.2
Car off track 6 men	8	00	1.3
Rock in teeth 1 man	0	30	0.1
Clearing bucket . 2 men	2	55	0.5
Stone on track	0	45	0.1
Rock in teeth	I	ō	0.2
Clearing bucket . 2 men	4	0	0.7
Oiling 2 men	2	40	0.4
Clearing dipper . 2 men	4	40	0.8
Rock on track 3 men	I	40	0.3
Chaining stone . 3 men	3	45	0.6
Replacing bolt in stick 5 men	11	15	1.9
Clearing bucket . 2 men	4	30	0.7
Total time under observation	607	40	100.0

	Co	st (of	Di	rect	L	abor	(I	oac	ling) pe	r I)ay		_		Standard Basis
Runner .												•		•		•	\$5.00
Cranemar	ì.																3 60
Fireman																	2.40
4 pitmen																	6.00
ı track cl	ear	ıeı	,														1.50
1 coal car	rie	r.															1.50
																	\$20.00

Number of carloads excavated on day of observation, 189 of capacity 7-yards (water measure).

Cubic yards loaded = 189 x 7 x 0.75* = 990.

Cost per day per cubic yard $=\frac{$20.00}{990} = 2.02c$. per cubic yard.

* o 75 = ratio of $\frac{\text{Place measure}}{\text{Water measure}}$

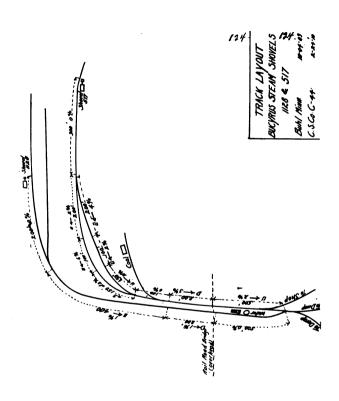
Process Analysis	Ti	me	Per	Cost per Yard	Total Cost	
Process Analysis	Min.	Sec.	Cent	in Cents	Cents	
Charge to loading 1. Actual loading 2. Delays	367	35	60.4	1.220		
a Moving up	49	40	8.2	0.166 >		
b Repairs	32	30	5.4	0.109	1.641	
c Miscellaneous	43	45	7.2	0.146		
Charge to transporting and dumping	5					
1. Waiting for cars	103	45	17.1	0.345 (0 270	
2. Miscellaneous	10	25	1.7	0.034 \$	0.379	
	607	40	100.0		2.020	

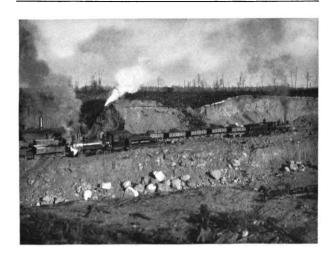
TIME STUDY DEDUCTIONS

	Number	Mini	mum	Ave	rage	Max	imun
	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle Time between moves,	6	5	10	8	16.6	9	45
shovel working .	5	56	15	64	55	82	15
Time between trains	5 16	3	55	6	22.5	12	05
Time per train, loading	18	13	10	20	25	28	35
Time per dipper	5		32.1		35.2		37.6
Number of dippers per move Number of dippers	5	9	0	1	12	I	53
per train Number of dippers	18	3	0	35	5 - 5		43
per car	189				3.38		
Number of trains loaded Number of cars loaded		18	8		, ,		
Cars per train					f 11 c		

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{44.400}{5,000 \text{ to } 6,000} = 8.88 \text{ to } 7.40$







Figs. 23 and 24. Bucyrus Shovel Engaged in Stripping at Grant Mine,]
Buhl, Minn.

REPORT No. 15 — SHOVEL No. 650

INSPECTED AUGUST 30, 1909 CHICAGO, ILL.

THE SHOVEL This is a 70-ton shovel, owned by the Illinois Improvement Company, located at South Deering, Ill., and employed in digging slag. Its only distinguishing feature is the kind of teeth which are of special form.

SUPPLIES Water was taken from the tank of the locomotive and was paid for at the rate of 50 cents a tank. The engineer said that 1100 gallons were consumed in loading 21 cars, which is at the rate of about 2½ cents per car of 31 cubic yards, place measure, or at about eight cents per 100 cubic yards.

MATERIAL The digging was not difficult, being about the same as firmly cemented gravel. No blasting was necessary.

TRACK AND TRANSPORTATION Large freight cars and railroad engines were used and supplied by the railroad company, with the result that sometimes many cars were on hand and sometimes none.

The arrangement of the track is shown in the sketch, and the extent of the excavation, which was begun last May, by the photographs. On the day of our observation the shovel was idle 70 per cent of the time

OBSERVATIONS

Gauge Standard
Capacity of dipper
Height of lift
Kind of teeth Special
Number of pitmen 4
Height blocked up
Length of boom
Length of dipper handle
Height of boom above pivot
Height of boom above shovel track 26' 4"
Horizontal reach of boom
Farthest dipper can reach to dump 27
Highest dipper can reach to dump 16'
Diameter of swing circle 7' 6"
Height of dinkey tracks above shovel tracks 2
Distance inside dinkey track to inside shovel track 201
Depth of dipper
Depth of dipper, including lip 60"
Depth of dipper, including teeth 82"
Number of cars loaded
Cubic yards excavated * 822
Total distance moved forward during day 36'
Number of times moved forward 6
Maximum distance moved forward in one move 6' 4"
Average time between beginning of one shovel move and
beginning of next 68.8 minutes
Number of cars to one shovel move 4.5
Time shovel is interrupted to change trains 362 minutes
Area of section 600 square feet
Height of face Maximum 20', minimum 2
Water used 1100 gallons to load 21 cars
Weather, clear

TIME STUDY

	Forenoon	Afternoon	
Started work	7:00	12:30	
Stopped work	I 2:00	5:30	
Total time worked	300 + 300 min.	= 600 min. = 10	o hours

	Minutes	Seconds	Per Cent
Actual working	156	00	26.0
Changing trains	362	00	60.4
Moving shovel	17	30	2.9
Idle—Taking water	8	30	1.4
Getting up steam Miscellaneous delays	50	00	8.3
Clearing track	6	00	0.1
Total time under observation .	600	00	100.0

Direct Labor Distribution							Standard Basis						
Per Day						Loading	Incidental	Total					
Runner		-	-		-			<u> </u>	\$5.00				
Craneman									3.60				
Fireman									2.40				
4 pitmen									6.00				
Watchman	_	•		·		. •				\$1.50			
Total cost	of	la	boi	r p	er	day			\$17.00	\$1.50	\$18.50		
Cost per da	ıу	ре	er o	cul	ic	yai	d		2.07	0.18	2 25		
Per cent						٠.			92.0	8.0	100.0		

The above costs are based upon the day's output of 822 cubic yards.

D. A. A. A. A.	Ti	me	Per	Cost per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to loading 1. Actual loading 2. Delays	156	00	26 0	0.538	
a Moving up b Miscellaneous Charge to transporting and dumping	17 58	30 30	2 9 9.7		0.799
Waiting for cars Miscellaneous	362 6	00	60.4 I.0	0.023	1.271
	600		100.0		- 2.070

Dipper Performance	Min.	Average	Max.	No. of Obs.	No. At- tempts
Digging Swinging loaded Swinging empty Falling empty	3 ½ 2 ½ 2 ½ 2	9.3 5.1 3.7 3.8	26 20½ 7 12	63 63 63	63 63
Time to fill and load one dipperful		21.9	651/2	63	

Time for a complete swing

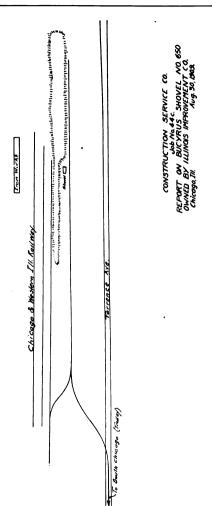
			Minimum	Average	Maximum	No. Obs.	
Seconds			14	19 7	26	63	

ACTUAL RATIOS

Incidental labor
Direct labor = 0.094



Fig. 25. Bucyrus Shovel No. 650







Figs. 26 and 27. A 70-ton Bucyrus Shovel at work, South Deering, Ill.

REPORT No. 16 — SHOVEL No. 980

INSPECTED AUGUST 28, 1909 CHICAGO, ILL.

THE SHOVEL This shovel of the 70-ton class is owned by the American Brick Company, and is at one of their yards, about 15 miles outside of Chicago, employed in digging clay. The boom and dipper handle are of steel and the boom is truss shaped.

CREW The crew consisted of engineer, craneman and two pitmen. In moving forward the "hooker-on" assisted, making four men for this purpose.

SUPPLIES Water is supplied from a tank located near the buildings. Coal is brought down in one of the dump cars and placed upon the shovel by hand.

POWER Steam power is used to run the brickmaking machinery and to haul the cars up the inclined plane, while horses haul from the shovel to the bottom of the incline.

TRACK AND TRANSPORTATION Three-yard narrow gauge cars are used, which can be dumped on one side only.

The arrangement shown on the sketch and photographs worked satisfactorily, since with four cars the granulator was well supplied with material. The time

for a round trip was obtained several days after the observations were made on the shovel. The shovel was then located at the foot of the incline, so that no horses were necessary and only one car was used. One man at the bottom of the plane hooked the cable to the cars. He also assisted in moving forward.

OBSERVATIONS

Gauge												St	andard
Capacity of dipp	er											2 1	≨ yards
Height of lift						Α.	M.,	10	o' t	o i	2';		M., 14'
Height blocked	up												ı'
Length of boom	ı.												281
Length of dippe	r hanc	lle											18' 6"
Height of boom			vot										21.5
Height of boom					ack								26.51
Horizontal reac													20'
Farthest dipper	can re	each	ı to	du	mp								27′
Highest dipper													16'
Diameter of swi					٠.								7' 6"
Height of dinke				e s	hov	el tr	ack	s (1	var	ied	fre	m	6 to 8')
Distance inside													21'
Depth of dipper													4′
Depth of dipper		ıdin	g li	p)									· 5′
Number of cars													166
Cubic yards exc	avated	ł											498
Coal used .												1	.3 tons
Total distance r	noved	for	war	d d	lurin	ıg d	ay						12'4"
Number of time													2
Maximum dista	nce me	ove	d fo	rwa	ard i	in o	ne i	no	ve				6′ 4″
Average time b	etwee	n b	egi	nni	ng d	of c	ne	sh	ov	el '	mo	ve	•
and beginn													minutes
Number of cars												٠.	7.5
Area of section										8	30 :	squ	are feet
Height of face							10	to	20				age 18'
Weather, A. M.													~

TIME STUDY

	Forenoon	Afternoon
Started work	7:00	1:02
Stopped work	I 2:00	3:53
	Min. Min. Min.	

Total time worked 300 + 171 = 471 = 7 hours 51 minutes

	Minutes	Seconds	Per Cent
Actual working	154	30	32.8
Waiting for cars	²⁷⁵		58.4
Moving shovel	8		1.7
Idle			
Tightening bolts on bull wheel			
engine	I		0.2
Firing	1		0.2
Oiling	5		1.1
Car off track	21	30	4.6
Repairing track	3	30	0.7
Miscellaneous delays			•
Moving boulder		30	0.1
Clearing track	I	•••	0.2
Total time under observation	47 I		100.0

Direct Labor Distribution per Day							Standard Basis				
							Loading	Trans- porting	Dumping	Total	
Runner .							\$5 oo				
Craneman							3.60				
2 pitmen .							3.00				
ı hooker-on								\$1.50			
2 drivers .								3.00			
2 horses .								3.00	İ		
Hoisting engi	ne	er						2.40			
ı dumpman					٠				\$1.50		
Total cost of	lat	or	pe	r d	ay		\$11.60	\$9.90	\$1.50	\$23.00	
Cost per day							2.33	1.99	0.30	4.62	
Per cent .					٠.		50.4	43.1	6.5	100.0	

Process Analysis	Ti	me	Per	Cost per Yard	Total Cost
Trocess Analysis	Min.	Sec.	Cent	in Cents	
Charge to waiting for blas-					
ters		30	0.1	0.002	0.002
Charge to loading			_		
1. Actual loading	154	30	32.8	0.764)	
2. Delays				l U	0.839
a Moving up	8		1.7	0.040	0.039
b Miscellaneous .	7		1.5	0.035	
Charge to transporting			_		
and dumping					
 Waiting for cars . 	275		58.4	1.361)	
2. Repairs	3	30	0.7	0 016 }	1.489
3. Miscellaneous	22	30	4.8	0.112	
	47 I	00	100.0		2.330

Dipper Performance	Min.	Av.	Max.	No. Obs.	No. Attempts
		10.7 6.6 5.5 2.9	17 14 9 4	30 28 25 20	30

Time for a complete swing

			Minimum	Average	Maximum No. Obs.		
Seconds			19	26.2	31.5	19	

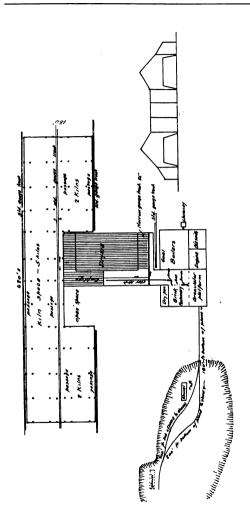
TRANSPORTATION

		Observa- snoit		Hooking-on	uo-	නිකී ්	Shovel to Bottom of Plane	5 Å	W ₃	Waiting at Bottom of Plane	of	8g x	Bottom of Plane to Knives	Jo s	Wai Dur K	Waiting and Dumping at Knives	nd at	3. X	Knives to Bottom of Plane	5 . 2
			Min	14.	Max.	Min.	7.	Max.	Min.	4.	Max.	Min.	AV.	Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max.	Min.	47.	Max.	Min.	AV.	Max.
Time (seconds)		×	c	4 6	2	\$	58.3		55	181	260	1.5	28.1	0 9 4 20 40 58.3 85 85 181 260 15 28.1 40 35 92.5 175 5 11.3 15	35	22.5	175	2	11.3	1.5
Distance (feet)	:	×	:	:	:	200	8	200 200 200	:	:	:	180 180 180	8	%	:	:	:	180 180	%	82
Speed (feet per second) .		×	:	:	:	2.4	3.4	5.0	:	:	:	5.4	6.4	2.4 3.4 5.0 4.5 6.4 12.0 12.0 15.9 36.0	:	:	:	12.0	15.9	36.0

		Observa-	™ Bo I	Waiting at Bottom of Plane	of at	Plar 100	Bottom of lane to Poir o Feet from Shovel	Bottom of Plane to Point Waiting at ∞ Feet from this Point Shovel	≱ €	aiting is Po	s at int	This Point to Shovel	is Po Shov	e ii.	Waiting before Shovel	iting Sho s to I	be- vel		Actual Round Trip	.1 frip
			Min	. A	Max.	Ē	¥.	Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max.	Min.	Av.	Max.	Min	A.	Max.	Min.	۸۷.	Max.	Min.	<u>;</u>	Max.
												*						N X	S W S W	×
Time (seconds)	•	»	c	6 91	Q	*	7.5	0 16 9 40 0* 7.5 30 0* 13.1 50 30 30 30 0 13.1 30 5-207-57 9-20	*	13.1	20	30	30	30	0	13.1	30	5-20	7-57	9-20
Distance (feet)	•	90		:	:	8	8			:	100 100 100	8	8	8		:	:	760 760 760	260	760
Speed (feet per second)	•	∞	:	:	:	3.3	13.3	3.3 13.3 3.3 3.3	:	<u>:</u>	:	3.3	3.3	3.3	:	:	:	4	9.1	2.3

* Five times out of eight observations cars did not stop at this point, but went direct to the shovel in the average time of 52 seconds.

** Three observations.



CONSTRUCTION SERVICE CO.
REPORT ON BUCKRUS SHOVELN. 390
Owned by American Brick C. Mag 28,1309.



Fig 28

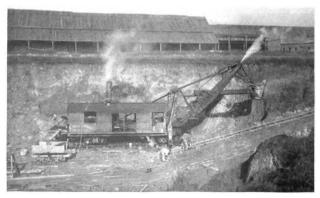


Fig. 29. 70-ton Bucyrus Shovel Digging Clay in Pit of American Brick Company, Chicago, Ill.

REPORT No. 17 — SHOVEL No. 424

INSPECTED SEPTEMBER 2, 1909 RIVERDALE, ILL.

LOCATION Bucyrus steam shovel No. 424, owned by the Chicago Brick Company, is located in one of their clay pits at Riverdale.

THE SHOVEL The machine was new when the brick company bought it and has been used by them ever since (now about eight years) to dig out clay. A chain is used for hoisting, but the swinging is done with a steel cable. The cutting edge of the dipper is a solid plate extending 18 inches beyond the lip and riveted to the latter, being rounded off and drawn out to a sharp edge in front. The face against which the shovel works is very high (26 feet) and it frequently caves in, sometimes falling upon the dipper, causing considerable strain on the dipper handle and crane engine.

MATERIAL not blasted before digging. The shovel shows no undue strain when digging, but several times the dipper handle has been thrown out so far that it has been caught on the tie bars holding the boom and has bent them considerably. As there is often considerable sand in seams and layers between the clay, the engineer has to judiciously mix it so that the clay will not be too "short" for good bricks. This causes the digging to be very uneven at times, since on one side there will often be good clay, and on the other poor sand.

LABOR The engineer does his own firing and the craneman superintends the moving forward. One of the two pitmen sees that the track is not obstructed, throws the switch for the cars, the other looking after the jacks and the pit.

SUPPLIES Coal is brought out in one of the clay cars and thrown upon the shovel by the pitmen, usually after the loading is stopped in the afternoon, when enough coal is taken to last throughout the following day. Water is obtained from a pipe line leading from the mill.

The cars are all provided with TRANSPORTATION two horse-power motors, to which current at 125 volts is supplied through a third rail in the middle of the tracks. The capacity of the cars is 3.12 cubic yards, but they are heaped full. They dump on one side only. The top of each car is five feet above the track. They do not move very fast, but their motion is constant and the service is satisfactory. The steepest grade is 5 per cent against the empties, but even here the speed is noticeably reduced, so that it is not likely that cars of such low horse-power would be of use to a contractor under the usual conditions. Seven horsepower cars were tried on this track, but were found to be too fast and easily became derailed. The cars are run by one man, who controls switches located at about the center of the system, which is divided into seven circuits, each controlled by a single-pole knife switch, so that the operator can control each individual car at any time and at any place along the line. the end of each branch, or where a car is switched back on another track, the reverse switch is thrown by an automatic contrivance, which is simply a small steel frame with a bent bar that knocks the reverse lever up as the car passes by. At the end of the line, where the cars are loaded, one of the pitmen knocks down the lever when the car is ready to start, and the switchman, seeing this done from his shed, closes the switch for that circuit. When the cars run out to the shovel the switchman has to open the circuit when they near the end; then, just as they strike the bumper, which

is part of an old hoisting chain wrapped around one rail, the pitman places a block under the wheels. The third rail runs to the foot of the incline, where a wire cable is attached, and are drawn up by an electrically operated hoisting engine.

All the switches work automatically by springs, there being no one to attend to the cars after they pass the switchman and until they arrive at the foot of the incline, where a man attaches the cable.

There are two granulators in the mill, but at present only one is in use so that the shovel is often delayed waiting for the cars to be dumped and returned. When both machines are run, however, there is more work for the shovel, and a fireman is furnished.

Ground up brick powder is used on the rails in place of sand to keep the shovel wheels from slipping when moving up.

OBSERVATIONS

Weight																		6	5 t	ons
Gauge																				
Capacity	of	d	ipp	er											. 2	2 1/2	cu	bic	ya	rds
Height																				
Kind of																				
Number	of	рi	tm	en																. 2
Height 1	blo	cke	ed	up																Ι'
Length																				
Length																				
Height																				
Height																				
Horizon	tal	rea	ach	of	E b	oor	n.												19	' 6"
Farthest	di	pp	er	car	re	acl	to	d	lun	ıр										27'
Highest																				
Diamete	er o	f s	wi	ng	cir	cle														7.5′
Height.	of (din	ke	y t	rac	ks	abo	νe	e sh	101	æl	tra	cks	3						25'
Distance	e in	sic	le (din	ke	y tı	ack	s	to	ins	side	e si	hov	/el	tra	\mathbf{ck}				15,

HANDBOOK OF STEAM SHOVEL WORK

OBSERVATIONS-Continued

Depth of dipper
Depth of dipper, including lip 62'
Depth of dipper, including cutter blade 80
Number of cars loaded
Cubic yards excavated (place measure) 472
Total distance moved forward during day 8
Number of times moved forward
Maximum distance moved forward in one move 3
Average time between beginning of one shovel move and be
ginning of next
Number of cars to one shovel move 50
Time shovel is interrupted to change trains 283 minutes

TIME STUDY

	Forenoon	Afternoon
Started work	6:54:00 9:13:30	11:48
Statted work	9:13:30	
Stopped work	8:59:30 11:09:00	3:42:30
	(11.09.00	

Min. Min. Min.

Total time worked $241 + 234\frac{1}{2} = 503\frac{1}{2} = 7$ hours 55 minutes 30 seconds.

	Minutes	Seconds	Per Cent
Actual working	160	30	33.8
Waiting for cars	283	oo	59.5
Moving shovel	11	00	2.3
Idle	•		}
Engineer firing	4	30	0.9
car	ΙI	00	2.3
Tightening jacks	0	30	0.1
Miscellaneous delays			
Clearing track	5	00	1.1
Total time under observation .	475	30	100.0

HANDBOOK OF STEAM SHOVEL WORK

D:	D:						Sta	andard B	asis	
Direct Labor Per			outi	on		Loading	Trans- porting	Dump- ing	Inci- dentals	Total
Runner						\$5.00				
Craneman .						3.60				
2 pitmen						3.00				
1 controllerma	ın						\$2.60			
ı cableman .							1.50			
I hoistman.							1.50			
1 cardumper								\$1.50		
1 watchman									\$1.50	
Total cost of	lab	or	pei	r da	ay	\$11.60	\$5.60	\$1.50	\$1.50	\$20.20
Cost per cubi	c y	ard				2.45	1.18	0.32	0.32	4.27
Per cent .							27.6	7.5	7.5	100.0

Process Analysis	Ti	me	Per	Charge	Total
Process Analysis	Min.	Sec.	Cent	Cents	Total
Loading 1. Actual loading 2. Delays	160	30	33.8	0.828	
a Moving up b Miscellaneous Transportation and dumping	5	00	2.3	0.056	0.909
 Waiting for cars . Miscellaneous 	283 16	00	59·5 3·4	0.083	1.541
	475	30	100.0		2.450

TRANSPORTATION

	-svrsedC enoit		Shovel to Switch No. 1	Shovel to Waiting at Switch No. 1	Wa Swit	iting ch N	at 0.1	Switch No. 1 to Bottom of Plane	ch N Bottc Plan	. E a	ä	Waiting Bottom Plane	of of	of B	Bottom of Plane to Knives	to s	Wai Of	Waiting and Dumping of Knives	nd Se se
	,	Min.	Av.	Max.	Min.	AV.	Max.	Min.	AV.	Max.	Min.	Av.	Max.	Min.	AV.	Max.	Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max.	AV.	Max.
Time (seconds)	80	50 62	62	8	8	8	8	30 74 100 105 284 415 35 44	74	8	105	284	415	3.5	4	50	8	100	135
Distance (feet)	တ	350	350 350 350		:	:		648 648 648	648	648	:	:	:	обі обі сбі	61	190	:	:	:
Speed (feet, seconds)	∞	4.4 5.6 7	5.6	7	:	:	:	6.5 8.8 21.6 3.8 4.3 5.4	8.8	21.6	:	:	:	3.8	4.3	5.4	:	:	:

fax.	s 6	. SI	3.7
	S M -IOI-	51 25	4.6 6.5 10.3 2.9 3.2 3.7
- I	30 I3	51 25	9 3
×	¥ ¦	25	3 2.
Мах	8	410	10.3
Av.	63	410	6.5
Mtn.	\$	410	4.6
Max.	8	:	:
Av.	8	:	:
Min.	8	:	:
Max.	140	263	8.5
AV.	118	763	6.5
Min.	8	263	5.5
Max.	8	:	7 4.8 7.0 9.5 5.5 6.5 8.5
Av.	8	:	:
Mfn.	8	:	:
Max.	0	c6 1	9.5
AV.	27	61	7.0
Min.	8	61	8.4
	7	7	7
		•	•
			•
			ds)
			con
	spuc	eet)	t, se
	seco	e (f	feet
	, e	tanc	eq (
	Tim	Dis	Speed (feet, seconds)
	Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max.	Time (seconds) 7 20 27 40 00 00 00 90 118 140 00 00 00 00 63 90 117-30 13-10 14-30	Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. Min. Av. Max. 7 7 2 2 7 40 0 0 90 118 140 0 0 40 63 90 7 1 190 190 19 753 763 <t< td=""></t<>

REPAIRS

We were given, by permission, the following interesting statement of repairs for $6\frac{1}{2}$ years, not including labor:

YEAR 1903

- February 13 1 cutter blade, 1 1/4" x 16" x 44" mild steel. Plate bent and drilled 6.1" x 3 3/4"; bolts, same.
- June 7 2 valve stems for boom engine, 2 pins for same.
- June 15 1 hoisting chain for shovel (1½ " x 122'); 1 cutter blade, 1½ " x 15" x 44".
- July 20 1 friction brake complete with band; 12 hard wood blocks.
- September 18 Four 43/8" cylinder cocks.
- October 9 12 countersunk bolts, 3¾", and nuts; 50 turned bolts, ¾" x 5" nuts.
- November 27 { I swinging cable, I 1/4" x 48' } 100'

YEAR 1904

- June 24 { 1 swinging cable, 1 ¼ " x 48' } 100'

 July 9 60 forged rack bolts
- July

 15 \ 8 forged rod bolts, 158" x 22" \ 1 forged rod bolt, 2 " x 30" \ 156 pounds.

 50 turned bolts, \ \%" x 4", 61 pounds.
- August 3 3 bolts, 1" x 2 ¼", and nuts September 21 . . . Two 2 ¾" hexagon nuts, as per sample

YEAR 1905

- August 25 2 bearings with caps and bolts for same (used on dipper shaft).
- September 16 I long toggle lever, No. 9133B; I double forked link and pin; 2 short toggle links and pins; I double forked link pin; I toggle link pin;
 - I latch keeper, 54 pounds.

September	14	Two 2½" bolts, 34" long, 127 pounds; two 2¾" bolts, 34" long, 137 pounds.
October		60 tack bolts 10 turned bolts 40 turned bolts 8-15%" x 22 " rod bolts 12-1 " x 33" " countersunk bolts 8-34" x 2 " countersunk bolts 8-34" x 2 " countersunk bolts
November	8	2½" x 12" plates drilled complete, 56 pounds; rivets for same, 17 pounds
		YEAR 1906
March	10	1 shipper shaft, No. 1-9157, 232 pounds; one 1½ moran joint; 12 small screws as per sample; 6 large screws as per sample; 36 copper rivets; 2 rack pinions with key for same; 1 set keys for same.
May	24	One 3" throttle valve complete
June	14	One 1 ½" x 122' hoisting chain, 214 pounds; one 1½" x 52' swinging cable; twenty-seven ½" x 3½" finished bolts and nuts, 30 pounds; twenty-four ½" x 5½" finished bolts and nuts, 37 pounds; six ¾" locomotive cylinder cocks; 2 steel bushings for dipper bail.
September	8	. Two 1½" x 27" bolts, 4" thread on each end
September	13	1 jack nut, No. 9011, 205 pounds
October	4	1 jack nut, No. 9011, 202 pounds
October	5	14 bushings; 2 V. S. pins; 4 ecc. rods pins.
October	25	I rocker shaft bearing, 2 rocker shaft bearings, 2 common rods for valve stems with pins.
December	11	1 cutter blade, 1 1/4" x 18" x 44"; two 2 1/4" hexagon nuts.
		YEAR 1907
June	I	52' of 1 1/4" ex. flex. plow steel rope
June	27	Twelve ½" finished bolts, 5" long with nuts, 38 pounds; twelve ½" finished bolts, 5½" long with nuts, 38 pounds; twelve 1½" x 22" rod bolts with nuts, 206 pounds.
July	3	2 bushing No. 2 standard 13; 1 pin, 1¾" x 38" long, 7-9030.

YEAR 1908

September 22 One 1¾" turnbuckle, 9140; I hoop end, S. X. bracer, 9140; 2 lower boom guys, 10-9140; 2 upper boom guys, 9-9140, with pins and bolt, 1233 pounds; I A. frame collar pin and bolts, 140 pounds; I thorough bolt and nuts.

YEAR 1909

March	24	Two 23/4" x 34" holding down bolts, 139 pounds.
April	. 26	1 Fulcrum bracket, 9139 A; 1 Fulcrum bracket pin, 1-9135.
April	7	I swinging cable, 1¼" x 48'; twenty-four ¾" finished bolts, 5" long hexagon nuts; twenty-four ¾" finished bolts, 5½" long hexagon nuts; 2 braces for cross-head pins, 9525 A; 2 cross-head pins with nuts, 1-9549.
May	10	1 cutter blade, 1 1/4" x 18" x 44" plat.
June	I	Two 11/4" U-bolts, 5-9176, and nuts, 214 pounds.
June	15	Six 1½" x 22½" bolts with hexagon nuts; 20-pound ¾" lock washer, 340 washers.
July	23	One 1500-gallon tank complete.
August	2 I	1 hatch keeper, 10-9030, 51 pounds.

	_	Summary												Cost		
1903	١.		٠.													\$273.20
1904																70.88
1905	١.															138.20
1906	١.															375.12
907	١.															47 - 55
908	١.			•												116.43
909					•						•		´•			266.86
		ota o t						lde	d. f	or	bo	iler	re	pai	rs.	\$1288.24
		inc						•	-, -				•			200,00

Per Year

Maximum = \$375

Average = 198

Minimum = 48 Not including boiler.

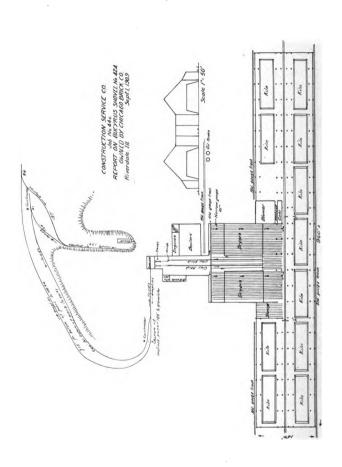




Fig. 30



Fig. 31. Two Views of Clay Pits owned by the Chicago Brick Co., showing Tracks and a Bucyrus Shovel

REPORT No. 19 — SHOVEL No. 517

INSPECTED OCTOBER 4, 1909 BUHL, MINN.

LOCATION Butler Brothers have two shovels working on their stripping contract in the Grant Mine (see p. 123). This is a new project, the mine undergoing the first stripping at the present time although heretofore ore has been taken from underground.

MATERIAL In a cut about 900 feet long and 200 feet wide, which represents the limit of operations at present, nearly every kind of material met with on the Mesabi has been encountered. The top is clay and loam almost entirely free from boulders. In places this clay seems to retain its moisture and is heavy, damp and sticky, hard to dig out of the bank and harder to dislodge from the dipper. In other places the clay was impregnated with iron and was dry and crumbling. This was easy to handle. At some points boulders were intermingled with the dry material, and while in general they were not large they interfered considerably with the digging. At about 30 feet from the surface was a layer of boulders varying in size from 8 inches to 5 feet in thickness. These lay with almost no material between them, a clean mass of stones that looked as if they had been picked and placed by hand. This presents perhaps the most difficult work to be encountered by a steam shovel in any locality. Extra heavy teeth are often bent and broken so as to be utterly useless. A couple of small pockets of gravel were uncovered. Solid taconite and taconite mixed with earth, and low grade ore in a clean body and also mixed with taconite were encountered.

Shovel No. 517 was working in soft clay mixed with boulders. These boulders were not very large nor were

they massed, but were scattered through the clay in such a manner as to be readily picked up with it. Most of them passed through the dipper without trouble. When a boulder too large to handle was uncovered it was thrown to the side of the pit away from the loading track and as far back as possible. For the day's work these boulders averaged less than one per "shovel move."

The shovel bank was very low—too low for economical work. At the beginning of the day the bank on the extreme right of the cut was high enough to allow the dipper to be filled at one trial. After three hours' work the shovel experienced greater difficulty in filling dipper. For the first seven moves, while working with the high bank at one side, the shovel averaged nearly a car to the move more than during the remainder of the day.

The low bank also had its effect upon the time per dipper. For the first 7 trains the average time per dipper was 22.07 seconds while for the rest of the day the average time was 26.83 seconds, an increase of 21 per cent.

MOVING UP bank ahead was not high enough to cave into it. For this reason it was found possible to lay the track before the signal was given for the move-up, which of course necessitated working in the pit and in front of the shovel while it was working, a rather dangerous procedure. While the runner never stopped his dipper because of the men below, their presence made him more cautious and it is to be doubted whether he was able to operate quite as fast and freely as would have been the case with a clear pit.

The moves of the shovel were unusually difficult because of the curve of the track, and consequently the time per move cannot be compared with that for other shovels with ordinary moves and ordinary methods. Whatever time is gained on the actual move is probably lost by the more cautious work of the runner while the track is being laid, and although this cautious running may not be individually noticeable, its effect on a whole day's work is important.

different from the ordinary ones. Mr. Butler said that they had been trying different kinds and had found that pyramiding several thin ones was better than the use of large heavy blocks. The ground block in this case was 4 feet by 6 feet, composed of 3 layers of 2-inch by 10-inch stuff. The top and bottom members run the 6 feet length of the block. The next block was 3 inches by 3 inches by 4 inches thick, the next 2 feet 6 inches by 2 feet 6 inches by 4 inches and the top block 2 feet by 2 feet by 4 inches. The jack plate rested on this with a base about 1 foot square. The plate was free from both block and jack.

Extra large and strong teeth are necessary in this mine because of the nature of the digging. Teeth weighing 460 pounds each are used and these are often bent and broken. One tooth was observed which had been bent over and down until it lay against the lip of the dipper.

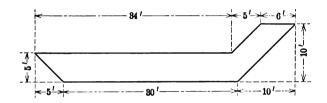
In attempting to move a large boulder from the front part of the pit it became jammed in the dipper. The craneman was carrying the boulder on the dipper teeth and it toppled into the dipper. Being too large to go through, it caught on the back of the dipper and the entire shovel crew, the rockmen, the coal passer and the train crew of three men 64 minutes and 10 seconds to remove it.

The bolster of the front truck has been reinforced with four plates, 3/4" x 6", riveted to the sides of the two regular I-beams; and the A frame, which is of the built-up type, has been reinforced with plates along its side.

The lower chord of the boom truss has a $1'' \times 6''$ plate riveted to its underside and extending the length of the open part of the boom.

OBSERVATIONS

Type of shovel										Buc	yrus	, 75-ton
Distance of move												
Kind of teeth .												
This is the section	of	ban	ık	when	sh	οve	el st	arte	d	work	ing.	-



It was turning slightly to the left, and at 9.45 cut out of bank left by old loading track and section became



Height of lift	{	Car Sho	s ab	ove trac	rai k t	il o	loadi	ng	tra	c k	, 5' r	7′3″ ninus
Size of ties under show												
Size of bucket											2 1/2	yards
Length of shift .											10	hours
Number shifts per day												2
Coal is dumped from	ď	ump	car	· bac	k c	ρf	shove	el a	and	is	carri	ied in
basket to bunker l	by	mai	n.									•
TT7 1 C	. 1	1			•		1		1			*

Water is piped from underground mine nearby and run in pipe over side of cut.

Repairs are made on Sundays and whe Coal used	2½ tons per shift
Water used	. 4200 gallons per shift
	Standard; 60-pound rails is used.
Hand signals used. Kind and size of dinkey Stand	
Age of cars and dinkey. New on this j Weather, fair, rather cold.	job. Bought early in 1909

TIME STUDY Forenoon

Afternoon

Started work	5:20	12:55:15
Stopped work	8:00	6:00:10
Total time worked		Sec. 55 = 10 hours 7 minutes

			Minutes	Seconds	Per Cent
Actual working			296	40	48.8
Waiting for cars			46	30	7.7
Moving shovel		.	141	35	23.3
Miscellaneous delays			•		
Fixing bale pin		.	4	45	0.8
Boulder on track			İ	25	0.2
Fixing bale pin		.	2	55	0.5
Clearing track		.	2 6	ő	1.0
Tightening jack		.	0	35	0,1
Putting on new bale pin			II	10	1,8
Boulder on track		. [2	30	0.4
Loading old teeth .		.	6	30	1.1
Repairs to locomotive		.	6	45	1.1
Pulling timber from pit		.]	I	20	0.2
Rock in teeth		.	I	05	0,2
Dumping coal from car			3	30	0.6
			3	ĭo	0.8
Rock stuck in dipper			64	10	10.6
Rock in teeth			i	30	0,2
Car off track			3	30	0.6
Total time under observat	ion		607	35	100.0

HANDBOOK OF STEAM SHOVEL WORK

Cost of Direct Labor (Loading) per Day											Standard Basis	
Runner .												\$5.00
Craneman .												3.60
Fireman .												2.40
4 pitmen .												6 00
2 track cleane	ers											3.00
ı coal carrier			•			•		٠				1.50
					_							\$21.50

Car loads excavated on day of observation, 156 @ 7 cubic yards per car, water measure.

Cubic yards loaded on day of observation, $156 \times 7 \times 0.75^* = 820$. Cost of labor per day per cubic yard = $\frac{$21.50}{820}$ = 2.62 cents

* 0.75 = ratio of $\frac{\text{Place measure}}{\text{Water measure}}$

per cubic yard.

D		Tir	ne	Per	Cost per Yard in	Total	
Process Analysis	М	in.	Sec.	Cent	Cents	Cost	
Charge to loading 1. Actual loading 2. Delays a Moving up b Repairs	. I	96 41 18	40 35 50	48.8 23.3 3.1	0.610	2.308	
c Miscellaneous . Charge to transporting and dumping 1. Waiting for cars . 2. Repairs	d	78 46 11	30 55	7.7	0.202	0.312	
3. Miscellaneous	$\cdot \left \frac{6}{6} \right $	07	$\frac{^{25}}{35}$	100.0	0.058)	2,620	

Ti C. I. D. I. d	Number				ean	Maxi	mum
Time Study Deductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle	22	3	10	6	26	11	00
Time between moves, shovel working	23	9	10	12	53.6	17	00
Time between trains .	14	2	10	3	13.5	5	35
Time per train, loading	16	12	40	19	OI	25	00
Time per dipper	23		14		25.2		35
No. of dippers to move	23	2	:4	30	0.8	3	8
No. of dippers to train	15	3	6		44	-	7
No. of dippers to cars				4	54		

ANALYSIS OF COMPLETE DIPPER SWING Where only one trial was necessary to obtain dipperful

	Obser-	Minimum	Average	Maximum
	vations	Seconds	Seconds	Seconds
Digging	. 28	3.60	6.00	9.60
Swinging over	. 37	4.00	5.74	7.20
Swinging back	. 34	2.80	7.49	9.60
Total		10.40	19.23	26.40

Where more than one trial was necessary to obtain dipperful

	Obser-	Minimum	Average	Maximum
	vations	Seconds	Seconds	Seconds
Scratching	. 18	4.80	5.76	8.00
Digging	. 19	6.20	9. 0 8	11.40
Swinging over	. 23	4.00	6.08	8.00
Swinging back	. 20	6.8o	7.40	9.60
Total		21.80	28.82	37.00

ACTUAL RATIOS

Water consumption, pounds = 35,000 = 7.00

EXPLANATION OF TIME STUDY

We give with the description of this shovel's work, the complete time study on it, to indicate how an operator may get up such information as is given in this report for himself.

The starting point of the study and the feature upon which all figures are based is the shovel move, and the attempt has been made to make the study read from this in logical order. By reading across the lines, the complete day's work of the shovel can be followed.

Let us take the time study for No. 517 and follow it through in explanation:

The day's work began at 6.55.20. From the blowing of the whistle to the time when the first train came up to be loaded was 5 minutes 10 seconds, and is called "Waiting for first train" under "Miscellaneous Delay," in column No. 8. After the train arrived, 4 minutes 45 seconds were occupied in repairing a bale pin, and then the shovel started loading. That these two delays came before the loading began is shown by the figures occupying lines above that in which the first "Loading time" is given, and the fact that they are successive delays is shown by their being on different lines.

The shovel loaded the first train in 15 minutes 30 seconds, as shown in column No. 2, and this required 37 swings. Only one train was loaded on this move, as is shown by the fact that "Loading time of train," column No. 2, and "Working per move," column No. 4, are identical and by the fact that the "Dippers per train," column No. 3, and "Dippers per move," column No. 6, are identical. During the loading of the train a delay of 1 minute 25 seconds, because of "boulder" on track, is noted in column No. 8.

This move having been finished and the train loaded, the shovel next moved up in 7 minutes 5 seconds, as shown in column No. 1, and loaded for 15 minutes, making 38 swings in that time.

The shovel moves again in 6 minutes 5 seconds and loads for 3 minutes 50 seconds or 9 swings, filling the train. There follows a wait of 2 minutes 35 seconds for the next train. When this train came up it loaded 22 dippers in 9 minutes 20 seconds and the shovel then moved up. The shovel worked on this move 3 minutes 50 seconds on one train and 9 minutes 20 seconds on the next, or a total of 13 minutes 10 seconds (column No. 4) and in that time loaded 31 dippers at an average rate of .424 minute per dipper. During the loading of 22 dippers on the last train, 2 minutes 55 seconds were consumed in "fixing bale pin," 11 minutes for the move, and, after starting to load, 22 dippers were dumped in 8 minutes 15 seconds, filling the train. The total loading time of the train and the total number of dippers are not given but are the sums of the figures in bracket, in this case 9 minutes 20 seconds plus 8 minutes 15 seconds=17 minutes 35 seconds for loading time of 44 dippers.

After filling the train a delay of 3 minutes 15 seconds followed while waiting for the next train. When this arrived the shovel loaded 10 dippers in 3 minutes 40 seconds and then moved up. Besides the 3 minutes 40 seconds consumed in loading this train, 8 minutes 15 seconds were used on the previous train, or a total loading time for the move of 11 minutes 55 seconds, 32 dippers being loaded. During the loading of the last 10 dippers 6 minutes were needed to clean the track.

The move up took 5 minutes 50 seconds and was followed by 9 minutes 25 seconds of loading when the train was full, having taken 36 dippers on this move and 10 on the previous one, or 46 altogether. That the entire move was needed to load this train is shown by the fact that figures in column Nos. 2 and 4, and in Nos. 3

and 5 are the same. The next move up took 7 minutes 15 seconds, and the train came up in 3 minutes 45 seconds. These 3 minutes 45 seconds were then not lost, as the time occurred during the 7 minutes 15 seconds, and is put in parentheses to show that it is not to be counted as lost time.

After the move occupying 7 minutes 15 seconds, the shovel loaded 30 dippers in 11 minutes and moved up again. The total working time of this move was 11 minutes and the total dippers were 30. After the next move, which took 5 minutes 45 seconds, the shovel loaded 16 dippers in 4 minutes 50 seconds and the train was full. The next train was up in 5 minutes 35 seconds and loaded 16 dippers in 6 minutes, before the shovel had to move. After the move, which took 5 minutes 50 seconds, 31 dippers were loaded in 11 minutes 35 seconds and the train was full. These 31 dippers also made another move up necessary.

To make the notes clearer the time of any one train has been put in brackets. The time per train, however, is not essential, the essential time being based on the moves rather than on the trains. This fact must be kept in mind constantly in reading all time study notes.

The "Miscellaneous delays" in column No. 8 may have occurred either during the loading of the train on whose line they appear or after that train is loaded. That is a detail that makes no difference so long as the time is shown to have been lost.

The total working day is given in its two parts at the head of the sheet and is reduced to minutes and seconds. The number of trains loaded is given at bottom of the page, together with the number of moves worked, and such other facts as may be pertinent. The number of moves worked will be the same as the number of items in column No. 4 and may be the same as the number of items in column No. 1, or may be one less than this.

EXPLANATION OF TABLES OF

"TIME OF DIFFERENT PARTS OF DIPPER ACTION"

This time study was made by two methods. To properly fill the dipper it was often necessary to make two lifts. For this reason different sets of figures were obtained to cover each condition.

In table No. 1 only one movement of the dipper was needed to get a full load. Where two trials were made the figures have been put in parentheses and omitted from the totals and averages, but when the times of swinging are not thereby affected they are shown. An attempt was made to divide the time of the two trials equally, but it was seen that this would not give true values.

In table No. 11 the first digging movement of the dipper is called "scratching," not only to indicate it more clearly, but because that is what the process really is. The material of the bank is simply loosened and falls down into the bottom of the pit, where it is picked up by the dipper on the next trial.

The time for "scratching" was taken from when the throttle of the hoisting engine was open to that when it was closed. The time of "digging" then is the time required to drop the dipper to the bottom of the pit and raise it, picking up a load in the meantime, and ends when the "swing over" starts. This it will be seen is not a fair apportionment of time to this item of the dipper action, as it is too great by the time required to drop the dipper.

When the dipper was filled in one trial in table No. 11 the time of that dipper is put in parentheses and not counted in the total and average, as in these cases a different condition obtains. The average of these times, 510, is seen to be near the average for "digging" in table No. 1.

Wherever a figure is widely different from the other figures of a column it has been enclosed in parentheses and left out of the average.

TIME STUDY. SHOVEL No. 517

Hrs. Min. Sec.	15	01	spi
Min.	55 15	8	secon
			35
Hrs	. 12	9	ıtes
	•	٠	nin
	•	٠	7
	•	Ď	8
	degan	stopped	or
	Beg	Sto	Total work, 10 hours 7 minutes 35 seconds, or 607 minutes 35 second
ec.	30	8	35 s
32	`•	Ŭ	es
Min. Sec.	55	28	minut
			7
Hrs.	9	Ξ	ours
	•	•	0
	•	•	Ι,
	ork		work
	Began work	Noon	Total

Read left to right and down

Moving Up	Loading Time of Trains	Dippers per Train	Working per Move	Dippers per Move	Time per Dipper	Waiting Between Trains	Miscella	Miscellaneous Delays
Min. Sec.	Min. Sec		Min. Sec.		Min.	Min. Sec.	Min. Sec.	
	-	:	•	:	:		s ro Wa	Waiting for first train
		:	•	:	•	•	4 45 Fix	Fixing bale pin
		37	15 30	37	.420	(3 20)		Boulder on track
7 05	15 00)	38	15 00	38	•395			
6 05	3 50)	6	•	:	:	2 35		
	02 6	22	13 10	31	.424	•	2 55 Fix	Fixing bale pin
8 11	8 15)	22	•	:	:	•		
	•	:	•	:	:	3 15		
	3 40)	10	11 55	32	.370		e ∞ Cle	Cleaning track
5 50	9 25)	36	9 25	36	.263	(3 45)	o 35 Tig	htening jack
7 IS		တ္	8 11	30	.366			
5 45	4 50)	91	•	:	:			
		:	•	:	:	5 35		
	δ 9	91	10 50	35	.340	•		
5 50	11 35)	31	11 35	31	.372		11 to Put	Putting new bale pin
6 15	11 15)	30	11 15	သ	376	(3 30)		ilder on track
5 10	4 20)	13	•	:	:		ဇ္တ	Loading old teeth
	٠	:	•	:		2 50		
	(or 9	8 1	10 30	31	.338	•		
30	(01	90	2	ç	910			

TIME STUDY. SHOVEL No. 517-Continued

	Sec. Min. Sec. (2) (2) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4
	5. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6.
80 : 0 : 4 : 0 : 1 : 0 : 1 : 0 : 0 : 0 : 0 : 0 : 0	\$\frac{1}{2}\tilde{8}\tilde{8}\tilde{9}
	Min. Sec. 6 3 3 3 6 6 6 7 7 7 8 7 7 7 8 7 8 7 8 7 8 7 8 7

Trains loaded, 16; moves worked, 23; total cars loaded, 156. First and last trains, 8 cars each; others, 10 cars. * Not included in average.

SHOVEL No. 517

TIME OF DIFFERENT PARTS OF DIPPER ACTION

	TABLE	No. 1			TABL	E No. 2	
	Digging Seconds	Swing- ing Over Seconds	Swing- ing Back Seconds	Scratch- ing Seconds	Digging Seconds	Swing- ing Over Seconds	
	6.0	6.4	7.6	- 6		. 0	
• •	4.8	4.4	7.2	5.6	9.8	4.8	7.2
• •		5.6	8.0	5.6	9.0	5.6 6.2	7.2
•	4·4 8.0	5.6	7.4	5·4 4·8	10.0 9.6	(12.6)	8.0
	6.4	6.4	7.0	4.0	(6.0)		8.4
• •	8.4	7.2	6.2	6.0	10.6	4.2	7.4
• •	5.4	6.2	7.6	8.0		5.4	7.8
	6.4	0.2	/.0		7.6	(10.8) 6.0	(12.2)
• •	3.6	5.6	9.4	5.0	9.0		7.2
•		7.2	7.8	5.2	9.2	4.6	7.2
(8.0)	7.0 (8.0)	5.8	7.6	- :	(5.2) 8.0	4.0	9.6
(8.0)	(8.0)	6.2	8.4	5.6	(4.0)	5.0	. :
4.8	8.4	6.6	9.0	6.8	10.6	5.6	7.2
	4.4	6.2	6.8	0.0	(6.0)	5 2 7.8	(10.0)
	4.8	4.8	(14.0)		(4.8)		9.2 8.8
6.4	7.2	7.0	(14.0)	5.6	11.4	5.4 6.6	
	6.0	4.0	6.4	6.4	10.4	6.4	7·4 7·8
5.8	8.2	1.0	0.4		9.2	6.8	
3.0	5.2	5.2	0.2	5.0	7.8	7.2	9.0 6.8
(6.8)	(7.0)	6.2	6.6	7.2	(5.0)	6.8	8.0
(6.8)	(7.0)	6.4	6.8	5.0	q.6	8.0	
	6.8	6.2	2.8	5.8	8.8	7.4	7·4 8.o
	(10.4)	4.2	7.2	6.0	8.2	7.2	8.4
8.2	9.6	5.2	8.0	0.0	6.2	8.0	(12.8)
(8.2)	(8.2)	5.2	6.4	4.8	7.6	6.8	(12.0)
(6.4)	(6 6)	6.0	0.6	4.0	,	0.0	
	7 2	7.0	6.8				
	5.2	4.8	8.4			١.	
(7.6)	(7.6)	6.4	7.2	i '			
	4.8	6.4	8.2				ŀ
	5.8	6.2	'	1 .			
	5.6	7.0	9.0				
	5.6	5.6	6.4				
	8.0	4.8	8.6	į.			
(7.4)	(7.6)	6.0	5.6				
	7.2	4.8	8.0				
·(7.6)	7.8	4.6	7.8			l	1
(8.1)	(8.1)	4.4	7.6	1 1			
(6.8)	(7.0)	4.8	8.o				
Γotal	168.2	212.6	254.6	103.8	172.6	141	158.0
Γrials	28	37	34	18	19	23	20
Average .	6.∞	5.74	7·49	5.76	9.08	6.13	7.90



* Fig. 32. Type of Dump Car used at Grant Mine, Buhl, Minn.

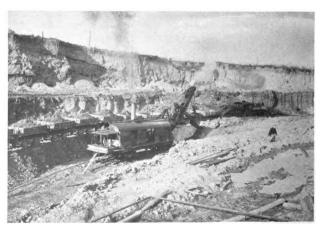


Fig. 33. View of Grant Mine, Buhl, Minn.

REPORT No. 20 — SHOVEL No. 727

INSPECTED AUGUST 26, 1909 CHICAGO, ILL.

LOCATION Bucyrus Steam Shovel No. 727, owned by the American Brick Company, is located in one of its clay pits near 45th and Roby Streets, Chicago, Ill.

SHOVEL AND CREW from the factory about five years ago and has been used continuously since then to excavate clay. No itemized list of the repairs has been kept, but they have been slight, not amounting to over \$350. It is provided with a chain hoist and cable swing, each being operated by a separate steam engine. The friction ram which operates the hoist is worked by hand and not by steam, as on some of the larger machines.

The crew is composed of four men, the engineer, who is also fireman, the craneman and two pitmen. The pitmen keep the dinkey track clear and lay the ties and rails for the shovel to move upon.

MATERIAL The pit is very soft and sticky in wet weather, but when it is dry is not unpleasant to work in. There is some sand mixed with the clay but not enough to cause trouble when they are loaded together.

SUPPLIES Coal is brought out in one of the clay cars and shoveled into a box on the ground since the cars dump on the side away from the shovel. Water is supplied to the tank through a pipe connecting with the city mains.

TRANSPORTATION One dinkey hauls the cars back and forth from the shovel to the incline, where they are drawn up to the granulator by a wire cable connected to a steam driven drum. The man who runs the engine also dumps the cars. Two cars generally constitute a train, but occasionally there are The haul to the bottom of the incline is about four hundred feet. One man is stationed at the botton The dinkey engineer does his to hook on the cars. own firing. The cars weigh about a ton and a half and hold 3.12 cubic yards. The shovel could work considerably faster if the machinery could use the clay, but often a car is drawn to the granulator and held there for several minutes before it is dumped, and as very large chunks of clay can not be easily handled in the granulator the engineer must so run the shovel as to shave off the bank, which, greatly retards the speed of loading. There is a switch at a little distance from the foot of the incline where the track divides, coming together again half way up the slope. The loaded cars are run in on the right track of this switch and the empties are hauled out from the other side. Since the switches all work automatically by springs the dinkey cannot pull out of the switch and back in to get the empties, so a cross over is provided

OBSERVATIONS

Weight													55	to	ns
Gauge								• .					Stan	da	rd
Capacity	of	dip	per								2	cυ	ibic y	yar	ds
Height o	of li	ft													5'
Kind of															
Height b	loc	ked	up									٠.			ı′
Length o															
Length of	of d	ippe	er h	and	le								. І	6′	6″
Height o							el tr	ack					. 2	22 5	۷′
Horizont	al r	eac	h o	f bo	om	ı							17	′ I	o″
Farthest	dip	per	car	ı re	ach	to	du	mp						2	51

OBSERVATIONS—Continued

Highest dipper can reach	to	dum	р.							15'
Diameter of swing circle										6½'
Height of dinkey track a										0
Distance inside dinkey to	ack	to in	side	sho	vel	trac	:k			15'
Depth of dipper										46"
Depth of dipper, includir	ıg lir									58"
Depth of dipper, includir										72"
Number of cars loaded										160
Cubic yards excavated (p	olace	mea	sure	e)						320
Total distance moved for										19'
Number of times moved			- 0		Ĭ.			•	•	1
Maximum distance move			d in	one	mo	ve	•	•	•	5' 2"
Average time between b							m		•	<i>)</i> –
ginning of next	egiii	mig	٠.	one	3110	J V C1	111			utes
		. i i		•	•	•	•	110	11111	
Number of cars to one s	nove	ei mo	ve			•	•	•	•	42.7
Area of section							500	SQ1	uare	feet
Height of face							٠.	. *		22'

TIME STUDY

	F orenoon	Atternoon
Started work	6:45	12:57
Stopped work	I 2:00	3:52
	Min. Min. Min.	
Total time worked	315 + 175 = 490 =	8 hours 10 minutes.

	Minutes	Seconds	Per Cent
Actual working	140	00	28.6
Spotting cars	5	00	1.0
Waiting for cars	295	30	60.3
Moving shovel	16	30	3.4
Idle		_	
Car off track	20	00	4.1
Firing	I	00	0.2
Bringing out coal	I	00	0,2
Miscellaneous delays			
Clearing track	ΙΙ	00	2,2
Total time under observation .	490	00	100.00

HANDBOOK OF STEAM SHOVEL WORK

				-				Standar	d Basis	
Direct		ibor Per		tribu	ıtion		Load- ing	Trans- porting	Dump- ing	Total
Runner .						•	\$5.00			
Craneman							3.60			
2 pitmen .							3.00			.
								\$2.60		
Hooker-on								1.50		
ı dumpman									\$1.50	
Cost of labo	rı	oer	day			•	\$11.60	\$4.10	\$1.50	\$17.20
Cost per day					ard			1.28	0.47	5 . 37
Per cent				. *			67.4	23.8	8.8	100.0

Process Analysis	Ti	me	Per	Cost Per Yard in	Total Cost
Trocess Analysis	Min.	Sec.	Cent	Cents	Cents
Loading 1. Actual loading 2. Delays	140	00	28.6	1 035	
a Moving up b Miscellaneous .	16.	30	3.4	0.123	1.172
Transportation and dump- ing					
 Waiting for cars Miscellaneous 	300	30	61.3	0.228	2.448
	490	00	100.0		3 620





Figs. 34 and 35. 55-ton Shovel in Clay Pit of American Brick Co., Chicago, Ill

CHAPTER VIII

STEAM SHOVEL WORK IN IRON ORE

Very unusual efficiency is shown by the investigation of the work done in the iron ore regions of Michigan and Minnesota. There seem to be the following reasons for this: I. The work is largely in the nature of a permanent installation, and consequently years of study on one job have developed an efficiency that a contractor is not likely to attain on one comparatively short piece of work with uniform conditions, or on many jobs with varying conditions; 2. The material is generally quite uniform, and presents month after month and year after year fewer new and strange conditions than does the average run of rock work, therefore the problem is simpler; 3. It appears that the companies operating in this region for some reason are in the habit of studying their unit costs more systematically than the average contractor's organization. Study of these costs invariably leads to more economical work, wherever we have observed them.

It is the general policy of the mining companies not to give out any information from their books, and, therefore, much instructive data on cost of repairs, etc., could not be obtained from them, but they have extended the courtesy of allowing our inspectors to make observations in the field very freely.

The notable feature in ore handling is its great density, involving a much greater amount of power to raise a cubic yard, than in the case of the earths.

MESABI RANGE

In St. Louis County, Minnesota, some thousand feet above the level of Lake Superior, is located one of the most remarkable iron ore regions in the world, due

directly to the geological formation, and, indirectly arising from this to the method of excavating the ore which has been extensively adopted. Beneath the bases of the huge mountain ranges of past ages, which millions of years of the slow but incessant action of the natural elements, frosts, floods and great fields of ice have gradually ground down to a nearly uniform surface, are found the great beds of red and black iron oxide of the Mesabi Range. The soluble alkalis and silica cement of old bed rock, an unstable iron silicate locally known as taconite, have been slowly worn away by centuries of constant water action, until now the vast disintegrated deposits extend for miles, covered by a mantle of drift material, gravel and boulders varying in depth from o to go feet or more, and in some spots rise up through the surface. The range is about 100 miles in length and from one-half to three miles wide. covering an expanse of 150 miles, or thereabouts, of which 15 per cent to 30 per cent is capable of producing an iron ore whose quality is unsurpassed, even by the best products of the old world. The beds average in depth from 75 feet to 250 feet, but have been known to extend down 500 feet and 600 feet. Thus it is seen that these wonderful deposits embody all of the requisites for ideal ore mining, not only in quality and quantity of product, but ease and facility of handling. This feature opened the way for a new method of excavation, one far superior to the old, that of the steam Unknown in mining work twenty years ago, this method, which enables the output of the Mesabi district to surpass that of any other region of the world, has done much toward making the United States the foremost iron and steel producing country of to-day. The location of these mines places their product within easy reach of the principal inland cities and ports, thus making them an ideal distributive center for this country. Contributing to this valuable and bountiful supply

are more than one hundred mines in active operation. According to the inspector of mines of St. Louis county, the output of various mines for the fiscal year ending June 30, 1909, was as follows: Hull Rust, 3,266,905 tons; Fayal, 1,660,919 tons; Burt, 1,595,435 tons; Virginia, 1,181,726 tons; Adams, 1,176,330 tons; Mahoning, 1,064,611 tons. The supply promises to hold out for many decades, both from the output of the mines operated at present, as well as from those which are continually being discovered and put into operation.

When a new mine is to be opened, in the first place an "exploration company" is employed to locate, as nearly as possible by drilling, the position and shape of the deposit, to map it out, to estimate the probable productive capacity and the amount of "stripping" necessary. This latter, which consists of removing the overburden of drift with the steam shovels, after clearing of timber, etc., is usually done by contract. This overburden varies from a glacial till, easily handled, to coarse gravel, clay, boulders, low grade ore, etc., frequently requiring to be loosened by blasting. It is the usual practice to strip enough ore to enable the mining to be started, and then to strip and mine simultaneously. but occasionally the stripping is entirely completed before the mining proper begins. The steam shovel is placed upon a portable track. Upon a parallel one, close by, automatic dump cars from four to seven cubic vards in capacity, in trains of seven to ten cars each, are run alongside by a dinkey engine, and when filled by the shovel are hauled to the dump, usually from oneeighth to one and one-half miles distant from the mine.

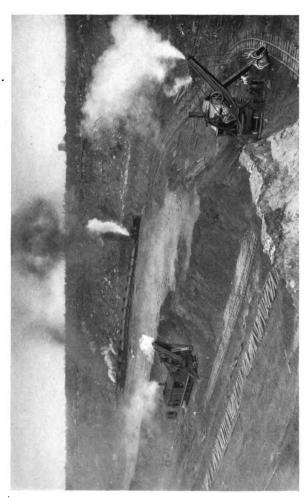
Although contracts are made for both stripping and mining, the latter is usually performed by mining companies. The process is practically the same as that of stripping, the cars in this case, however, being of about fifty tons capacity. The railroad furnishes the cars and takes them in charge at the entrance to the mine; all

other equipment is owned by the mining company, and the spotting of the cars for the shovel and all transportation in the mine is done by them. The shovel ordinarily employed weighs from 65 to 90 tons, though larger ones are used, and will handle from two to five tons of ore at each swing of its dipper.

Although the method of "open-pit" mining described above is the most economical and productive, as well as the one most extensively practiced in this region, others are employed, such as the "milling," and the old universally known "underground" methods. In the "milling" process a shaft is sunk close beside the ore bed to a depth sufficient to allow a tunnel to branch off beneath the deposit. After "stripping," a funnel-shaped opening is made through the bed and down to the tunnel. The ore is fed or "milled" down this opening into tram cars, which in turn convey the ore through the tunnel to the shaft, where skips raise it to the surface. During the summer the skips dump into bins from which the ore is loaded directly into the railway company's cars, but in the winter season stock piles are formed from which the steam shovel loads the ore the following summer.



Fig. 36. Hull-Rust Mine, Oliver Iron Mining Co., Hibbing, Minn. Largest Producing Mine in the World. Output for Fiscal Year Ending June 30, 1909, 3,266,905 Tons



Pool-Burt Mine, Hibbing, Minn. Output for Fiscal Year Ending June 30, 1909, 1,595,435 Tons (Burt) Fig 37.



Fig. 38. Mahoning Mine, Hibbing, Minn. Output for Fiscal Year Ending June 30, 1999, 1,064,611 Tons

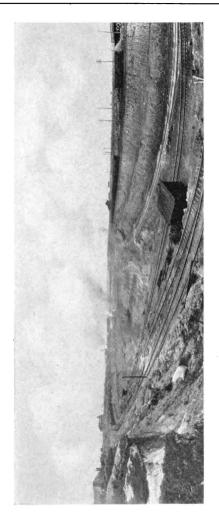


Fig. 39. Sellers Mine, Hibbing, Minn.

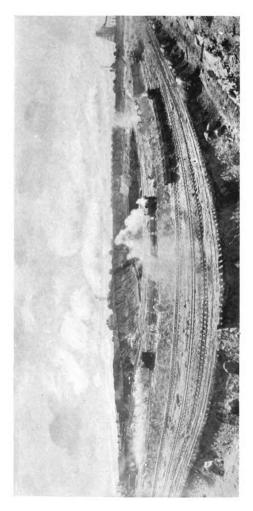


Fig. 40. Leonard Mine, Chisholm, Minn.

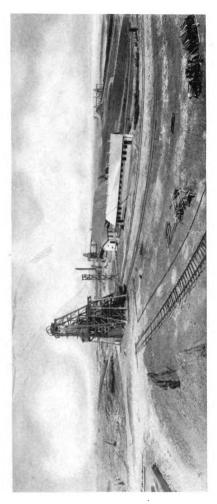


Fig. 41. Chisholm Clark Mine, Chisholm, Minn.



Fig. 42. Sliver Mine, Virginia, Minn.

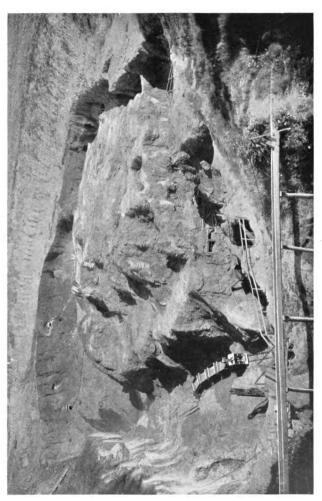


Fig. 43. Higgins Mine, Virginia, Minn.



Fig. 44. Pillsbury Mine, O. I. M. Co., Chisholm, Minn.



Fig. 45. Illustration Showing Self-sharpening Wear on Teeth at Hanna Mine



Fig. 46. Monroe Pit at Chisholm, Minn.



Fig. 44. Pillsbury Mine, O. I. M. Co., Chisholm, Minn.

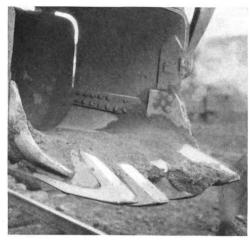


Fig. 45. Illustration Showing Self-sharpening Wear on Teeth at Hanna Mine



Fig. 46. Monroe Pit at Chisholm, Minn.

GENERAL REMARKS

OLIVER IRON MINING COMPANY HIBBING, MINN.

GAUGE Many of the companies use standard gauge equipment entirely and this simplifies their work immensely; for instance, if necessary, the loading track can be broken behind the shovel and the shovel moved back on that track at any time. Generally, however, a standard gauge track is laid keeping within 40 or 60 feet of it and when the shovel has finished a cut it backs up on this track, which at once becomes the loading track for the next shovel cut.

REPAIRS In case heavy repairs are to be made on a shovel a locomotive crane is run in on the loading track and the work done with its help. A locomotive crane is kept in the Hull-Rust mine at all times and is used as a wrecking outfit when needed in addition to its use on shovel repairs.

TEETH In the stripping, as done in the Sellers' Approach, the teeth on the dipper have to be renewed at least once a week and this is generally done every Sunday. It sometimes becomes necessary to replace a single tooth or perhaps two of them during the week, but each shovel is supposed to use 4 teeth per week and this average holds as a general rule. In ore the teeth are supposed to last a month. They are never broken and seldom bent and all wear down evenly. They wear from the outside or the bottom, as one craneman expressed it, and so keep themselves sharpened. They are allowed to wear down within about 6 inches of the lip and the short blunt teeth thus obtained seem to make no difference in the digging.

TRANSPORTING

The cars used for earth are of the seven yard side-dump type. For ore the one most commonly used is the 100,000-pound pressed steel hopper car, although there are still in use many 70,000-pound capacity wood cars, hopper bottom. Both types are M. C. B. standard equipment throughout. The hopper doors are worked by a hand crank. The steel cars have, in general, a height of 10 feet from rail and the wood cars 7 feet 6 inches. This equipment belongs to the railroad company that carries the ore to the loading docks. The stripping equipment is the property of the mining company or the contractor, as the case may be. All hauling within the mines is done by the mining companies' locomotives, the railroad companies merely placing the empties on the mine siding, as they would for any other shipper.

SHOVEL CREW usual organization with 4 or 6 pitmen, varying with the nature of the work. The number is generally 4, with 2 extra men to clear track. These two men are called "rock men" and are used in the pit only in case of emergency. When loading ore the pit crew is always 4 and the rock men may number as many as 8. The rock gang varies according to the nature of the ore being loaded. If the ore breaks out in large pieces it has to be sledged, and if taconite occur this must be removed. On No. 1083 there were 6 rock men in the pit and two in the cars throwing out rock and suspicious looking ore.

ORE REQUIREMENTS

for ore affect the output of a mine very largely and consequently the working of the shovels. In order to produce ore of a certain grade for shipment, that from several mines is often

mixed. For instance, if the ore of one mine should run .05 in phosphorous, it may be mixed with the ore from another mine running .02 and be in such proportions that the shipment will pass as Bessemer grade. In this way one mine may be rushed to fill orders for shipment while another is almost idle.

All pieces of rock or taconite too large to LOADING lift by hand and too hard to break are thrown by the shovel as far back as possible and left. The pieces that the men can handle are thrown down near the loading track at the foot of the bank to be loaded later. This loading is done as follows: Several dump cars are left at each shovel. When a train arrives to be loaded these cars are coupled to the front end of it and pushed along with the train. When loaded, the train spots the dump cars at the shovel and pulls out, leaving them there. The shovel then picks up what it can of the pile of rock by the loading track and what it cannot get hold of readily is thrown into the dipper by hand. This is then dumped into the cars. When the next ore train arrives it simply pushes the dump cars out of the way, loads and again spots the cars and pulls out. When rock is loaded into the cars with the ore there is sometimes a slight delay when the two workmen on the cars jump down to pick it out. If there is much of it, or if it has to be sledged, the loading must be stopped while the men finish their work and get out of the way. In such cases the full dipper is held just clear of the car, while the men move aside, immediately after which the swing is completed. This delay does not amount to much for each swing, since it is only a few seconds long, but if much rock should be loaded with the ore the delay might amount to several dippers full per day.

GENERAL Work is seldom stopped by rain and it may be said that during the shipping season the loading of ore is never interrupted because of the weather. Of course, an occasional shower of great severity might cause temporary suspension of work, but the crew would not leave the shovel for such cause. The mines are comparatively dry until the bottom of the ore is reached, as water goes through it easily, and all of the deep pits are underdrained by means of shafts sunk in them and kept dry by pumps.

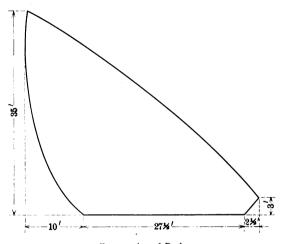
REPORT No. 21 — SHOVEL No. 710

INSPECTED SEPTEMBER 5, 1909 CHISHOLM, MINN.

MATERIAL pile work for the Oliver Iron Mining Company. The stock pile had been accumulating for two years and was some 35 feet high. It was about as ideal a material to work in as could be desired. Two shafts of the Monroe mine furnished the ore for the stock pile. Some trouble was caused by piles of lagging that fell down in front of the dipper. This had been used to make a solid base for the end dump cars to run upon. The ore was soft and in small pieces. There was no frost and a full dipper was obtained at each swing. It might be expected that with such a high pile there would be trouble due to burying of the jack, but here the cave-in always occurred ahead of the dipper and caused no trouble.

PERFORMANCE A very good morning's work was observed, fifty-eight cars in all, forty-nine being 50-ton steel cars and nine 35-ton wooden cars. The afternoon's work was delayed by one of the

large steel cars getting off the track. It was loaded, and nothing could be done until the section gang came up. Meanwhile the string of empties was taken out and no more work was done that afternoon.



Cross-section of Bank

OBSERVATIONS

Type of shovel .											Вu	суі	rus,	90-1	on
Distance of move															6′
Kind of teeth .															
Height of lift, steel	ca	rs I	2';	wc	od	cai	s, I	ю′	4";	siz	e o	f ti	ies,	6″ x	8″,
and 5" x 7".															
Size of bucket .													2 1/2	ya	rds
Age of shovel .													4 1/2	ye	ars
Duration of job: w															
about two wee	eks			•											
Length of shift .													10	ho	urs
Number of shifts 1															

OBSERVATIONS—Continued

How supplies are handled (coal and water): Coal is brought up by team and shoveled into bunkers. Water pumped from tank.
How and when repairs are made: Repairs made on Sunday by regular crew.
Coal used
Oil used Engine, I gallon in 10 hours. Cylinder, 2 gallons in 10 hours. Cup grease, 5 gallons in two weeks.
Water used
Water used
Number of working and rainy days: Weather did not make as much difference as car supply. Total per cent of lost and idle days not obtainable.
Kind of track, i. e., gauge, etc.: Standard gauge, 60-pound.
Kind and size of cars used: Steel, 50-ton capacity. Wooden, 35-ton capacity.
Steel cars: U.S. Standard Pressed Steel Car Company; Pressed Steel Car Company.
Wooden cars: American Car & Foundry Company; Pullman Company.
How train is braked: By air, hand signals.
Kind and size of dinkey: Standard locomotive about 60-ton.
Length of haul varies, but around 2000'.
Number of trains
Weather, clear and cool.
Shovel has swing jacks.
Moved forward 36' during day
Moved forward
Swing engine and crane engine 9" x 9"
Side cut.
Dipper of larger capacity might easily be used. Cut dry and clean.

TIME STUDY

	Forenoon	Afternoon
Started work	7:00:00	1:00:00
Stopped work	I 2:00:00	2:42:05
	Min. Min. S	ec.
Total time worked 5 seconds.	300 + 102	5 = 6 hours 42 minutes

	Minutes	Seconds	Per Cent
Actual working	278	40	69.3
Waiting for cars	77	35	
Moving shovel	27	5	19.3
Miscellaneous delays			
Picking lagging out of pit	8	30	2,1
Fixing block for wheels	3		0.7
Oiling (3 men)	5		1.3
Other delays	2	15	0.6
Total time under observation .	402	5	100.0

Co	ost c	f D	irec	t La	bor	(Lo	oadi	ng)	Per	Da	y		Standard Basis
Runner .													\$5.00
Craneman													3 60
Fireman													2.40
6 pitmen													9.00
ı trimmer													1.50
													\$21.50

Number of carloads excavated on day of observation, sixty-four 50-ton and thirteen 35-ton = 3655 tons.

Based on the observed performance, the number of tons ex-

Based on the observed performance, the number of tons excavated per 10-hour day $3655 \times \frac{600 \text{ minutes}}{402 \text{ minutes } 5 \text{ seconds}} =$

5455. Number of cubic yards excavated per 10-hour day (2 tons per yard) 2728.

Cost of direct labor per day, per cubic yard = $\frac{$21.50}{2728}$ = 0.79 cents per cubic yard.

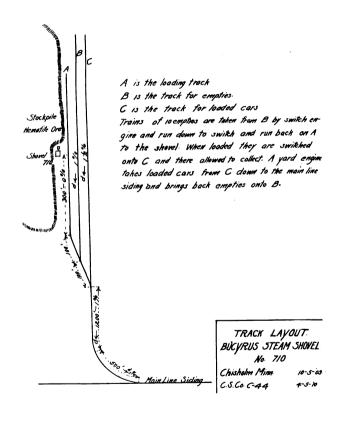
D A		Tir	ne	Per	Cost per Yard in	Total Cost
Process Analysis		Min.	Sec.	Cent	Cents	Cents
Charge to loading		 				
 Actual loading 		278	40	69.3	0.548)	1
2. Delays		ļ		1	Į	0.638
a Moving up .		27	5	6.7	0.053	0.030
b Miscellaneous		18	45	4.7	0.037)	
Charge to transportin	g					
Waiting for cars .		77	_35	19.3	0.152	0.152
		402	5	100.0		0.790

ACTUAL RATIOS

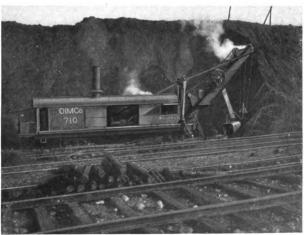
 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{64,150}{9,000} = 7.12.$

Time Study Deductions	Number	Mini	mum	Ave	rage	Max	mum
Time Study Deductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle	6	2	35	4	31	7	50
Time between moves, shovel working.	6	18	5	46	27	77	40
Time between trains.	7	6	35	10	16	14	10
Time per train, loading	10	8	30	27	52	42	0
Time per dipper	5		21.2		22.4		24.4
Number of dippers per move Number of dippers	6	5	I	117	7.5	20	5
per train	10	2	4	72	2	9	7
per car				9	35		

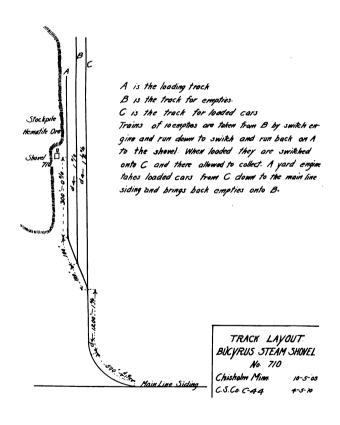
	Train Number	Steel Cars	Wood Cars
	1	8	2
	2	7 8	3
	3 4	2	2
Cars per train	5	10	0
	. 6	9	I
	7	5	0
	8	6	3
	9	5	0
	10	4	I
Total		64	13



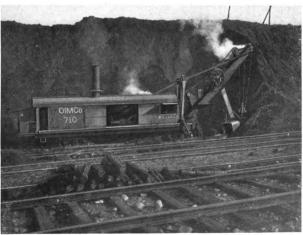




Figs. 47 and 48. 90-ton Bucyrus Shovel at Work on Stock Pile of Oliver Mining Company, Chisholm, Minn.







Figs. 47 and 48. 90-ton Bucyrus Shovel at Work on Stock Pile of Oliver Mining Company, Chisholm, Minn.

REPORT No. 22 — SHOVEL No. 719

INSPECTED AUGUST 7 AND 8, 1909

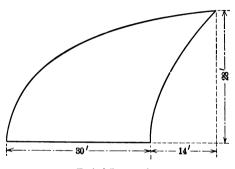
AMASA, MICH.

LOCATION Iron Mining Company, of Stambaugh, Mich. At the time of this investigation the shovel had been leased to the Iron Mining Company, at Amasa, for the purpose of cleaning up the stock pile at that place. Runner, craneman and fireman went with shovel.

SHOVEL It took one day to set up the shovel after its journey from Stambaugh, and another half day to put on a new lip. The usual style of "lip" employed in stock pile work is of manganese steel. But the one that had been ordered for this shovel did not fit, and so an ordinary mild steel lip, minus the teeth, was attached. The boom of this shovel was supported by two cables instead of the customary eye-bars.

MATERIAL frost, and furnished very easy digging. The posts used in forming the trestle work were pulled up by the shovel by means of a chain wrapped around the pole and secured to the dipper, and afterward swung in alongside the shovel. Usually these poles could be removed between trains and so cause no extra delay. Three and a half minutes was the observed time for one of these operations. Because the ore was slightly undercut, one man was kept on the pile with a pick to loosen the bank and so prevent the jack from becoming buried after the shovel moved forward. This man also manipulated the chain used in the removal of the posts. Between trains, when not pulling posts, the

runner would "claw" in toward the main pile as much of the ore lying near the loading track as possible. Whatever ore the runner could not thus handle was shoveled into the dipper by the pitmen. In this way a clean trail was left by the shovel and very little ore wasted.



Typical Cross-section

OBSERVATIONS

Type of shovel						•	•							70 C
Type of shovel. Distance of move Kind of teeth.	·	•	•	•	•	·	•	•	•	•		•	•	6'
Kind of teeth	•	•	•	•	•	•	B	•		lin.	min		tha	teeth
Kind of teeth .	•	•	•	•	٠	•	Du	Lyr	us	пÞ	111111	lus	me	teeth
Height of lift	•					•		•			•		•	9½′
Height of lift Size of ties under	sho	ove!	l, 6º	″ x	8"		Ti	es	ha	.d a	arrai	nge	mei	nt for
slipping in rail	as	b e f	ore	de	scr	ib	ed	(see	e 1	ig.	51	01	11	06.
Size of bucket .											•	. :	2 1/2	yards
Age of shovel .												Fif	th s	eason
Size of bucket . Age of shovel . Duration of job .								Αt	Aı	mas	a, N	Mic	h., c	days
Length of shift .													10	hours
Number of shifts pe	er d	lay							٠.					. I
Coal is brought by														
the bunker. Í	Dist	anc	e a	.bo	ut 2	0	o ya	ards	s.				_	
Repairs small, and	ma	de '	wh:	ile	wai	ti	ng f	or	ca	rs.				
Coal used						2	2 1/2	ton	s j	per	day	of	10	hours
				(0.7	8	gal	lon	in	I	day	(bl	ack)
Oil used				₹	0.4	4	gal	lon	in	1	day day	(cy	lind	ler)
				ı	0.2	2	gal	lon	in	1	day	(ke	ros	ene)

OBSERVATIONS-Continued

Water used . No record, but about 3500 gallons in 10 hours Boiler is cleaned once a week while waiting for cars.

Kind of track, weight of rail, gauge, etc. Standard gauge, 50-

Kind and size of cars used. Cars, 40 tons capacity; weight, 37.5 tons; estimate by maker; kind, wooden.

The train is braked by air.

Kind and size of dinkey. One switch engine, American locomotive about 40 tons; one line engine to bring in empties. Saturday, August 7, shovel began working after luncheon at 1:30 and worked until 3:31:20, when cars gave out and no more until the 8th.

Weather, raining almost all day Aug. 8.

NOTE.—The shovel had been brought over to Amasa from Stambaugh. It had been at Amasa 9 days. The office gave the following data:

Shovel at Amasa . 9 days; excavated 17,850 tons Actual hours worked 59 hours

Delays due to setting up shovel, taking off old lip and pufting on new, and waiting for cars to come to mine. (Do not include time between trains).

Delays Setting up . 1 day
New lip . 1/2 day
No cars . . 1/2 days

TIME STUDY

	Forenoon	Afternoon
Started work	9:37:5	(1:04:15) (1:30:00)
Stopped work	12:01:00	(5:30:40) (3:31:20)

Min. Sec. Min. Sec. Min. Sec. Min. Sec. Total time under observation 143 55 + 266 25 + 121 20 = 8 hours 51 minutes 40 seconds.

*	Minutes	Seconds	Per Cent
Actual working	310	26	58.4
Waiting for cars	154	19	29 0
Moving shovel	63	20	11.9
Miscellaneous delays	3	35	0.7
Total time under observation	531	40	0.001

Cost of Direct Labor (Loading) Per Day														Standard Basis		
Runner												-	_			\$5.00
Craneman	١															3.60
Fireman															.	2.40
4 pitmen																6.00
																\$17.00

Number of tons excavated per day (average of 6 days) 3000 tons.

Number of cubic yards loaded per day (average of 6 days, 2 tons per yard,) 1500.

Cost of labor per day \$17.00 = 1.12 cents per cubic yellows.

 $\frac{\text{Cost of labor per day}}{\text{Number of cubic yds. per day}} = \frac{\$17.00}{1500} = 1.13 \text{ cents per cubic yd.}$

D 4 . 1 . !	Ti	me	Per	Cost in	Total Cost Cents	
Process Analysis	Min.	Sec.	Cent	Cents per Yard		
Charge to loading					į	
1. Actual loading	310	26	58.4	0.660)	•	
2. Delays				j	0.802	
a Moving up	63	20	119	0.134	0,602	
b Miscellaneous	1 3	35	0.7	0.008	1	
Charge to transportation and dumping						
1. Waiting for trains.	154	19	29.0	0.328	0.328	
	531	40	100.0		1.130	

TIME STUDY DEDUCTIONS

	Number	Mini	mum	Ave	rage	Maximum		
	Obser- vations			Min.	Sec.	Min.	Sec.	
Time of moving up, shovel idle Time between moves,	10	5	0	6	20	7	50	
shovel working	10	21	18	31	3	41	25	
Time between trains	13	3	40	11	52	27	45	
Time per train, loading	16	10	10	19	24	35	30	
Time per dipper	10		20.6		23 9		28.9	
No. of dippers per move	10	6	I	77	. 9	C	9	
No. of dippers per train	16	2	9		3.7		5 .	
No, of dippers per car				,	.74			

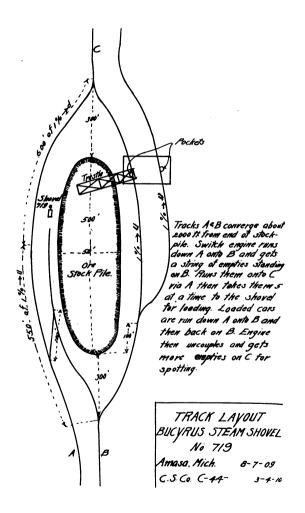
Number of trains loaded Number of cars loaded												80
Number of cars per train	•	•	•	{	14 1 1	trai trai trai	ins in c in c	of of 7 of 3	ca ca ca	ars rs. rs.	ea	.ch.

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{29,160}{5000} = 5.83$



Fig. 49. "Clawing" between trains



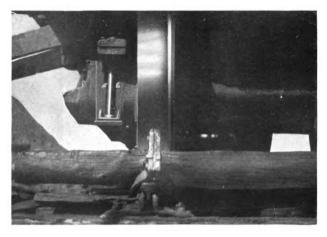


Fig. 50. Method of Chucking Shovel



Fig. 51. View Showing Method of Removing Old Trestle Post from Stock Pile (See page 198)

REPORT No. 23 — SHOVEL No. 707

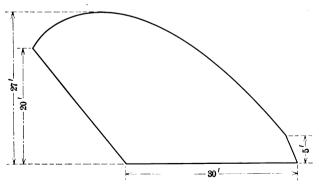
INSPECTED JULY 27, 1909

NEGAUNEE, MICH.

GENERAL CONDITIONS

This shovel belongs to the Cleveland Cliffs Iron Mining Company, and at the time of this investigation was engaged in stock pile work at the Negaunee mine.

MATERIAL The ore was badly frozen in spots, making very tough digging. It was so hard several times that the runner threatened to stop work until the ore could be blasted. As is usually the case, the ore had been stocked on planking. In the Maas mine about a mile distance, and operated by the same company, a 65-ton shovel was used in similar stock pile work. The shovel crew worked part of the time on one shovel and part on the other, according to the grade of ore needed.



Typical Cross-section of Bank

TRANSPORTATION One engine spotted the cars and also pulled them out to the main

line siding after loading. It is the common practice for the engine to bring in a certain number of cars, and, after loading, to take out the same number. But here, probably on account of the steep grade shown in "track lay out," trains were broken and two or three loaded cars taken out at a time.

OBSERVATIONS
Type shovel Bucyrus, 70-ton Distance of move 5' Kind of teeth Manganese lip Lift 10' high Size of ties under shovel 6" x 8"
Distance of move
Kind of teeth Manganese lip
Lift 10' high
Size of ties under shovel 6" x 8"
Number of buckets to car and to each move: 12 dippers to each
50-ton car; about 7 dippers to each 30-ton wood car.
Shovel in use 4½ years.
Job started June, 1909.
Shift, 10 hours.
One shift per day-
Water is pumped from boiler house, in a pipe which terminates
in a flexible rubber hose, a distance of 200 yards. Coal is
drawn up to shovel in a wagon and shoveled directly into
hopper.
Coal used 1½ to 2 tons in 10 hours (Valve, 2¾ quarts 10 hours Black, 1¾ quarts 10 hours Engine, 1½ quarts 10 hours
(Valve, 2 ² / ₃ quarts 10 hours
Oil used Black, 13/4 quarts 10 hours
(Engine, 1½ quarts 10 hours
Water used About 3000 gallons in 10 hours
Boiler is cleaned every fourth Sunday.
Kind of track, i. e., weight of rails, gauge, etc.: Standard gauge; 50-pound rail.
Kind and size of cars used: Steel, 50 tons, Pressed Steel Car
Company; wooden, 30 tons, L. S. and I. R. R.
Twin is harked by air Hand signals used

Train is braked by air. Hand signals used.

Kind and size of dinkey: Pittsburg locomotive, 1896, 65 tons, No other spotting engine than one mentioned.

Weather, clear and warm.

TIME STUDY

	Forenoon	Afternoon
Started work	10:37:00	12:36:15
Stopped work	11:36:15	4:57:30
	Min Sec	Min Sec

 $59 ext{ } 15 ext{ } + ext{ } 261 ext{ } 15 ext{ } = 5 ext{ hours}$ Total time worked 20 minutes 30 seconds.

				Minutes	Seconds	Per Cent
Actual working				148	2	46.2
Waiting for cars .			.	139	18	43.5
Moving shovel			.	25	20	7.9
Miscellaneous delays			-	7	50	2.4
Total time under obse	rva	tion	-	320	30	100

Cost of Direct Labor (Loading) per Day												Standard Basis		
Runner														\$5.00
Craneman														3.60
Fireman														2.40
6 pitmen														9.00
														\$20.00

Number of cars loaded on day of observation, 46, at average of 40 tons.

Cubic yards loaded on day of observation (2 tons per cubic yard) = $\frac{46 \times 40}{2} = 920.$

Based upon the observed performance the cubic yards loaded per 10-hour day = $\frac{920 \times 600}{320 \frac{1}{2}}$ = 1720

 $\frac{\text{Cost of direct labor per day}}{\text{Number cubic yards per day}} = \frac{\$20.00}{1720} = \frac{1.16 \text{ cents per cubic}}{\text{yard}}$

Process Analysis	Ti	ime	Per	Cost per Yard	Total Cost
	Min.	Sec.	Cent	in Cents	Cents
Charge to loading 1. Actual loading 2. Delays	148	2	46.2	0.536	
a Moving up b Miscellaneous .	2 5 7	20 50	7.9	0.092	0.656
Charge to transporting 1. Waiting for cars .	139	18	43.5	0.504	0.504
	320	30	100.0		1.160

TIME STUDY DEDUCTIONS

of	Min	imum	Ave	rage	Max	imum
Obser- vations	Min	Sec.	Min.	Sec.	Min.	Sec.
7	2	45	3	37	4	50
5	23	55	25	55	30	50
9	3	5	8	31	16	20
7		20.5		24. I		28.9
		1	6	12	7	2
	of Observations 7	Observations	of Observations Min Sec. 7 2 45 5 23 55 9 3 5 7 20.5 5 54	of Observations Min Sec. Min. 7 2 45 3 5 23 55 25 9 3 5 8 7 20.5 5 54 6	of Observations Average Min Sec. Min. Sec. 7 2 45 3 37 5 23 55 25 55 9 3 5 8 31 7 20.5 24.1 5 54 63	of Observations Min Sec. Min. Sec. Min. Sec. Min. 7 2 45 3 37 4 5 23 55 25 55 30 9 3 5 8 31 16 7 20.5 24.1 5 54 63 7

^{*} Time per train could not be obtained owing to the erratic nature of the engine's work.

ACTUAL RATIOS

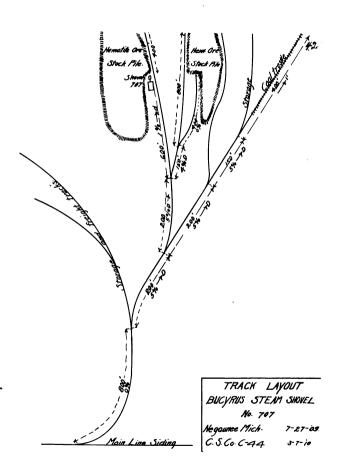
 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{25,000}{3,000 \text{ to } 4,000} = 8.33 \text{ to } 6.25$

CLEVELAND-CLIFFS IRON COMPANY. NEGAUNEE MINE STEAM SHOVEL REPORT.

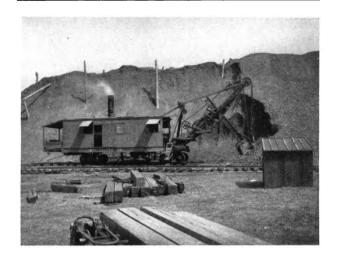
No. 7 Form 125-1M-4-07- I.O. 190 TIME SPENT NUMBER (HOURS) WHERE NUMBER CRADE KIND NO.OF OF CARS OF TONS OF ORE OF CARS WORKING MEN LOADED WORKING DELAYS IDLE TIME OF DELAY TIME LOST CAUSE OF DELAY FROM MINUTES HOURS TO Waiting for cars Waiting for engine _. Moving Shovel Track work Shovel repairs Switching

Report must be sent to office PROMPTLY every morning.
All delays and time lost must be accurately reported.

Engineer.



HANDBOOK OF STEAM SHOVEL WORK





Figs. 52 and 53. 70-ton Bucyrus Shovel at Work on Stock Pile of Cleveland Cliffs Iron Company, Negaunee, Mich.

REPORT No. 24 — SHOVEL No. 1127

INSPECTED SEPTEMBER 10 AND 11, 1909

IRONWOOD, MICH.

MATERIAL This shovel, a 70 C, was engaged in Hematite ore stock pile work. The function of the so-called "stock pile" is to keep the mine running at its full capacity the year round.

GENERAL CONDITIONS

During the navigation season the mined ore is brought up in skips from below, dumped into the two pockets and thence into the ore cars. The loaded cars are then hauled to the docks and dumped into the pockets there. From here it runs by gravity into the ore vessels.

When navigation closes and it is no longer possible to ship ore, work is begun on the stock pile. The principle of construction is much like that of an immense fill on railroad work. The ore is mined and brought up in skips and dumped into the pockets as usual. From here it is dropped into cars, which are run out upon the trestle work and dumped. Usually planking is laid on the ground to receive the ore. Stock piles, of course, vary in size according to the output of the mine. This one was exceptionally large, being some 900 feet in length and almost 30 feet high. An important feature of a large stock pile is that it permits the use of a long train and materially reduces the lost time due to switching. The ore thus stored in winter is loaded into cars during the navigation season by steam shovels.

OBSERVATIONS

Type shovel .								Buc	yru	s 70	-ton
Distance of move	:										6′
Kind of teeth					Βı	icyr	us,	ma	nga	nes	e lip
Height of lift						-			-		.10'

OBSERVATIONS—Continued

Size of bucket						2	/2	yaro	1S, 4	1.27	tor	is ave	rage
Age of shovel													
Duration of job											Fi	rst sea	ison
Length of shift												10 h	ours
Number of shifts	s pe	r da	ay										I
Supplies are han	dled	1:	Čo	al h	aul	ed l	oy t	ean	ı as	sho	wn	in Fig	. 54.
Haul about							•					·	•
Water pumped fr	rom	bo	iler	ho	use								
Repairs are mad	le l	у	egu	ılar	cre	ew;	im	me	diate	ely f	or	impor	tant
ones; others	s at	od	d ti	mes	; .					•		-	
Coal used .							Ab	out	2 1/2	ton	s ii	10 h	ours
Oil used													
gallon; engi	ne,	0.6	6 ga	allo	n, iı	n I	o ho	urs	i.		•		_
Water used			_						A ~	1100	. :.	· to be	

. . 4500 gallons in 10 hours Boiler cleaned once in four weeks, on Sunday.

Cost of repairs . . 4 hours (reported) in 23 days at \$2.18 an hour, equals 38 cents a day.

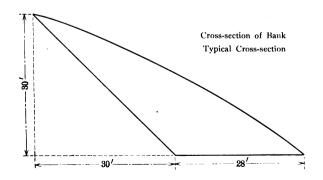
Kind of track 45-pound, standard gauge American Car and Foundry Co. steel ore cars, capacity 40 tons, but carrying 47 tons each.

Train is braked by air.

Hand signals used.

Kind and size of dinkey: Fairly heavy switch engine is used. One engine for spotting.

All repairs to cars and engine made by railroad company by whom they are owned.



TIME STUDY

The shovel did not work on the 11th, the day that time study was to have been made, so the deductions are made from the following office record.

OFFICE RECORD OF SHOVEL

Date	Cars 47 Tons	Switch- ing Min.	Moving Shovel Min	Miscel- laneous Min.	Time Worked Hours
August 9	85	103	75	, 75	10
August 7	78	89	84	{ 15 (1) 79	10
August 6	80	113	89	54	10
August 5	67	99	94	115 (2)	10
August 4	66	121	88	44	10
August 3	53	148	69	140	10
July 20	58	188	56 -	83	10
July 19	69	132	60	101	10
July 17	68	140	64	101	10
July 13	64	56	54	215	10
July 12	62	135	70	97	10
July 8	81	102	90	141	10
July 9	67	69	65	147	10
July 7	56	66	68	35 (3)-	10
July 4	69	42	54	{ 15 127	10
June 30	48	83	70	65	10*
June 25	40	53	52	210	Blast often
June 22	51	106	48	110	10
June 21	56	60	58	105 (4)	10 6
June 12	60	67	66	100	10
June 11	74	73	78	Noon(5)	10
July 6	70	83	- 73	167	10
July 3	58	QI	58	120	10
Total	1480	2219	1583	2750	230
Average .	64.3	921/2	69	120	10

(1) Small repair item, 15 minutes. No cause given.

(2) Cable on swing engine broke, causing delay of 1 hour and 55 minutes.
 (3) Nipple on exhaust of crane engine broke, causing delay of 35 minutes.
 (4) Putting new stud in pillow block of main engine, causing delay of 2

hours and 45 minutes.

(5) Replacing clutch on propeller shaft, delay, 1 hour.

Note—Average time moving up, 8 minutes.

*Pick bank, car shortage on this day.

DEDUCTIONS FROM ABOVE DATA

Number of days work	ked						. 23
Total tons output .							69,560
Tons per day							. 3,024

Time Lost, Average per Day	Hours	Minutes	Seconds
Moving up	ı	9	
Switching	I	32.5	
Miscellaneous delays, including		" "	
repairs	2		
Total delay	4	41.5	
Actual shovel time	5	41.5 18.5	
Actual shovel time, per ton .			6.33
Actual shovel time, 47-ton car		4	
Actual shovel time, dipper .		١	57 27

TIME STUDY

Average	of	23	Day	ys		Minutes	Per Cent
Actual working						318.5	53.1
Changing trains						92.5	15.4
Moving shovel .						69	11.5
Miscellaneous dela	ys					, 120	20.0
Total time under	obs	er	vati	on	. 4	600	100.0

C	ost	of	Di	rec	L	abor	(I	oad	ing) pe	r D	ay		Standard Basis
Engineer									1					\$5.00
Cranema	n													3.60
Fireman														2.40
6 pitmen														9.00
													_	20.00

Tons excavated per day (average 23 days), 3,024. Two tons per yard, 1512 cubic yards per day. Cost of labor per day, \$20.00.

Cost of labor per day, per cubic yard (load only) $\frac{$20.00}{1512}$ = 1.32 cents per cubic yard.

HANDBOOK OF STEAM SHOVEL WORK

PROCESS ANALYSIS

Process Analysis	Ti	me '	Per Cent	Cost per Yard in	Total
Process Analysis	Min.	Sec.	Per Cent	Cents	Cents
Charge to loading 1. Actual loading 2. Delays a Moving up b Repairs c Miscellaneous Charge to transportation	318 69 120	30	53.1 11.5 20.0	0.701 0.152 0.264	1.117
1. Waiting for cars .	92	30	15.4	0.203	0.203
	600		100		1.320

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{37,500}{5,000} = 7.5$



Fig 54. Coal Car

NEWPORT MINING COMPANY. STEAM SHOVEL REPORT.

SHAFT

	CA	RS				D	ELAYS	
TIME	S	В	TONS	Repairing	Switching	Cars	Move Shovel	Miscellaneous
7 to 8								
8 to 9								
9 to 10								
10 to 11								
11 to 12								
12 to 1								
1 to 2								
2 to 3								
3 to 4								
4 to 5								
5 to 6								
6 to 7								
7 to 8								
8 to 9								
TOTAL			VI.,					
								
REMAR	KS	:						

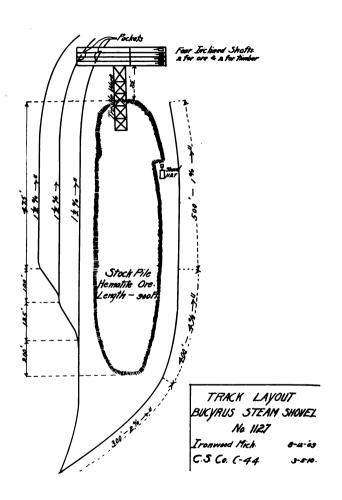




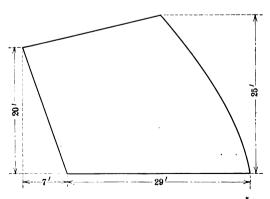
Fig. 55. View Showing Method of Forming Stock Pile

REPORT No. 25—SHOVEL No. 1142

INSPECTED AUGUST 6, 1909 STAMBAUGH, MICH.

GENERAL CONDITIONS This shovel, a 70 C, is owned by the Munro Iron Mining Company and was purchased for stock pile work.

PERFORMANCE The shovel was new in the summer of 1909 and at the time of the inspection had worked eighteen days with an output of 34,590 tons. Unfortunately this time the shovel was not working and so no timing could be done. However, the superintendent stated that it averaged half time at actual work. The best run the shovel had made in one day was 88 cars of 38 tons each.



Cross-section of Bank. Typical Cross-section

OBSERVATIONS

Type of Shovel											7	o-ton Bucyrus
Material										9	Soft	Hematite ore
Distance of move												
Kind of teeth .												
Lift												9' high
Size of ties under	r sh	ove	el									6" x 8"
Size of bucket Age of shovel												. 2 ½-yard
Age of shovel		٠.										First season
Job ran 18 days.												
Shift, 10 hours.												
One shift per day												
Coal is generally	hai	ulec	l al	ou	t 10	oo f	eet	: by	/ te	an	n.	
Water is pumped	l fro	om	boi	ler	ho	use						
Repairs are gene						gul	ar (
Coal used		٠.		·		gul	ar o	z to	ns	rι	ınni	ng ¾ of a day
Coal used Water used	•			•	•	gul	ar o	2 to	ns	rı A	ınniı Abou	ng ¾ of a day
Coal used	•			•	•	gul	ar o	2 to	ns	rı A	ınniı Abou	ng ¾ of a day
Coal used Water used Cost of repairs . most trouble		· s	ligh	it.	B	gul rok	ar o en	to ste	ns ms	ru A to	innii bou oil	ng ¾ of a day at 3000 gallons cups gave the
Coal used Water used Cost of repairs .		s	i ligh	it.	Bı Sta	gul rok and	ar o ar d	to ste	ons ms	ru A to	inni bou oil ab	ng 3/4 of a day at 3000 gallons cups gave the out 45 pounds
Coal used Water used Cost of repairs most trouble Kind of track	& I	S S rie	i ligh	it.	Bı Sta	gul rok and	ar o ar d	to ste	ons ms	ru A to	inni bou oil ab	ng 3/4 of a day at 3000 gallons cups gave the out 45 pounds
Coal used Water used Cost of repairs . most trouble Kind of track . Use Williamson	& I	S S rie ir,	i ligh	it.	Bı Sta	gul rok and	ar o ar d	to ste	ons ms	ru A to	inni bou oil ab	ng 3/4 of a day at 3000 gallons cups gave the out 45 pounds
Coal used Water used Cost of repairs . most trouble Kind of track . Use Williamson Train is braked by	& I by a use	S Prie ir. ed key	ligh s ca	nt.	Bi Sta	gul rok and Ave	ar o en arderag	ste ga ge	ms ug 38 t	to to	innii bou oil abo ns ca	ng ¾ of a day at 3000 gallons cups gave the out 45 pounds apacity.

TIME STUDY

Days worked										18
Total output	•					•		34	,590	tons

,	Minutes	Per Cent
Actual working (average 18 days)	300	50
Spotting cars { (average 18 days)	1 50	25
Moving shovel Miscellaneous delays (average 18 days)	1 50	25
Total time per day (average)	600	100

HANDBOOK OF STEAM SHOVEL WORK

	Cost	of	Di	rect	La	bor	(Lo	adir	ng) l	Per	Day	,		Standard Basis
Kunner														\$5.00
Craneman	1													\$5.00 3.60
Fireman														2.40
4 pitmen														6.00
			_			-								\$17.00

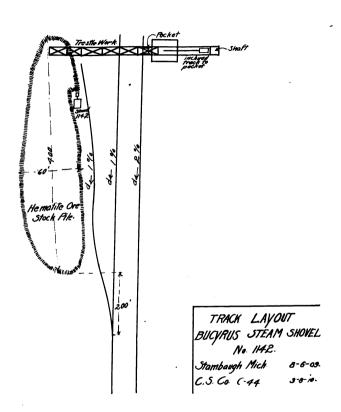
Number of tons loaded per day (average of 18 days) . . 1922 Number of cubic yards loaded per day (2 tons per yard) . 961

Cost of labor per day $\frac{\text{Cost of labor per day}}{\text{Number of cubic yds. per day}} = \frac{\$17.00}{961} = 1.77 \text{ cents per cubic yd.}$

Process Analysis	Ti	me	Per	Cost per Vard	Total Cost	
Trocess Analysis	Min.	Sec.	Cent	in Cents	Cents	
Charge to loading 1. Actual loading 2. Delays	300	00	50.0	0.885	1.3275	
a Moving up b Repairs	150	00	25.0	0.4425		
Charge to transportation 1. Waiting for cars	150	00	25.0	0.4425	0.4425	
	600	00	100.0		1.7700	

ACTUAL RATIO

 $\frac{\text{Water consumed, pounds}}{\text{Coal consumed, pounds}} = \frac{25,000}{4,000} = 6.25$



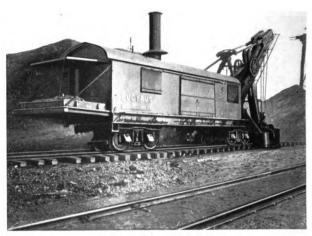


Fig. 56 Bucyrus Shovel No 1142 at Stambaugh, Mich.



Fig. 57. View showing rocks encountered by Shovel No. 1124 in Mine Stripping at Michagamme, Mich.

REPORT No. 26 — SHOVEL No. 1124

INSPECTED JULY 29 and 31, 1909 HOOSE & PERSON, Contractors MICHIGAMME, MICH.

GENERAL CONDITIONS This shovel was installed about the middle of March and began work about the first of April. This mine said to be the first in Michigan to use the steam shovel for open pit work. The ore was covered with a 10-foot layer of earth, which had to be stripped. Pit stripping was hardpan and boulders. Standard gauge Oliver dump cars of 61/2 yards capacity were used.

PERFORMANCE The contractors stated that an average of 800 yards was stripped each day of ten hours. The principal drawback to a larger output was poor train service, which seems to be the chief difficulty at most of the mines visited. The large masses of rock and boulders encountered offered no difficulties at all. Boulders up to 3 and 4 yards each were tossed aside with the greatest ease. It is much like working in an immense borrow pit. The contractor estimated that moving back 500 feet and cutting in would take the regular crew and two extra pitmen 5 hours; throwing track and putting in shape for train, fifteen men 5 hours.



Cross-section of Bank. Typical Cross-section

OBSERVATIONS

Type of shovel
Size of bucket
Repairs made by regular crew while waiting for cars, or at night. Coal used 1½ to 2 tons per day of 10 hours Oil used
Contract price:
Stripping
Stripping

TIME STUDY

Forencen

	Forenoon	Afternoor	l
Started work	8:31:50	12:45:30	12:38:20
Stopped work	11:38:45	4:41:05	2:04:40
	Min. Sec	Min. Sec. Min.	Sec.
Total time worked	86 20 +	$186 ext{ } 55 + 235$	35 = 8 hours
28 minutes 50	seconds.	• • • • • • • • • • • • • • • • • • • •	

							Minutes	Seconds	Per Cent
Actual working	•		•	•	•	-	256	. 38	50.4
Waiting for cars							152	17	30.0
Moving shovel .							38	45	7.6
Miscellaneous del	ays						Ü	'	•
Chain off sheav							61	10	12.0
Total time under	obs	er	vati	on	•		508	50	100.0

C	ost	of I	Dire	ct L	abo	r (L	oad	ing)	per	Da	y		Standard Basis
Runner													\$5.00
Craneman													3,60
Fireman													2.40
4 pitmen				٠.						•		•	6.00
					_							_	 \$17.00

Cars loaded in two days, 119 (a) 30 tons = 3570 tons = 1785tons per day.

Cubic yards loaded per day (2 tons per cubic yard) = $\frac{1785}{2}$ =

 $\frac{892\%}{\text{No. of cubic yards per day}} = \frac{\$17.00}{892.5} = 1.90 \text{ cents per cubic}$ yard.

Process Analysis	Ti	me	Per	Cost per Yard in	Total Cost	
Frocess Analysis	Min.	Min. Sec.		Cents	Cents	
Charge to loading 1. Actual loading 2. Delays a Moving up b Repairs	256 38 61	38 45 10	50.4 7.6 12.0	0.958 0.144 0 228	1.330	
Charge to transportation Waiting for cars	152	17	30.0	0.570	0.570	
	508	50	100.0		1.900	

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{25,000}{3,000 \text{ to } 4,000} = 8.33 - 6.25$

Time Study Deductions	Number	Mini	mum	Ave	rage	Maxi	imum
Time Study Deductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle Time between moves,	9	2	10	4	18	6	50
shovel working	10	11	40	25	40	43	20
Time between trains.	15	3	30	10.	9	28	20
Time per train, loading	15	5	25	14	15	28	15
Time per dipper	10		22.8		26.5		32.6
No. of dippersper move	10	2	8	56	.9	8	7
No. of dippers per train	18	1	7	31			4
No. of dippers per car					.77		

	Train Number	20-Ton Cars	25-Ton Cars	30-Ton Cars
(I	5		
	2	I	I	4
	3	2	I	2
	4	I		3
	3 4 5 6	3		
	6	3 5 2		
1	7	2		3
	7 8	3		3 2
Cars per train	9			5
Cars per train	10	4		Ĭ
	11	3 2		2
	12	2		2
	13	4		
	14	4		
	15	I	3	I
·	16	6		
	17	I	I	2
	18	4		••
Total	<u> </u>	51	6	27

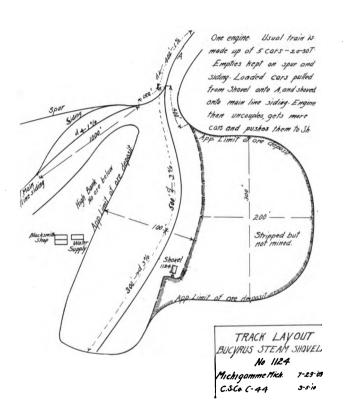




Fig. 58. 12-ton Boulder Encountered by Shovel No. 1124

REPORT No. 27 — SHOVEL No. 1074

INSPECTED JULY 30, 1909

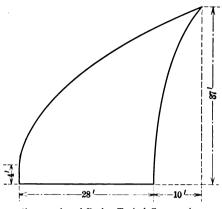
ISHPEMING, MICH.

GENERAL CONDITIONS

This shovel belongs to the Pittsburg and Lake Angeline Mining Company, at Ishpeming, Mich. It was engaged in stock pile work similar to that of Shovel No. 866, page 245. The stock pile here was not frozen, and it rested on planking which greatly facilitated moving up. The height of this stock pile was very noticeable. It was at least 37 feet, and caused considerable trouble because of the overhanging of the bank when undercut by the shovel.

MOVING BACK In view of this fact the method of keeping a continuous track behind the shovel was used, so that it could move back at a moment's notice. This was done by having enough extra 6-foot sections of rail which could be left behind in place until the shovel had moved forward far enough for a regular full length rail section to be put in by the track gang. When the shovel became buried, the first thing to do was to clear the jacks, the next to move back, and the last to shovel up the fallen material and then move ahead until another slide occurred.

TRANSPORTATION Here as at most of the mines in northern Michigan, there was one engine to spot cars and draw them out to the main line siding. Each day a string of empties was brought in by a main line engine and the supply of cars for the shovel was taken from these by the spotting engine.



Cross-section of Bank. Typical Cross-section

OBSERVATIONS

Kind of teeth Manganese lip
Height of lift $\dots \dots
Height of lift
Size of bucket
Age of shovel Second season
Duration of job Began June 3, 1909
Length of shift 10 hours
Number of shifts per day
Coal is brought up by wagon and shoveled into bunkers. Water
from city mains.
Repairs are made by regular crew while waiting for trains, or at
night; average about 50 cents per day.
Coal used 2½ tons in 10 hours
Oil used
Black, 1½ quarts in 10 hours
Water used About 3500 gallons in 10 hours
Boiler is cleaned once a month.
Kind of track, weight of rail, gauge: Track, 45 pounds; standard
gauge.
Kind and size of cars used: 50-ton P. S. Car Co. pressed steel cars, and L. S. and T. 40-ton wood cars.
cars, and 12. 25. and 1. 40° toll wood cars.

232

OBSERVATIONS—Continued

Train is braked by air.

Hand signals are used, brakeman on car.

Kind and size of dinkey: Engine and cars belong to railroad company, who make all repairs. Engine about 35-ton.

Length of haul: About 1/8 mile before empty cars could be obtained. One spotting engine and one main line engine.

TIME STUDY

	Forenoon	Afternoon
Started work	10:03:20	12:57:57
Stopped work	12:00:00	5:03:00

Total time worked 116 minutes 40 seconds + 245 minutes 3 seconds = 361 minutes 43 seconds = 6 hours 1 minute 43 seconds.

,	Minutes	Seconds	Per Cent
Actual working	121	41	33.6
Waiting for cars	222	40	33.6 61.7
Moving shovel	13	22	3.6
Miscellaneous delays	4	0	ı, ĭ,
Total time under observation .	361	43	100.0

	Cos	t o	f D	irec	t La	ιbor	(L	oadi	ng)	per	Day	7		Standard Basis
Runner							•						•	\$5.00
Cranema	n		٠											3.60
Fireman														2.40
5 pitmen	i			•										7.50
														\$18.50

Number of cars loaded on day of observation, 43 @ 45 tons (average).

Number of cubic yards loaded on day of observation (2 tons

per yard) =
$$\frac{1935}{2}$$
 = 967.

Cost of direct labor per day Number cubic yards per day = $\frac{$18.50}{967}$ = 1.91 cents per cubic yard

Process Analysis	Ti	me	Per	Cost per Yards in	Total
Trocess Analysis	Min.	Min. Sec.		Cents	Cost Cents
Charge to loading 1. Actual loading 2. Delays 3. Maring an	121	41	33.6	0.642	0.732
a Moving up b Miscellaneous	13	22	3.6	0.069 0.021	','
Charge to transportation and dumping					
1. Waiting for cars	222	40	61.7	1.178	1.178
	361	43	100.0		1.910

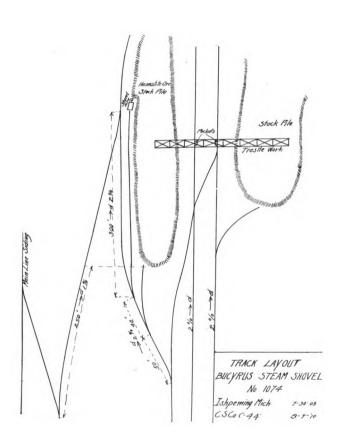
Time Study Deductions	Obser-	Mini	mum	Ave	rage	Maxi	mum
Time Study Deductions	vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time of moving up, shovel idle Time between moves,	8	I	05	I	40	3	45
working	8	10	25	15	13	21	55
Time between trains .	2	14	15	2 I	47	29	20
Time per train loading	5	10	40	24	53	49	13
Time per dipper	288	ł	20	į	25		28
No. of dippers per move	8	2	26		36	4	19
No. of dippers per train	5	1 :	30	į	57 8 8.7	ç	3
No. of dippers per car	33				8.7		

No. of trains loaded . . 5 | No. of cars 33*
*33 cars loaded during observation; 43 loaded during day.

	Train No.	50-Ton Cars	30-Ton Cars
	I	3	
Cars per train	3	5	7
cars per train	4	8	2
	3	 4	
Į		22	11

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{29,160}{5,000} = 5.83$



REPORT No. 28—SHOVEL No. 1083

INSPECTED SEPTEMBER 24, 1909

OLIVER IRON MINING COMPANY SELLER'S PIT, HIBBING, MINN.

MATERIAL This shovel was working in the soft ore typical of the Mesabi Range. There was considerable taconite mixed with it and some "paint rock." These materials did not occur in the form of regular intrusions, but were scattered through the ore in lumps 6 inches in diameter and upwards. Sometimes pieces too large for one man to handle were encountered. The paint rock was in smaller chunks and so soft that it was broken by the dipper which penetrated it. When completely disintegrated it was loaded with the ore, but when encountered in pieces large enough to be picked by hand, it was thrown aside to be loaded with the taconite.

METHOD OF HANDLING Whenever pieces of paint rock or taconite were torn

loose by the dipper and rolled down into the pit, one of the rockmen would pick it out and throw it into the corner of the pit next to the track. When the chunks stuck in the slope of loose material a rockman would run up the slope during the swing of the dipper and try to loosen it.

Great care was exercised in excluding foreign matter from the cars, and for this reason it was often necessary to stop the shovel completely.

The delays in getting rock out of the way generally followed a process called "clawing down." Although the ore had been shot, there often seemed to be masses that remained almost undisturbed, especially near the top of the bank. Doubtless the natural solidity of the ore is affected by the blasting, but not to such an extent that the material will crumble and fall down of itself.

In such event the dipper with bottom open is dragged across the face of the ore which drops to the bottom of the pit. Besides the clawing of the face directly in front of the shovel, this process is continued on the side as far back as the shovel can reach. There results a vertical face of ore at a distance from the shovel track equal to the extreme reach of the dipper handle.

With the tearing down of a large mass of ore by clawing, there is generally exposed or brought down a considerable amount of taconite.

TRANSPORTATION Mention has been made above of the spotting of the dump cars, which are provided for the removal of rock and foreign materials. In this case there were four 7-yard Russell Wheel and Foundry Company cars, which were spotted at the shovel after each train was loaded. When the next train came up it coupled on to these cars and they were handled as a part of the train as long as the train was loading.

The rejected material from the dump cars is thrown out on the shovel side of the car and remains scattered along the loading tracks in the shovel pit.

Both the shovel and loading track are standard gauge, laid with standard ties and 50 or 60-pound rails. The shovel is moved forward on 6-foot sections with the usual plate connections and bridles, but as soon as it has moved about fifty feet, a standard track, which is laid in the rear of the shovel, is extended for a rail length and is so carried along directly behind the shovel. When the shovel is ready to move back this track is connected with the shovel track and the shovel has a continuous standard track to move on. This track then becomes the loading track for the next cut, and that previously used as a loading track is torn up.

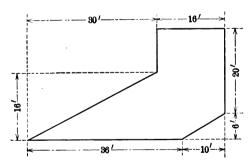
CASTING AHEAD There is another item of lost time between trains which is listed in the time study under the heading of "Casting Ahead." While loading the ore cars a small bank is formed in the pit next to the loading track. Ordinarily, as soon as a train pulls out with its load the dipper is swung over and this material is dragged back into the pit where it can be seized by the dipper when loading is resumed. In this case, however, when the loading track is not occupied by the ore cars it is by the dump cars, so little opportunity is given to load this material near the loading track. So when the empty train of ore cars comes up it pushes the dump cars out of the way and as rapidly as possible the dipper grabs this material, swings over, and dumps it directly in front of the shovel. From here it is loaded with the rest of the ore.

WORKING SEASONS

The working season is limited by the shipping season on the Lakes. This generally opens on about the first of April. By the first of May the full capacity of the mine is being produced and shipped. The shipping season ends on about the first of December, although if demand for ore is good and tonnage rates are high, shipping may continue until well into December. Insurance on ships and cargoes runs out about the fifteenth of December, and but few vessel owners care to take the risk of operating after that time.

When study was made of this shovel, the mine was working apparently to full capacity. It was inspected on Saturday afternoon and a shift was to work that night and all the next day. This was very unusual, as the Oliver Company never work in their mines on Sunday and do only such shop and other work on that day as is absolutely essential. This would indicate large demand for Sellers' ore. The same was true of the Burt & Pool mines, which adjoin the Sellers.

BLASTING Shooting of the ore is done by churning holes about sixteen to twenty feet from the edge of the bank. These holes are sprung with two to four sticks of 60 per cent dynamite $\frac{7}{8}$ by 6 inches and then loaded with black powder. About two kegs of powder are inserted in each hole. These holes are about 10 feet apart and three or four are shot at the same time. The shooting is generally done at the close of work, but the shot is sometimes fixed during working There seems to be no danger from the blast, although a signal is always given for it. No attempt is made to blow the bank down, the desire being simply to give the material a slight shaking. In some cases the face of the bench blasted is hardly disturbed, while in others some of the face is thrown down, but never violently.



Typical Cross-section

OBSERVATIONS

Material				Ir	on	ore,	В	ess	em	er	grade
Type of shovel .											95 B
Distance of move											
Kind of teeth .											

OBSERVATIONS—Continued

Lift 9' high
Size of ties under shovel 6" \times 6" and 6" \times 8" \times 8"
Size of bucket
Age of shovel Second season
Shift
Two shifts per day.
Coal is brought up in dump car; plank laid from car to coal
bunker and coal carried across in boxes, each holding about
a cubic foot. Water is taken from locomotive tender.
Repairs are made on Sundays and as needed. Completely over-
hauled each season in shop when needed. This shovel has
never been in shop even for minor repairs.
Coal used
Oil used
Oil used
Water used 4000 to 6000 gallons per shift
Boiler is cleaned every second Sunday. Very clean, soft well
water used.
Kind of track, etc Standard, 60-pound rail
Kind and size of cars used: Steel ore cars, 100,000 pounds
capacity; wood ore cars, 70,000 pounds.
Train is braked by air.
Hand signals are used by man on ground.
Kind and size of dinkey Standard locomotives, 60-ton \pm
Length of haul To mouth of pit, 1/2 mile
Number of trains, two; two locomotives. Locomotives alter-
nated with trains to be loaded. Locomotive would take
full train out and bring in string of six empties. Would then
stand on siding until other train was full and out of way.
Weather Fair, warm and sunny
TIME STUDY
Afternoon

									Afternoon
Started work .									1:00:20
Stopped work									
		Mi	n.	Sec.	i				

Total time work 300 10 = 5 hours 10 seconds

				Minutes	Seconds	Per Cent
Actual working .				173	30	57.9
Waiting for cars .				71	5*	23.6
Moving shovel .	•			9	40	3.2
Miscellaneous delays						
Taking rock from	ca			4	40	1.6
Breaking rock .				5	15	1.8
Breaking rock .				18	50	6.2
Clawing down .				1	ĬO	0.4
Clawing down .				2	45	0.9
Breaking rock .				2	40	0.9
Picking rock from	ca	ır		9	35	3.2
Clawing down .	•	•	•	I	o	0.3
Total time under obs	er	vat	ion	300	10	100.0

^{*}While waiting for cars the shovel was idle 23 minutes 5 seconds out of the 71 minutes 5 seconds, but spent the remaining 48 minutes as follows:

					Minutes	Seconds
Loading rock					25	5
Clawing down					5	40
Casting ahead					17	15

	Cost of Direct Labor per Day													
Runner		•					•		•		•			\$5.00
Craneman														3.60
Fireman														2.40
4 pitmen														6.00
8 rockmen														12.00
														\$29.00

Number of cars loaded on day of observation, 231/2 of 50 tons and 5 of 35 tons. Number of cubic yards loaded on day of observation (2 tons per

yard) = $\frac{1350}{2}$ = 675.

Based upon the observed performance, the number of cubic yards

loaded per day of 10 hours = $675 \times \frac{600 \text{ minutes}}{300 \text{ minutes 10 seconds}}$ $\frac{\text{Cost of direct labor per day}}{\text{Number cubic yards per day}} = \frac{\$29.00}{1350} = \frac{2.15 \text{ cents per cubic yard}}{\text{yard}}$

D	Ti	me	Per	Cost per	Total		
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost Cents		
Charge to waiting for blasters	31	40	10.5	0.225	0.225		
Charge to loading				_	•		
 Actual loading 	173	30	57.9	1.245)			
2. Delays	_	_		}	1.314		
a Moving up	9	40	3.2	0.069			
Charge to transportation				-			
1. Waiting for cars	71	5	23.6	0.508 }	- (
2. Miscellaneous	14	15	4.8	0.103 \$	0.611		
	300	10	100.0		2.150		

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{33,000 \text{ to } 50,000}{5,500 \text{ to } 6,500} = 6.00 \text{ to } 7.70.$

TIME STUDY ON SHOVEL No. 1083

This time study follows the scheme used and explained for No. 517, but a variation has been made in the column giving time "between trains."

In this case the shovel was seldom idle, even when waiting for a train. This condition is explained in the notes on No. 1083, and the itemized times are given there. While waiting the shovel was either clawing at the bank, loading stones or picking up ore along the edges of the pit and throwing it ahead where it could be more easily loaded. As this was all useful work it should hardly be classed as lost time. On the other hand it is not "loading" and so could not be counted in as useful working time. It has therefore been put in a column by itself under "Working between trains" and another column of "Between trains" time has been headed "Idle." This last is when the shovel was actually standing still.

The last column gives, as usual, "Miscellaneous delays," and in this study it contains only those items of delay that occurred while the train was at the shovel being loaded. The items which make up these delays are explained in the remarks on No. 1083.

TIME STUDY ON SHOVEL No. 1083

Total, 300 minutes 10 seconds Hrs. Min. Sec. Hrs. Min. , 1 oo 20; stopped work, 6 oo

Miscellaneous Delays While	Train is Loading	Sec.				40 Taking rock from car		15 Breaking rock					,		ro Clawing down							5 Ficking rock from car				∞ Clawing down	16
fisce		Min. Sec.				4		5						85 S	ĭ					4	-	9 35				٥	45 55
_		2	_	_		_	_	_		_		_		Ħ					_			_				_	4
Between Trains	Working	ec.					Loading rock		Clawing down	Loading rock	Casting ahead	Rep. coupler on car	1	: :		Clawing down	Loading rock	Casting ahead			•		Clawing down	Loading rock	Casting ahead		
Betv		Min. Sec.		40	2		8		15	8	35	;				45	45	8					4	2	8		8
			_	4	_		0		C4	9	٠,					_		_					_	*	3	_	05 48
	Idle	M. S.		3	· :	:	30	:	:	:	:	10 35		:	:	:	:	:		:	:	:	:	:	6	:	23 05
Time	Dipper	Min		:	:	0.545	:	:	:	:	:	:	0.487	:	:	:	:	:	0.393	:	:	:	:	:	:	0.368	0.448
Dippers	Move			:	:	66	:	:	:	:	:	:	26	:	:	:	:	:	6	:	:	:	:	:	:	86	386
=	Move	Min. Sec.		:	:	54 00	:	:	:	:	:	:	47 15	:	:	:	:	:	36 Io	:	:	:	:	:	:	36 05	173 30 43 221%
Loading Dippers	Train		81	:	:	81	:	84	:	:	:	:	13	8	:	٠:	:	:	23	67	:	:	:	:	:	31	386
Loading	Trains	M. S.	7 30	:	:	46 30	:	39 IS	:	:	:	:	8	29 IO	:	:	:	:	7 8	25 35	:	:	:	:	:	10 30	173 30
Moving		Min. Sec.	:	:	:	:	:	3 25	:	:	:	:	:	8	:	:	:	:	:	4 IS	:	:	:	:	:	:	Tot. 9 40

TIME STUDY ON SHOVEL No. 1083-Continued

ıst train						. 1 steel car + 3 dippers
2d train						
3d train						. 5 steel car, 1 wood car
4th train						6 steel cars
5th train						. 4 steel cars, 3 wood cars
6th train						
Total car	S					. 23½ steel, 5 wood cars
Dippers p	per	car				14.25 steel, 10.20 wood cars

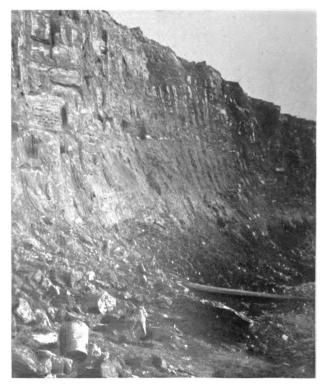


Fig. 59. View of Sellers Pit Mine in the Mesabi Range, Oliver Iron Mining Company, Hibbing, Minn.

REPORT No. 29 — SHOVEL No. 866

INSPECTED AUGUST 2-5, 1909 PRINCETON, MICH.

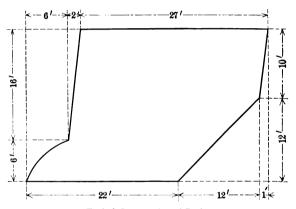
LOCATION This shovel is owned and operated by the Cleveland Cliffs Iron Co., at Princeton, Mich. On the first day of the inspection it was "cutting in."

MATERIAL AND PERFORMANCE ing loaded was the soft Hematite Ore in stock pile. The small carts used for building stock pile are of the "end dump" type. The skips hoist the ore upward out of the shafts to a certain point above the ground, where there is a catch that restrains the top of the skip as it tends to go on up. The action is to thus automatically dump the contents of the skip into the pockets. In winter when no ore can be shipped it is dropped from the pockets into the end dump cars which run outward by gravity across a trestle to the stock pile.

In order to cut in more rapidly than is possible with the ordinary 5-foot rail sections, small 1-foot sections were used between the 5-foot rail sections to make the shovel track more flexible. The ore in this stock pile was very badly frozen in places. It occurs in this manner: A great deal of the ore is wet when it comes out of the mine, and being piled in the open air in the winter, freezes solid. It is a common occurrence on a hot summer's day to see a shovel suddenly run into ore so badly frozen and solid that the white frost is visible and the cold air felt a distance of 25 feet.

TRANSPORTATION The lack of sufficient cars was very noticeable here. On one day cars gave out after an hour's work, and there were no more until the next morning. On another day

there was a supply of cars all morning, but it gave out for the day at 1.56 P. M. One of the railroad men offered this explanation of the shortage of cars: The railroad companies own the ore pockets at the docks and their capacity is limited. Therefore when a vessel arrives for a cargo from some mine, cars are plentifully supplied to that mine until the vessel is loaded; while other mines receive only a nominal supply.



Typical Cross-section of Bank

OBSERVATIONS

Type of shovel .						Bucyrus, 70-ton
Distance of move						6'
Kind of teeth .						Manganese lip
Lift						II' high
Size of ties under	shove	el 💮				6" x 8"
Size of bucket .						3 yards
Age of shovel .						. Fifth season
Job began in June						
Shift						10 hours

OBSERVATIONS-Continued

One shift per day. Supplies are handled: Coal, by team to point near shovel, then shoveled aboard by pitmen. Water, from a company main. Repairs are made by regular crew either while waiting for cars or at night.
Coal used 21/ tone in to hours
Water used
Rlack 2 quarts in to hours
Coal used
Engine 1 1/2 quarts in 10 hours
Boiler is cleaned about once a month.
Repair cost small, but company would give no figures. Plates
had to be put on the front of the bucket near rim to save
the latter from wearing out. True also of Lake Angeline
Mine shovel, No. 1074.
Kind of track Standard gauge, about 60 pounds
Cars used 50-ton pressed steel; 30-ton wooden L. S. & I.
Train is braked by air.
Hand signals are used. Man on shovel.
Kind and size of dinkey. Large Baldwin 4-wheel driver.
Length of haul . About 1/8 mile before engine reached empties
Cars and engines owned by railroad company, who make all
repairs.
Weather Clear and bright
The state of the s

TIME STUDY

First Day	Forenoon	Afternoon
Started work	7:00:00	1:04:45
Stopped worked	12:02:00	6:02:45
	Min. Min.	
Total time worked	302 + 298 = 600	minutes = 10 hours

						Minutes	Seconds	Per Cent
Actual working						170	40	28,4
						311	45	52.0
Moving shovel						61	20	10.3
Pulling track .						42	30	7. I
Miscellaneous dela	ıys					13	45	2.2
Total time under	obs	erv	vati	on		600	0	100.0

	Cos	t of	Di	rect	La	lbor	·(L	oadi	ng)	per	Day	y		Standard Basis
Runner								•						\$5.00
Cranema	an													3.60
Fireman														2.40
6 pitme	n													9.∞
														\$20.00

Number of cars loaded on first day of observation = 39 @ 47 ton Number of cubic yards loaded on first day of observation (2 ton per yard) = $\frac{1833}{2}$ = 916 ½.

 $\frac{\text{Cost of direct labor per day}}{\text{Number cubic yards per day}} = \frac{\$20.00}{916.5} = 2.19 \text{ cents per yard.}$

Process Analysis			Ti	me	Per	Cost per Yard	Total Cost
Trocess marysis			Min.	Sec.	Cent	in Cents	Cents
Charge to loading 1. Actual loading 2. Delays			170	40	28.4	0.622	
			61 13	20 45	10.3	0.226	0.896
Charge to transporting dumping	and	d					
 Waiting for cars Miscellaneous . 			311 42	45 30	52.0 7.1	0.155	1.294
			600	00	100.0		2.190

Time Study Reductions	Number of	Mini	mum	Ave	rage	Max	imum
Time Study Reductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec
Time of moving up, shovel idle	7	5	30	8	46	13	40
Time between moves, shovel working	7	15	20	24	02	47	50
Time between trains .	3	15	10	17	30	19	.00
Time per train loading	7	18	00	24	23	31	10
Time per dipper	335		23		30		37
No. of dippers per move	7	3	2	4	8	9	5
No. of dippers per train	7	3	6	4	9	6	4
No. of dippers per car	39				83/4		

Number of trains loaded Number of cars loaded	:	•	:	:	:		· 	•	:	•	:	•	7 39
			_	Tr Nun	ain nbe	r	5	o-to Car	n s			ton ars	_
				1	I			4				I	
					3	-		3		1		I	
Cars per train		₹		2	1			ż				I	
		- [1		5			2				3	
		-		(5			2				4	
		Ĺ	_	7	7			5				3	
				•		.		25			1	4	

TIME STUDY

Second Day		Fore	noon		Afterno	oon
Started work		7:0	0:00)	12:50	:00
Stopped work		11:5	9:30		5:48	:30
	Min.	Sec.		Min.	Sec.	
Total time worked = 9 hours 58 min	299 utes.	30	+	298	30 =	598 minutes

	Minutes	Seconds	Per Cent
Actual working	170	52	28.6
Waiting for cars	306		51.2
Moving shovel	50	30 38	51.2 8.5
Miscellaneous delays			
Car off track	25 8	30	4.3
Repairing dipper hinge	8	őo	i.3
Repairing connecting rod			
caps	36	30	6.1
Total time under observation .	598	00	100.0

Cost of direct labor per day (loading) \$20.00 Number of cars loaded on second day of observation, 38 @

47 tons = 1786 tons.

Number of cubic yards loaded on second day of observation
1786

 $\frac{1780}{2}$ = 893.

 $\frac{\text{Cost of direct labor per day}}{\text{Number of cubic yard per day}} = \frac{\$20.00}{\$93} = 2.24 \text{ cents per yard.}$

	Ti	me	Per	Cost Per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to loading 1. Actual loading 2. Delays	. 170	52	28.6	0.640	
a Moving up b Repairs	. 50	38 30	8.5	0.191	0.997
Charge to transporting and dumping			,.,	3,133	
1. Waiting for cars .	. 306	30	51.2	1.147 (1 242
2. Miscellaneous	. 25	_ 30	4.3	0,096∫	1.243
	598	00	100.0		2.240

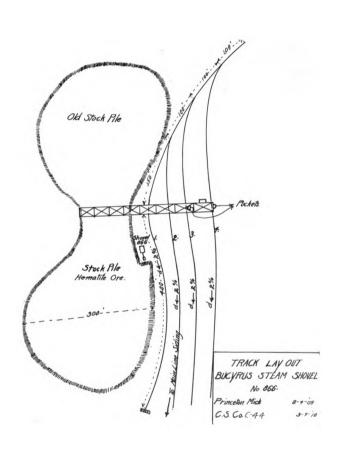
Time Study Reductions	Number	Mini	mum	Ave	erage	Maximum		
Time Study Reductions	Obser- vations	Min.	Sec.	Min.	Sec.	Min.	Sec.	
Time of moving up, shovel idle Time between moves,	7	5	55	7	14	11	25	
shovel working	8	12	10	21	21	33	40	
Time between trains .	4	16	25	20	48	24	15	
Time per train loading	5	22	50	34	10	48	50	
Time per dipper	344		22		29		34	
No. of dippers per move	8	3.	3	4.	3	59	9	
No. of dippers per train	5	5		60		80	5	
No. of dippers per car	38				9			

Number of trains loaded									
Number of cars loaded				•	•	•		•	38

			Train Number	50-Ton Cars	30-Ton Cars
			I	3	4
		- 1	2	6.	2
Cars per train		\prec	3	7	0
		- 1	4	I	7
			5	I	7
				18	20

ACTUAL RATIOS

$$\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{25,000}{5,000} = 5.0$$



CHISHOLM, MINN.

TAKING DOWN BOOM AND DIPPER

Shovel No. 700 was being dismantled preparatory to taking boom and dipper into the shop. The process is as follows: An empty flat car is placed on the track directly ahead of the shovel. The dipper is then thrust out as far as possible by the crane engine and allowed to rest on the far end of the flat car and on the left hand side. The hoisting chain is then slackened and the bight pulled down between the two sides of the dipper handle. A stout rod is then thrust in between this bight and the underside of the dipper handle near its upper end. After disengaging dipper handle from the rack pinions, it is slowly lowered to the flat car by paying out the hoisting chain. The hoisting chain is then released from the padlock and wound up on the The end of the hoisting chain is then pulled out and passed over a pulley suspended from the A frame: thence up the boom and around a sheave at its top and thence back to the top of the A frame to one leg of which it is securely fastened. The boom is then raised slightly by the hoisting engines until the strain is removed from the tie rods which connect the upper end of the boom and the top of the A frame. These tie rods are now uncoupled from the top of the A frame and gradually eased down onto the car. The method used for thus lowering the tie rods is as follows: A stick of round timber some 4 inches in diameter and 4 feet long, to which a pulley is lashed, is jammed into the head of the A frame. Through this block a rope passes from below and is secured to the upper end of the tie rods, one at a time. A workman holds the lower end of the rope, and so the tie rods are let down gently.

The boom itself is now supported only by the hoisting chain and this is now slacked away until boom rests on the right hand side of the flat car. The hoisting chain is then disengaged and wound up on the drum. The shovel then backs up a little, thereby removing the lower end of the boom from its socket. A timber is then placed between the front of the shovel proper and the end of the boom and the shovel moved forward until the boom is pushed over the flat car far enough to be clear of the end. The only thing remaining to be done is to take down the block suspended from the top of the A frame and place it on the car with the boom and dipper.

The photograph shows a similar 90-ton shovel after it has been dismantled and its boom and dipper loaded on flat car for transportation.

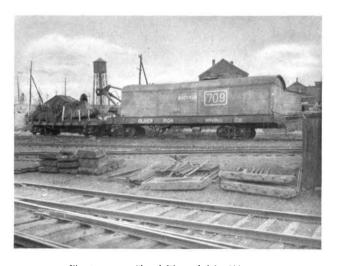


Fig. 60. 90-ton Shovel Dismantled for Shipment

CHAPTER IX

STEAM SHOVEL WORK IN ROCK It will

It will be noted, from the study of

the data in this volume, that as the material becomes more irregular in quality the unit cost rises. This effect is more noticeable in the case of variations in the size of the individual pieces handled than in the density of the material itself. For example, there is more difference in the economic results of handling earth mixed with large boulders than there is in handling good earth, which is comparatively light, and well broken iron ore, which is comparatively heavy.

Another cause of inefficient work is the lack of coordination between the different processes. For example, if rock is badly blasted, or if the steam shovel has to wait for blasts, the necessary cost of loading the rock is considerably greater than it would otherwise be, owing to delay caused by the inefficiency of the previous process. Thus, on some classes of work, it is very difficult to tell how much of the delay or extra expenses are due to the loading process and how much are due to the breaking or loosening process.

The variations in the quality and sizes of the materials are a further cause of delay in the transportation and dumping processes. A large piece of rock that gets wedged in the side of a car and delays a train in getting back to the shovel is a real cause of expense, and yet it is difficult to classify that expense between the three processes. It is perhaps the fault of the breaking process that it should have been so large. It has already delayed the steam shovel in getting it on the car, and with some types of equipment and some classes of men the delay to the dumping on account of it is much less than with more experienced men and with other classes of cars.

Because blasted rock necessarily comes out in very uneven sizes and shapes, and when not very thoroughly blasted offers great resistance to being loosened by the shovel, the unit cost of loading this material is higher than if it were of uniform sizes or well blasted. The photographs give the only adequate idea of the condition of the material handled and described in this chapter.

REPORT No. 30 — SHOVEL No. 1108

INSPECTED JULY 1 TO 3 AND 21-22, 1909

D., L. & W. CUT-OFF

HOPATCONG, N. J.

LOCATION Shovels No. 1108 and No. 1137 (page 323) are located on section No. 1 of the D., L. & W. cut-off and both were working in similar material, although No. 1108 had a decided advantage on July 2. This section extends from the junction of the main line tracks at Hopatcong to a point three miles north of the village of Netcong and is about three miles in length. Like section No. 2, it includes some heavy cuts and fills and concrete work in the shape of arches over streams.

MATERIAL The material consists of porphyry and granite and makes hard digging, but as yet the cuts are not as deep as on section No. 2, and the percentage of earth is larger.

SHOVEL The shovels are both new, having been purchased from the Bucyrus company last November. They are consequently of the latest design, and, being alike, the parts are interchangeable. The

car body is square at the ends and unprotected with wooden buffers, as on some of the other types. The boom and dipper handle are made of wood, reinforced with iron plates on the faces. There is a device for dropping the ashes by pulling a lever and a similar device for turning the grate. Water and coal are supplied in the usual way, except that the hose is attached to a pipe running up the side of the shovel and entering the tank at the top. By having all three machines of the same type the contractor is able to keep a larger supply of extra parts on hand. The wooden boom and dipper handle give more limberness, and consequently they stand rougher usage.

Another advantage which these machines have, is that the jacks can be swung toward the shovel, so that in passing boulders or through narrow places the jack braces only have to be loosened and the jacks swung to one side. The advantage of this was shown twice during our inspection, once while moving forward, when the jack hit a piece of ledge, to have passed which, without swinging the jack would have taken considerable time; and once while moving back beside a tumbled down stone wall.

The contractors report a very light repair bill so far, the only items being a new pinion for the dipper engine and new teeth for the dipper.

ARRANGEMENT OF PLANT The track arrangement for this job is very sim-

ple. The shovels are separated from each other by a swamp about 1000 feet long, and the ends of excavation shown on the sketch are not identical. In both cases a single track and only two trains are used (three new dinkeys, however, arrived at the freight yard the day this inspection closed), with a turnout near the shovel. The run for No. 1108 has only a curve, but for No. 1137 the trains must be switched back along

the hillside. There are no grades against the loads and the dinkeys have no trouble in returning. The dinkey tracks at No. 1108 were at the same elevation as the shovel tracks, but at No. 1137 here was a considerable lift at the end of the day on July 3, and on July 23 the shovel was loading as high as it could reach.

Shovel No. 1108 began on the afternoon of July 1, and on the afternoon of July 21 had finished the run of 1025 feet, with an average depth of face of about 15 to 20 feet, the dinkey tracks being only a couple of feet above the shovel tracks at the maximum. On the afternoon of July 21 the shovel was started on its backward journey, but as we did not arrive at this shovel until 4.06 p. m. on the 23d, the records for this moving are incomplete, but there is enough shown to give an idea of the progress made. The method employed here was similar to that at Shovel No. 893 (see report No. 6) and consisted in laying standard length rails for a considerable distance preparatory to moving. When we arrived the rails had all been laid and had been run into the dinkey tracks, which had been widened to a standard gauge for a distance of about 500 feet. This was done by simply taking the outside spikes out of one rail and shifting it over, leaving in the inside spikes to be used when the track should be shifted back again to narrow gauge. Fig. 62 shows the shovel as it has completed its journey as the men are in the act of un-bolting a section of track to swing over to the area which the other laborers are leveling.

TIME STUDY From the tables, comparisons as to the efficiencies of the two shovels will suggest themselves, but attention is called to the time necessary to fill the dipper and load the cars. The digging for No. 1137 was very hard at times, and much time was spent in trying to loosen rock that was finally

"mud-capped." On the other hand, during the morning on which No. 1108 was observed, the digging was easy, consisting of gravel with well broken sod that fell down of its own accord. At about noon, however, this changed to a hard, unbroken rock, and continued so until about 4.30. The difference between these materials is shown in a very plain manner by the average submitted in the tables.

OBSERVATIONS

Weight								70	to	ns
Gauge								Sta	nda	rd
Capacity of dipper										
Kind of teeth .										
Number of pitmen		•	•	•	•		•			6
Height blocked up										
Weather						•			Cle	ar

TRANSPORTATION

Capacity of cars, water measure						4.	38	cul	oic	vards
Capacity of cars, place measure										
Number of cars in train	-	•	•	Ċ	·	J.	٠.			7
Height of cars above their track	•	•	•	•	•	•	٠	•	•	. 61
Length of haul (approximate).	٠	٠	٠	•	٠	•	٠	٠	٠	4800′
Length of runaround					•		•	•		96 00 ′
Weight of dinkeys									18	3 tons
Style of car			Si	de	dui	np	01	ı bo)th	sides
Height of top of cars above sho	vel	trac	·k			•				61
Gauge of dinkey tracks				•	•	•	•	•	Ň	arrow
Number of trains	•	•	•	•	•	•	•	•	1.4	allow
Number of trains	•	•	•	•	•	•	•		•	. 2
Average time for round trip, 13	3.5	mir	ıute	es;	ma	axi	mυ	ım,	39	min-
Average time for round trip, 13 utes; minimum, 13.5 minut	3.5 es;	mir 26	ute ob:	es; ser	ma vati	axi on	mu s.	ım,	39	min-
Average time for round trip, 13 utes; minimum, 13.5 minut	3.5 es;	mir 26	ute ob:	es; ser	ma vati	axi on	mu s.	ım,	39	min-
Average time for round trip, 13 tes; minimum, 13.5 minute. Maximum grade	3.5 es;	mir 26	ute ob:	es; ser	ma vati	axi on	mu s.	ım,	39	min-
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade	8.5 es; Abc	mir 26 ut	obs p	es; ser er (ma vati cen	on ta	mu s. gai	im, inst	39 en	min- npties
Average time for round trip, 12 utes; minimum, 13.5 minut Maximum grade	8.5 es; Abc	mir 26 ut	obs p	es; ser er (ma vati cen	on ta	mu s. gai	im, inst	39 en	min- npties
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade	3.5 es; Abc	mir 26 out:	obs 2 p	es; ser er (ma vati cen ver	axi on t a	mu s. gai e,	im, inst 520	39 en ';	min- npties mini-
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade	8.5 es; Abc	mir 26 out:	obs p	es; ser er (ma vati cen ver	on t a	mu s. gai	im, inst 520	39 en ';	min- npties mini-
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade Full trains on grades. Rate of transportation: Maxim mum, 250'. Swings per minute Number of cars loaded	8.5 es; Abc ium	mir 26 out:	obs 2 p 11'	es; ser er (ma vati cen ver	axi on t a age	mu s. gai e,	im, inst 520	39 en ';	min- npties mini- 2.9
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade. Full trains on grades. Rate of transportation: Maxim mum, 250'. Swings per minute Number of cars loaded Cubic yards excavated	8.5 es; Abc	mir 26 out:	obs p	es; ser er (ma vati cen ver	axi on t a age	mu s. gai e,	im, inst 520	39 en ';	min- npties mini- 2.9 336 ½
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade. Full trains on grades. Rate of transportation: Maxim mum, 250'. Swings per minute Number of cars loaded Cubic yards excavated	8.5 es; Abc	mir 26 out:	obs p	es; ser er (ma vati cen ver	axi on t a age	mu s. gai e,	im, inst 520	39 en ';	min- npties mini- 2.9 336 ½
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade. Full trains on grades. Rate of transportation: Maxim mum, 250'. Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward	8.5 es; Abc	mir 26 out:	obs	es; ser er (ma vati cen ver	axi on t a age	mu s. gai	im, inst 520	39 en ';	min- npties mini- 2.9 336 ½ 1200
Average time for round trip, 13 utes; minimum, 13.5 minut Maximum grade. Full trains on grades. Rate of transportation: Maxim mum, 250'. Swings per minute Number of cars loaded Cubic yards excavated	8.5 es; Abc	mir 26 out:	obs p	es; ser er (ma vati cen ver	axinon tage	mu s. gai	520	39 en ';	min- npties mini- 2.9 336 ½ 1200 . 14 6' 1"

TRANSPORTATION—Continued

Time in minutes to load I cubic foot with dipper . . .

Time in minutes to round to account appears to the control of the
Time shovel is interrupted while spotting one car009 minute
Minutes per working day, less time for accidental delays . 601 1/2
Shovel expenses in cents, not including superintendent and over-
head or preparatory charges, 3349.
Coal used
Area of section 880 square feet
Height of face
Average time to move forward once 9.429 minutes
Average time to move forward 1 foot 1.553 minutes
Average time to load one car
Pounds of coal per cubic yard excavated 4½
Total cost to excavate, transport and spread 1 cubic yard, 9.69
cents.
Number of cars for one shovel move
Maximum distance moved forward in one move 7' 2"
Average time for one swing: a. m., 19.5 seconds; p. m., 20.6
seconds.
Average time between beginning of one shovel move and begin-
ning of next, 44.6 minutes.
<i>'</i>

TIME STUDY

	Forenoon	Afternoon
Started work	6:59	12:28
Stopped work	11:59	5:29 ½

Total time worked 300+301½ minutes = 10 hours 1 minute 30 seconds.

			Minutes	Seconds	Per Cent
Actual working			388	18	64.6
Spotting cars			3	I 2	0.5
Changing trains			74	30	12.4
Moving shovel			I 32	00	21.9
Idle Boulder in tooth .			0	30	0.1
Miscellaneous delays Tearing down bank			3	00	0.5
Total time under observ	ati	on	601	30	100.0

Direct			Standa	rd Basis		
Labor Distribution Per Day	Break- ing	Load- ing	Trans- porting		Inci- dental	Total
Runner		\$5.00				
Craneman		3.60				
Fireman		2.40				
6 pitmen		9.00				
ı coalman		1.50				
2 waterboys					2.00	
3 drillers	7.50					
3 drillers' helpers .	4.25					
2 laborers stripping						
rock	3.00					l
4 laborers loading	"					
holes	6.00		١			l
1 boiler engineer .	2,00				١	
1 powderman	2.00		l	1		
2 blacksmiths	1				6.00	l
2 blacksmiths' help-						
ers	l		١	l	3.00	١
2 brakemen			3.00		J	• •
I pumpman					1.50	
2 locomotive en-						`
gineers			5.20			
5 dumpmen		• • •	3	7.50		
Half sec. foreman .				7.55	2.00	` ' '
Superintendent .					6.00	
Half watchman .		• • •		' ' ' '	0.75	
		· · ·	<u> </u>			
Total cost of labor						
per day	\$24.75	\$21.50	\$8.20	\$7.50	\$21.25	\$83.20
Cost per day per	,					J
cubic yard, cents	2.06	1.79	0.68	0.63	1.77	6.9
•		, , ,				
Per cent	29.7	25.8	9.8	9.1	25.6	100.0

Process Analysis	cess Analysis Time Per		Per	Cost per Yard	Total
Trocess Thatysis	Min.	Sec.	Cent	in Cents	Cost
Charge to waiting for blasters	3		0.5	0.009	0.009
Charge to loading 1. Actual loading 2. Delays	388	18	64.6	1.156	
a Moving up b Miscellaneous	132	00 30	21.9 0.1	0.392	1.550
Charge to transporting and dumping 1. Waiting for cars	77	42	12.9	0.231	0.231
	601	30	100.0		1.790

ANALYSIS OF COMPLETE DIPPER SWING

Forenoon	Mini- mum	Average	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Time	4	9.18 5.76	21 1/2	25 23	28
Swinging loaded in	3	5.76	91/2	23	••
falling empty seconds	4	8.20	22 1/2	_23	
Time to fill and load one dipperful	11	23.14	531/2		

Percentage of complete dipperfuls to attempts $=\frac{25}{28}=89.3$.

Afternoon	Mini- mum	Average	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Swinging loaded in	4 ½ 3	12.5 7·3	44 37 ½	23 22	31
Swing and fall- seconds ing empty seconds	51/2	8.7	17	22	
Time to fill and load one dipperful	13	28.5	98 1/2		

Percentage of complete dipperfuls to attempts $=\frac{23}{31}=74.2$

Time for a complete swing (seconds)

		Minimum	Average	Maximum	Number of Obser- vations
Forenoon		12	19.5	31.5	36
Afternoon		14	20.6	26.0	37

Swings per minute

				Maximum	Average	Minimum	Number of Obser- vations
Forenoon Afternoon	•	•	•	5.0 4.3	3. I 2.9	1.9	36 37

		(ost	to M	Iove :	Back						Standard Basis
Runner .				(a)	1.73	3 day	(a)	\$5.0	0			\$8.65
Craneman				(a)	1.73	day	(a)	3.6	ю			6.23
Fireman .				(a)	1.7	day	(a)	2.4	0			4.15
27 laborers				(a)	1.73	day	(a)	1.5	0/0	da	y	70.07
1 foreman				(a)	1.73	day	@	4.0	Ю			6.92
ı foreman				(a)	1.7	day	<u>@</u>	3.5	0			6.06
												\$102.08
Coal (1 ton)												4.00
Oil and wast	te											1.00
												\$107.08

Total distance moved .						
Total time consumed .						
Number of men employe	d					32
Cost per foot moved .						. 6.6 cents
Cost per foot, per man						0,21 cent

ACTUAL RATIOS Superintendence Direct labor = 0.06

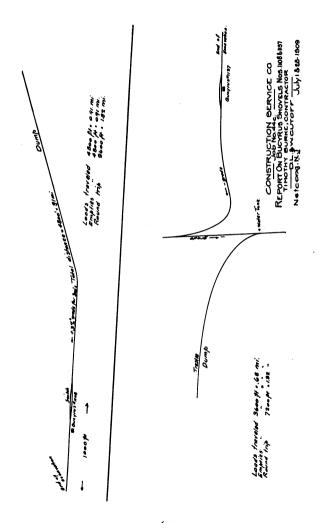




Fig. 61

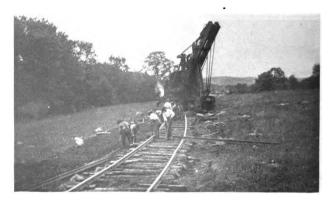


Fig. 62. Shovel on the D., L. & W. R. R. Cut-off, near Hopatcong, N. J.
Track being prepared for Moving Machine

REPORT No. 31 — SHOVEL No. 1138

INSPECTED OCTOBER 2 AND 8, 1909 BROWNELL IMPROVEMENT COMPANY THORNTON, ILL.

MATERIAL With the track layout shown in the sketch, shovels No. 1073 (p. 278) and No. 1138 are turning out from 2600 to 3000 cubic yards of crushed stone a day, the material being a hard crystalline limestone, which, if October 2, 3, 4 and 5 are any criterion, is not too well blasted. It is the same sort of limestone as found on the Jas. J. Hart contract on the D., L. & W. cut-off, where it was said that powder cost 15 cents a vard. On this work powder costs from 2 ½ cents to 13 cents a yard. On the first day of observation (shovel No. 1073) the rock was well broken up in the morning, but during the afternoon some was encountered which came out in large slabs that had to be mud-capped, 150 pounds of dynamite being used for this purpose. October 3d (shovel No. 1138) the digging was very easy, the rock being broken into small pieces, not over a foot in diameter. It was necessary to blast the bank only three times on this day as against eight times the previous day at No. 1073. It was on this day that No. 1138 made the best run of the four days observed, working 50 per cent. of the time and loading 300 cars. On October 4th (shovel No. 1073) the rock was fairly well broken, but parts that had not felt the effect of the blast were frequently met. On the last day of the observation (October 5th, shovel No. 1138) the digging was very hard. The rock had not been blasted properly, so that while the rock was broken it was not loosened sufficiently to make easy digging, and as insufficient powder had been used, the rock was broken at the top, but there was a ledge about two-thirds the way down the face that had not been affected, and

which had to be drilled and blasted frequently. The day this shovel was observed was the day after the track was changed. The shovel had to follow the track and had to draw away from the bank to do so, as there was a slight curve at this point. When the track was thrown it was brought very near the shovel, a little too near in fact, for when the boom was swung around into its usual position preparatory to dumping the dipper, it was found that the contents of the dipper would land on the far side of the car rather than in it. By spotting the cars a little further ahead and not swinging the boom so far around, this difficulty was overcome. However, a new dilemma presented itself, for now, on account of the boom being in the line of sight, the runner could not see to properly spot the dipper. So until the shovel had cut in again far enough to dump with the boom swung out as usual, the time per swing was somewhat increased.

DRILLING AND BLASTING

The rock dips toward the shovels at about 30

degrees from the horizontal. Sixty per cent forcite in pieces 2" x 6" and 3" x 8" is used. There were four drills in front of No. 1138 and three behind, the latter drilling the holes. In front of No. 1073 there were four drills but none behind. During one week of seven days, selected at random, there were drilled 2258 feet of all large and small holes by 11 drills, or about 29 feet per drill day. The drillers work in pairs and are paid by the foot, receiving 8 cents a foot, large holes; 6 cents per first 30 feet of small holes and 7 cents a foot for all over 30 feet. A crew consists of two drills, two drillers and one helper, the latter receiving 17 ½ cents an hour. The large holes finish at 3 ½ inches. The holes are not sprung, as the material is so brittle it breaks off and fills the holes. Both top and toe holes are drilled. Ingersoll-Rand drills are used and are run by compressed air.

Dynamite costs $12\frac{1}{2}$ cents a pound. At each shovel one small one-man drill was kept in addition for making holes for light blasts.

These shovels are the largest and strongest The Bucyrus Company makes. They weigh 95 tons and have steel-plated booms and dipper handles, the boom being swung by chain instead of cable. There are two water tanks, one on each side of the boiler, and three propelling chains instead of only two. A crew consists of engineer, craneman, fireman and four or five pitmen. There were four on No. 1073 and five on No. 1138. The engineer, craneman and fireman receive time and a half for overtime and the two former are allowed one day a week off under pay. There is an extra crew who work nights making repairs and who substitute when the regular men are away.

SUPPLIES Water is supplied to the shovel from a tank on top of the quarry. Coal is brought in on the dinkeys and put right in the bunker on the shovel, which holds about five tons. Coal costs \$1.70 a ton. The boilers are washed out once a week, and this, together with the general repairs, costs about \$32 a week.

TRANSPORTATION

The hauling is done by four 35-ton dinkeys drawing ten car trains. There are five of these dinkeys, but one is taken in every day and washed and overhauled. Four of them are new engines. Besides these there are two others of about 50 tons, which are used for switching the large freight cars. The dinkey cars are five cubic yards capacity, weigh four tons empty and cost \$150 to build. They are very substantial, being lined with sheet iron. The door is tripped automatically when the cars are

dumped. These cars ride very well and do not getoff the track under ordinary conditions. No brakes are provided. A coal tender is attached to each engine.

COST KEEPING A registering clock is used to keep the time of arrival and departure of the men. From these cards the payroll is made up, and to save time the extensions are made weekly on the cards themselves. The timekeeper goes over the job during the day to check up the men. The payroll is made up on a large sheet about 10 inches by 14 inches. All purchases are made by the main office, the requisition being made in duplicate at the job. One copy is sent to the main office where it is reviewed by the manager, and if O. K., is copied in triplicate, one being kept at the main office, one sent to the dealer, and one sent to the job. The one sent to the job is in the nature of a receipt and is returned when the goods are delivered. At the job the payroll, car records or such other matter as it is desired to keep a record of, is written out with a copying pencil and copied in a copy book.

OBSERVATIONS—GENERAL

Weight													Ç)5 t	ons
Gauge															
Capacity of dipper											2 1/2	c	ubio	: ya	ırds
Kind of teeth .					Ma	nga	ane	se	ste	el l	oase	s a	and	po	ints
Height of lift					81	۷Ī,	Oc	tol	oer	5;	7 1/2	٧,	Oct	obe	er 3
Height blocked up					•				•	٠.					o'
Number of pitmen															5
Length of boom.														30	' 7"
Length of dipper	hand	lle												18	6"
Height of boom al	oove	pi pi	vot											22	9"
Height of boom al	ove	sh	ov	el	trac	ks									28′
Horizontal reach of	of bo	on	1												221

OBSERVATIONS—GENERAL—Continued
Farthest dipper can reach to dump
Weather clear. Depth of dipper (water measure)
OBSERVATIONS—FIRST DAY
Number of cars loaded
ginning of next, 75 1/2. Minimum time between beginning of one shovel move and beginning of next, 30.
Average number of cars to one shovel move
Time between moves when minimum was loaded . 30 minutes Average time to load one train
Number of times blasted bank
accurately. Water used, could not be ascertained; stream running con-

stantly.

TIME STUDY-FIRST DAY

	F	orenoon			Afterno	o n		
Started work		7:04:30		12:29:00				
Stopped work	I	2:09:00			5:02:3	30		
	Min.	Sec.	Min.	Sec.	Min.			
Total time worked 38 minutes.	304	30 +	- 273	30 =	= 578	= 9 hours		

	Minutes	Seconds	Per Cent
Actual working	289	00	50.0
Spotting cars	2	30	0.4
Waiting for cars*	(137)	(45)	(23.8)
Idle	50	45	8.8
Leveling in front	38	00	6.6
Drilling	16	30	2.8
Blasting	14	45	2.5
Preparing to move	17	45	3.1
Moving shovel	94	00	16.3
Idle	(26)	(15)	(4.6)
Blasting (cars on hand)	24	45	4.3
Waiting for trains to pull out .	I	30	0.3
Miscellaneous delays		_	
Pulling in and breaking bank	28	30	4.9
Total time under observation .	578	00	100.0

^{*} The whole of miscellaneous, and 36 minutes spent in moving up, was also accomplished while waiting for cars.

	Co	st o	f D	irec	t La	lbor	(Lo	oadi	ng)	per	Day	,		Standard Basis
Runner														\$5.00
Cranema														3.60
Fireman														2.40
5 pitmen	•				•	•								7 . 50
							-							\$18.50

Cubic yards loaded on first day of observation 1200 Based on observed performance, the cubic yards loaded per day

of 10 hours = 1200
$$\times \frac{600}{578}$$
 = 1245 cubic yards.

Cost per day of labor
Number of cubic yards per day

\$18.50 = 1.49 cents per cubic yard

	Ti	me	Per	Cost per	Total	
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost	
Charge to waiting for blasters Charge to loading	53	15	9.2	0.137	0.137	
1. Actual loading 2. Delays	289	00	50.0	0.745	0.988	
a Moving up	94	00	16.3	0.243	0.900	
Charge to transportation and dumping						
1. Waiting for trains	140	15	24.2	0.361 }	0.265	
2. Miscellaneous	I	30	0.3	0.004 \$	0.365	
	578	00	100.0		1.490	

Dipper Performance	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations
Digging	2.0 3.0 3.0 2.5	5·3 5·75 5·75 4·5	14.5 8.5 7.5 12.5	76 52 51 69
dipperful)	10.5	21.3	43.0	٠

Time for a complete swing

	Minimum	Average	Maximum	No. Obs.	No. Attempts
Seconds .	14	23.3	43.75	46	61

Number of observations less than 20'' = 19Number of observations greater than 20'' = 25Number of observations at $20'' = \frac{2}{46}$

Cubic yards excavated
Capacity of cars, water measure 5 cubic yards
Total distance moved forward during day 58' 6"
Number of times moved forward during day
Maximum distance moved forward in one move
Minimum time between beginning of one shovel move to be-
ginning of next 32 minutes
Average time between beginning of one shovel move to be-
ginning of next 87 minutes

210

840

OBSERVATIONS. SECOND DAY-Continued

Maximum time between beginning of one shovel move to be-
ginning of next 180 minutes
Minimum number of cars to one shovel move
Average number of cars to one shovel move 25.4
Maximum number of cars to one shovel move 43
Time between moves when minimum was loaded . 35 minutes
Time between moves when maximum was loaded 145 minutes
Average time to load one train
Number of cars in train
Area of section Very irregular but about 500 square feet
Height of face
Number of times blasted bank
Average time to make one blast 9½ minutes
Coal used, about 3 to 4 tons, could not be ascertained accurately.
Water used, could not be ascertained; kept steam running con-
stantly.

TIME STUDY. SECOND DAY

Started work	Forenoon 7:16:00	Afternoon 12:59:30	
Stopped work	12:34:00	7:13:00	
Total time worked 30 seconds = 11 hours	Min. Min. 318 + 373 31 minutes 30		minutes

	Minutes	Seconds	Per Cent
Actual working	243	30	35.2
Spotting cars	16	45	2.4
Waiting for cars	(59	00)	
Waiting for trains to be spotted	12	30	1.8
Idle	5	15	0.8
Tightening jacks	2	15	0.3
Clearing track	5	30	0.8
Blasting	33	30	4.8
Moving shovel	146	15	21.2
Idle	(193	30)	
Blasting (cars on hand)		30	6.0
Putting car on and clearing track		00	3.2
Clearing track		00 .	0.1
Drilling	124	45	18.1
Waiting for trains to pull out .	4	15	0.6
Miscellaneous delays		30)	
Pulling in bank to clear track.	2 I	45	3.1
Breaking bank	10	45	1,6
Total time under observation .	691	30	100.0

Cubic yards loaded on second day of observation . . . 840 Based on observed performance, the cubic yards loaded per day of 10 hours = 840 x 600 = 730.

691.5

 $\frac{\text{Cost per day of labor}}{\text{Number of cubic yards per day}} = \frac{\$18.50}{730} = 2.53 \text{ cents per cubic yard.}$

Process Analysis		me	Per	Cost per Yard in	• Total	
Process Analysis	Min.	Sec.	Cent	Cents	Cost	
Charge to waiting for blasters Charge to loading	198	45	28.8	0.728	0.728	
1 Actual loading 2 Delays	243	30	35.2	0.890)	1.426	
a Moving up Charge to transporting and dumping	146	15	21.2	0.536		
Waiting for cars Miscellaneous delays	75 27	45 15	10.9	0.276 }	0.376	
	691	30	100.0		2.530	

Dipper Performance	Minimum	Average	Maximum	No of Obser- vations
Digging Swinging loaded Swinging empty Falling empty . Time in seconds Time to fill and load one	3.5 3.0 3.0 2.5	7.5 3.8 4.2 4.5	19.0 11.5 7.0 9.5	89 61 57 69
dipperful	12.0	20.0	47.0	• •

Time for a complete swing

	Minimum	Average	Maximum	No. of Obser- vations	No. of Attempts
Seconds	13.5	21.6	54	54	60

Number of observations less than 20'' = 28Number of observations greater than 20'' = 23Number of observations at 20'' = 3

SOME DELAYS TO THE LOADING OF TRAINS CAUSED BY THE SHOVEL, AND THE TIME CONSUMED

Delay in loading; no apparent reason 7 minutes
Moving forward
Blasting
Some time on the various operations in moving forward:
Front clamps
Front clamps
Rear clamps, front trucks
Rear clamps, rear trucks
Carrying and placing ties
Carrying and placing rails
Bumper tie 6" to 10"
Screwing jacks, jack blocks and swinging 3' 4" to 3' 6"
Leveling ties
Placing rails
Placing rails
Front clamps
Some delays to the loading of trains caused by the shovel and
the time consumed are as follows:
Blasting 42 minutes
Moving forward
Drilling
Clearing track 9 minutes

TRANSPORTATION

Train Number	Time for Round Trip from Shovel to Switch, Minutes	Time Waiting at Switch, Minutes	Time Traveling from Switch to Shovel, Minutes
II	113/4	9½	2 1/2
I	151/2	4	31/4
I	121/4	8	3
11	121/2	Went to 1073	
I	17	0	3
I	40 1/2	0	2 1/4
I 2	24	0	2 1/2
12	8	Went to 1073	
I	10 1/2	2 1/2	2 1/2
11	161/2	Went to 1073	
1	31 1/2	Went to 1073	
2	II	31/2	2
verages .	17.6	3.4	2.6

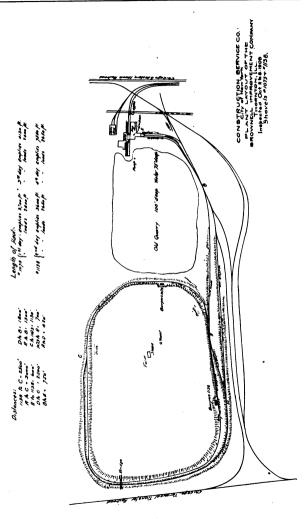
Average time for round trip = 23.6 minutes.

DINKEY No. 2-35-TON

	Minutes	Feet	Feet Per Minute
Waiting for empties	14		
Crusher to switch A	4	2050	510
Switch A to Shovel 1138	1 1/2	6ŏo	400
Shovel 1138 to crusher	31/2	265 0	760
Round trip (exclusive of delays)	9	5300	590
Delays	-	• •	
Letting loaded train out	I ½		
Clearing track and blasting.	6		
Loading	16		
Round trip (including delays) .	32 1/2	5300	163



Fig. 63. Bucyrus Shovel No. 1138



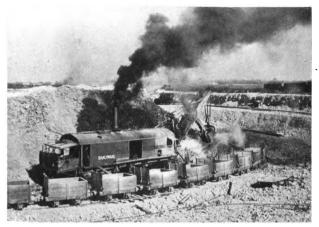


Fig. 64



Fig. 65. Two Views of Bucyrus Shovels Handling Crushed Rock.
Brownell Improvement Company, Thornton, Ill.

REPORT No. 32 — SHOVEL No. 1073

INSPECTED OCTOBER 2-8, 1908

BROWNELL IMPROVEMENT CO.

THORNTON, ILL.

See Report 31, page 265, for Description, etc.

OBSERVATIONS GENERAL

Weight		•	•		•		•			•	•	•	•	9	95-ton
Gauge															ndard
Capacity of di	ipper										2	2.3	cul	oic	yards
Kind of teeth Height of lift					M	ang	gan	ese	ste	el	ba	ses	an	d	points
Height of lift															I 2
Height blocke	ed up														c
Number of pi	tmen														4
Length of boo															30
Length of dip						:									18
Height of boo															22' 9"
Height of boo															28
Horizontal rea															22
Farthest dipp	er can	read	ch	to	dui	np									27
Highest dippe															17 1/2
Lowest dipper	r can r	each	t	o d	ig l	oelo	ow.	sho	ve	ltı	ack	s			4
Diameter of b															81/2
Height of din			a	bov	e s	ho	vel	tra	cks				Ċ		51/2
Distance insic															231/2
Depth of dipp								•							46"
Depth of dipp															55 1/2"
Depth of dipp													Ċ		72"
Dopui or dipp			-ъ			•	•	•	•	•	•	•	•	٠	,-
	OBSE	RV	A٦	ric)NS	5—	FΙ	RS'	Τ:	\mathbf{D}^{A}	١Y				
Cubic yards e	xcavat	$_{ m ed}$													910
Number of ca					-										227 1/2
Capacity of ca				eas								5 (cul		yards
Total distance															
Number of tir															
Maximum dis															
Minimum tim															
heginning	of ne	vt	•	-6		6	0,		•••			E 2	3/.	mi	nutes
beginning Average time	hetu	een	·ı	· ·	inni	in o	٠,	Ė۵	ne.	اء :	hos	o) O	/# m	ove	and
beginning	r of ne	vt		νъ		8	0		110			81	ı.	mi	nutes
beginning Maximum tin	ne het	wee	n n	he	zint	· vine	•	i if c	· ne	٠ وا	· hov	el.	m.	ove	and
heginning	of ne	vt	••	oc,	5****		5		,,,,	3.		. 16	14	mi	nutes
beginning Minimum nun	ober of	car	·	to d	one	sh	· ove	i elm	NOV	e e			/2		20

OBSERVATIONS-FIRST DAY-Continued

Average number of cars to one shovel move 30.7
Maximum number of cars to one shovel move 40
Time between moves when maximum was loaded 108 1/4 minutes
Time between moves when minimum was loaded 53¾ minutes
Average time to load one train
Number of cars in train
Area of section 259 square feet
Height of face
Number of times blasted bank
Average time to make one blast 10.1
Coal used, about 3 or 4 tons.

TIME STUDY. FIRST DAY

	Forenoon	Afternoon
Started work	7:42:30	12:28:00
Stopped work	12:06:30	6:00:00

Total time worked 264 + 332 minutes = 9 hours 56 minutes = 596 minutes.

These are the times when the observations began and ceased. The shovel worked 12 hours.

	Minutes	Seconds	Per Cent
Actual working	261	00	43.8
Spotting cars	4	30	0.8
Waiting for cars	(143	30)	(24.1)
Idle	30		5.0
Oiling chain	25	30	4.3
Wiping engine, etc	8	30	1.4
Blasting	68	00	11.4
Waiting for trains to be spotted	4	00	0.7
Leveling in front for moving			i
forward	7	30	1.3
Moving shovel	8o	15	13.5
Idle	(81	30)	(13.6)
Waiting for train to pull out .	Ì	oo	0.2
Blasting (cars on hand)	42	45	7.1
Taking coal	19		3.2
Putting two cars on track	7	30	1.3
Breaking boulder with sledge	6	30	1.1
Oiling machine	2	45	0.4
Minor repairs	2		0.3
Miscellaneous delays	(25	15)	(4.2)
Breaking bank	24	15	4.0
Handling boulder	i		0.2
Total time under observation	596	00	100.0

	st c	01 1	irec	t 1.	abo	r (L	oad	ing)	per	Da	y		Standard Base
													\$5.00
Craneman		•											\$5.00 3.60
Fireman													2.40
4 pitmen			. •	•						•			6.00
													\$17 00

Cubic yards loaded on first day of observation 910 Based on observed performance, the cubic yards loaded per day of 10 hours = 910 $\times \frac{600}{596}$ = 916 cubic yards. Cost direct labor per day

 $=\frac{\$17.00}{916}$ = 1.86 cents per cubic yards. Number cubic yards per day

	Ti	me	Per	Cost per	Total
	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to waiting for blasters	74	30	12.5	0.232	0.232
Charge to loading 1. Actual loading 2. Delays	261		43.8	0.815	
a Moving up	80	15	13.5	0.251	1.139
b Miscellaneous	23	45	3.9	0.073	
Charge to transporting and dumping					
1. Waiting for cars	149	00	25.0	0.465 1	0.190
2. Miscellaneous	7	30	1.3	0.024 \$	0.489
	596	00	100.0		1.860

Dipper Performance	Minimum	Average	Maximum	No of Obser- vations
Digging Swinging loaded Swinging loaded Falling empty . Time to fill and load one dip-	2.5 2.5 1.0 2.7	4.8 4.6 3.9 3.8	9.0 9.0 7.0 7.0	81 76 68 69
perful	8.7	17.1	32.0	

Time for a complete swing

	Minimum	Average	Maximum	No. Obs.	No. Attempts
Seconds.	 15.5	19.5	29.5	67	69

Number of observations less than 20'' = 45Number of observations greater than 20'' = 17Number of observations at 20'' = 5

SOME OF THE DELAYS TO LOADING TRAINS, AND TIME CONSUMED

Shovel crew	getti	ng	to	wc	rk									31/2	minutes
Blasting .	٠.												4	3	minutes
Moving forw	ard												5	2	minutes
Oiling machi	ne													3	minutes
Breaking bo	ulder	wi	th	sle	dge	;			٠.				- (Š 1/2	minutes
Waiting for	trains	ah	ıea	d t	o l	oad	١.						1	8	minutes
Shovel break	ing l	an	k											1 1/2	minutes
Shovel takin	g coa	ıl											1	9	minutes
Some times obtained								tio	ns	in	mov	vin;	g fo	orw	ard were
Moving .													29	1/2".	32", 15"
Screwing jac	ks ar	id s	wi	ngi	ing								. '	-	105"-75"
Leveling in f	ront									I 2	min	ute	s-1	3/4	minutes
Carrying and															
Carrying and															
	plac														
		ing	ra	ils											45"-55"
Screwing rail	clan	ing ips	ra	ils			:		:	:		:	:	:	45"-55" 50"-25"
Screwing rail Front clamps	clan s	ing ips	ra	ils ·		•		:		:	:	•	:	:	45"-55" 50"-25"
Screwing rail	clan	ing ips	ra	ils · ·							· · ·				45"-55" 50"-25" 50"-27" 15"

OBSERVATIONS—SECOND DAY

Number of cars loaded
Cubic yards excavated . 900 (cars equal 4 yards, place measure)
Capacity of cars (water measure) 5 cubic yards
Total distance moved forward during day 44' 6"
Number of times moved forward during day 8
Maximum distance moved forward in one move 6'
Average time between beginning of one shovel move and begin-
ning of next 67 1/2 minutes

OBSERVATIONS-SECOND DAY-Continued

Maximum time between beginning of one shovel move and beginning of next 80¾ minutes Minimum time between beginning of one shovel move and beginning of one shovel move and beginning of one shovel move and beginning of one showel move and beg
ginning of next 50¾ minutes
Average number of cars to one shovel move 30
Maximum number of cars to one shovel move 34
Minimum number of cars to one shovel move
Times between moves when maximum was loaded, 763/4 minutes
Times between moves when minimum was loaded, 37 minutes
Average time to load on train: 12 minutes for 10-car trains; 19
minutes for 15-car trains.
Number of cars in train 3 trains of 15 cars
Area of section
Height of face 20 feet
Number of times blasted bank
Average time to make one blast 7.7 minutes
Coal used, about 3 to 4 tons. Could not be ascertained accurately.
Water used could not be ascertained. Tank leaked.

TIME STUDY. SECOND DAY

Started work Stopped work	Forenoon 7:16:00* 12:00:00	Afternoon 12:00:00 6:50:00	
Total time worked minutes.	Min. Min. 284 + 410 = 6	94 min. = 11 hour	's 34

*This is the time when the observation began. The crew started at 6:00.

					Minutes	Seconds	Per Cent
Actual working					272	00	39.2
Spotting cars					I	00	0.1
Waiting for cars					(122	15)	(17.6
Idle					<u>` 5</u> 6	30	8.1
Oiling chain					10	00	1.4
Blasting					34	30	5.0
Minor repairs					21	15	3.1
Moving shovel					76	15	0.11
Idle					(215	45)	(31.1)
Oiling crane e					4	00	0.6
Putting on oil	cι	ıp			3	15	0.5
Oiling chain					3	15	0.5
Minor repairs					3	00	0.4

	Minutes	Seconds	Per Cent
Blasting (cars on hand)	20	15	2.9
Getting up steam	46	30	6.7
Repairing safety valve	118	30	17.1
Getting ready to dig	2	00	0.3
Taking coal	10	00	1.4
Repairing water pipe	5	00	0.7
Miscellaneous delays	_		
Breaking bank	6	45	1.0
Total time under observation .	694	00	100.0

Cubic yards loaded on second day of observation 900 Based on observed performance, the cubic yards loaded per day Based on observed performance, of 10 hours = $900 \times \frac{600}{694} = 778$.

Cost of direct labor per day = $\frac{\$17.00}{778} = 2.18$ cents per cubic yard.

Process Analysis	Ti	me	Per	Cost per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to waiting for blasters	29	00	4.2	0.092	0.092
1. Actual loading 2. Delays	272	00	39.2	0.854	
a Moving up	76	15	0.11	0.240	1.702
b Repairs	137	00	19.7	0.429	
c Miscellaneous	56	30	8.2	0.179	
Charge to transporting and dumping				-	
 Waiting for cars . 	123	15	17.7	0.386	0.386
	694	00	100.0		2.180

Dipper Performance	Mini- mum	Aver- age	Maxi- mum	Number of Obser- vations
Digging Swinging loaded Swinging empty Falling empty Time to fill and load Seconds	2.5 3.5 2.5 2.5	5.9 6.2 4.3 4.1	15.5 10.5 7.5 7.0	75 51 47 61
one dipperful	11.0	20.5	40.5	·

Time for a complete swing

	Minimum Average Maximum		Maximum	No. of Obs.	No of Attempts
Seconds	14	23.4	431/4	46	49

Number of observations less than 20 seconds

Number of observations greater than 20 seconds = 25Number of observations at 20 seconds

46

SOME CAUSES OF DELAYS TO THE LOADING OF TRAINS AND THE TIME CONSUMED

	Delays	Minutes
Oiling chains	I	3.4
Waiting for train ahead to load		331/2
Minor repairs to shovel	I	1 1/4
Blasting	3	311/4
Getting up steam	4	4134
Moving forward and waiting for train	1	
ahead to load	1	29
Moving forward		31 3/4
Putting on oil cup		334
Engine getting ready to dig	I	34
Oiling crane engine	I	4

Some times on the various operations in moving forward were obtained and are as follows:

Carrying and placing rails $\dots \dots 43''-35''-47''-57''$
Bolts and plates
Front clamps $35''-33''-25''-55''$
Bumper tie $10''-5''$
Moving $21''-15''-23''-17''$
Screwing jack, placing jack blocks and swinging . 2' 15", 1' 40",
I' 24", 3' 28"
Leveling rock service in front for ties . 3 minutes, 6' 30"-6' 30"
Unscrewing jacks
Unbolting rails in rear $60''-25''$
Carrying rails from rear to alongside jacks
Carrying ties from rear to front 2' 31"
Leveling ties
Leveling rails
Clamps and blocks (rear of front truck) 1'-35"-35"

Train Number	Times for Round Trip Minutes	Engine Number	Time from Shovel to Stopping Place	Time Waiting
11	28		13	30
ΙI	20 1/2	II	17	29
2	27	10	20	16
2	26	ΙΙ	33	14
11	30	10	24	35
2	32	10	24	6
11	20	I 2	29	17
2	18	I	30	8
2	24		<u> </u>	
11	25	A	0	
2	25	Averages	23.8	22
11	24 1/2			
	300			
Average	25			

DINKEY No. 12-35-TON

		Minutes	Feet	Feet Per Minute		
Crusher to shovel	.	7	4130	590		
Loading		10 ½ 2	700	350		
Switch to top of grade		2	1000	500		

DINKEY No. 10-35-TON

	Minutes	Feet	Feet Per Minute
Shovel to switch A	2	700	350
Switch A to crusher	3	2050	68o
Switching	I ½		
Crusher to switch C	5	5050	1010
Switch C to shovel No. 1138.	33/4	2 500	670
Shovel 1138 to crusher	4 1/2	2650	590
Round trip (exclusive of delays)	131/4	10200	770
Delays—Waiting for empties .	2		
Loading	28 ½		
Round trip (including delays) .	413/4	10200	245

DINKEY No. 1-35-TON

	Minutes	Feet	Feet Per Minute
Crusher to shovel No. 1073. Shovel No. 1073 to switch A. Switch A to crusher. Round trip (exclusive of delays) Delays—Loading Round trip (including delays).	8 3 2½ 13½ 10½ 24	4130 700 2050 6880	515 235 820 510

REPORT No. 33 — SHOVEL No. 1096

INSPECTED JULY 27, 28, 1909

D., L. & W. CUT-OFF

NEAR JOHNSONBURG, N. J.

LOCATION AND MATERIAL The contractor for section No. 5, D., L. & W. cut-off, is the Hyde-McFarlin-Burke Company. This section is located in slate and limestone and is about three miles long, being about equally divided between cut and fill. Figs. 66 and 67 give an idea of the nature of the material in which No. 1096 and No. 1097 have cut through. This, however, was not the same as during our inspection, at which time the digging was easy and no time was spent in handling boulders, although on the second day (No. 1096) 19 minutes (total of three times) was spent in blasting a portion of a projecting ledge.

SHOVELS These two shovels are exactly alike. They weigh 70 tons, have standard gauge railway car trucks, and all steel boom and dipper handles, the former being of the lattice type. For the purpose of



Fig. 66



Fig. 67. View Showing Materials Encountered on D., L. & W. R. R. Near Johnsonburg, N. J.



Fig. 68



Fig. 69. Views Showing Method of Moving Back Shovel on D., L. & W. R. R. R. Near Johnsonburg, N. J.



Fig. 70. View Showing Device for Turning Cars on D., L. & W. R. R. Near Johnsonburg, N. J.

drilling holes for small blasts these machines are fitted with a small air compressor and tank. The compressor is located in the rear left-hand corner of the shovel and takes up a space about 6 feet high by one foot in diameter. The jacks fold against the A frame.

These shovels have been in use constantly on this work, and in some very hard digging, for just about a year, but show no wear.

An attempt was made to get the angle that the dipper makes with the vertical when the dipper handle is horizontal. Any such measurements to be of any use must be exact, as the variations in the angle would be so small that rough figures would be misleading. In general the dippers were at the same angle on each shovel, although that on No. 1096 may have been a trifle greater.

These shovels have the lever device for dropping the ashes and turning the grate.

ARRANGEMENT The track arrangement on this job, because of its extent, circuitous route, and, in spite of the uneven country, its splendid facilities for serving cars to the shovel, is of special interest. The sketch shows accurately the arrangement and gives the grades and distances. All distances shown were measured, and all grades were obtained by a hand level and by pacing the distance. The maximum grade against the empties was 5.8 per cent, and it was observed that the dinkeys could only get up this by acquiring plenty of speed beforehand, or else by applying the brakes and shutting off steam every time the wheels slipped. On the sketch are indicated the direction of traffic and location of the grades.

TRANSPORTATION With the dump 13/4 miles from the shovels, and two shovels working, the subject of transportation becomes of vital importance. For this reason a detailed study of the time for a round trip together with the time and causes of delays was made.

Vulcan dinkeys are used, and the cars, which are side dump on one side only, were made by the South Baltimore Car & Foundry Company, Curtis Bay, Baltimore, Md. One of the illustrations (Fig. 70) shows the device for turning the cars when the fill must be made on the opposite side.

MOVING BACK On the second day of our inspection, shovel No. 1097 was moved back 1063 feet, and on the fourth day, shovel No. 1096 was

moved. The method employed for moving both shovels is plainly shown in the illustrations (Figs. 68 and 69), and as it was somewhat different from others that have been observed, it will bear some description. Two horses and sixteen men were used, eight lengths of 30 feet 60-pound rail and about one hundred ties, besides bridles, spikes, etc. The shovel is moved back two rail lengths at a time, the forward rails and ties being taken up and hauled by the horses to the rear, where the laborers lift them into place. Two men stay in front to unbolt as soon as the shovels move back, two others take up the ties as the horses haul away the rails. One man is required to follow the chain used for hauling the ties to see that it does not get caught in an obstruction, it being apparently too heavy to throw over a horse's back. Four men are kept in the rear to lay the ties as they come in, and the remaining men go where instructed. Eight men are required to lift each rail into place. The bridles are carried forward by the men, or else laid among the ties that the horse draws. are enough extra ties to support the first rails that are brought, and these are laid while the shovel is moving, so that there is no delay when the rails are taken up.

CONTRACTOR'S METHODS
The form submitted herewith is used for labor

distribution. It fails, however, in that it does not show (and the contractor does not know) on what part of the work the men are engaged in making repairs.

OBSERVATIONS—GENERAL

Capacity of dipper									2	½ yards
Kind of teeth on dipper							M	an	gané	ese steel
Height blocked up									•	o
Weather, clear.										
Maximum height dipper of	an	rea	ch	to	dui	mp				181
Length of dipper handle										18′ 6″
Length of boom										28.51
Maximum distance dipper										28.8
Maximum distance dipper	r ca	ın 1	rea	ch t	to d	lig				30'

OBSERVATIONS—GEN	IERA	L— <i>C</i>	onti	ruea	!
Greatest depth dipper can dig .					7'
Diameter of bull wheel Capacity of cars, water measure Number of cars in train Height of cars above their track Length of haul (approximate)					7′ 8′
Capacity of cars, water measure.			4.0	o cul	bic vards
Number of cars in train					o and 10
Height of cars above their track Length of haul (approximate) Length of runaround Weight of dinkeys Style of car Height of top of cars above shovel Gauge of dinkey tracks Number of trains					5' 8"
Length of haul (approximate)				•	75001
Length of runaround			•	3	.61 miles
Weight of dinkeys	• •	•	•	, ,	18 tons
Style of car	Side	dum	n on	one :	side only
Height of top of cars above shovel	track		r		15.21
Gauge of dinkey tracks		• •	•	•	Narrow
Number of trains	• •	• •	• •	•	7
Average time for round trip				4 5	minutes
Maximum grades for loads	400	er cer	tano	1 20	ner cent
Number of trains Average time for round trip Maximum grades for loads Maximum grades for empties Complete trains for grades	nlus	: r 8 r	er ce	nt_2	ner cent
Complete trains for grades.	. prus	3.0 F	oci cc	111-2	per cent
Time traveling to dump				188	minutes
Time traveling to dump Time traveling from dump to shove			•	17.7	minutes
Average time to dump care			•	1/./	minutes
Average time to dump cars Distance inside dinkey track to insi	de ch	vel t	rack	4.9	22.4/
Distance hiside difficely track to hisi	ide sin	JVEI L	iack	•	23.4
OBSERVATIONS-	FIRS	ST D	AY		
OBSERVATIONS—	-FIRS	ST D	AY		. 2.56
OBSERVATIONS— Swings per minute	-FIRS	ST D	AY 		. 2.56
OBSERVATIONS— Swings per minute Number of cars loaded Cubic vards excavated	FIRS	ST D	• A Y • • • • • • • • • • • • • • • • • • •		. 2.56 . 468
OBSERVATIONS— Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward	FIRS	ST D	• A Y • • • • • • • • • • • • • • • • • • •		. 2.56 . 468 . 1685
OBSERVATIONS— Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time	-FIRS	ST D	· · · · · · · · · · · · · · · · · · ·		. 2.56 . 468 . 1685 . 16
OBSERVATIONS— Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day	-FIRS	ST D	OAY 		. 2.56 . 468 . 1685 . 16 5' 11"
Swings per minute					. 2.56 . 468 . 1685 . 16 5' 11" . 95'
Swings per minute	of oot w	ith di			
Swings per minute	of oot w	ith di			
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute	foot wo	ith di		 .01. . 9	minute minutes
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic f Time shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time t Coal used Area of section Height of face Number of times blasted bank Average time to move forward once	foot wotting train for acc	one ons	pper car de		# minutes # minutes # 608 # minutes # 608 # minutes # 1000000000000000000000000000000000000
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic f Time shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time t Coal used Area of section Height of face Number of times blasted bank Average time to move forward once	foot wotting train for acc	one ons	pper car de		# minutes # minutes # 608 # minutes # 608 # minutes # 1000000000000000000000000000000000000
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic f Time shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time t Coal used Area of section Height of face Number of times blasted bank Average time to move forward once	foot wotting train for acc	one ons	pper car de		# minutes # minutes # 608 # minutes # 608 # minutes # 1000000000000000000000000000000000000
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic films shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time Coal used Area of section Height of face Number of times blasted bank Average time to move forward once Average time to move forward one Average time to load one car Pounds of coal per cubic vard exca	foot wotting ge train for according to the control of the control	ith di one ons cident			minutes 608 3.16 tons uare feet average) I minutes
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic films shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time Coal used Area of section Height of face Number of times blasted bank Average time to move forward once Average time to move forward one Average time to load one car Pounds of coal per cubic vard exca	foot wotting ge train for according to the control of the control	ith di one ons cident			minutes 608 3.16 tons uare feet average) I minutes
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic films shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time Coal used Area of section Height of face Number of times blasted bank Average time to move forward once Average time to move forward one Average time to load one car Pounds of coal per cubic vard exca	foot wotting ge train for according to the control of the control	ith di one ons cident			minutes 608 3.16 tons uare feet average) I minutes
Swings per minute Number of cars loaded Cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved during day Time in minutes to load one cubic f Time shovel is interrupted while sp Time shovel is interrupted to chang Minutes per working day less time t Coal used Area of section Height of face Number of times blasted bank Average time to move forward once	foot wotting ge train for a constant of the co	ith di one one one one one one one one one one one	pper car		4 minutes minutes . 608 3.16 tons uare feet average) I minutes minutes minutes minutes 75 75 seconds

TIME STUDY

	Forenoon	Afternoon
Started work	6:29:00	12:25:00
Stopped work	11:53:30	ς: ςδ:00

Min. Sec. Min. Min. Sec.

Total time worked 324 30 + 331 = 655 30 = 10 hours 55 minutes 30 seconds.

	Minutes	Seconds	Per Cent
Actual working	434	54	66.3
Spotting cars	6	54 36	1.0
Waiting for cars	9	oo	1.4
Moving shovel	117	30	17.9
Idle	(31)	(30)	(4.8)
Repairing chain	25	30	3.8
Jacking	3		0.5
Oiling up	3		0.5
Miscellaneous delays	(56)		(8.6)
Clearing way	43		6.6
Placing car on track	13	••	2.0
Total time under observation .	655	30	100.0

Cost of Direct Labor (Loading) per Day										Standard Basi			
Runner .											_		\$5.00
Craneman													3.60
Fireman .													2.40
8 pitmen													12.00
													\$23.00

Number of cubic yards loaded during first day of observation, 1685. Based on above performance the cubic yards loaded per day of

10 hours =
$$1685 \times \frac{600}{655.5} = 1542$$
.

 $\frac{\text{Cost of direct labor per day}}{\text{Number of cubic yards per day}} = \frac{\$23.00}{1542} = \frac{1.49 \text{ cents per cubic yard.}}{\text{vard.}}$

D 1 1 1			Ti	me	Per	Cost per Yard	Total
Process Analysis			Min.	Sec.	Cent	in Cents	Cost
Charge to loading 1. Actual loading 2. Delays	,		434	54	66.3	0.988	
a Moving up . b Repairs c Miscellaneous			117 25 6	30 30 00	17.9 3.8 1.0	0.266	1.326
Charge to transporting dumping 1. Waiting for cars 2. Miscellaneous		nd	15 56	36	2.4 8.5	0.036 }	0.164
			655	30	100.0		1.49

Analysis of complete dipper swing

	Mini- mum	Aver- age	Maxi- mum	No. of Obs.
Digging	7 4.5 2	17.3 8.7 4.6 3.5	39 16 6 22	31 31 31 31
Time to fill and load one dipperful	15.5	34.1	83	31

		attempts to											
Number	of	complete d	ipperfuls .	•	٠	•	٠	٠	٠	٠	٠	•	31

Dipper efficiency, 47.7%.

Time for complete swing

	Minimum	Average	Maximum	Number of Obser- vations
Seconds	17	23.4	34	31

Number of swings per minute

Minimum	Average	Maximum	Number of Observations
1.8	2.56	3.5	31

COST OF MOVING BACK. STANDARD BASIS

	_						
Runner .						. for 1.25 days . (a) \$5.00	\$ 6.25
Craneman						for 1.25 days . (a) 3.60	4.50
Fireman .		٠.				. for 1.25 days . (a) 2.40	3.00
14 laborers						. for 13½ hours @ 0.15	28.35
						. for 13½ hours @ 0.15	4.05
						. for 1.23 days . (a) 1.50	3.69
						. for 1.25 days . @ 2.00	10.00
						. 2 tons (a) 3.50	7.00
							1,00
Shifting track	: :						
						. for 13½ hours @ 0.15	10,12
						. for 11 hours . (a 0.15	14.85
						. for 1.25 days . @ 2.00	2.50
Total cost to	n	ov	e ł	ac	k		\$95.31

1063 feet Total distance moved Total time required 1,25 days Total number of employed . 9.0 cents

* Includes shifting track; one horse taken as equivalent of four men.

o. 196 cent

OBSERVATIONS-SECOND DAY

Swings per minute														885
Number of cars loaded														266
Cubic yards excavated														
Number of times moved	fo	rw:	ard											I 2
Average distance moved	ea	ch	tin	1e									6	5' 3"
Total distance moved for	rwa	ard	du	rin	gć	lay							73	;′ 6″
Time in minutes to load	on	e c	ubi	c f	oot	ŧŵ	ith	di	ρρε	er				.013
Time shovel is interrupted	d w	hil	le si	pot	tin	go	ne	cai	٠.		.0	19	mi	nute
Minutes per working day	, le	ss t	im	e f	or :	acc	ide	enta	al c	lela	ays		6	171/4
Shovel expenses in cents														
and overhead or pre														

OBSERVATIONS—SECOND DAY—Continued

Coal used
Area of section
Height of face
Number of times blasted bank
Average time to move forward once 9.083 minutes
Average time to move forward one foot 1.311 minutes
Average time to load one car
Pounds of coal used per cubic yard excavated 5.05
Total cost to excavate, transport and spread one cubic yard, 12.26
cents.
Number of cars for one shovel move
Maximum distance moved forward in one move 6' 6"
Average time for one swing 23.3 seconds
Average time between beginning of one shovel move and begin-
ning of next 55.1 seconds

TIME STUDY

	Forenoon	Afternoon
Started work	6:30	12:35
Stopped work	12:06	6:05

Total time worked 336 minutes + 330 minutes = 666 minutes = 11 hours 6 minutes.

	Minutes	Seconds	Per Cent
Actual working	311	15	46.7
Spotting cars	5	00	0.8
Waiting for cars	148	00	22.2
Moving shovel	109	00	164
Idle	(68	15)	(10.2)
Blasting	19	30	2.9
Repairing chain	10	00	1.5
Trouble with water pipe	38	45	5.8
Miscellaneous delays			
Clearing track	24	30	3 7
Total time under observation .	666	00	100.0

Number of cubic yards loaded on second day of observation, 958. Based on the above performance, the number of cubic yards loaded

per day of 10 hours =
$$958 \times \frac{600}{666} = 865$$
.

 $\frac{\text{Cost of direct labor per day}}{\text{Number of cubic yards per day}} = \frac{\$23.00}{568} = \frac{2.66 \text{ cents per cubic}}{\text{yard.}}$

Process Analysis		Ti	me	Per	Cost per Yard in	Total Cost
Process Analysis		Min.	Sec.	Cent	Cents	
Charge to loosening or brea	k-	19	30	2.9	0.077	0.077
Charge to loading		19	30	2.9	0.0//	0.077
Actual loading Delays		311	15	46.7	1.243	
a Moving up		109	00	16.4	0.436	1.873
b Repairs		10	00	1.5	0.040	
c Miscellaneous		38	45	5.8	0.154	
Charge to transporting an dumping	nd					
1. Waiting for cars		153	00	23.0	0.612)	
2. Miscellaneous		24	30	3.7	0.098 \$	0.710
		666	00	100.0		2.660

Analysis of complete dipper swing

	Mini- mum	Aver- age	Maxi- mum	No. of Obs.
Digging Swinging loaded Swinging empty Seconds	4 4 3 3	10.4 6.9 4.8 6.4	25½ 16 9 7	26 23 14 12
Time to fill and load one dipperful	14	28.5	57 1/2	

Number of attempts to fill dipper					33
Number of complete dipperfuls .					26
Dipper efficiency $= 78.8$ per cent.					

Time for a complete swing

	Minimum	Average	Maximum	Number of Obser- vations
Seconds	121/2	23.3	34	16

Number of swings per minute

Maximum	Average	Minimum	Number of Observations
4.8	2.57	1.77	16

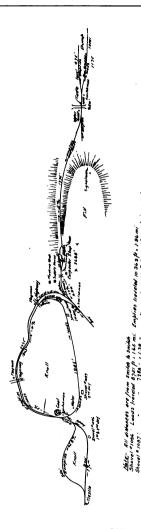
It is our understanding that the number of cars loaded daily for the months of 1909, as designated, is as follows:

	February	March	April	May	June	July
ı	112	260	216	206	200	320
2	262	216	168	Sunday	200	424
3	262	216	40	200	216	477
4	176	104	Sunday	200	80	Sunday
Ś	168	144	184	206	200	459
5	216	184	144	210	Sunday	387
	Sunday	Sunday	170	200	234	180
7 8	208	168	165	216	152	414
9	176	216	150	Sunday	216	450
10	56	208	192	224	50	432
11	147	102	Sunday	168	J 30	Sunday
12	206	152	132	176		Junuay
13	184	168	132	200	Sunday	459
14	Sunday	Sunday		16	Sunday	459
15	144	128	56	160		
16	102	208	100	Sunday	1	351
17	102	184	180	Sunday		396
18	240	216	Sunday	256		Sunday
	Moved	200	202	250		
19	Back			202	l ei	405
20	Sunday	232	96		Sunday	474
21		Sunday	252	208	٠,٠	410
22	105	168	326	160	160	371
23	136	156	140	Sunday	280	282
24	120		180	240	264	318
25	232	192	Sunday	216	248	Sunday
26	232	224	160	160	256	363
27	232	156	105	272	Sunday	
28	Sunday	Sunday	235	160	200	1
29	1	175	200	240	376	
30	1 1	184	140	Sunday	312	
31	••	165		208	• •	
Totals	3844	4816	4029	5044	3644	
Average	175	185	168	202	214	381
Ü	,,,	33				[Not Con

HYDE-MCFARLIN-BURKE COMPANY DAILY TIME REPORT

	NO. HRS. RATE	AMOUNT	TOTAL		NO.	IRS. RATE	AMOUNT	TOTAL
GENERAL WORK				BRT.FORWARD				
				HAND EXCAV.		+		
Timekeeper				Foreman	1			
			*********	16				
S.S.EXPENSE				Waterboy				
				Laborers				
				Foreman				
				44				
TRAINMEN				Waterboy				
Locomotive Eng	r			Laborers				
				CLEANING				
Switchman				Foreman				
Oiler								
				. Waterboy				
Laborers				_Laborers				
TRACK Foreman				WATER SUPPLY				
				Pumpman Pipeman				
				TEAMS				
				Teams				
TRESTLE				Teamster				
				Helper				
Carpenters								
				-				
DUMP								
				EXTRA WORK				
				DAY'S EXPENSE				
				PREVIOUS				
DRILL & BLAST				TOTAL				
				Earth Moved		1 20	ock Moved	
Drillers				Previous			revious	
Powderman								
Laborers				Total				
REPAIRS				Large Cars			ards per L	
				Previous			ards per Si	
				Total			Total	
				Small Cars			hovel Work	
				Previous		_		· // // // // // // // // // // // // //
							rrect:	
				Total				
							Sup	erintender
Laborers				Trains				

DISTRIBUTE ENTIRE LABOR FOR THE DAY UNDER HEADS NOTED HEREON



REPORT ON BURYANG SERVICE CO.

REPORT ON BURYANG SHORELS NOS 1086, 8108

HYDE METARINI BURKECS CONTRACT

CHANGE METARINI SURVEY

CHANGE METARINI SURVEY

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REPORT No. 34 — SHOVEL No. 1097

INSPECTED JULY 26 AND 28, 1909 D., L. & W. CUT-OFF

NEAR JOHNSONBURG, N. J.

SHOVEL No. 1097 is located at Section No. 5 of the D., L. & W. cut-off, near Johnsonburg, N. J. It is working with and is just like shovel No. 1096, under the report of which will be found a complete description of both. See page 286.

OBSERVATIONS—GENERAL

Weight	s
Weight	d
Capacity of dipper	s
Kind of teeth on dipper Manganese stee	1
Maximum height dipper can reach to dump	′
Length of dipper handle	"
Length of boom	′
Maximum distance dipper can reach to dump 28	1
Maximum distance dipper can reach to dump	s
Capacity of cars, loose	s
Number of cars in train	0
Height of cars above their own tracks 5'8 Length of haul	"
Length of haul	,,
Length of runaround, 1st day, 3.37 miles; 2d day, 3.35 miles	
Weight of dinkeys	s
Style of car, side dump on one side only.	
Style of car, side dump on one side only. Height of top of cars above shovel track, 14' 1st day; 15' 20	d
Height of top of cars above shovel track, 14' 1st day; 15' 26	
Height of top of cars above shovel track, 14' 1st day; 15' 26	
Height of top of cars above shovel track, 14' 1st day; 15' 26	
Height of top of cars above shovel track, 14' 1st day; 15' 26	
Height of top of cars above shovel track, 14' 1st day; 15' 26	
Height of top of cars above shovel track, 14' 1st day; 15' 20	7 s
Height of top of cars above shovel track, 14' 1st day; 15' 2d day. Gauge of dinkey tracks	7 s t.
Height of top of cars above shovel track, 14' 1st day; 15' 20' day. Gauge of dinkey tracks Number of trains Average time for round trip Maximum grades for loads Complete trains for grades? Yes. Time traveling to dump	7 5 1.
Height of top of cars above shovel track, 14' 1st day; 15' 20' day. Gauge of dinkey tracks Number of trains Average time for round trip Maximum grades for loads Complete trains for grades? Yes. Time traveling to dump	7 5 1.
Height of top of cars above shovel track, 14' 1st day; 15' 20 day. Gauge of dinkey tracks	7 5 1. s
Height of top of cars above shovel track, 14' 1st day; 15' 20' day. Gauge of dinkey tracks Number of trains Average time for round trip Maximum grades for loads Complete trains for grades? Yes. Time traveling to dump	7 5 5 5 8 8
Height of top of cars above shovel track, 14' 1st day; 15' 20' day. Gauge of dinkey tracks	7 5 5 5 8 8

OBSERVATIONS-FIRST DAY

Number of cars loaded
Average time to load one car
Cubic yards, place measure 1065 yards
Total distance moved forward during day
Average time for one move 6.5 minutes
Average time to move one foot I minute
Maximum distance moved forward at one time 7' 3"
Average distance moved forward each time $6\frac{1}{2}$
Average time beginning of one move and beginning of next,
41.6 minutes.
Number of cars to one shovel move 24.7
Time to load one cubic foot with dipper
Time shovel is interrupted while spotting one car006 minute
Time shovel is interrupted to change trains 114 minutes
Minutes per working day less time for accidental delays . 518
Area of section 210 square feet
Average height of face 4½'
Number of times blasted bank
Number of times blasted bank
Coal used

TIME STUDY-FIRST DAY

	Forenoon	Afternoon
Started work	6:24	12:25
Stopped work	11:54	3:33

Total time worked 330 + 188 minutes = 518 minutes = 8 hours 38 minutes.

	Minutes	Seconds	Per Cent
Actual working	276	48	53.4
Spotting cars	I	42	0.3
Waiting for cars	114	00	22.0
Moving shovel	79	00	15.3
Miscellaneous delays	(46	30)	(9.0)
Clearing away	43	30	8.4
Breaking bank	I	00	0.2
Placing car on track	2	00	0.4
Total time under observation .	518	00	100.0

Cost of Direct Labor (Loading) per Day										Standard Basis			
Runner .									_				\$5.00
Craneman													\$5.00 3.60
Fireman .													2.40
8 pitmen .													1 2.00
_												_	\$23.00

Cubic yards loaded on first day of observation 1065 Based on the above performance the cubic yards loaded per day

of 10 hours = $1065 \times \frac{600}{518} = 1235$ Cost of direct labor per day

Number of cubic yards per day

\$\frac{\\$\\$23.00}{1235} = \frac{1.86 \text{ cents per cubic}}{\text{yard}}\$

Process Analysis	Ti	me	Per Cent	Cost per Yard in	Total	
Process Analysis	Min.	Sec	rei Cent	Cents	O.004	
Charges to waiting for blasters	I	00	0.2	0.004		
Charge to loading 1. Actual loading 2. Delays	276	48	53.4	0.993	1.278	
a Moving up	79	00	15.3	0.285	1.270	
Charge to transporting and dumping						
1. Waiting for cars .	115	42	22.3	0.415	0.578	
2. Miscellaneous .	45	30	8.8	0.163	0.570	
	518	00	100.0		1.860	

OBSERVATIONS—SECOND DAY

Swings per minute											. 2.6
Number of cars loaded											. 270
Cubic yards excavated .			•								972
Number of times moved	for	wai	ď								. 19
Average distance moved	forv	var	d e	ach	tir	ne					6′ 2″
Total distance moved for	war	d d	luri	ng	day	,				ı	17' 3"
Time to load one cubic f	oot	wi	th (lipp	er			.00	279	ır	ninutę

OBSERVATIONS—SECOND DAY—Continued

Time shovel is interrupted while spotting one car .0315 minute
Time shovel is interrupted to change trains 171 minutes
Time moving forward
Minutes per working day less time for accidental delays . 6461/2
Coal used
Coal used
Height of face o to 9'
Number of times blasted bank
Average time to move forward once 10.447 minutes
Average time to move forward one foot 1.693 minutes
Average time to load one car
Dounds and used for cubic yard averaged
Pounds coal used for cubic yard excavated 6.55
Number of cars for one shovel move
Maximum distance moved forward in one move 6' 10"
Average time for one swing
Average time between beginning of one shovel move and next,
34.8 minutes.

TIME STUDY-SECOND DAY

	r orenoon	Atternoon
Started work	6:25	12:26
Stopped work	11:58	5:55

Total time worked 333 + 329 minutes = 662 minutes = 11 hours 2 minutes.

	Minutes	Seconds	Per Cent.
Actual working	230	30	34.8
Spotting cars	8	30	1.3
Waiting for cars	171	·	25.8
Moving shovel	198	30	30.0
Idle	(32)	l	(4.8)
Car off track	` 5		0.7
Removing rails in front of shovel	14		2.1
Repairing steam pipe	13		2.0
Miscellaneous delays	(21	30)	(3.3)
Clearing way	6		2.3
Car off and shifting dinkey track	6	30	1.ŏ
Total time under observation	662	• • • •	100.0

Cubic yards loaded on second day of observation . Based upon the above performance the cubic yards loaded per

day of 10 hours = $972 \times \frac{600}{662} = 881$.

Cost of direct labor per day = $\frac{$23.00}{881}$ = 2.61 cents per cubic yard

Process Analysis		Time	Per	Cost per Yard	Total	
Process Analysis	Mi	n. Sec.	Cent	in Cents	Total	
Charge to loading 1. Actual loading 2. Delays	. 23	0 30	34.8	0.908		
a Moving up b Repairs c Miscellaneous .	-	3 00	30.0 2.0 2.1	0.783	1.798	
Charge to transporting and dumping 1. Waiting for cars .		30	27.1	0.708)		
2. Miscellaneous		-	4.0	0.708 (0.812	
	66:	2 00	100.0		2.610	

	Mini- mum	Aver- age	Maxi- mum	No. of Obs.
Digging	5 3½ 4½ 2½	7.6 8.4 5.7 5.3	12½ 12½ 7 6	20 18 15
Time to fill one dipperful	151/2	27.0	38	

Number of attempts to fill dipper Dipper efficiency 76.9 per cent

Time for a complete swing

			Minimum	Average	Maximum	Number of Observa- tions
Seconds			19	23.2	261/2	14

Number of swings per minute

 Minimum	Average	Maximum	Number of Observations
2.26	2.59	3.16	14

Cost of Moving Bac	k			Standa	rd Basis
Runner for 1.59 days			(a)	\$5.00	\$7.95
Craneman for 1.59 days .			(a)	3.60	5.72
Fireman for 1.59 days			(a)	2.40	3.82
14 laborers for 17 1/2 hours			(a)	0.15	36.75
2 drivers for 17 ½ hours .			(a)	0.15	5.25
2 horses for 1.59 days			(a)	1.50	4.77
4 pipe fitters for 1.59 days			@	2.00	12.72
Coal, 2 tons			•	3.50	7.00
Oil and waste					1.00
Shifting track					
10 laborers for 171/2 hours			@	0.15	26.25
1 foreman for 1.59 days			(a)	2.00	.3.18
Tearing down trestle					
6 laborers for 5½ hours			(a)	0.15	4.95
2 horses for ½ day			<u>@</u>	1.50	1.50
Coal, 2 tons			(a)	3.50	7.00
Oil and waste					1.00
Total cost to move back .					\$128.86

Total distance moved					. 820'
Total time actually moving					. I day
Total time idle					. 1.59
Number of men employed					. 6o*
Cost per foot moved					15.71 cents
Cost per foot per man					.262 cent

^{*} Includes pulling down trestle, shifting track, and one horse equal to four men.

It is our understanding that the following represents the number of cars loaded daily, for the months shown, 1909:

	February	March	April	May	June	July
ı	152	192	102	240	344	122
2	272	176	184	Sunday	224	190
3	136	168	208	264	304	198
4	192	40	Sunday		224	Sunday
Ś	224	160	200	216	240	99
5 6	160	160	168	248	Sunday	144
	Sunday	Sunday	152	240	232	144
7 8	200	168	160	248	296	180
9	136	160	200	Sunday	224	198
ΙÓ	28	248	200	288	208	225
11	200	280	Sunday	304	176	Sunday
12	216	256	192	288	248	
13	184	216	200	200	Sunday	
14	Sunday	Sunday	200	212	208	١
15	224	144		336	272	109
16	88	88	192	Sunday	328	189
17	184	248	240	320	136	189
18	168	216	Sunday	272	184	Sunday
19	144	216	184	232	168	224
20	184	200	72	272	Sunday	153
21	Sunday	Sunday	216	176	184	122
22	248	240	232	248	168	248
23	152	264	240	Sunday	176	270
24	176	256	232	176	184	262
25	200	248	Sunday	160	192	Sunday
26	272		248	316	200	
27	248	240	288	73	Sunday	
28	Sunday	Sunday	288	216	152	
29		264	200	320	170	••
30		216	208	Sunday	180	
31		184		376		• •
Totals	4388	5248	5096	6241	5622	
Average	183	202	204	250	216	

Causes of Delays	Taking water	Switching	Waiting for No. 2 to	pass. Two empties ahead	Took on coal				Switching	Dumping	Waiting for train to	pass. Taking water		Repairs	
PerCent of Delays to Total Time	:	:	:	:	÷	8.18	:	:	:	:	:	:	:	:	38.2
Time Trip	P. M. 2:26	2:54	÷	:	:	88	:	4:23	5:16	:	:	:	:	:	53
Rate Delays eet Per Minutes Minute	2	%	31/2	81%	:	141%	:	:	1	9	3%	81	:	8	%oz
Time Distance Feet pelays	250.0	887.5	768.6	488.8	333-3	Av.545.5	184.8	467.4	457.1	1175.0	333-3	887.5	896.0	535.0	Av.617.0
Distance	250	1775	2688	2200	500	:	1525	2688	3200	1175	250	1775	2688	2675	:
Time	-	8	31/2	41%	7,1	121/2	81%	53%	7	-	%	8	3	5	32¾
To	Water tank	Station 710	Arch	500 feet from coal pile	Coal pile		Arch	Station 710	Dump	Switch at dump	Water tower	Station 710	Arch	Coal pile	
From	Switch at dump	Water tower	Station 710	Arch.	500 feet from coal pile		Shovel 1097	Arch	Station 710	Dump	Switch at dump	Water tower	Station 710	Arch	
Dinkey	3	8	ю	'n	3		ю	ю	ю	ĸ	ю	8	8	8	

Causes of Delays			Dumping	Taking water	Waiting for train to	pass			Two trains ahead					Dumping	Taking water				
PerCent of Delays to Total Time	:	:	:	:	:	:	:	:	:	79.2	:	:	:	:	:	:	:	:	78.4
Time for Trip	M :	2:32	4:521/2	:	:	:	:	:	:	1401/2	:	3:29	5:371/2	:	:	:	:	:	1281/2
Delays Minutes	:	.:	4,4	5%	3	:	:	:	3/86	7,111	:	:	:		23%	:	:	931%	1003/4
Distance Feet per Minute	217.9	632.4	3200.0	285.0	2000	750.0	899.3	486.3	0.000	Av.807.9	217.9	672.0	457.I	2850.0	1420.0	2000	668.7	0.000	Av.956.2 1003/4
Distance Feet	1525	2688	3200	1425	100	1875	2688	2675	300		1525	2688	3200	1425	1775	2688	2675	300	:
Time	7	4,74	H	2	×	27%	ю	5,7%	×	291/4	7	4	7	74	1,4	31/2	4	74	2734
To	Arch	Station 710	Dump	Water tower	Side track	Station 710	Arch	Coal pile	Shovel		Arch	Station 710	Dump	Water tower	Station 710	Arch	Coal pile	Shovel	
From	Shovel 1097	Arch	Station 710	Dump	Water tower	Side track	Station 710	Arch	Coal pile		Shovel 1097	Arch	Station 710	Dump	Water tower	Station 710	Arch	Coal pile	
Dinkey Number	ı	-	н	1	1	н	H	-			7	7	7	7	7	7	7	7	

Ξ	From	01	Time	Feet	r eet per Minute	Shovel	Shovel Minutes	ot Delays	Causes of Delays
٦	900	1001	2412	17914	240.5	1007	74.1%	:	
ĭ	1006	coál	45	17202	382.3	1006	7837	333%	Held at switch, four trains
ĭ	9601	1001	:	17914	325.7	1001	£	:	ahead
ä	1007	1096	63	18996	301.5	1006	63	:	
ĭ	260	1097	491/2	96241	359.5	1001	4972	:	
ĭ	960	coal	64	17202	351.0	1097	54	2	One train ahead
ĭ	960	coal	57.1/2	17202	299.3	1001	631%	9	Train ahead
ĭ	260	1001	51%	96221	345.5	1001	51%	:	
ĭ	- 560	9601	62	19144	308.0	9601	62	:	
×	1001	1001	Şī	96221	349.7	1001	Şı	:	
ĭ	960		2 00	19144	316.4	1096	80%	:	
ĭ	960	coal	40	17202	430.5	9601	54	14	Shovel moving held switch
ĭ	262	2601	82	96221	217.0	1097	82	:	
ĭ	26	1001	45	96221	395.4	1001	45	:	
ĭ	960	1001	451/2	17914	393.7	1097	451%	:	
ĭ	260	1095	4872	96681 .	391.6	9601	481%	:	
ĭ	96	9601	95	19144	201.5	9601	95	:	Cars off track at dump
ĭ	262	1001	46	96221	189.2	2601	46	:	Cars off track at dump
<u>-</u>	960	9601	431/2	19144	440.I	9601	431/2	:	
ä	260	1001	267%	96221	299.1	1001	59%	:	
ĭ	960	1001	57.72	17914	311.5	1097	57.72	:	
ĭ	262	1007	70	96241	254.3	1001	20	:	



Fig. 71. View of D., L. & W. R. R. Cut at Johnsonburg, N. J.

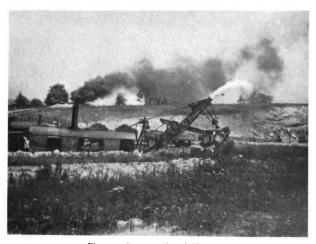


Fig. 72. Bucyrus Shovel No. 1007

REPORT No. 35 — SHOVEL No. 795

INSPECTED AUGUST 10, 1909

NEAR COLUMBIA, N. J.

LOCATION Shovels No. 795 and No. 875 (page 357) were working on section No. 7 of the D., L. & W. cut-off, near Columbia, N. J.

MATERIAL The material is a hard crystalline limestone, and on the day of inspection the shovel worked in this until 3:45 p. m., thereafter in earth. The limestone was well broken but mixed with some very large pieces. There are 291,166 cubic yards of earth and rock in this cut, according to the engineer's preliminary figures of which two-thirds or three-quarters are rock. The shovel had been working about six or eight weeks in this location.

It was noticed that the thrusting engine did not hold the dipper against the face of the rock properly, which was due to the fact that the boom engine of a 65-ton shovel with 7 x 7-inch cylinders was not adequate for rock excavation of this character. The 70-ton shovel, however, such as No. 875 with 8 x 8-inch cylinders on the boom engines, gave perfectly satisfactory results. The boom and dipper handle are made entirely of steel, the former being of the truss type.

TRANSPORTATION The cars were built by the Western Wheel Scraper Company. Some of them dump on both sides and some on one side only. They measure 110 x 83 x 19 inches and are 5 feet 6 inches above their tracks. When loaded with stone they average about 2½ yards. Three 18-ton Vulcan dinkeys are used at each shovel, with an extra,

one which during inspection held trains back in descending a steep grade ending in a sharp curve. In order to dump from the trestle it was necessary for the dinkey to run around the train, as they always pulled, instead of pushing, the cars when running loaded. This took from Then, after dumping, it was two to three minutes. necessary for the dinkey to switch back again, but as this was a flying switch very little time was lost. Under the observed conditions it was necessary for the dinkey to uncouple while the car next to it was loaded. The reason for such an arrangement appears to be in the fact that the cars ride better when being hauled than when pushed, and in this connection it should be remarked that the number of derailed cars was very The dinkeys maintained a steady pace that was not as fast as on some other jobs, but which made better time in the end because the chances for a car to jump were diminished.

OBSERVATIONS

Height of lift										. 7	
Kind of teeth						N	lan	ga	nes	e stee	ŀ
Height blocked up											
Length of boom .											
Height of face .										. 15	,
Length of dipper h											
Inside shovel track											
Reach of boom .											
Height of point of											
Dinkey tracks 16" l											
Diameter of bull w	_									7 1/2	,
Highest dipper can											
Farthest dipper can											
Dipper, 48" deep; h											

OBSERVATIONS—Continued

Weather, clear.
NT 1 C
Number of cars in one train
Height of cars above their track $5\frac{1}{2}$
Length of haul (approximate)
Length of runaround (approximate) 19,200'
Weight of dinkeys
Gauge of dinkey track Narrow
Number of trains
Grades One of about 4 per cent for 300'
Full trains on grades, with extra dinkey to help.
Number of cars loaded 206; 133 rock, 73 earth
Cubic yards excavated: 133 of rock at 2 yards = 266, and 73 of
earth at 3.2 yards = 233; total, 499 cubic yards.
Total distance moved forward during day, 44.7'; 27.7' of rock,
17' of earth.
Number of times moved forward 8; 5 rock, 3 earth
Maximum distance moved forward in one move, 5' 11"; 5' 11"
rock, 5' 10" earth.
Average time between beginning of one shovel move and begin-
ning of next, 75.7 minutes.
Number of cars to one shovel move, 25.7; 73.7 rock, 49 earth;
26.6 rock, 24.3 earth.
Average time shovel is interrupted while spotting one car, .004
minute.
Minutes per working day, less time for accidental delays 589
Area of section . 325 square feet = when material was blasted
Height of face 14.5'; 14 rock, 15 earth
Coal used

TIME STUDY

	Forenoon	Aftern	ioon
Started work Stopped work	Rock \ 7:00	$Rock \begin{cases} 1:03\\ 3:28 \end{cases}$	Earth $\begin{cases} 3:28 \\ 6:04 \end{cases}$

Total time worked:

	Min.	Min.	Min.	Hrs.	Min.			
Rock – Earth –	- 301 + - 156	145 =	= 446	= 7 = 2	26 36	}	10 hours 2 minutes	5.

			Total Min.	Rock Min.	Per Cent	Earth Min.	Per Cent
			324	247.5	55.5	76.5	49.1
Spotting cars			1.0	0.5	0. I	0.5	0.3
Waiting for cars			49.5	34.5	7.7	15	9.6
Moving shovel			88.5	49.5	II.I	39	25.0
Idle			(91)	(76)	(17.1)	(15)	(9.6)
Blasting			84	72	16.2	12	7.7
Tightening bolts .			3			3	1.9
Repairing dipper ·			4	4	0.9		
Miscellaneous delays			(48)	(38)	(8.5)	(10)	(6.4)
Clearing track .			28.5	18	4.1	10	6.4
Moving boulder			6.5	6.5	1.5		
Putting car on trac	k .		6	6	1.3		
Tearing down bank			7	7	1.6		
Tot. time under observ	vati	ion	602	446	100.0	156	100.0

Co	ost c	f D	rect	La	bor	(Lo	adir	1g) [per	Day		Standard Basis
Runner .					-							\$5.00
Craneman												3.60
Fireman .												2.40
6 pitmen .											٠.	9.00
Coalman .		•						•		•		1.50
					•							 \$21.50

Number of cubic yards of rock loaded during observation, 266. Based upon the above performance the number of cubic yards loaded per day of ten hours, $602 \times 266 = 358$.

446

Cost of direct labor per day per cubic yard $\frac{$21.59}{358}$ = 6.00 cents per cubic yard.

Process Analysis—Rock	Ti	me	Per	Cost per Yard in	Total
1 focess Analysis—Rock	Min.	Sec.	Cent	Cents	Cost
Charge to loosening or breaking	85	30	19.3	1.158	1.158
Charge to loading 1. Actual loading 2. Delays	247	30	55.5	3.330	
a Moving up b Repairs	49 4	30	0.9	0.666	4.050
Charge to transporting and dumping				317	
1. Waiting for cars	35	00	7.8	0.468 (0.792
2. Miscellaneous	24	30	5.4	0.324 5	0.792
	446	00	100.0		6,000

Number of cubic yards of earth loaded during observation, 233. Based upon above performance the cubic yards loaded per day = 600 x 233 = 896.

 $\frac{\text{Cost of direct labor per day}}{\text{Number of cubic yards per day}} = \frac{\$21.50}{896} = \frac{2.40 \text{ cents per cubic yard.}}{\text{cubic yard.}}$

D. A. J. C. F. al.	Ti	me	Per .	Cost per Vard in	Total
Process Analysis-Earth	Min.	Sec.	Cent	Cents	Cost
Charge to loosening or breaking	12		7.7	0.185	0.185
Charge to loading 1. Actual loading 2. Delays	76	30	49.1	1.178	
a Moving up b Repairs	39	00	25.0 I.9	0.600	1.824
Charge to transporting and dumping	J		1.9	0.040)	
1. Waiting for cars 2. Miscellaneous	15	30	9.9 6.4	0.238 }	0.391
	156	00	100.0		2.400

Analysis of Complete Swing	Mini- mum	Aver- age	Maxi- mum	No. of Obs.	No. of Attempts	
Digging	Time in seconds	5 4 3 4	7.4 5.3 7.8	18 17 9 15	23 23 23 23	41
perful		16	32.1	59	23	

Time for a complete swing

	Minimum	Average	Maximum	No. of Obser- vations
Seconds	17	24	42	23



Fig. 73. Dump near Columbia, N. J.

TRANSPORTATION

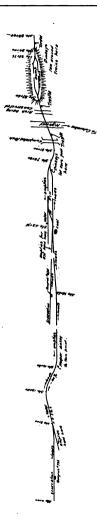
Causes of Delay	Switching Dumping Taking water Waiting for train to-load	K ₆₉ =	To take off brakes at bottom of grade	= 63½ minutes
Delay	2 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	541%	1	34%
Rate Feet per Minute	450 796 1034 1550 1014 904 1150	840	635 723 435 620 258 1034 760 1032 	648
Distance Feet	1150 4375 775 775 775 160 3615 1150	12,600	4125 3615 760 775 775 775 775 775 775 775 775 775 77	18,625
Time Minutes	~~~~~ : × 4	15	:	2834
То	Water tower No. 2 Switch No. 2 Dump Switch No. 2 Switch No. 1 Water tank No. 2 Shovel		Water tower No. 2 Switch No. 1 Switch No. 2 Dump Rear of train Switch No. 2 Switch No. 2 Switch No. 2 Switch No. 3 Switch No. 7 Switch No. 7 Switch No. 7 Switch No. 7 Shovel No. 795	
From	Shovel No. 875 Water tower No. 2 Switch No. 2 Dump Switch No. 2 Switch No. 2 Switch No. 1 Water tank No. 2	Total time for round trip	Shovel No . 795 Water tower No . 2 Switch No . 2 Switch No . 2 Front of train Dump Switch No . 2 Switch No . 2 At switch At switch Water tower No . 2 At switch Side track	Total time for round trip
	Dinkey No. 5	Total tim	Dinkey No. 7	Total tim

TRANSPORTATION—Continued

Causes of Delay	Helper left Switching Dumping Taking water Waiting for train to pass proper train to pass pass here cars here	= 41.0	Switching Dumping for train to Waiting for train to load Taking water Waiting Taking coal Waiting Blasting	= 56 minutes
Delay		711		39%
Rate Feet per Minute	467 467 778 778 778 778 520 520 571		512 761 1013 775 896 896	:
Distance Feet	700 700 2725 4375 775 775 775 3615 3425	:	3615 3615 775 775 5150	:
Time	********	29%	7, 7, 7, 7, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	16%
To	Water tower No. 1 Bottom of grade Water tower No. 2 Switch No. 2 Dump Switch No. 1 Water tower No. 2 Side track Shovel		Water tower No. 2 Switch No. 2 Switch No. 2 Dump Water tower No. 2 Part way to shovel To shovel	
From	Shovel No. 795 Water tower No. 1 Bottom of grade Water tower No. 2 Switch No. 2 Dump Switch No. 1 Water tower No. 2 Side track	Total time for round trip	Shovel No. 875 Water tower No. 2 Switch No. 2 Switch No. 2 Dump Water tower No. 2	Total time for round trip
	Dinkey No. 9	Total time	Dinkey No. 5	Total time

TRANSPORTATION—Continued

Causes of Delay	Trying to start 15 minute taking off brakes, pusher left			Dumping	Hooking up cars		Held at switch	asis	\$20.00	14.40	09.60	8 8	111.75	12.00	0.00	4.50	\$102.25
Delay	, %	::	o :	2,72	*.	: :		Standard Basis	\$ 0.50	0.36	0.24	50.00	0.15	0.30	0.30		
Rate Feet per Minute	467	778 804	. 506	620 515	9911	979	:				s, s	(e)		<u>(g)</u>	3)		
Distance Feet	7007	2725 3615	. %	775 775	4375	3425	3 :	ng to W	40 hours	40 hours	40 hours	40 hours	745 hours	40 hours	20 hours		
Time Minutes	1,7	3.7% 4.7%	: :%;	7.7.	33.	%%	12	rom Sidi						•			
To	Water tower No. 1 Bottom of grade	Water tower No. 2 Switch No. 1	Switch No. 2	Dump Switch No. 2	Water tower No. 2	Water tower No. 1	Shovel	Cost to Move Shovel (65-ton) From Siding to Work.									
From	Shovel No 795 Water tower No. 1	Bottom of grade Water tower No. 2 Waiting for train ahead	to dump Switch No. 1	Switch No. 2 Dump	Switch No. 2	Water tower No. 2	Side track	Cost to Mov							al	oil	
	===		N ye		 [Runner .	Craneman	Fireman	w atcillian Fireman	Laborers	l'eam-ties	ream—coal	Coal and oil	



CONSTRUCTION SEFFICE CO REPORT ON BUCKTORIS SHOULES NOS 7958-075 James A. Mort, Contractor Colombia A.U.

La J. W. CUT OFF

July 3610, 139



Fig. 74.



Fig. 75. Views of D., L. & W. R. R. Cut-off near Columbia, N. J.

REPORT No. 38 — SHOVEL No. 1137

INSPECTED JULY 1-3 AND 21, 22, 1909

D., L. & W. CUT-OFF

HOPATCONG, N. J.

This shovel was working in section No. 1 of the D., L. & W. cut-off, together with shovel No. 1108, in the report on which will be found a complete description of both. See page 255.

OBSERVATIONS

337 . .1 . .1....

w eatner	, си	ear.															
Weight																	70-ton
Gauge																N	arrow
Capacity	of	dipp	er											2 1/2	cu	bic	yards
Kind of	teet	h]	Man	gar	ese	steel
Maximui	n h	eigh	t d	ipp	er	can	re	ach	to	du	mp					16	√₂ feet
Length o	of d	ippe	r h	and	dle						. •					. ′	18' 6"
Length o																	28.3'
Height o				ove	tr	ack	s										25.6′
Height o																	20.1
Maximuı								rea	ch	to	dun	np					26.51
Swings p					•		_					•					2.5
Number					ď												190
Cubic ya	rds	exca	ava	ted	l	Ċ							i				646
Numbér						for	wa	rd									·6
Average									e					Ċ			5' 10"
Total dis										da	v		Ī	·		Ĭ.	35′
Time in												ı di	ibi	er.	.01	6 г	
Time she																	
Time she																	
Time mo																	inutes
Minutes																	579
Coal use				٠ ٥٠	,							••••			-,-		3 tons
Area of	-		•	:	:	•	:	:	:	•	•	•	•	407	so		re feet
illua oi .	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		•	•	•	•	•	•	•	•	•	•		47/	30	, ~a.,	. C LCCC

OBSERVATIONS—Continued

Height of face	
Number of times blasted bank	
Average time to move forward once 13.83	minutes
Average time to move forward one foot 2.571	minutes
Average time to load one car 1.446	minutes
Pounds of coal per cubic yard excavated	. 5.35
Number of cars for one shovel move	. 31.7
Maximum distance moved forward in one move	. 6' 5"
Average time for one swing	seconds
Average time between beginning of one shovel move	and be-
ginning of next	. 101.3

TRANSPORTATION

Canacity of cars water measure	rde
Capacity of cars, water measure 4.17 cubic yas Capacity of cars, place measure, 3.3 cubic yards first day; 3.4 cu	hic
yards second day.	
Number of cars in train	7
Height of cars above their track	6′
Length of runaround 720	∞′
Weight of dinkeys	ton
Style of car Side dump on one side or	nly
Height of top of cars above shovel track	1/2"
Gauge of dinkey track Narr	OW.
Number of trains	2
Time for round trip Average, 29.8; maximum, 69	1/2 :
minimum, 16 minutes; 22 observations	
Maximum grade About 3 per cent against empt	ies
Full trains in grades.	
Rate of transportation (feet per minute): Average, 242; ma	xi-
mum. 450; minimum, 104; observations 22.	
Distance from inside shovel track to inside track 21	.6'

TIME STUDY—FIRST DAY

	Forenoon	Afternoon
Started work	7:01	12:30
Stopped work	12:00	5:24
Total time worked 53 minutes.	299 minutes + 2	94 minutes = 9 hours

						Minutes	Seconds	Per Cent
Actual working					_	274	45	46.3
Spotting cars .						6	45	1.2
Waiting for cars						133	30	22.5
Moving shovel						133 83	. 00	14.0
Idle						_		
Repairing stea	mp	ipe	, d	lipp	er			ļ
and chain .				•		25	30	4.3
Blasting						31	30	5.3
Boulder in buc	ket					7	30	1.3
Miscellaneous de	lay	s				1		
Moving boulde	rs					9	00	1.5
Clearing way						· 2Î	30	3.6
Total time under	ob	ser	vat	ion	١.	593	00	100.0

Direct Labor		Standard Basis								
Distribution Per Day	Break- ing	Load- ing	Trans- porting	Dump- ing	Inci- dentals	Total				
Runner Craneman Fireman		\$5.00 3.60 2.40				• • •				
6 pitmen		9.00								
2 locomotive engineers 2 brakemen			5.20 3.00							
½ section foreman 15 laborers	22.50				2.00	· · ·				
5 drillers 5 drillers' helpers 4 dumpers	8.75			6.00						
1 powderman. 1 powderman's	2.00					• • •				
helper	1.50 2.00		:::							
ı blacksmith			• • •		3.∞					

Direct Labor			Standa	rd Basis		
Distribution Per Day (Continued)	Break- ing	Load- ing	Trans- porting	Dump- ing	Inci- dentals	Total
ı blacksmith's		•				
helper					1.50	
ı boiler fireman	1.50					
ı well driller .	2.50					
Half watchman					0.75	
ı assistant	1			l		
watchman .					1.50	
ı pumptender .					1.50	
7 trackmen			10.50			
2 waterboys .					2 00	
Superintendent.					6.00	
			l			
Total cost of direct		1		l	1	
labor per day .	\$53.25	\$21.50	\$18.70	\$6.00	\$18.25	\$117.70
Cost per day per		1		1		
cubic yards (cts)	8.24		2.89	0.93	2.83	18.22
Per cent	45.2	18.3	15.9	5.1	15.5	100.00

	Ti	me	Per	Cost per - Yard in	Total
Process Analysis	Min.	Sec.	Cent	Cents	Cost
Charge to waiting for blasters	40	30	6.8	0.227	0.227
Charge to loading 1. Actual loading 2. Delays	274	45	46.3	1.541	
a Moving up	83		14.0	0.466}	2.193
b Repairs	25	30	4.3	0.143	
c Miscellaneous	7	30	1.3	0.043	1
Charge to transporting and dumping					-
I. Waiting for cars	140	15	23.7	0.7901	0010
2. Miscellaneous	21	30	3.6	0.120	0.910
	593		100.0		3.330

CALCULATED AND OBSERVED DATA—SECOND DAY I 57 551 Number of times moved forward Average distance moved forward each time Total distance moved forward during day 34' o" Time in minutes to load one cubic foot with dipper017 Time shovel is interrupted to change trains . . . 30½ minutes Time moving forward 713/4 minutes Minutes per working day less time for accidental delays . Area of section 412 square feet Average time to move forward once 11.96 minutes Average time to move forward one foot 2.11 minutes Average time to load one car 1.893 minutes Maximum distance moved forward in one move . . . 6' o"

TIME STUDY—SECOND DAY

	Forenoon	Afternoon
Started work	7:00	12:30
Stopped work	12:00	5:30
	Min. Min.	• •
Total time worked	300 + 300 = 10 hour	s.

		_				
				Minutes	Seconds	Per Cent
Actual working				307	15	51.2
Waiting for cars			.	30	30	5.1
Moving shovel				71	45	12.0
Idle					_	
Repairs				I	00	0.2
Blasting				29	00	4.8
Replacing dipper .			.	147	00	24.5
Miscellaneous delays						
Chaining boulder .				8	00	1.3
Moving boulders .				5	30	0.9
Total time under observa	atio	on		600	00	100.0

COST OF DIRECT LABOR (LOADING) PER DAY STANDARD BASIS

The direct labor distribution during the second day's observation was the same as upon the first, with the exception that the seven trackmen were not employed, and that one extra well driller and two assistant watchmen were engaged, affecting the results as follows:

	Break- ing	Loading	Trans- porting	Dump- ing	Inci- dentals	Total
Total cost of direct labor per day . Cost per day, per	\$55.75	\$21.50	\$8.20	\$6.00	\$19.75	\$111.20
cubic yard, cents	10.12	3.90	1.49	1.09	3.58	20.18
Per cent	50.2	19.3	7.4	5.4	17.7	100.0

1 1 1 1	Ti	me	Per	Cost per Yard in	Total
Process Analysis	Min. Sec.		Cent	Cents	Cost
Charge to waiting for blasters	42	30	7.1	0.277	0.277
Charge to loading 1. Actual loading 2. Delays	307	15	51.2	1.996	
a Moving up b Repairs	71 148	45	12.0 24.6	0.468	3.424
Charge to transporting and dumping 1. Waiting for cars	30	30	5.1	0.199	0.199
1. Waiting for cars	30	_30	5.1	0.199	0.199
	600		100.0		3.900

Analysis of Complete Dipper Swing	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Time Swinging loaded Swinging empty Falling	5 5 3 3	7.53 6.06 7.35	53 15 14 20	34 34 32 31	57
Time to fill and load one dipperful	16	37.31	102		

Time for complete swing

		Minimum	Average	Maximum	No. of Obs.	No. of Attempts
Seconds.		15.5	24.3	40	50	50

Number of swings per minute

Minimum	Average	Maximum	No. of Obs.	No. of Attempts
 1.5	2.5	3.9	50	50

Per cent of full dipper to number of attempts to fill the dipper $\frac{34}{57}$ = 59.6 per cent.

Labor Cost Replacing Dipper Handle Time Required

							Per Day	2½ Hours
Runner						(a)	· \$5.00	\$1.25
Craneman	ı					(a)	3.60	0.90
Fireman						(a)	2.40	0.60
6 pitmen						(a)	1.50	2.25
Foreman						(a)	4.00	1.00
Rigger .						(a)	3.00	0.75
2 locomot				ers		(a)	2.60	1.30
2 brakeme	n					$\hat{\boldsymbol{a}}$	1.50	0.75
4 men on	du	mj	р			@	1.50	1.50
Total	٠,							\$10.30



Fig. 76



Fig. 77. Views on the D., L. & W. R. R. Cut-off, Hopatcong, N. J.

REPORT No. 42 — SHOVEL No. 350

INSPECTED JULY 2 AND 20, 1909

NEAR NETCONG, N. J.

LOCATION Section No. 2 (Waltz & Reece, contractors), on the D., L. & W. cut-off, is located about three miles north of the village of Netcong, on the main line of the D., L. & W. Railroad. The section is about two and one-half miles long and is about equally divided between cut and fill, one of the deepest (110 feet, maximum) side hill cuts on the line being located here.

MATERIAL This work is entirely in porphyry and is about 2000 feet long and 150 feet wide at the foot of slope at present. About 30 feet are still to be taken out before reaching grade. There are about 770,000 cubic yards of excavation in this cut, and which is expected to make a fill of 1,270,000 cubic yards, implying an expansion of about 65 per cent. The material, when properly blasted, breaks up into small chunks that make very easy digging, but if, as on one of the days of our observation, the holes are not properly spaced, or heavily enough charged, and the rock in consequence not well broken, the digging is hard and very wearing on the shovel. Unusually hard digging was experienced during our night observations on July 22 and the following day.

DRILLING and, in order to break up the rock, must be very large in diameter, it has been found more economical, and more convenient in handling the long drill steel, to use well drills rather than the largest steam drills. The contractors also claim that the rock is so hard and fissured that it would make poor drilling for

steam machines. On the first day of our observations two of these well drills were in operation and on the remaining days four.

Sketch on page 344 show the track arrangement. The one leading to the Bucyrus shovel is visible at the extreme right. This switches back along the face of the cut to the Bucyrus shovel and past that to the Marion indicated by the white streak of steam in the background. From this point the cars are switched past the second Marion, shown at the left, and upon the side hill tracks shown at the extreme left. Figure 80 shows these tracks as they extend down the hill to the fill, the left hand one being for loads and the right hand one for empties.

DESCRIPTION OF SHOVEL Bucyrus shovel No. 350 weighs 65 tons, has standard gauge railway car trucks, and an all-steel boom and dipper handle. It is about ten years old and has been used by

Kilpatrick Brothers & Collins, at Sherman Hill, N. Y. Mike Elmore, Western Maryland Railway. Waltz & Reece, D., L. & W. cut-off.

Figure 81 shows the shovel as it appeared at the D., L. & W. cut-off on July 23. It will be noticed that the dipper chain passes over two wheels side by side on the same axle at the point of the boom rather than over two wheels, one behind the other. The boom is provided with an auxiliary engine for holding the dipper to the face. The jacks fold against the A frame. Water is supplied to the tank through a hose attached to a pipe which runs to a tank on the hill and is pumped into the tank from a distant brook. Coal is brought

in by teams and shoveled aboard the dump cars, which are then hauled to the shovels and dumped as needed, a laborer carrying it in small boxes from this pile to the shovel. This shovel has seen much usage, but is now doing good work and is in some very hard digging.

TIME STUDY Three complete runs for this shovel have been obtained: One on July 2, 1909; one during the night of July 20-21, and one on July 21.

Date	Minutes Loading	Time Waiting for Cars Per Cent of Total	Time Blasting Per Cent of Total	Number Cars Loaded
July 2	24 I	17.5	0.11	177
July 20 (night)	241.4 228.2	18.8	24.9	88
July 21	228.2	9.9	26.2	123

From the above it appears that the hardest digging was on the 20th and 21st, and that the darkness on the 20th materially affected the output. This is also shown by the time taken to fill the dipper before dumping. On the 2d the ratio of attempts to fill the dipper to complete dipperfuls was 133 trials to 45 complete dipperfuls, while on the 20th (night) it was 232 to 22, and on the 21st 210 to 21 complete dipperfuls. The time for a complete swing did not vary much in the three cases, and the number of swings per minute averaged about 2½ to 3, the machine being designed for about three. This time for a complete swing is taken from the moment the dipper point touches bottom until it comes back to the same position, and includes only those cases where it works freely and without delay. This is given in detail later. The time to fill and load one dipperful, as given in these tables, includes all

delays. The observations were taken at random, and every attempt to fill the dipper was recorded and included in the time to get a dipperful before loading. This also gives another indication of the nature of the material, for on July 2 the average time to load a dipper was 26.1 seconds, while on the 20th (night) it was 34.4 seconds, and on the 21st 35.4 seconds.

We happened to come upon the shovel on the 20th and 21st, when it had struck a hard spot that was poorly blasted, while on the 2d the material was well blasted, broken into small pieces, and was not much more difficult to dig than ordinary gravel. The comparison, as shown above, is very marked and interesting. Light was supplied for the night work by large acetylene lamps with reflectors.

It will be noted that the time for spotting cars on July 2 was very large. This was due mainly to the cars being so well filled that the material fell over the sides and thus blocked the track until it was removed. On July 20 and 21 this amounted to only four minutes, as against 21 minutes on July 2.

By "clearing track" is meant the operation of *pulling* in the rock next to the dinkey tracks as it accumulates near them in the course of the digging.

OBSERVATIONS-GENERAL

Weight
Weather, clear (all three observations)
Maximum height dipper can reach to dump
Length of dipper handle
Length of boom
Height of point of boom above tracks 21'
Maximum distance dipper can reach to dump
Height of cars above their track
Length of haul (approximate)
Length of runaround

OBSERVATIONS—GENERAL -Continued	
Weight of dinkeys	3 tons 1 steel
Height of cars above shovel track	6'
Number of trains	. 5
Number of trains	r cent
Maximum grades for empties 2 per cent to $2\frac{1}{2}$ pe	r cent
Complete trains for grades.	:
Average time to dump cars	mutes
Distance from histor dinkey track to histor shover track .	10
OBSERVATIONS—FIRST DAY	
Swings per minute Number of cars loaded Number of cubic yards excavated Number of times moved forward Average distance moved each time Total distance moved forward during day Time in minutes to load one cubic foot with dipper Time shoved is interrupted while pretting one care.	2.95
Number of cars loaded	177
Number of times moved forward	030
A vergge distance moved each time	1 .3/11
Total distance moved forward during day	4 %
Time in minutes to load one cubic foot with dinner	54 0
Time shovel is interrupted while spotting one car . 0.119 n	oinute
Minutes per working day, less time for accidental delays	570 I/
Shovel expense in cents, one day, not including superinte	5/0/2
and overhead or preparatory charges 2218	nuem
and overhead or preparatory charges, 3358 Areas of section	o foot
Height of face	25/
Number of times blasted bank	~ 5
A verage time to move forward once	inutes
A verage time to move forward one foot 2.22 m	inutes
Average time to load one car	inutes
Total cost to excavate, transport and spread one cubic yard,	28 15
cents	30 17
Number of cars for one shovel move	17.7
Average time for one swing	20.3
Average time between beginning of one shovel move to	hegin.
ning of next, 56.4.	begin
ming of next, 30.4.	
TIME STUDY—FIRST DAY	
Forenoon Afternoon Started work 7:00 12:11 Stopped work 1:20	
Started work 7:00 12:11	
Stopped work 11:30 5:11½	
Min. Min. Min.	
Total time worked $270 + 300\frac{1}{2} = 570\frac{1}{2} = 9$ hours 30 m	inutes
30 seconds.	

						Minutes	Seconds	Per Cent
Actual working						241	00	42.3
Spotting cars .						21	00	3.7
Waiting for cars						100	00	17.5
Moving shovel						120	00	21.0
Idle						(65	30)	(11.5)
Laying ties number of ca Placing dinkey Repairing dippe Blasting	to rs on er o	tra	o v ack iin	e 1	1 p	20 15 23 6	30 30 00 30	3.6 2.7 4.0
Miscellaneous del Breaking down	lays	s nk		:	:	(23 18	oo) 30	(4.0)
Clearing tracks						4	30	0.8
Total time under	obs	ser	vat	ion		570	30	100.0

	Cost	of	D	irect	La	bor	(L	oadi	ng)	per	Da	ıy		Standard Basis
Runner														\$5.00
Cranem	an													\$5.00 3.60
Fireman	١.													2.40
7 pitmei	n													10.50
		_												\$21.50

Cubic yards loaded on first day of observation 630 Cost of direct labor per day per cubic yard = $\frac{$21.50}{630}$ = 3.41 cents per cubic yard.

2010/03/03	Ti	me	Per	Cost in	Total
Process Analysis	Min.	Sec.	Cent	Cents per Cubic Yard	Cost
Charge to waiting for blasters	25	00	4.4	0.150	0.150
1. Actual loading	241	00	42.3	1.443	
a Moving up	120	00	21.0	0.716}	2.418
b Repairs	23	30	3.6	0.136	
Charge to transporting and dumping		3	3	32	
1. Waiting for cars	121	00	21.2	0.723 }	0.842
2. Miscellaneous	20	00	3.5	0.119 \$	0.042
	570	30	100.0		3.410

Analysis of complete Dipper Swing	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Swinging loaded Swinging empty Falling States	4 3½ 3 1	10.0 5.95 5.10 5.07	29 14 8 10	45 46 44 41	60
Time to fill and load one dipperful	111/2	26.12	61		

Time for a complete swing

	Minimum	Average	Maximum	No. of Obs.
Seconds	11	20.3	39 · 5	71

Swings per minute

Maximum	Average	Minimum	No. of Obs.
5.45	2.95	1.52	71

OBSERVATIONS—SECOND DAY

Swings per minute								2.67
Number of cars loaded								88
Cubic yards excavated								264
Number of times moved forward .								. 3
Average distance moved each time .								3′ 8″
Total distance moved forward during da								
Time in minutes to load one cubic foot	wi	th	dip	ре	r			.0253
Time shovel is interrupted while spotting								
Minutes per working day less time for a	acc	ide	nta	ıl d	lela	ıvs	٠.	593
Shovel expenses in cents, one day, not	in	clu	din	gs	sup	érii	ite	ndent
and overhead or preparatory charg	es							3508
Coal used							2.2	tons
Area of section								
Height of face					•			27'
Number of times blasted bank								
							:	
					-19	٠75	1111	nutes
Average time to move forward once Average time to move forward one foo								

OBSERVATIONS—SECOND DAY—Continued

Average time to load one car
cents. Number of cars for one shovel move
Average time for one swing

TIME STUDY—SECOND DAY

Worked at night

	Afternoon	Forenoon				
Started work	6:25	11:57 P. M.				
Stopped work	11:27 <mark>½</mark>	5:00 A. M.				

Total time worked $302\frac{1}{2} + 303 = 605\frac{1}{2} = 10$ hours 5 minutes 30 seconds

	Minutes	Seconds	Per Cent
Actual working	241	30	39.9
Spotting cars	4	00	0.7
Waiting for cars	114	00	18.8
Moving shovel	59	30	9.8
Idle	(160	00)	(26.4)
Putting chain on block	` 3	00	0.5
Blasting	150	30	24.8
Removing boulder from teeth	6	30	1.1
Miscellaneous delays	(26	30)	(4.4)
Putting car on track	3	00	0.5
Breaking bank	12	00	2.0
Clearing track	ΙΙ	30	1.9
Total time under observation .	605	30	100.0

Cost of direct labor per day, per cubic yard= $\frac{$21.50}{264}$ = 8.14 cents per cubic yard.

Process Analysis—Second Day		me	Per	Cost per	Total
Process Analysis—Second Day	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to waiting for blasters	162	30	26.8	2.180	2.180
Charge to loading 1. Actual loading 2. Delays	241	30	39.9	3.248	
a Moving up	59		9.8	0.798	4.177
b Repairs	3 6		0.5	0.041	4//
		30	I,I	0.090	
Charge to transporting and dumping					
1. Waiting for cars	118	30	19.5	1.587	100
2. Repairs to cars	II	30	1.9	0.155	1.783
3. Miscellaneous	3		0.5	0.041)	
	605	30	100.0		8.140

Analysis of Complete Dipper Swing	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Swinging loaded Swinging empty Falling State of the seconds	5 3 3 2½	15.20 6.02 5.91 7.30	40 11 11 2½	22 22 17 20 (1)	51
Time to fill and load one dipperful	131/2	34.43	641/2		

Time for a complete swing

	Minimum	Average	Maximum	No. of Observa- tions
Seconds	13	22.9	39	22

Swings per minute

Maximum	Average	Minimum	No. of Observations
4.6	2.7	1.54	22

(1) Gives the average time for a complete swing with no allowance for hard digging.

OBSERVATIONS-THIRD DAY

Swings per minute
Number of cars loaded
Cubic vards excavated
Number of times moved forward
Number of times moved forward
Total distance moved during day 7' 10"
Time in minutes to load one cubic foot with dipper, .028 minute
Time shovel is interrupted while spotting one car .027 minute
Minutes per working day less time for accidental delays . 556
Shovel expenses in cents, one day, not including superintendent
and overhead or preparatory charges 3358
Coal used 2 tons
Area of section
Height of face
Number of times blasted bank
Average time to move forward once
Average time to move forward one foot 3.064 minutes
Average time to move one car 1.95 minutes
Pounds coal per cubic yard, excavated 11 pounds
Total cost to excavate, transport and spread one cubic yard 58. 26c.
Number of cars for one shovel move 61.5
Maximum distance moved forward in one move 5' 10"
Average time for one swing 27.8 seconds
Average time between beginning of one shovel move and begin-
ning of next

TIME STUDY-THIRD DAY

	Forenoon	Afternoon
Started work	6:28	12:11 1/2
Stopped work	11:261/2	5:08 1/2
Total time worked hours 55 minutes 30	Min. 298 ½ + ⊃ seconds.	Min. 297 = 595

		Minutes	Seconds	Per Cent
Actual working		228	12	38.3
Spotting cars		3	48	0.6
Waiting for cars		59	00	9.9
Moving shovel		24	00	4.0
Idle		(171	00)	(28.8)
Oiling up		5	00	0.8
Boulder in dipper		6	00	1.0
Blasting		158	00	26,6
Jacking		2	00	0.4
Miscellaneous delays .		(109	30)	(18.4)
Clearing track		16	30	2.8
Breaking bank		18	30	3.1
Repairing boom drain	and	1		
dipper		39	30	6.6
Taking boulder off track		35	ŏo	5.9
Total time under observation	on .	595	30	100.0

Cost of direct labor (loading) per day. Standard basis . \$21.50 Cubic yards loaded during third observation 369 Cost of direct labor per day per cubic yard = $\frac{$21.50}{369}$ = 5.82 cents per cubic yard.

B 1 1 1	Ti	me	Per	Cost per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost
Charge to loosening or breaking	176	30	29.6	1.722	1.722
Charge to loading 1. Actual loading 2. Delays	228	2	38.3	2.230	
a Moving up b Repairs	24 39 13	30	4.0 6.6 2.2	0.233 0.384 0.128	2.975
Charge to transporting and dumping					
1. Waiting for cars	62	8	10.6	0.617 (1.123
2. Miscellaneous	51	30	8.7	0.506	1.123
	595	30	100.0		5.820

Analysis of Complete Dipper Swing	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations	No. of Attempts to Fill Dipper
Digging Swinging loaded Swinging empty Falling Time in seconds	6 3 5½ 3	14.4 8.0 9.0 4.0	32 15 20 6	21 21 21 21	44
Time to load and empty one dipperful	17 1/2	35.4	73	2 I	

Time for one complete swing

				Minimum	Average	Maximum	No. of Observa- tions
Seconds	•	•	•	22.5	27.8	39	19

Number of swings per minute

Minimum	Average	Maximum	No of Observations
1.54	2,12	2,66	19

TRANSPORTATION

	62	34	Av. 604.8		28		Fotal
Taking water	::	н :	380.0	4400	21/2	Switch	Water tank Switch
Dumping stone caught in door of car	::	372	120.0	300	21/2	Water tank	Dump
Delay at switch to single track because of train ahead at dump	:	11 1/2	470.0	4700	OI	Dump	Blacksmith shop
	5.16 P.M.	· :	571.4	2000	372	Blacksmith shop	Switch
Loading one car	4.14 P.M.	н	212.5	850	4	Switch	Marion shovel
	• • • •	29/2	Av. 600.2	16,000	301/2		Total
Coal car off track Coal car off track Three empty cars now at shovels, one standing idle	::	3/2	1.33.7	936			
Car off track Going for goal	::	4 8	1333.3	2000	1/2	Shovel	Switch
Dumping	::	31/2	552.9	4700	81%	Dump Blacksmith shop	Blacksmith shop Dump
	2.59 P.M. 3.50 P.M.	::	571.4	2000	31/2	Blacksmith shop	Switch
Completing load Switching	::	1 S	400.0	800	01 01	Marion shovel Switch	Shovel No. 350 Marion shovel
	581/2	581/2	Av. 592.6	16,000	27		Total
Getting cars repaired while shovel is being repaired	А.М.	52.14	1333.3	2000	17,2	Switch Shovel	00
Dumping Taking water	8.48 to 10.13½		412.5 571.4 626.6 300.0	2000 4700 300	4 18 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Third switch Blacksmith shop Dump Water tower Blacksmith shop	Shovel No. 350 Third switch Blacksmith shop Dump Water Tower
Causes of Delays	Time for Trip Minutes	Delay Minutes	Rate Feet Per Minute	Distance Feet	Time Minutes	To	From

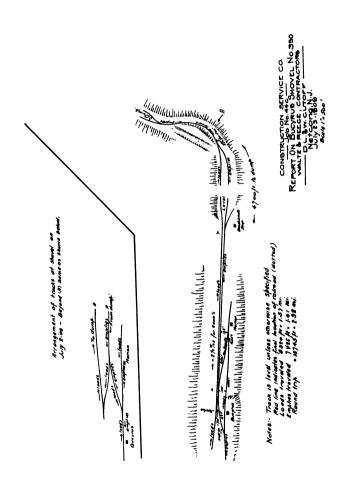




Fig. 78



Fig. 79. Scenes on D., L. & W. Cut-off Near Netcong, N. J.



Fig. 80



Fig. 81. 65-ton Bucyrus Shovel on D., L. & W. Cut-off Near Netcong, N. J.



Fig. 82



Fig. 83. Scenes on Sec. 2, D., L. & W. Cut-off

REPORT No. 43 — SHOVEL No. 1106

INSPECTED JULY 23, 24, 1909

SOO ST. MARIE, MICH.

GENERAL CONDITIONS
This shovel is engaged in the improvement of the United States Ship Canal above the locks at Soo St. Marie, Mich., and is operated by the Great Lakes Dredge and Dock Company, which has the contract for widening the present canal over an area averaging 125 feet in width and 3700 feet in length to a depth which would allow 24.6 feet of water.

MATERIAL The material is almost entirely of Pottsdam sandstone with occasional stratifications of hard white rock. Due to the material and the character of the blasting, the work for the shovel is extremely difficult, as is shown in some of the figures. The rock is broken into large irregular pieces, many of which must be pushed aside by the shovel. The shovel was just cutting out on the first day of investigation. It moved back 800 feet during the night and cut in next morning.

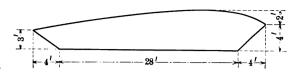
MOVING BACK AND The throwing of the loading track was very difficult because of the roughness of the material which was left in the shovel pit and because of the large number of boulders which the shovel could not handle. Much delay was caused on account of having to break up boulders to permit of lifting full sections of track over them, and considerable time was lost for both track gang and shovel crew by blasting. The blast itself took no longer than usual, but because of the uneven

character of the material the charge could not always be properly regulated, with the result that very often considerable damage was done to the track and to the shovel by flying material. The track foreman said that with a crew of twenty men it would take two hours' continuous work to throw 800 feet of track. Most of the track had been thrown before the shovel moved back. When the shovel did move back over this part the rails were placed over the track which had been thrown. Moving back was also interrupted, due to blasts. The foreman said that with an average force of twenty-two men the shovel could be moved back the 800 feet in four hours' continuous work.

After the shovel had moved back and cut in, it encountered many boulders which were too large to be loaded into the dump cars. They had to be clawed out and tossed to one side to be broken up later. Other boulders somewhat smaller in size, but still too large to be handled by the dipper, were raised and lowered into the cars by chains. Altogether it was very difficult work for the shovel, which accounts for the poor showing that it made.

Transportation was also hard work. At the time of the first day's observation the shovel was worked beside the loading track, which was on a 5% grade. This extended for some distance on both sides of the shovel and gave the trains no opportunity to start. After leaving a pit considerable switching was necessary before the trains could get upon the dump track.

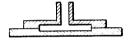
The job was well supplied with water, and the supply for the shovel was obtained through a hose about 300 feet long, extending over the bank from a water main. Coal was brought in by the regular dump train and dumped behind the shovel, and then carried on board in boxes by the pitmen.



Cross section of bank, sketched a short time before shovel had to cut out and run back to enter new cut.

OBSERVATIONS

Weather, bright	an	d cl	ea	r;	bri	sk	no	rth	wi	nds							
Distance of mov	e																6′
Type of shovel															. :	70-	ton
Kind of teeth .																R	ock
Height of lift .																	10'
Size of ties unde																	
6-foot lengt																	
plates were								pe	r d	ista	ınc	e f	roi	m e	acl	h e	nd,
each with tw	VO:	ang	les	at	tac	hec	ı.										



ma tha 6 fact will coation could be readily

c poir moving up each time the 0-100t ran section could be readily
slipped into the groove, as shown in sketch, and pins slipped
into holes to secure it.
Size of bucket
Age of shovel
Duration of job
Shift Eight hours long; two shifts per day
Water is pumped through line of hose about 300 feet long. Coal
is drawn to shovel by dinkey and then dumped. Carried
on to shovel in boxes by pitmen. Repairs are made on
Sunday by regular crew.
Coal used per day of 16 hours 3 tons
Oil used per day of 16 hours: Cylinder 2 gallons: black 2 gallons

Oil used per day of 16 hours: Cylinder, 2 gallons; black, 3 gallons Water used 4500 gallons per 16 hours Boiler is cleaned every other Sunday

Contract price: 55 cents per yard for earth and soft material; \$1.30 per yard for rock.

Contract includes excavation channeling, building and filling cribs, concrete.

Kind of track, etc. Rail, 30-pound; 3-foot gauge Kind and size of cars used K and G 1905; 4-yard

OBSERVATIONS—Continued

Train is braked by steam brake on engine. Hand brake on cars Hand signals are used by man on shovel.

Kind and size of dinkey. . . . H. T. Porter Company, 14-ton Haul is about one-half mile long.

Number of trains, three $\begin{cases} No. & 4, \text{ 10 cars} \\ No. & 5, \text{ 8 cars} \\ No. & 6, \text{ 10 cars} \end{cases}$ 7/24/09; 8-car trains on 7/23/09

Age of cars and dinkey: Dump cars, 1905; dinkeys, 1909 and

TIME STUDY—FIRST DAY

	Forenoon	Afternoon
Started work	8:48:00	00:00:00
Stopped work	11:54:45	00:00:00

Min. Sec.

Total time worked 186 45 = 3 hours 6 minutes 45 seconds.

						Minutes	Seconds	Per Cent
Actual working						65	24	35.1
Waiting for cars						74	14	35.1
Moving shovel	•	•	٠	•	•	47	7	25.1
Total time under	ob	ser	vat	ion		186	45	100.0

Cost of Direct Labor (Loading) per Day												Standard Basis	
Runner .													\$5.00
Craneman													3.60
Fireman													2.40
6 pitmen												•	9.00
									_			 	\$20.00

Cars loaded during observation . . 80 at 4 yards = 320 yards Cubic yards loaded during observation . . $80 \times 4 \times 0.6 = 192$ Based on observed performance, cubic yards loaded per day of

8 hours =
$$\frac{192 \times 480}{186.75}$$
 = 495.

Cost of direct labor per day in cubic yards = $\frac{$20.00}{495}$ = $\frac{4.04 \text{ cents per}}{\text{cubic yard.}}$

Process Analysis	Ti	me	Per	Charge	Total	
Trocess Analysis	Minutes	Seconds	Cent	Cents		
Charge to loading 1. Actual loading 2. Delays a Moving up Charge to transporting and dumping	65 47	24 7	35. I 25. I	1.419	2.433	
1. Waiting for cars.	74	14	39.8	1.607	1.607	
		!	100.0		4.040	

* o.6 = ratio of $\frac{p. m.}{w. m.}$

TIME STUDY DEDUCTIONS—FIRST DAY

	No. of Obser-	Mini	mum	Ave	rage	Maxi	mum
	vations	Min.	Sec.	Min.	Sec.	Min.	Sec.
Time idle, shovel moving up	7	6	32	7	51	8	45
shovel working	5	8	10	11	17	14	50
Time between trains .	5 8	7	16	9	17	13	15
Time per train loading	10.	4	00	6	32	8	43
Time per dipper	7		17		22		26
Number of dippers per							
move	5	2	7	3	2	4	0
Number of dippers per		1					
train	10	10	6	18	. 2	2	3
Number of dippers per							
car	80			2	. 3		

TIME STUDY—SECOND DAY Forenoon

Afternoon

Started work		8:39:55	
Stopped work			4:30:00
	Min.	Sec.	

470 5 = 7 hours 50 minutes 5 seconds Total time worked

		1	
	Minutes	Seconds	Per Cent
Actual working	246	35	52.5
Waiting for cars	6 o	30	12.9
Moving shovel	108	15	23.0
Miscellaneous delays	(54	45)	(11.6)
Clearing boulders	20	00	4.2
Coaling and changing shifts	27	15	5.8
Small repairs	7	30	1.6
Total time under observation .	470	5	100.0

Cost of Direct Labor (Loading) per Day

Number of cars loaded during observation . . 107 @ 4 yard Cubic yards loaded during observation . 107 x 4 x 0.6* = 257 Based on observed performance cubic yards loaded per day of 8 hours = 257×480 minutes o seconds

 $\frac{1}{470 \text{ minutes}} = 262$

Cost of direct labor per day, per cubic yard = $\frac{$20.00}{}$ = 7.64 cents per yard.

Process Analysis	Ti	me	Per Cent	Cost per Vard	Total Cost
	Min.	Sec.	Cent	in Cents	Cost
Charge to loading 1. Actual loading 2. Delays a Moving up b Miscellaneous	246 108 54	35 15 45	52.5 23.0 11.6	4.011 1.757 0.886	6.654
Charge to transporting and dumping 1. Waiting for cars	60	30	12.9	0.986	0.986
	-				
	470	5	100.0		7.640

^{*} o.6 = ratio of $\frac{P. M.}{W M}$

TIME STUDY DEDUCTIONS—SECOND DAY

	No. of	C	utting	In. I	Many E	Boulder	s.	
	Obser- vations	Obser- Minimum			rage	Max	ximum	
		Min.	Sec.	Min.	Sec.	Min.	Sec.	
Time idle, shovel moving up	10	7	55	10	49	15	00	
shovel working	11	4	25	22	25	40	50	
Time between trains .	7	3	30	8	25 38	12	30	
Time per train loading	II	15	20	21	41	28	00	
Time per dipper	11		33.9		50.6		62.7	
Number of dippers per move	ΙΙ		5	2	8	4	3	
Number of dippers per train . Number of dippers per	11	2	2	2	711	3	0	
car	107			2.	86			

Number of trains loaded										I 2
Number of cars loaded .										107
Cars per train			}	8 tr 3 tr 1 t	ain ain rain	s o s o	f id f	o ca 8 ca 3 ca	ars ars ars	each each

ACTUAL RATIOS

 $\frac{\text{Water consumption, pounds}}{\text{Coal consumption, pounds}} = \frac{37,500}{6,000} = 6.25$

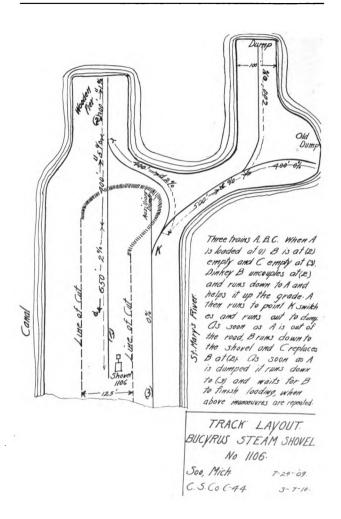




Fig. 84



Fig. 85. Shovel No. 1106 Near Soo Ste. Marie, Mich.

REPORT No. 45 — SHOVEL No. 875

INSPECTED AUGUST 11 AND 21, 1909

NEAR COLUMBIA, N. J.

Shovel No. 875 was working on Section No. 7 of the D., L. & W. cut-off near Columbia, N. J., together with No. 795, under the report on which will be found a general description relative to both. See page 312.

No. 875 has an all-steel boom and dipper handle. The boom is reinforced with lattice bracing, and does

not spread in hard digging.

OBSERVATIONS—GENERAL

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OBSERVATIONS-GENERAL-Continued

Number of trains
Number of cars loaded
Cubic yards excavated
Total distance moved forward during day
Number of times moved forward
Average distance moved forward in one move 6' 6"
Average time between beginning of one shovel move and be-
ginning of next, 46.1 minutes.
Number of cars to one shovel move 10.1
Time shovel is interrupted while spotting one car083 minute
Minutes per working day less time for accidental delays . 604
Area of section 200 square feet when material was blasted
Height of face . 7 1/2 square feet when material was blasted
Number of times blasted bank
Coal used

TIME STUDY—FIRST DAY

		Forenoon	n	Afternoon
Started work		6:59		1:03
Stopped work		12:04		6:06
	3.61	3.61		

Total time worked 305 + 303 = 608 = 10 hours 8 minutes.

			Minutes	Seconds	Per Cent
Actual working			274	00	45. I
Spotting cars		.	10	00	1.6
Waiting for cars		.	5	30	0.9
Moving shovel		.	5 180	00	29.6
Idle		1			-
Blasting		.	61	00	10.0
Boulder in bucket		.	9	30	1.6
Repairing dinkey track .		. [15	30	2.6
Miscellaneous delays			-	_	
Clearing track		.	35	30	5.8
Moving boulders		.	12	ŏo	2.0
Tearing down bank		.	2	00	0.3
Car off track			3	00	0.5
Total time under observation	1		608	00	100 0

C	ost	0	f Di	rec	t La	bor	(Lo	oadi	ng)	per	Day	7			Standard Basis
Runner .														_	\$5.00
Craneman															3.60
Fireman .														٠	2.40
6 pitmen .															9.00
1 coalman			•		•	•	•		•	•		•	•	•	1.50
														_	\$21.50

Number of cubic yards loaded on day of observation . . . 242 Cost of direct labor per day per cubic yard $\frac{$21.50}{242} = 8.88$ cents per cubic yard.

Process Analysis	Ti	me	Per	Cost per	Total
Process Analysis	Min.	Sec.	Cent	Yard in Cents	Cost in Cents
Charge to waiting for blasters	7.5	00	12.3	1,092	1.092
Charge to loading	/3	00	12.3	1.092	1.092
 Actual loading Delays 	274	00	45.1	4.004	
a Moving up	180	00	29.6	2.630	6.776
b Miscellaneous	9	30	1.6	0.142	
Charge to transporting and dumping					
1. Waiting for trains .	15	30	2.5	0.222 /	1.012
2. Miscellaneous	54	00	8.9	0 790 }	1,012
	608	00	100.0		8.88

Dipper Performance	Mini- mum	Aver- age	Maxi- mum	No. of Obser- vations	No. of At- tempts
Digging Time Swinging loaded in Swinging empty seconds	3 3 4 2	12 3 5.3 5.3 3.5	30.5 9 11 6	21 21	48.
Total time to fill and load one dipperful	12	26.4	56 5		

Time for one complete swing

			Minimum	Average	Maximum	Number of Observa- tions
Seconds			14	18.1	28	21

OBSERVATIONS—SECOND DAY

Number of cars loaded 84
Cubic yards excavated
Total distance moved forward during day 28'
Number of times moved forward
Maximum distance moved forward in one move 6'2"
Average time between beginning of one shovel move and begin-
ning of next, 43.9 minutes
Number of cars to one shovel move
Time shovel is interrupted to change train 18 minutes
Area of section
Height of face
Number of times blasted bank

TIME STUDY

	Forenoon	Afternoor
Started work	7:00	1:06
Stopped work	12:08	6:04

Min. Min.

Total time worked 308 + 298 = 606 minutes = 10 hours 6 minutes.

	Minutes	Seconds	Per Cent
Actual working	151	15	25.0
Spotting cars	7	30	1.2
Waiting for cars	18		3.0
Moving shovel	89	45	14.8
Idle	1	.5	ļ <u>'</u>
Blasting	309		51.0
Miscellaneous delays	(30	30)	(5.0)
Pulling in bank	26	30	4 4
Moving boulders	4	Ĭ.	ò.6
Total time under observation .	606	00	100.0

Cost of direct labor per day per cubic yard $\frac{$21.50}{168} = \frac{12.80 \text{ cents per}}{\text{yard}}$

Process Analysis	Ti	me	Per Cent	Cost Per Yard in	Total	
Process Analysis	Min.	Sec.	rer Cent	Cents	Cost	
Charge to loosening or breaking Charge to loading	339	30	56.0	7.167	7.167	
 Actual loading Delays 	151	15	25.0	3.200	5.095	
a Moving up Charge to transporting and dumping	89	45	14.8	1.895	57.	
Waiting for trains	25	30	4.2	0.538	0.538	
	606	00	100 0	*	12.80	

Dipper Performance	Mini- mum	Aver- age	Maxi- mum	Number Obser- vations	Number Attempts
Digging	4.0 3.0 3.0 2.0	9·3 4·4 4·3 5·2	30 634 61/2 1634	51 51 51 51	51
Timeto fill and load one dipperful	12.0	23.2	60	51	

Time for one complete swing

	Minimum	Average	Maximum	Number Observations
Seconds .	 12.0	15.3	19.5	51

TRANSPORTATION (See Report No. 795)

Moving Sh	ove	l			Average Seconds	Number of Observations	
Unjacking					131	2	
Leveling in front				.	49	I	
Laying ties				.	77	4	
Laying rails					69	5	
Unclamping .				.	25	Ī	
Moving · .					21	4	
Clamping up .				.	· 66	3	
Jacking up				.	167	2	
Carrying rails to f	roi	nt		.	40	3	
Carrying ties to front .				.	49	3	
				694 = 11 n	ninutes 34 secon		

Cost of L	abor	to	Mo	ve l	No.	875 From Siding t	o Work	Standard Basis
Runner .		•				80 hours (a)	\$0.50 =	\$40 00
Craneman						80 hours (a)	0.36 =	28.80
Fireman .						80 hours (a)	0.24 =	19.20
Watchman						80 hours (a)	0.15 =	12.00
Foreman						80 hours (a)	0.20 =	•16.00
Laborers						1135 hours (a)	0.15 =	170.25
Team, ties						130 hours (a)	0.30 =	39.00
Team, coal						50 hours (a)	0.30 =	15.00
Coal								28.00
Oil		•						8.50
								\$376.75



Fig. 86



Fig. 87. Bucyrus Shovel No. 875 on D., L. & W. Cut-off

CHAPTER X

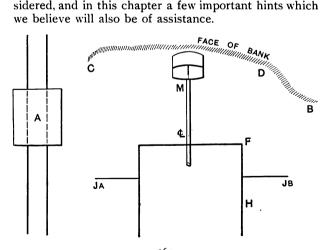
DIRECTIONS FOR MOVING SHOVEL

ECONOMIC HINTS In order to systematize the various operations in moving a steam shovel and thus reduce the cost to a minimum, as referred to in Chapter II, we have given the order in which these movements should be made.

A contractor who finds, upon timing his work, that he is not moving his shovels within the limit given in this chapter, will do well to investigate wherein his trouble lies by comparing the actions of his men with the movements herein tabulated.

We also give in this chapter valuable hints to superintendents and managers, which, if adhered to, will be of great assistance in obtaining economical results.

For the use of estimators we have given, in Chapter IV, a complete classification of the items to be considered, and in this chapter a few important hints which we believe will also be of assistance.



(1) Just before moving, the last dipperful will be taken from B. As this dipper is being filled, runner gives one whistle signal to the pit gang (six men in pit). Two men go to JA and two to JB, and one man goes out to F on the rail clamp and one to H on the rail clamp.

(2) As soon as the dipper has swung to the left of the center (M) JB is loose, and one of the men there runs up the screw.

- (3) One man at JA puts his pole over the jack and gets ready to raise his jack block. Meanwhile the dipper has dumped at A.
- (4) Other man at JB now raises his jack block and is ready to move.
- (5) Dipper swings to the right far enough past M to take the weight off of JA, which is immediately screwed up and the block raised.
- (6) While runner is throwing in his moving clutch, one man at F is knocking loose rail clamp, and one man from JA and one from JB pick up the chock and carry it forward to its new position.
- (7) Runner now moves shovel ahead; H knocks the clamp loose. F is meanwhile putting his clamp on in the new position.
- (8) As soon as the shovel strikes the front chock, H puts his clamp on. The bucket is in the center position for this movement.
- (9) The jackmen JA and JB immediately screw down their jacks, and the first man to get his jack down gives signal to runner, who takes first bucketful on his side. This enables man on either side to get his jack well screwed down before bucket crosses center line again, working away at full speed.

Shovel now works away even if a little out of level. It can be leveled up by runner telling JA or JB to loosen a little, the

opposite man screwing down on the next half swing.

HINTS

(1) Drag rear chock by chains fastened to the shovel.

(2) Have jackmen use jack arm for fulcrum on which to rest poles for carrying jack block.

ECONOMIC HINTS TO SUPERINTENDENTS

Cultivate the habit of learning new methods from published accounts, and then don't wait to see them used, but apply them yourself, even if you have to devise some details which were not described. The man who avails himself of published data becomes a centenarian in experience before he is thirty in years.

Responsibility without authority, and authority without responsibility, are fatal to successful work. Don't let the men "knock" each other on the work.

One of the secrets of successful management consists in quickly finding out who is inefficient. The best superintendent always hails "from Missouri."

One of Gilbreth's rules: No superintendent, walkingboss, engineer, time-keeper, or other employee is permitted to give an order direct to any workman, except in case of great emergency. Not even a member of the firm is exempt from this rule. The foreman in direct charge of a gang is the only man permitted to instruct his men what to do. He is the officer in charge, and his superior officers must not, intentionally or unintentionally, degrade him in the eyes of his men by issuing orders over his head.

In order to get the most work out of a man for his money it is necessary to offer him a stronger incentive to do his best than the mere fear of discharge for incompetency.

It is highly economical to use all possible means to prevent men from getting injured on the work.

Don't mistake activity for work.

Look out for the man whose mind is centered upon more help instead of more method.

One of the most demoralizing agents on a large piece of construction work is the rumor, especially if the rumor is true, that the work is being unsuccessfully prosecuted. The belief that the contractor is losing money, if allowed to circulate among his own men is almost fatal to a high state of discipline and efficiency.

Time-keeper must not gossip on the work, a sure cause of dissatisfaction. The men should know as little of the politics of the work as possible. Dissentions at headquarters are bound to affect the men and

their work. If unity is lacking in high places it will also be lacking lower down.

Don't let the executive do any avoidable detail work. It may be economical to pay higher wages than the prevailing rate. This attracts the best class of labor. Men will often do 10 per cent more work for 5 per cent more pay.

Cut of 10 per cent in wages may mean reduction of 20 per cent in output.

Differential rates of pay for the same kind of work are a menace to effective results.

To avoid demoralization men must be paid promptly on regular pay day. No matter how sure the men may be of their pay, failure to meet them on pay day affects the work badly.

Rule of Gilbreth's: No smoking allowed on the job except to finish noon smoke. Not over one-half hour and no refilling of pipes.

Gilbreth advertises that he will pay one dollar for every suggestion that is made by an employee and accepted by the company, and they award monthly the sum of \$20 for the most valuable suggestion received during the previous month. First prize \$10, second prize \$5, third prize \$3, and fourth prize \$2. As soon as awards are made prizes are paid in cash. A notice is posted to this effect on every job.

All monthly men or steady pay men should be on the job before the first whistle is sounded and remain there until quitting time regardless of weather.

A daily report should be sent to the home office on the blanks provided. If no work is being done, still a report should be sent in stating that fact, and giving reasons for delays, etc.

All sources of dissatisfaction should be immediately and impartially investigated, and the men must know that, although they are responsible for the quantity of their work to the immediate foreman, they are absolutely in touch with the management as far as justice to the men is concerned.

Poor coal supply causes serious delay and loss of money.

Breakdowns of machinery will cause loss of money which cannot be estimated and will always be uneconomical.

Keep parts of all machines together in storage, so that they can be easily found.

Upon laying up rock drills, hoists, etc., cover the bright surface with a mixture of paraffin and vaseline heated and applied with a brush. The mixture is readily rubbed off.

In cold weather, at night, drain all water and oil from cylinders and lubricators of engines and pumps. The common lard oils are full of acid and will cut machinery.

By means of lye bath and air blasts, dirty, greasy machinery may be quickly cleaned.

Cylinders of engines and steam drills are frequently cracked in cold weather by suddenly letting in steam. To avoid this, open drip cocks and cocks on steam chest and blow in steam for a few minutes to warm up the cylinder before starting the machine. A broken cylinder may delay work for a week or longer.

Test boiler gauges from time to time.

Use three-wire connection with three-wire machine for blasting.

Look out for air in water pipe at top of a grade. Provide a blow-off cock.

Description of the work on the Sonlengs Canal states that clay excavated by steam shovels came out in lumps so hard that it could not be cut up economically. The problem was solved by the use of a sprinkling hose.

A 16-foot hickory or ash pole, shod with a pointed spike for breaking down the bank in front of the shovel in deep cuts is often a great time saver.

Steam shovels can be buried by slips where the bank is too high.

When the shovel has a lift of 9 feet, and it is desired to take out a 12-foot cut, this can often be done by putting the shovel on stilts, as it were, i. e., blocking up the tracks the requisite amount.

Plot the location of all drill holes on cross-section paper and write thereon the depth of each hole and the powder charge in it.

In drilling open cut work it is wise to pitch the holes down away from the face. The explosion will then throw the rock away from the face.

In forging rock-drill bits, those for medium hard rock should have sharp chisel bits. As the hardness of the rock increases, the angle of the bit may be made more obtuse and the cutting edge shaped from a straight line to a curve to prevent the corners from being chipped off.

There should be no air cushions in the blast hole. To accomplish this, slit the cartridges with a knife lengthwise of two sides, being sure not to do this to a frozen or partly frozen stick, and place it well home with a wooden rammer.

In springing for black powder work, it is important not to load the hole until after the rock has cooled off, as the springing charge develops considerable heat.

The usual size of a case of dynamite is three-quarters of a cubic foot, therefore an old powder box is often much more convenient for measuring coal than a bushel basket.

Dynamite, when frozen, can sometimes be exploded by extra strong caps.

Don't blow unexploded dynamite out of a hole with a steam jet. Use air instead.

ADVANTAGE OF WHISTLE OR BELL SIGNALS OVER HAND SIGNALS

To get hand signals, a man must look for

the signals, which requires that he should be constantly watching the signal man and will be unable to give his attention to other things. Bell or whistle signals do not require his attention.

Acknowledgment should be made of the excellent field work in gathering the data contained in this volume by Messrs. F. M. GAIGER, CHAS. HOUSTON, E. C. WILDER, A. C. HASKELL and W. T. BALL, and the marked courtesy rendered us by all the contractors to whom we applied for information.

No effort has been spared to make this book entirely trustworthy as to facts, but although it has been carefully checked for errors it is possible that mistakes may have escaped notice. If any should be noted by the reader a memorandum to that effect addressed to the Construction Service Co., 15 William Street, New York City, would be much appreciated.

R. T. DANA

For Construction Service Company