COST OF MINE LIGHTING.

BY F. P. MILLS, STAMBAUGH, MICH.

THE plant was set up and running at the Cleveland iron mine, Ishpeming, Mich., May 10th, 1880.

The machine employed was a No. 7 Brush dynamo, with old style armature core, and lights of 2,000 candle power each.

For the underground workings was used a so-called dye house, single carbon lamp. The connections across the top of the lamp being filled in with tar; rubber gaskets being placed between the case and side plates. The surface lamps were of the ordinary double carbon pattern.

The dynamo on stone foundation, topped with a shellacked hard wood plank, was placed in their No. 1 engine house; and three distinct loops, all of No. 8 copper wire, were run from there.

The number one circuit comprised all the lamps underground in No. 3 pit, and was about 3,000 feet long.

Number two circuit took in all the lamps on surface, they being placed at the various pockets and engine houses, and was about 4,600 feet long; while number three circuit ran into the incline pit, a distance there and back to dynamo of 6,000 feet.

A continuous ringing bell, permanently connected to a Leclanché cup; and with an outside coil of heavy wire traversed by the light current, serves to call attention to a break in the line.

In such an event the broken wire was cut out by a short circuiting switch, one being connected with each loop, and thrown in again upon the repairs being made.

The wires were run wholly upon glass insulators. Underground, where the brackets could not be spiked to stull timbers or wooden pockets, they were run to some iron ore pillar, or to the walls of the pit; and where neither of these could be reached, the wires were suspended from the roof or hanging wall. When run to pillars, or walls of the pit, the brackets were bolted to an iron cramp, having a suitable number of iron cross arms.

A split end, fitted with a wedge, served to securely fasten the cramps in a hole drilled into the ore or rock. In the mine the lamps were suspended by a rope, running through a sheave attached to an eye cramp let into the roof. The other end of the rope was tied to any convenient piece of ore, rail or timber, as the case might be.

The lamps were always taken down out of the way at each blast, the switch-boards being pulled up close to the roof, to get them as much out of danger as possible, though this did not prevent them from being occasionally smashed.

The surface lamps were suspended in the usual way. The wires underground hung slack between the insulators, they proving less liable to be broken that way.

They could not, however, be prevented from being cut by the flying pieces of ore and rock in spite of all possible care, and every day a number of splices in each pit had to be made.

Lengths of wire would often have to be renewed entire, for the reason of their having been hit so many times, and containing so many splices.

There was used a 10 by 20 inch variable cut-off engine belted direct to the dynamo.

A stationary bricked-in boiler, 5 by 16 feet with 81 3-inch tubes, supplied the steam, the boiler being shut off from the hoisting engine and used only for lighting purposes.

Both wood and coal were used, though for each separate month it was all coal or all wood.

The engineer's time was not charged, as he could easily attend to the dynamo and engine while doing his other work, neither did the light stand the expense of firemen, as it cost no more to fire than when simply doing the hoisting, no extra wages being paid. The only labor cost was that of one man upon each shift, whose business it was to renew carbons, mend lamps, and keep the wires in repair. The plant worked 20 hours out of the 24 every day, except Sundays.

With wood at \$2.50 per cord, it cost for fuel for the three months of September, October and November, in all 8,291 hours, an average of 3.0907 cents per hour per lamp, or .01233 cords of wood per hour per lamp. For December month, with soft coal carefully weighed and charged at \$5.00 per ton, the 4,676 hours

run cost 3.462 cents per hour per lamp, or 13.85 pounds of coal per hour per lamp. The above is simply the fuel cost, the complete cost, in detail, is as follows:

OPERATING EXPENSES.

MONTH OF DECEMBER, 1880.

Costs common to all Lamps.

LAMPS.	COAL.				OIL.				ATTENDANCE.		
	Tons.	Cost.	Per Hour per Lamp.		Gal- lons.	Cost.	Per Hour per Lamp.		Days	COST.	
			P'nds.	Cost.			Gal- lons.	Cost.		Am't.	Per Hour per Lamp.
All Lamps.	327.60	161 90	13.85	.03462	12.	12 00	.00256	.00256	50	100 00	.02138

SPECIAL COSTS.

LOCATION OF LAMPS.	CARBONS.			COPPER WIRE.			ROPE.			SUPPLIES COST.	
	Number.	Per Hour per Lamp.		Feet.	Per Hour per Lamp.		Feet.	Per Hour per Lamp.		A'mt	Per Hour per Lamp.
		Inch.	Cost.		Feet.	Cost.		Feet.	Cost.		
No. 1 Engine House	75	1.8127	.01057								
No. 3 Dock - -	44	2.4082	.01404								
Incline Dock - -	4	2.5263	.01473								
No. 3 Engine House	42	1.7439	.01017								
Total surface	165	1.9341	.01128							1 40	.00136
Incline Pit - - -	335	2.0727	.01209	276	.14230	.00593	75	.03867	.00049	2 30	.00118
No. 3 Pit - - -	343	2.4085	.01402	216	.12613	.00325	100	.05339	.00074	4 09	.00239
Grand total -	843	2.1638	.01262	492	.10522	.00438	175	.03742	.00048	7 79	.00166

RECAPITULATION.

LOCATION OF LAMPS.	LAMPS BURNING.		TIME. Hours. min.	TOTAL COST.	COST PER HOUR PER LAMP.		REMARKS.
	Day.	Night.			with- out	with	
					Attendance.		
No. 1 Engine House	1	1	496.30	35.02	.04922	.07060	Price of Carbons .07 each. " Coal - 5.00 per ton " Oil - 1.00 " gal. " Cop. Wire .50 " pd. " Rope - .16 " " " Supplies - at cost. " Attendance, \$2.00 per day.
No. 3 Dock - -		1	219.15	16.21	.03263	.07402	
Incline Dock - -			19	1.40	.03230	.07368	
No. 3 Engine House		1	289	20.27	.04875	.07014	
Total surface -	1	3	1,023.45	72.90	.04980	.07119	
Incline Pit - - -	4	4	1,939.30	151.82	.05687	.07826	
No. 3 Pit - - -	5	5	1,712.30	138.72	.05964	.08103	
Grand total -	10	12	4,675.45	363.44	.05634	.07772	

The cost for four months, hours burning, and cost per hour per lamp is as follows :

OPERATING EXPENSES FOR FOUR MONTHS, ENDING
DECEMBER, 1880.

MONTH OF	TIME. hours, min.	COST.		REMARKS.
		Amount.	Per Hour per Lamp.	
September	1,668.10	122.86	.073657	This includes everything but the expense of firemen and engineers who attend to other work and do this without extra cost.
October -	3,353.20	239.37	.071384	
November	3,270.20	251.81	.077000	
December	4,675.45	363.44	.077724	
Total -	12,967.35	977.48	.075382	

It will be noticed, from these cost statements, that the consumption of carbons was greater in the exposed surface lamps, than in those in the engine houses, and but a little more than those underground.

The cost of lights, in the hoisting engine houses, was less than with kerosene, as with the latter one lamp would be put over each drum, in addition to lights for the engine.

Upon the docks there was no comparison with oil, as the electric lamp threw a light that enabled the cars to be readily handled, and of such assistance to the ore sorters in the way of showing the true colors, that they could not be dispensed with.

In the mine they were employed at all the big stopes, and especially where much filling or ore sorting was going on.

Although many miners' lamps had still to be used, it was considered economy, even at an additional expense, to run the lights to admit of a better supervision of the operations; more work done, and cleaner ore.

Another use to which the lamps were sometimes put, was to reverse them in the line, and examine the roof by the strong upward light thus thrown.

The plant is still running without material alteration, excepting the mine circuits, which have to be advanced as the work progresses.

Following are figures the chief engineer has just sent, showing their present fuel consumption, which indicates an improvement

on the old run. With seven lamps burning, the engine indicated 11.73 horse power, with a consumption of 36.79 pounds water, and 4.9 pounds coal per horse power per hour. This is adding 20 per cent. of water shown for indicated horse power, by the card, for loss by condensation, and making a moderate allowance for boiler evaporation of 7.5 pounds water per pound of coal. This gives 1.675 horse power per light, and 8.211 pounds of coal per hour per lamp. With more lights, or a larger plant, the result would show still better on account of less friction, a longer cut-off, with a consequent higher effective pressure, and less condensation.

DISCUSSION.

The CHAIRMAN: Discussion on this paper is now in order. I presume there are gentlemen present who are experts in are lighting. I will call upon Mr. E. P. Roberts to give us his views.

Mr. ROBERTS: I would like to ask what kind of coal. I heard \$5.00 a ton for soft coal, and I thought I heard before that \$2.50.

Mr. MARTIN: \$2.50 for wood.

Mr. ROBERTS: Then I misunderstood. Does it say whether it is lump, slack, or what?

Mr. MARTIN: It says here: "Soft coal carefully weighed and charged at \$5.00 per ton.

The CHAIRMAN: I suppose that Mr. Roberts is acquainted with the use of storage batteries for lighting?

Mr. ROBERTS: We have no mine lights at present.

Mr. MARTIN: There is one point there that seems to me to call for a little remark.—"They (the wires) could not, however, be prevented from being cut by the flying pieces of ore and rock in spite of all possible care, and every day a number of splices in each pit had to be made. Lengths of wire would often have to be renewed entire, for the reason of their having been hit so many times, and containing so many splices." If I may be permitted to refer to the *Electrical World* of January 24th, there was an article by Mr. C. E. Reynolds, who had done some lighting in tunneling in the Mantiqueira mountains in Brazil. He says with regard to the running of the wires through the mine: "The wires were fixed against the sides of the tunnel by wooden plugs driven into holes bored for them. At first these were simply laid along the tunnel without any covering, but I soon found that it would

never do to leave them bare. The pieces of rock flying about from the frequent blasting soon made havoc both with the wires and with the lamps. Some means had to be devised to protect them. The wires I placed in a casing of thick boards right through the tunnel with a lid that could be easily opened when I wanted to get at the wires.

Mr. ROBERTS: The figure given as to the cost per hour—does that include repairs on wires, for it seemed to me pretty high?

Mr. MARTIN: The remark is, "This includes everything but the expense of firemen and engineers who attend to other work and do this without extra cost." It is a comprehensive cost statement, I take it. This paper, I might state, refers to arc lighting under ground. If any gentleman would favor us with remarks on incandescent lighting to the same purpose it would be interesting.

The CHAIRMAN: I assume that for incandescent lighting storage batteries may be in use. I am not aware that they are. I think, perhaps, the branch of the subject relating to storage batteries and incandescent lighting might be discussed to advantage, if there is anything to be said on that subject.

Mr. THOMPSON: Would not that subject come more properly under the head of the paper on storage batteries for commercial purposes?

The CHAIRMAN: Has Mr. J. F. Kelly any views on this subject?

Mr. KELLY: I have nothing to say that would interest the Society sir, in regard to that.

The Chairman: If there is nothing further to be said, the discussion on that paper is closed and the next paper will be read by Mr. Edward P. Thompson, mechanical engineer on the Electric Arc Lamp Frictional Clutch.