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6. SURFACE:
(Continued)

b. Stockpiles: (Continued)

The Model 60 Marion shovel from the Wade Mine was used in the underground stockpile and a Model 60 Marion from the Hill-Trumbull Mine worked on the lean sandy stockpile. These shovels were, for the most part, operated by one crew, moving back and forth as shipping requirements necessitated. During the latter part of the season both shovels were operated at the same time in order to insure cleaning them up before the end of navigation.

c. Tracks, Roads, Transmission Lines:

Tracks:

Only such track work was done during 1927 as open pit ore operations necessitated. The pit tracks were put in very good shape. All of the clean-up material from the pit, handled during 1927, was dumped into the West end of the pit and we did not operate over the dump tracks. The tracks between the pit and the dump were taken up during the latter part of the summer so that when the ore season was concluded it was necessary to take up only the tracks in the pit and those leading down the approach. All of the rails which were in shape for further service, together with tie plates, rods, switches, etc., were shipped to the Hill-Trumbull Mine for storage and the unusable material was sold for scrap. On account of the very severe weather it was necessary to leave about 1,000 feet of track in place on account of the large expense in taking it up. This track will be taken up during the summer of 1928.

The two approaches, which served the Boeing Mine tracks to the dump, were put in satisfactory condition to satisfy the Oliver Iron Mining Company's inspectors. This was in accordance with our agreement with the Oliver Company.

Roads:

Very little work was done on the mine roads during the year, further than to fill up some ruts and holes with cinders.

In accordance with the request on the part of the fee owners and the St. Louis County Mine Inspector, the entire Boeing pit was enclosed with a fence. This fence has iron posts at 10 foot intervals, with large substantial wooden posts at intervals of less than 300 feet for strengthening, is composed of a four foot woven wire and has two strands of barbed wire above, fastened to the iron posts securely.

Before the lease on the Boeing Mine was surrendered, the premises adjacent to the shaft were cleaned and all equipment that could not be placed in the buildings was covered and stored here. Four cars of scrap iron were collected about the mine and shipped. This is exclusive of three cars of scrap rail picked up from the tracks.

The shaft collar was carefully covered and should be safe for a long period of idleness.

7. UNDERGROUND & OPEN PIT:

a. Shaft Sinking & Stripping:

(1) Shaft Sinking:

A second level heading was driven in from the open pit winze to the

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7. UNDERGROUND & OPEN PIT: (CONTINUED)

a. Shaft Sinking & Stripping: (Continued)

(1) Shaft Sinking: (Continued)

shaft during the early part of the year. After cutting out the second level plat, a small raise was put up 45 feet to the center of the skip compartment in the old shaft bottom. This work was complated on May 16th and the work of stripping down the two skip compartments was then undertaken, the job being finished May 26th. Hoisting in the shaft was started at this time and work through the winze abandoned. A small pipe and man-way was put under the ladder road during the latter part of May. The second level skip pit was begun June 21st and was sunk 28 feet. The excavation for the chutes was made at the same time. All work on the shaft was completed July 2nd.

(2) Stripping:

Between May 11th and June 2nd the large shovel was engaged in cleaning the sand and mud accumulation, over the deep ore channel. This material had collected as the result of four years of wash down the stripping banks. With the approval of the fee owners, all of the material cleaned here was dumped into the West end of the pit. Six 20-yard stripping cars were rented from the Oliver Iron Mining Company in connection with this work.

b. Development:

Development work on the second level was carried on continuously from the first of the year until August 22nd, when it was permanently abandoned.

The pumphouse on the second level was completed and the pumps installed by the middle of January.

A drift was driven 250 feet Northwest from the winze along the main ore channel and crosscuts put in to determine the width of the ore at this elevation. To the East of the winze a drift was extended 200 feet along the ore channel and a crosscut was turned off for the shaft connection. It was necessary to drift 230 feet through rock to get under the bottom of the old shaft. This work was completed before the underground ore operations were closed down on May 4th. Later, a 50 foot tail drift was driven Northeast from the shaft and a drift was pushed in 50 feet to the East to make a "Y" connection to facilitate tramming. This latter job was not completed when all underground operations were suspended. A small dog drift was driven along the North ore shore line for a connection to the pumphouse and a rock raise had been started for a pump discharge pipe line when underground work was abandoned.

When the first open pit slide occurred on August 3rd, the only access to the second level pumphouse was through the discharge raise from the second to the first level. This raise was close to the open pit face opposite the shaft, and when the slide occurred the top of this raise was blocked. One of the pumpmen was on the second level at the time of the slide and two crews of men were immediately put to work, the first to endeavor to open a connection to the top of the discharge raise and the second in driving a dog drift on the second level, between the dog drift and the pumphouse.

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7. UNDERGROUND & OPEN PIT: (Continued)

b. Development: (Continued)

The breast of the dog drift was only 15 feet from the pumphouse and an opening was put through and the pumpman released before the discharge raise was made accessible. Fortunately, the pumpman suffered no ill effects from being confined for approximately six hours.

c. Stoping (Underground)

West Deposit - First Level:

On January 1st, 1927, one gang was employed in the Northerly extension of the West Channel and one in the Northerly extension of the main channel. These working places were exhausted by the end of April and the tracks were then taken up and the main tram-way bulkheaded.

East Deposit:

1365' Sub-Level:

At the beginning of the year seven contracts were engaged on this sub. The small pillars were worked back rapidly and by the first of May the deposit at this elevation had been mined out.

1342' Sub-Level:

A force of four gangs was employed here the first of the year, but as the working places were exhausted on the sub above, the contracts dropped down and seven crews were employed here when underground ore mining was discontinued. The pillars remaining on this sub are quite small and, due to the very wet conditions, operations were not alone unsatisfactory but hazardous.

First Level:

A force of five contracts was employed at this elevation the first of the year. The minable area at this elevation was much smaller than that on the subs above and while it had been blocked out and some slicing done, operations were highly unsatisfactory and it is a question whether this ore can ever be recovered safely.

A gradual reduction of working places in the East deposit, with the increase in the flow of water and sand-runs, was the direct cause for closing down underground mining operations when the productive West deposit places were exhausted. When underground mining activities were discontinued, all tracks, cars, pipe and tools were taken to the surface and stored. Bulkheads were placed in accordance with the request of the fee owners and the underground workings left in as safe a condition as possible.

All pumps were taken from the mine during the fore part of November and the workings allowed to flood.

d. Timbering:

On account of the underground operations being suspended after the first four months of 1927, the quantity of all timber products used in the mine was very much less than for the previous year. On account of the harder back in the East Deposit, where the bulk of the 1927 operations were conducted, the amount of timber used per ton of ore was decidedly less; the lagging was slightly less but the boards and poles were higher. It was necessary to use more boards and poles on account of the sand-runs that occurred. The cost per ton for all timber products was $.03 per ton less in 1927 than it was in 1926.

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7. UNDERGROUND & OPEN PIT: (Continued)

d. Timbering: (Continued)

Comparative Timber Statement for the years 1926 and 1927:

	LINEAL FEET	AVG. PRICE PER FOOT	AMOUNT 1927	AMOUNT 1926
7" to 9" Timber---	25270'	.0700	1768.90	5480.89
9" to 12" Timber---	16396	.1202	1972.36	18523.12
Total Timber 1927-	41666	.0897	3741.26	23904.01
Total Timber 1926-	222754	.1075	23904.01	43192.82

	1927	1926	Per 100'		
6' Cedar Lagging---	172200'	747840'	.691	1190.00	5168.00
Poles, ----------	134250	344000	1.250	1678.12	4300.00
Covering Boards----	163511	544093	1.406	2299.41	7442.60
Total 1927--------	469961	1635933		5167.53	16910.60

PRODUCTION, ----------	56330	218678
Feet of Timber Per Ton of Ore----------	.739	1.018
Feet of Lagging Per Ton of Ore----------	3.057	3.419
Feet of Boards Per Ton of Ore----------	2.902	2.488
Feet of Poles Per Ton of Ore----------	2.383	1.573
Feet of Lagging Per Foot of Timber---------	4.132	3.213
Cost Per Ton for Timber, ----------	.066	.109
Cost Per Ton for Lagging----------	.021	.024
Cost Per Ton for Boards----------	.040	.034
Cost Per Ton for Poles----------	.029	.019
Cost per Ton for All Timber----------	.156	.186
Equivalent of Stull Timber to Board Measure	123331	651236
Feet of Board Measure Per Ton of Ore-------	2.189	2.978

e. Drifting and Raising:

The only main level drifting and raising undertaken during 1927 was confined to development work in connection with the second level. There was no work done under this caption during 1926.
The following statement shows the ore and rock drifting and raising accomplished during 1927:

ORE DRIFTING	ROCK DRIFTING	ORE RAISING	ROCK RAISING
745'	315'	0	110'

The rock drifting from the North shore line to the shaft amounted to 240 feet and there was a 50-ft. extension beyond the shaft for tail track. The remaining 25 feet of rock drifting was to connect to the pump discharge raise.

The ore drifting was for the purpose of developing the deep channel at this elevation.

The discharge pipe raise had been pushed up 78 feet when underground development work was stopped, leaving about 22 feet to hole to the first level. A 45-ft. ladder way was put up under the old shaft on the second level.

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7. UNDERGROUND & OPEN PIT: (Continued)

f. Explosives, Drilling and Blasting:

Underground operating conditions during the first four months of 1927 were very similar to those existing during 1926, so far as explosives were concerned and the cost per ton for all explosives used was very close, being $.003 per ton lower for 1927.

Comparative Statement of Explosives Used in Underground Operations For Years 1926 and 1927.

	QUANTITY	AVERAGE PRICE	AMOUNT 1927	AMOUNT 1926
40% 1-1/8" Spec.Gel.---	15150#	$13.25	2007.38	754.00
35% 1-1/8" Spec.Gel.---	8850#	12.75	1128.37	9746.62
30% 1-1/4" R.C.--------	-	-	-	369.75
40% 1-1/4" R.C.--------	-	-	-	1282.50
TOTAL----------	24000#	$13.06	3135.75	12152.87
Fuse, Crescent---------	61100'	.624	381.26	1581.22
Caps, #6, E.B.---------	14500	1.062	154.06	920.46
TOTAL----------			535.32	2501.68
TOTAL ALL EXPLOSIVES----------			3671.07	14654.55
Production, ----------			56,330	218,678
Pounds of Powder Per Ton of Ore----------			.426	.431
Cost Per Ton for Powder, ----------			.055	.055
Cost Per Ton for Fuse and Caps----------			.009	.011
Cost Per Ton for All Explosives, ----------			.064	.067
Average Price per Pound of Powder----------			.1306	.1289

g. Open Pit Mining and Loading:

Open pit ore loading operations were started on May 2nd and continued until October 15th. There were several interruptions to ore loading, caused by the necessity for clean-up work and for taking out and moving the shovel when the bank slides occurred.

The Model 350 shovel continued loading along the South bank, where it was engaged at the end of the ore season in 1926. The cut was taken in an Easterly direction until May 11th, when rock was encountered and it was decided advisable to commence the clean-up work along the deep channel. The loading out of the material washed on to the deep channel ore occupied the shovel until the second of June. During the months of June and July the machine cut down in the deep channel, moving in a Northwesterly direction. The shovel was turned around at the end of July and started cutting to a greater depth in the channel, moving in a Southeasterly direction. As depth was attained in the second cut, the channel had narrowed to such an extent that it was difficult to make a complete swing and it was necessary at times to handle some rock in order to attain this.

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7. UNDERGROUND & OPEN PIT: (Continued)

g. Open Pit Mining and Loading: (Continued)

On August 3rd, when the shovel was digging in the deep channel opposite the shaft, a large slide occurred that pushed the machine off from its track and buried one side above the swinging circle. While no damage was done to the shovel, nor was anyone injured, owing to the narrowness of the channel most of the digging to free the machine had to be done by hand. It required several days to clear away sufficient material to allow the shovel to operate. It was decided not to go any deeper with the cut on account of the slide having filled the cut to quite an extent and also to the fact that it was deemed unsafe to operate at a lower elevation at this point.

A second slide, extending to the Eastward, occurred on August 11th and again the shovel was pushed from its tracks and one side buried. It required two days to free the shovel so that it could resume operations. After the second slide all attempts to take any deep channel ore were abandoned. The machine cut its way up and continued moving Eastward, taking only about 10 feet of the bottom of the old cut and as much ore from the North bank as was considered safe. No further slides occurred and the East end of the cut was reached September 14th and from that time until October 15th the machine dug along the South bank, digging out the old track bench.

A small revolving shovel was rented from the Oliver Iron Mining Company on September 10th and was used for cleaning pockets of ore over the old pit bottom to the West of the deep ore channel. These clean-up operations were completed on October 2nd and met with the approval of the fee owners.

A churn drill from the Hill-Trumbull Mine was used from July 5th until August 10th for drilling blast holes in the deep ore channel.

The slide of August 11th crushed part of the first level leading to the East deposit and as most of the water handled in the mine, flowed to the main pumphouse through this drift, it was necessary to make other pumping arrangements. A 1300 G.P.M. electric centrifugal pump was rented from the M. A. Hanna Company and installed in the East end of the pit. This pump handled the East deposit water direct to surface. The pump remained in service until the early part of November.

After the shipping season was completed the 350-ton shovel was moved on to a level place at the West end of the pit and the work of dismantling begun. A locomotive crane was brought over from the Hill-Trumbull Mine for use in connection with the dismantling and loading of the shovel for shipment. The shovel was loaded on cars and shipped from the Boeing pit, together with the other open pit equipment, on November 12th.

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8. COST OF OPERATING:

a. Comparative Mining Costs:

	1927	1926	INCREASE	DECREASE
PRODUCT:				
Open Pit	316,572	294,938	21,634	
Underground	56,330	218,678		162,348
Total Product	372,902	513,616		140,714
Avg. Daily Product	1,608	-		
Days Operated	129-104	150-308		
Budget, Estimated Production	500,000	-		
" " Cost at Mine-	2.255	-		
COST:				
Total Cost at Mine:				
Open Pit	.454	.329	.125	
Underground	1.734	1.538	.196	
Total	.647	.844		.197
Depreciation - Plant & Equipment-	.400	.400		
Ore Loading Equipment-	.050	.050		
Taxes	.044	.040	.004	
Occupational Taxes	-			
Central Office	.013	.010	.003	
Cost Adjustment	.005	.004	.001	
Stripping	1.150	1.150		
Winter Expense	.148	.068	.080	
Misc.Debits & Credits	.007	.004	.003	
Administrative Expense	.100	.100		
Cleveland Office Items	.005	.005		
Total Cost at Mine	2.367	2.118	.249	

b. Detailed Cost Comparison:

(1) Product:

The total production from the Boeing Mine was 140,714 tons less in 1927 than it was for the previous year. The production of open pit ore was 21,634 tons higher for 1927 and the underground output showed a shrinkage of 162,348 tons. Underground mining conditions reached such a stage, on account of the excessive water and sand-runs in the East deposit, that it was decided to discontinue work of this nature the fore part of May, which explains the large decrease in the underground production. In the open pit the slides of surface banks along the North side of the deep ore channel made it unsafe to continue digging with the big shovel in this territory and the tonnage that we had anticipated mining from the open pit was reduced considerably as a result.

(2) Open Pit Costs:

The open pit "Operating Accounts" showed an increase of $.125 per ton in 1927. The bad bank slides in the pit and the extra cleaning operations, together with an unusual amount of track work, resulted in a lower tonnage output and seriously affected the costs.

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8. COST OF OPERATING: (Continued)

b. Detailed Cost Comparison: (Continued)

(2) Open Pit Costs: (Continued)

During 1927 the drilling and blasting in the open pit was $.013 per ton higher than for the previous year. This was due to the necessity of heavy blasting in the deep ore channel. Pumping and drainage was $.06 higher in 1927. Underground operations were discontinued the fore part of May and the open pit had to take care of a large proportion of the charges under this account. Further than this, it was necessary to do considerable work on the launders and pit drainage system. The general open pit expense showed an increase per ton of $.038 in 1927. It was necessary to clean bank slides in order to get the shovel out of the deep cut and also to clean considerable material washed on to the channel ore.

Under "Special Expense" there was an increase of $.008, which covers the $2,500.00 settlement with Pribich for the flooding of his lands in the vicinity of the Boeing dump. The District Office charges were $.01 higher in 1927. The reduced tonnage output of the Boeing Mine was largely responsible for this increase.

(3) Underground Costs:

Under this caption almost all of the items showed an increase as compared with the previous year. This was due to the reduced output during the time the mine was operating the first four months of 1927 and also to more unsatisfactory mining conditions. During 1927 the operations were conducted in the East deposit, where the flow of water was excessive and sand-runs occurred frequently. During 1926 a substantial tonnage was obtained from the West deposit, where working conditions were much more favorable.

The items which showed the larger increase in the 1927 costs were: cave-ins, an increase of $.02, the result of clean up work in the East deposit; stocking ore, an increase of $.04, due to the erection of a trestle for a comparatively small tonnage; insurance - an increase of $.021 the result of a charge against a greatly reduced output; personal injury expense, an increase of $.054, which was the result of a number of semi-serious accidents during the past year - and an increase of $.006 in Mine Office and $.039 in District Office, explained by the reduced output from underground operations.

(4) Miscellaneous Group:

Under Taxes there was a 1927 increase of $.004 per ton. While the tonnage shown by the Tax Commission was less and the rate was also reduced in 1927, the shrinkage in the output more than off-set this and resulted in the above increase.

The increase of $.003 per ton in Central Office was the result of the reduced output from the mine, as compared with the previous year.

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8. COST OF OPERATING: (Continued)

b. Detailed Cost Comparison - Continued:

(4) Miscellaneous Group - Continued:

"Winter Expense" showed an increase of $.08 per ton in 1927 as against the previous year. More repairs were put on the open pit equipment than in 1926 and there was considerably more track work and general preparation in the pit during 1927 than was the case in 1926. If our anticipated open pit tonnage had been realized, the increased cost for this account would have been reduced decidedly.

9. EXPLORATIONS: AND FUTURE EXPLORATIONS:

No exploratory work was undertaken at the Boeing Mine during the past year.

10. TAXES:

Tax Statement:

	1927	1926	Increase	Decrease
Boeing Mine------	$16,650.45	20,933.42		$4,282.97

The decrease in the 1927 taxes at the Boeing Mine, as shown above, is the result of the shipments made during the season of 1926 and a reduction in the rate of valuation of the underground ore from 16¢ to 12¢ per ton and of the open pit ore from 23.1¢ to 22¢.

11. ACCIDENTS AND PERSONAL INJURY:

The following statement shows the number of accidents and total time lost during the years 1926 and 1927:

	-------1927---------		-------1926---------	
	Accidents	Time Lost	Accidents	Time Lost
Boeing Mine---	19	387 days	42	821½ days

There were no fatal accidents during 1927.

12. NEW CONSTRUCTION AND PROPOSED NEW CONSTRUCTION:

No new construction work was undertaken during the year 1927 and as the lease of the mine has been surrendered, no new construction work is contemplated.

13. EQUIPMENT AND PROPOSED EQUIPMENT:

At the end of the shipping season the following equipment was moved to the Hill-Trumbull Mine:

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13. EQUIPMENT AND PROPOSED EQUIPMENT: (Continued)

Shovel No.28 - Model 350
Locomotives Nos. 104,105 & 106.
One Flat Car.
2 - 12-yd. Dump Cars.
One Push Car.
4.71 Miles of Track, consisting of:
8375 ft. 80 lb. rail -and-
41051 ft. 70 lb. rail -with-
angle bars, tie plates, spikes and
switches.

The following rented equipment was returned to the Hill-Trumbull Mine:

No.22 Shovel - Model 60
No.23 Shovel - Model 60

The 1300 G.P.M. electric centrifugal pump was returned to the Wabigan Mine of the M. A. Hanna Company.

17. CONDITION OF PREMISES:

The Boeing Mine premises were maintained in a satisfactory condition during the past year, although no work was undertaken that was not absolutely necessary. Everything in and about the mine and location was left in a condition satisfactory to the fee owners' representative.

18. NATIONALITY OF EMPLOYES:

NATIONALITY:	NO. OF MEN 1927	NO. OF MEN 1926
American	23	38
Finnish	19	32
Austrian	17	30
Slavish	10	15
Italian	9	15
Swedish	2	8
Montenegrin	3	7
Croatian	5	6
Bulgarian	1	4
Swiss	1	2
Polish	-	2
English	1	1
German	-	1
Russian	1	1
Canadian	1	1
TOTAL	93	163

22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1927.

A. STAFF.

The staff of the Geological Department in 1927 is shown in Table I below. Mr. M. C. Drake, who has been employed in the Department as assistant geologist since June 1, 1924, was dismissed on October 31, 1927 to make room for Mr. A. H. Tillson, who for many years has been district chief engineer at Gwinn. Mr. Tillson assumed his new duties as assistant geologist on October 31, 1927:

TABLE I.

NAME.	OCCUPATION.	DURATION OF EMPLOYMENT IN 1927.	DAYS LOST. SICKNESS.	DAYS LOST. VACATION.	% OF WORKING DAYS WORKED.
E.L.Derby,Jr.	Chief Geologist,	Entire year	0	0	100.00
M. C. Drake,	Assistant Geologist,	10 months	6½	21½	87.8
A.H.Tillson,	" "	2 "	0	0	100.0
E. A. Allen,	Assistant, testing diamond drill holes, collecting & labeling samples, etc,	Entire year	1	½	99.5
Gustav Afuhs,	Draftsman,	" "	2½	7½	96.4

The year was divided into the factors as shown in Table II below:

TABLE II.

Total days of eight hours worked, - - -	276 days.
Sundays, - - - - - - - - - - -	52 "
Days resulting from Saturday afternoons, -	26½ "
Holidays, - - - - - - - - - - -	10½ "
Total,	365 days.

Table III, below, shows the average number of men regularly employed on the staff of the Geological Department during the past five years:

TABLE III.

YEAR.	AVERAGE NUMBER OF MEN.
1923	3.00
1924	3.58
1925	4.00
1926	4.00
1927	4.00

B. DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

H. L. Smyth. Mr. Smyth, who has acted as consulting geologist for the Company the past 28 years, approximately, resigned and severed his official connection with the Company on April 1, 1927. No one has succeeded him in this capacity.

E. L. Derby, Jr. I continued to have charge of the Department as Chief Geologist. The larger part of my time, as in former years, was taken up with the general oversight and supervision of the work of the Department. This has included, besides the usual routine office work, surface geological surveys and surface drilling explorations in the Tilden District on the Marquette Range and surface drilling explorations in the Crosby-Ironton District on the Cuyuna Range; underground drilling in the Cliffs Shaft, Holmes and Virgil Mines; and geological surveys in the Athens, Austin, Cliffs Shaft, Holmes, Maas, Morris-Lloyd, Negaunee, Republic, Stephenson and Virgil Mines. I personally made frequent underground geological surveys of the new development work in the Virgil Mine.

My time, not taken up with these duties, was spent chiefly as follows:

I visited once each month our explorations which were conducted on the Cuyuna Range. This comprises the Clark, Benedictine Sisters, Mathisen and Joan No.3 options, all in Section 34, 47-29, some three miles Northwest of Crosby, Minnesota. It was also frequently necessary, while on these trips, to go to Hibbing for conference with Mr. Barber and to make estimates and joint reports with him in connection with this drilling. This work was completed on December 6, 1927. In additions to this special work, I was engaged as follows:

In February, I prepared a report on the tonnages and operating conditions covering the properties we received either in fee or lease under the terms of the so-called Oliver Exchange. This was in connection with the valuation work undertaken by Mr. Geffine with the government engineers at Washington. I spent two days in Duluth and on the Cuyuna Range with Mr. W. G. Pearsall of the R. M. Adams Company, going over the data of several Cuyuna Range properties in which the latter company hoped to interest us. At the same time I was able to collect a lot of miscellaneous information on other Cuyuna Range operations.

In March, I conferred with Mr. F. G. Pardee, at that time engineer for the Michigan State Tax Commission. We went over the maps of the Company mines in Michigan very thoroughly and particularly those of the Virgil Mine. The principal discussion in connection with the latter was the occurrence of sulphur in the ore. I emphasized this damaging feature very strongly and he requested a complete report covering the subject. This was prepared and submitted to him by Mr. Meyers, Superintendent of the property, accompanied by a photographic longitudinal cross-section illustrating the ore occurrences as we interpret them from our geological data. I also spent some time going over the list of lands in the various counties of the Upper Peninsula which were being offered for sale for the taxes of 1924 at the spring tax sale, held in May.

In May, following the completion of the drilling on the Pontiac Mine proper, then called the Clark property, I made a detailed revised estimate of the ore developed, embodying the results in a special report. In company with Mr. Meyers, I examined the Ravenna-Prickett property at Crystal Falls and the records of the exploring done there in Mr. Cannon's office of the M. A. Hanna Company at Iron River. Mr. Meyers and I made a joint report on this investigation.

In June, I made a special estimate of the ore developed on the Pontiac Mine property to be used in our report to the Minnesota State Tax Commission. I prepared additional estimates and gathered miscellaneous data on the properties in-

volved in the so-called Oliver Exchange which were used in the report to the Federal Income Tax Unit prepared at our Cleveland office. Mr. Jackson and I spent two days in Chicago in conference with Mr. Geffine, our Auditor, and Mr. Rashleigh, Engineer of the Federal Income Tax Unit, going over all this data.

In July, I prepared a set of white print cross-sections of the Pontiac Mine property for the Minnesota State Tax Commission. While visiting our Cuyuna Range explorations, I went down to Minneapolis with Mr. Barber and called on Professor Lambert, Engineer for the Minnesota Tax Commission, at his office at the University of Minnesota. We went over the ore estimate of the Clark Mine and presented these cross-sections. Mr. Barber and I were shown through the Mines Experimental Station at the University, in company with Dean Appleby and Professor Lambert, by Mr. Davis, Superintendent of the Station.

In August, I made an estimate of the available ore remaining in the Mary Charlotte Mine and collected other miscellaneous information, all of which was incorporated in a report on this property by Mr. Jackson. I also made a number of estimates for Mr. Geffine while he was in Ishpeming to be used in his negotiations with the Tax Unit of the Internal Revenue Department at Washington in valuing the assets which we obtained from the Oliver Iron Mining Company in the so-called Oliver Exchange. I re-examined the core from our Pontiac Mine drilling and selected a number of samples from it to demonstrate the plausibility of benefiting this ore by hand picking or jigging. These results were embodied in a special report. In this connection, I called on Mr. W. G. Swart at Babbitt, Minnesota, while I was in Hibbing to get his opinion of the plausibility of this plan of beneficiating the Pontiac ore. Mr. Swart is General Manager of the Mesabi Iron Company and has had a lot of experience in the jigging and other concentrating fields. I consider him one of the best informed men in the country along these lines. He gave me a great deal of encouragement after examining the results of my sampling and agreed with the conclusions of my report.

In September, I made a detailed estimate of the ore developed and prospective in the Virgil Mine. I conducted Mr. M. C. Lake, Geologist for the Hanna Company, through all the working places in the Virgil Mine, paying particular attention to the occurrence of sulphur in the ore body. The Hanna Company, who is a relatively large operator in the Crystal Falls-Iron River District, is also experiencing difficulty with high sulphur ore in some of their properties and Mr. Lake was eager to see the way we were treating the problem.

In October, I made an estimate of the manganiferous ore developed up to that time by the drilling on the Joan No. 3 option, including in this the lean material that I consider may be beneficiated and brought up to the grade of the first class ore by hand picking or jigging. Messrs. J. E. Nelson and E. W. R. Butcher, of the Republic Iron & Steel Company, spent a day with me in my office, going over the maps and cross-sections of the Virgil Mine and the drilling information on their Sherwood property in anticipation of drilling some additional holes into the Sherwood from our underground workings along the latter boundary. I examined the maps and cross-sections and made underground examination of all the accessible workings of the Hartford and Cambria Mines at Negaunee, operated by the Republic Iron & Steel Company. This was in connection with the desire on the part of the Republic Company to lease a portion of the Jackson property lying immediately South of their South boundary. The result of this examination was covered by a special report. I also went to Sidnaw and conferred with Mr. Prickett relative to the preparation of geological maps of the Michigan Mineral Land Company's property to be used in a general report and prospectus covering this property. While in Hibbing conferring with Mr. Barber on our Cuyuna Range explorations, I accompanied him to the Holman-Brown pit and examined the proposed washing plant site to the South of this property.

GEOLOGICAL DEPARTMENT.

In November, I made a new estimate of the ore, developed and prospective, in the Virgil Mine. While in Minnesota visiting the Cuyuna Range explorations, I went to Hibbing and assisted Mr. Barber in preparing a final report on the Joan No.3 property. I attended a conference at Chicago with Messrs. S. L. Mather, Elliott and Barber, going over a large number of questions connected with our properties on all of the various ranges.

In the first part of December, I attended a meeting of the Minnesota section of the American Institute of Mining & Metallurgical Engineers held at the Mines Experiment Station at the University of Minnesota, Minneapolis. I also attended the Fortieth Annual Meeting of the Geological Society of America and Society of Economic Geologists held at the Western Reserve University and Case School of Applied Science, Cleveland, Ohio, the last of the month. I made a new estimate of the ore on the Erickson lease and went to Sidnaw and conferred with Mr. Prickett in connection with the geological report we are preparing for the Michigan Mineral Land Company.

M. C. Drake. Mr. Drake continued as assistant geologist until November 1st when he left the Company's employ to make room for Mr. A. H. Tillson, formerly our district engineer at Gwinn. He made regular underground geological surveys in the Cliffs Shaft, Holmes, Morris-Lloyd and Republic Mines and posted these surveys on the geological maps and cross-sections. He also made occasional geological surveys at the Athens and Stephenson Mines. He posted, periodically, the geological maps and cross-sections of the Athens, Austin, Maas, Negaunee, Stephenson and Virgil Mines from the data supplied us by the engineers of these properties. During June, July and August, he spent considerable time in the field as geologist with a party of engineers who located contours and rock outcrops in the NW¼ of Section 25, 47-27, in the Foster-Tilden District. He checked over the plotting of all the final set of Pontiac Mine exploration cross-sections. The rest of his time was taken up with office routine work.

A. H. Tillson. As stated above, Mr. Tillson, formerly district mining engineer at Gwinn, took Mr. Drake's place in the Geological Department as assistant geologist on October 31st. He made an underground geological survey in the Cliffs Shaft,Mine and posted this survey on the geological maps and cross-sections. He also posted the geological maps and cross-sections of the Athens, Maas, Negaunee and Virgil Mines. He checked over the plotting of the Joan No.3 exploration cross-sections and also the Michigan Mineral Land Company maps that we are making for a geological report on this property. He spent several days on engineering workmconnected with the Gardner-Mackinaw Mine, which is being re-opened, and also a small amount of time on engineering work connected with the new Cataract water power development, as he was familiar with both these projects before leaving Gwinn. The rest of his time was taken up with the routine work of the office.

E. A. Allen. Mr. Allen continued as an assistant in the Department during the year. At times, however, he also assisted several of the engineers with their surveys and drove the Dodge truck. The major part of his time was spent in collecting, sampling and filing diamond drill samples from the current explorations. Frequently he classified and reported on the core and samples from the various explorations while I was absent on my monthly trips to Minnesota. He also made the regular monthly carbon reports and the annual inventory of diamond drill equipment.

Gustav Afuhs. Mr. Afuhs continued as our draftsman throughout the year. His work, as formerly, has in part, consisted in preparing cross-sections of all current drilling. A great deal of this work was necessary in connection with our Cuyuna Range explorations at the Pontiac Mine and adjoining options. A special set of cross-sections was made of the recent Tilden drilling. He prepared several maps

which were used in our depletion reports to the Federal Income Tax Unit covering the property involved in the so-called Oliver Exchange. He prepared two sets of blue print maps and cross-sections of the Mary Charlotte Mine workings to accompany Mr. Jackson's report on this property. He posted the geological longitudinal cross-sections through the Morris-Lloyd and Spies-Virgil Mines. He prepared three sets of blue print maps to accompany my special report on the examination of the Hartford-Cambria Mines. He also made copies of drill results, for our outside exploration files, of all important land offers that were received during the year. On account of our recent activity on the Cuyuna Range, we have had a large number of land offers from that District. He spends a considerable time at the beginning and close of each year coloring the annual report and Tax Commission white prints of our drilling for the year and the legend sheets to accompany them. He is now preparing five white print maps of Iron County showing the property of the Michigan Mineral Land Company and its relation to the geological features and explorations in the District to accompany my geological report on this property. The rest of his time was spent on the routine work of the office.

C. SURFACE GEOLOGICAL SURVEYS.

A detailed geological survey was made during the year in the NW¼ of Section 25, 47-27. This work was started during the fall of 1926 and discontinued when the winter weather set in. Work was resumed the past June and completed in August. The field notes of this work have not been plotted but we anticipate this will be done during the present winter. The field work consists in contouring, as well as locating and geologizing all rock outcrops.

In addition to this, a magnetic survey was made in connection with our exploring at the Pontiac Mine and adjoining options on the Cuyuna Range. This work was done for us by Mr. H. I. Pearl, an independent engineer of Crosby, Minnesota.

D. UNDERGROUND GEOLOGICAL SURVEYS.

D-1. ATHENS MINE.

The geological surveys at the Athens Mine were made periodically by Mr. Nicolson, Engineer up to the time of his departure for Alaska in April. Following this, the surveys were made by Mr. Allen, also of the Engineering Department. We have kept this information posted on both the geological maps and cross-sections. The area of hard jasper mixed with paintrock along the South footwall near the Lucky Star line above the 4th level, which was encountered in 1926, where we had anticipated good ore, continued to persist. The resulting decrease in ore tonnage is not important in size. Developments in other parts of the mine, however, were in accord with expectations as based on previous surveys.

D-2. AUSTIN MINE.

Mining in the shaft pillar at the Austin Mine was carried on up to September 31st. This completely exhausted all ore in the mine and the property was abandoned. We have since surrendered our lease. Mr. Tillson, Engineer at the property, collected the little geological data that was available and we have posted both the geological maps and cross-sections to the time of exhaustion.

D-3. CLIFFS SHAFT MINE.

We continued to make detailed geological surveys in the Cliffs Shaft Mine each time the engineer made his regular surveys. Both the geological maps and cross-sections have been posted regularly.

Ore continued to be developed from the 6th level "A" Shaft on the extension of the old Incline and No.3 Mines. The main Southeast deposit also continues to look good in stopes from the 4th, 5th, 6th, 7th and 8th levels "A" Shaft. The development of the extension of ore on to the Oliver lease in Section 3, which we call the Bancroft, continues to measure up to expectations. This work is going on from the 2nd, 5th, 7th and 8th levels "A" Shaft. A new lens of ore is being developed in a raise from the West end of the 15th level "B" Shaft and has already been followed considerably above the 14th level. It is in the hanging wall of the other ore in this vicinity. Drifting will soon commence from the 13th level to open up this ore at that elevation.

D-4. HOLMES MINE.

We have made geological surveys at this mine only occasionally during the year as the mine work was principally stoping in areas already developed and geologized. The geological maps and cross-sections, however, have been kept posted regularly.

The Holmes shaft was sunk from the 4th to the 5th level during the year. The new level is located 130' below the 4th level. The shaft was all in the same greenstone sheet as that encountered above. The hard ore tonnage above the 3rd level has been somewhat increased beyond expectations but diamond drilling from the 4th level demonstrated a decided contraction in the size of the ore in its pitch to the West beneath this level. This has resulted in a net loss of several thousand tons in anticipated ore.

D-5. MAAS MINE.

The work at the Maas consisted almost entirely of stoping in areas already developed and no notable changes were found in the anticipated conditions. Mining is being concentrated in the Northeast and upper part of the mine along the North footwall, just West of the Negaunee boundary in order to work out this area as soon as possible. When this is finished, the mining can then be concentrated in the area below the 3rd level. Pillars of ore, which were formerly left to support the surface of the Race Course, will now be mined as the clearing of the surface of the latter is under way, making it unnecessary to support it any longer. Geological data was collected regularly by Mr. Moulton, Engineer at the property, and we have posted this information on both the geological maps and cross-sections.

D-6. MORRIS LLOYD MINE.

We have made geological surveys periodically at this property and have posted the geological maps and cross-sections regularly. Development work in the No.33 deposit on No.9 lease during the year has continued to increase the limits of this deposit until it now extends beyond the South boundary of the lease on to land owned in fee by this Company.

The Morris shaft is being sunk and has reached a point below the 8th level, which will be opened up 200' below the 7th level. The shaft is being all in footwall Siamo slate. The other developments at the mine have been principally in areas previously more or less outlined and the mining has uncovered no unusual conditions.

D-7. NEGAUNEE MINE.

Mr. Moulton, Engineer at the Negaunee Mine, has collected the essential geological data at this property regularly and we have kept the geological maps and

cross-sections posted to date. Work continued during the year opening up the new 12th level. No other notable changes have occurred.

D-8. OGDEN MINE.

The Ogden pit was worked continuously during the past shipping season and the geological data was collected as work progressed by Mr. Allen, Engineer at the property. No special change has occurred in the geological conditions at this property and it is anticipated that the ore above the present bottom of the pit will be exhausted during the coming shipping season.

D-9. REPUBLIC MINE.

We have made regular geological surveys at the Republic and have posted the geological maps to date. The new ore, which was developed during 1926 close to the Pascoe Shaft and worked in a shallow stope from an incline near the shaft, was mined out during the past year. Some 14,000 to 15,000 tons of ore resulted from this operation. It proved, as we had anticipated, to be an irregular fringe or embayment of the large ore body close by that was mined out from an open pit many years ago.

The only mining now going on at the property and which was the principal operation during the year is the stoping out of floor pillars below the 1500' and 1570' levels. Small extensions of these ore bodies have been found and followed by stoping from these levels. Unless additional ore is found in recovering the floor pillars, the mine will probably be considered exhausted when this work has been completed. What ore will then remain in the mine will be either unavailable or too expensive to recover.

D-10. STEPHENSON MINE.

Geological data was collected at the Stephenson Mine at regular intervals by Mr. Sterling, Engineer at the property until he was transferred to the Mesabi Range, and then by Mr. Tillson. We have posted this information on the geological maps and cross-sections. The mine was abandoned on July 29, 1927. Mr. Tillson's estimate shows 207,097 tons remaining in the mine; 163,356 tons is located in the Southeast deposit and unavailable on account of the water hazard above it. The balance is scattered in small areas and on account of the increasing flow of water and difficulty in maintaining the drifts, it was considered uneconomical to mine the balance of this ore.

D-11. VIRGIL MINE.

We continued to make detailed geological surveys at the Virgil at regular intervals and the information was posted on the geological maps and cross-sections.

Stoping in the Southwest part of the deposit just above the 6th level had to be abandoned on account of a slide of black slate from the footwall. Fortunately, development work in the Northwest part of the mine above the 6th level had progressed sufficiently so that a new stope was soon started and production brought back to normal. All mining is now ~~scattered~~ concentrated in this part of the mine.

The 4th level was holed through to the raise put up from the 6th level and a main South crosscut driven through the ore to the South footwall. Several raises have been put up above the 4th and two sub-levels are being developed. So far the ore encountered in this development has been practically all high sulphur. There is a contracted area of low sulphur ore, encountered in the South crosscut on the

main level,and we hope that this will be found to continue upward. There were 834 samples taken, practically all of them at 10' intervals, throughout all the openings in the mine that are in ore. Complete analysis maps were prepared from this data to facilitate the laying out of areas to be stoped and to avoid bunches of lean and high sulphur ore. Production from the property has now reached an encouraging stage.

E. OPTIONS AND LEASES.

Three options for exploring, two leases and two mineral fees were acquired during the year; also four mining leases and two exploring options were surrendered.

Options for exploring were acquired as follows:

Option from Wilbur Van Evera of Crosby, Minnesota, on the Benedictine Sisters property, the $SW\frac{1}{4}$ of the $NW\frac{1}{4}$ of Section 34, 47-29, Cuyuna Range, Minnesota, extending to December 3, 1927. This property lies immediately West of the Pontiac Mine.

Option from Wilbur Van Evera of Crosby, Minnesota, covering the $NW\frac{1}{4}$ of the $SW\frac{1}{4}$ of Section 34, 47-29, Cuyuna Range, Minnesota, extending to September 2, 1927.

Option from Charles J. O'Connell of Crosby, Minnesota, covering the $S\frac{1}{2}$ of the $NE\frac{1}{4}$ of Section 34, 47-29, Cuyuna Range, Minnesota. This is the Joan No.3 property and the option extended to September 3, 1927. It was subsequently extended for ninety days to December 2, 1927.

The option which was acquired from Mr. B. Magoffin, Jr., during 1926 covering the Pontiac Mine property was exercised, both as to lease and fee. In other words, we purchased the existing mining lease on the property and also the fee.

The option covering the Joan No.3 property was also exercised and a lease acquired.

The fee of the Barnes-Hecker Mine was purchased November 4, 1927.

The following mine leases were surrendered and options relinquished:

Austin Mine lease No.4 was surrendered September 20, 1927.

Boeing Mine lease No.49 was surrendered November 19, 1927.

Gwinn Mine lease No.6 was surrendered May 31, 1927.

Spies Mine lease No.41 was surrendered July 28, 1927.

The options of both the Benedictine Sisters property and the Mathisen property on the Cuyuna Range, West and Southwest of our Pontiac Mine, were relinquished.

F. EXPLORATIONS.

Drilling explorations were carried on during 1927 in the following districts and mines:

F-1. FROM SURFACE.

DISTRICT.	RANGE.
Crosby-Ironton,	Cuyuna.
Tilden,	Marquette.

F-2. FROM UNDERGROUND.

MINE.	DISTRICT.
Cliffs Shaft,	Ishpeming.
Holmes,	Ishpeming.
Virgil,	Iron River.

Table IV, which follows, gives the footage drilled, the ore encountered, and the cost per foot of drilling for both the surface and underground explorations. It will be noted that the average cost of surface drilling was $3.60 per foot, excluding certain items which are not actual drilling expense but which are charged to explorations. By including these items, the average cost was $4.26. The average cost of underground drilling in the same way was $2.14 per foot and $2.47 per foot, respectively.

Tavle V, also shown below, gives a comparative cost per foot of total drilling for the past five years. It will be noted that the cost per foot of the total drilling for 1927 was somewhat higher than that for 1926 in spite of the fact that the cost of underground drilling was less. This is explained by the fact that the drilling done on the Pontiac property in 1926 under contract was paid for on the basis of $2.25 per foot for standpiping and churn drilling and $3.00 per foot for diamond drilling. As the diamond drilling was costing the contractor considerably more than he was getting, we allowed him to raise the price from $3.00 to $3.75 per foot.

Last year we drilled a total of 2297' in the Cliffs Shaft Mine at a cost of $3.33 per foot, excluding the accessory items mentioned in the note under Table IV. This year, with a total of only 1509', we did this work for $2.76 per foot. I think this is a remarkable reduction and a very cheap cost in hard ground such as exists in the Cliffs Shaft Mine. I don't think we have ever done this work as cheaply. The low cost of $1.66 per foot in the Holmes Mine is due to a considerable proportion of the footage being soft dike and slate.

TABLE IV.

SUMMARY OF DRILLING FOR 1927.

EXPLORATION.	DESCRIPTION. SEC. T. R.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST. "A".	COST PER FOOT. "A".	TOTAL COST "B".	COST PER FOOT. "B".
				SURFACE DRILLING.								
Pontiac, including adjoining options,	34, 47-29, Minn.	4241	613	9257	14111	1568	927	0	$58,802.63	$4.17	$49,382.72	$3.50
Tilden,	26, 47-27, Mich.	113	34	1671	1818			1611	9,087.20	5.00	8,031.87	4.42
Total Surface Drilling,		4354	647	10928	15929	1568	927	1611	$67,889.83	$4.26	$57,414.59	$3.60
				UNDERGROUND DRILLING.								
Cliffs Shaft Mine,	9 & 10,47-27			1509	1509	90	66	42	$4,681.23	$3.10	$4,162.78	$2.76
Holmes Mine,	9, 47-27			1370	1370	409	7	0	2,508.76	1.83	2,276.60	1.66
Virgil Mine,	24, 43-35		1361		1361	540	105	128	3,264.67	2.40	2,645.98	1.94
Total Underground Drilling,			1361	2879	4240	1039.	178	170	$10,454.66	$2.47	$9,085.36	$2.14
Grand Total Drilling,		4354	2008	13807	20169	2607	1105	1781	$78,344.49	$3.88	$66,499.95	$3.30

NOTE:- Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.
Cost "B" excludes " " " " " " " " (To compare with contract price).

The drilling on the PONTIAC AND ADJOINING OPTIONS was done under contract by the S. E. Atkins Company, of Duluth.

TABLE V.

SUMMARY OF FOOTAGE DRILLED AND COST PER FOOT OF DRILLING FOR PAST FIVE YEARS.

YEAR.	TOTAL FEET DRILLED.	COST PER FOOT "A".	COST PER FOOT "B".
1923	9,091	$3.65	$3.38
1924	11,007	4.10	3.54
1925	11,708	3.22	2.84
1926	19,299	3.21	2.86
1927	20,169	3.88	3.30

F-3. DIAMOND DRILL CARBON.

We had on hand January 1, 1927, a total of 430.15 karats of diamond drill carbon which inventoried at $46,954.40. No new carbon was purchased during the year. We consumed during the year 22.84 karats at a cost of $2,591.22, leaving a balance of carbon on hand December 31, 1927, of 407.31 karats inventoring at $44,363.18.

G. SURFACE EXPLORATIONS.

G-1. CUYUNA RANGE, CROSBY-IRONTON DISTRICT.

SECTION 34, 47-29, MINNESOTA, PONTIAC MINE.

The Pontiac Mine, which until we purchasedthe lease and fee in the spring of 1927, was known as the Clark option, comprises four forties, namely, the NW¼ of the NE¼, the N½ of the NW¼ and the SE¼ of the NW¼, all in Section 34, 47-29. We commenced a campaign of drilling on the SE¼ of the NW¼ in the fall of 1926. The drilling was done under contract by the S. E. Atkins Company of Duluth and four drills were used most of the time.

A mineable lens of black manganiferous ore had been discovered by drill holes put down several years ago. In the present campaign, we laid our holes out, both to check this old drilling and to explore for ore extensions.

Inclined holes were drilled on cross-sections averaging from 110' to 125' apart East and West and on a course of a little West of North and East of South, or roughly at right angles to the trend of the ore lens. Eleven holes had been completed and four were being drilled on the first of the year.

Drilling was completed April 27, 1927 after a total of 29 holes had been drilled. As a result, we have developed a lens of black manganiferous ore extending entirely across the forty, having a very steep or almost vertical dip, and enclosed in hard rock walls resembling the taconite of the Mesabi Range. This condition should lend itself to a cheap method of mining without timber. The ore outcrops at ledge surface. This is covered by from 65' to 70' of water-bearing sand with some clay. I estimate we have developed by this drilling 694,700 tons of manganiferous ore which will average 36.85% iron, 14.57% manganese, .073% phosphorus and 17.25% silica, all dried analysis, or a combined iron and manganese content of 51.42%.

SECTION 34, 47-29, SISTERS AND MATHISEN OPTIONS.

Near the close of our drilling on the Pontiac, we secured options on the forty immediately West, or the SW¼ of the NW¼ of Section 34, owned by the Benedictine Sisters, and the forty to the South of this, or the NW¼ of the SW¼ of Section 34, and owned by Mathisen et al. The trend of the manganiferous lens in its extensions, a little South of West, indicated the possibility of similar ore crossing these two descriptions and close to the line between them.

Drilling was commenced on the Sisters forty under contract with Atkins on February 20, 1927 and a series of ten inclined holes were put down on the two descriptions close to the line between them and extending pretty well across the area. A few holes had been drilled some years ago, indicating some ore along the line of the Pontiac lens extended. We were unable in our drilling to check this ore in some instances and no where did we get a continuity of enrichment which was at all encouraging; also, the wall rock on the North side of the ore horizon was found to be very largely decomposed in places, which

would be a serious condition in mining any ore that we might find by a method without timber.

After drilling the ten holes mentioned, the last of which, No.346, was completed on June 22, 1927, we decided to abandon a further attempt to locate a manganiferous ore on these descriptions. The options have been relinquished.

SECTION 34, 47-29, MINNESOTA, JOAN NO.3 OPTION

Towards the end of our drilling on the Pontiac Mine we also secured an option on the Joan No.3 property. This lies directly East of the Pontiac and comprises the S½ of the NE¼ of Section 34.

A few holes had been drilled on the West forty of this description showing manganiferous ore and about on the line of extension of the Pontiac lens. We laid out cross-sections 100' apart on a base line N. 75° E. across the entire eighty acres and on a course of N. 15° W.

Drilling was commenced by Atkins under contract with hole No.333 on April 14, 1927, and a total of thirty inclined holes were drilled on these cross-sections. The work was completed with hole No.369 on December 6, 1927.

As a result of this drilling, we found the Pontiac manganiferous ore lens to extend on to the Joan for a little over 500' with an estimated tonnage of 99,000 tons. The next 700' along the strike of the manganiferous horizon was unenriched. East of this point, however, we encountered good ore extending for about 900' along the strike, where it again played out. We estimate a tonnage of 237,200 tons of ore in this body, or a total in the two deposits of 336,200 tons.

In addition to the above, there is 57,200 tons in the West ore body and 73,800 tons in the East ore body, or a total of 131,000 tons, that we firmly believe can be recovered by picking out the rock seams that occur interbanded with the ore. This, we think, can be readily accomplished on a picking belt after the ore has been crushed. We will, therefore, have a total of 467,200 tons of manganiferous ore averaging 32.98% iron, 17.46% manganese, .078% phosphorus and 18.25% silica, all dried analysis, or a combined iron and manganese content of 50.44%. Similar to the Pontiac, the ore here has practically a vertical dip and is enclosed in walls of the same hard rock resembling taconite. It also outcrops at ledge surface under from 60' to 65' of water-soaked sand mixed with clay.

We acquired a lease on this property on January 1, 1928 and are now negotiating to buy the fee.

G-2, MARQUETTE RANGE, TILDEN DISTRICT, SECTION 26, 47-27, TILDEN EXPLORATION.

Drilling commenced during December 1926 to sample the large, hard siliceous ore outcrop in the NW¼ of the NW¼ of Section 26 and South of the old Tilden Mine, using two Company drills. This work continued until June 8, 1927.

Eleven holes were put down, nine of them with a dip of-60° S. 15° E. and two of them vertically. They were located on five cross-sections on a course of S. 15° E. extending across the area of outcrop. The depths of the holes were variable, depending on the contour of the ground, the plan being to sample the siliceous ore formation down to the elevation of the valley on the South side.

This drilling resulted in the development of close to five million tons of siliceous ore of approximately the grade which we have been mining at the Ogden pit. For the most part, the ore outcrops or is covered by only a few feet of soil.

GEOLOGICAL DEPARTMENT.

On the East side, however, there is in places as much as 26' of surface material. In this area, also, the sulphur in holes Nos.4, 5, 6 and 7 averages from .031% to .095%, which is rather undesirable in this class of ore. On account of this, we are eliminating from our estimate the ore in this area, which amounts to a little over a million tons, leaving a net tonnage of about 3,800,000 tons.

H. UNDERGROUND EXPLORATIONS.

H-1. CLIFFS SHAFT MINE.

One drill was operated continuously in the Cliffs Shaft Mine from the first of the year until early in March. It was then moved to the Holmes Mine and used until the end of July. After finishing the drilling at the Holmes, the drill was moved back to the Cliffs Shaft Mine and drilled continuously for the balance of the year. Five holes were completed and the sixth one started. All of them were drilled horizontally.

Hole No.374 was being drilled due North from the North side of the 3rd level "A" Shaft at the beginning of the year to aid in the development of that part of the Cliffs Shaft ore body which extends over on to Lot 2 Section 3 which is leased from the Lake Superior Iron Company. Three separate runs of good ore were encountered in the hole; one from 155' to 170', the second from 178' to 197' and the third from 251' to 261'. A second hole, No.375, was also drilled due North from this level into the same territory but from a point 200' West of No.374. It encountered no ore of importance and proved to be mainly in the footwall of the main lens encountered in the first hole.

The next two holes, Nos.376 and 377, were drilled from the North side of the 7th level over into the Lake Superior Iron Company lease, or the Bancroft as we call it, to continue exploring for the extension of the main Cliffs Shaft ore. Both holes encountered ore but it was a little leaner than the regular high grade ore which we are developing in this area. It is likely that neither hole passed through the main lens but instead cut the edges of it. If this interpretation is correct, the holes will still prove valuable in laying out the development work.

Hole No.377 was also drilled from the same locality on the 7th level but was drilled to the South to explore the main fault zone. Fourteen feet of good Bessemer ore was cut from 6' to 20' just before cutting into the brecciated material through which we drilled after a great deal of trouble from caving. It required two and a half months to drill 250' but we deemed it advisable to cut this fault vein at some point in the vicinity and this location seemed to be as good as any. A seam of ore was encountered but we believe it to be of no economic importance at this elevation. It will be explored for at other elevations where conditions for a mineable ore body may be found to be more favorable.

Hole No.379 is now drilling N. 20° E. from the same locality on the 7th level, the coordinates of the hole being North 30 and 1545 East. This hole is laid out to test what appears to be a minor syncline with nearly an East-West axis and probably pitching to the East. We encountered 14' of good ore at the start of the hole and then passed into hanging wall slate. The hole wasstill in slate at a depth of 404' at the end of the year. We hope we shall find commercial ore on the North limb of this syncline before passing into the main footwall.

H-2. HOLMES MINE.

The Cliffs Shaft drill was moved to the 4th level Holmes Mine early in March. Eight incline holes, Nos.21 to 28, inclusive, were drilled from this level to determine the bottom limits of the ore in its Westerly pitch and Southerly dip in order to facilitate the planning and laying out of a new main level. The angle of inclination of these holes varied all the way from-29° to -79° and they were laid out to cross-section the ore body on three sections, E-E1, F-F1 and G-G1, all N. 45° E., or at approximately right angles to the strike.

This drilling indicates that the ore is not as wide in its downward extension, nor does it extend as deep as we had anticipated. The new level, the 5th, has been laid out 130' below the 4th. The shaft has been sunk to this elevation and the work of driving the level will soon start.

H-3. VIRGIL MINE.

Drilling in the Virgil Mine was carried on continuously throughout the year, using the Denver deep hole reciprocating air drill, with the exception of the period from the first of March to the 21st of June when the machine was broken down and new parts had to be sent for before its repair could be accomplished.

Twenty five holes, Nos.71 to 95, inclusive, were drilled with a total of 1361' as follows:

LEVEL.	NO. OF HOLES.	FOOTAGE.	FIRST CLASS ORE.
4th,	19	909'	389'
145' sub,	1	70	40
90' "	4	246	96
6th,	1	136	15
Total,	32	1361'	540'.

The relatively large number of holes which were drilled on the 4th level was chiefly on account of the anticipation of high sulphur in the ore, although they were so laid out that the outline of the ore body itself was quite accurately located. The main ore body as it ascends from the 120' sub-level splits into three separate fingers. Two of these extend to the 4th level and above it. We found, as anticipated, that the larger part of the ore at the elevation of the 4th level is high in sulphur. From the drilling we have also outlined the low sulphur area where raises were put up, from which we are now driving exploration sub-levels to try and outline this ore. The holes on both the 90' and 145' sub-levels were all started in ore and drilled to find the limits of the ore. This type of drilling machine is not practical for much rock drilling, except possibly in the softer slates.

On the 6th level we drilled one hole to try and locate commercial ore in a fold in the iron formation just East of the slate footwall, which is encountered in the main North crosscut on this level. The hole encountered about 60' of enrichment in the formation but only two seams of good ore, one of 10' from 25' to 35' and the other 5' from 45' to 50'. The hole had to be stopped, however, at a depth of 136' in cherty iron formation because of its inability to make satisfactory progress. It is likely that ore may yet be found to exist in this fold. The ground will be explored by a different method of attack.

The Republic Iron & Steel Company are considering a campaign of drilling to resample and more completely outline their Sherwood ore body. This is probably an extension of the main Virgil ore body. They hope to do this with horizontal holes drilled from our Virgil Mine workings along the boundary between the two properties.

I. EXPLORATIONS BY OTHER COMPANIES.

We do not attempt, as we used to in years past, to keep close watch of the explorations conducted on the iron ranges by other companies by having one of our men make periodical trips to visit them. The explorations which have come to our attention, however, are as follows:

The Republic Iron & Steel Company put down seven vertical, or steeply inclined holes, from surface on the Lillie Mine property. These holes were in the area West of the main North-South dike near the West side of the Cambria property and South and East of the old Lillie Mine workings which were also cut off by a dike striking a little North of East. Mr. Hanson, Superintendent at this property, advises me that so far no commercial ore has been encountered in this drilling.

The M. A. Hanna Company are continuing to drill on the East end of the Gogebic Range. I understand they are using two drills and have laid out a campaign which will last approximately two years. I do not know exactly where this work is going on but it is on that part of the Range which bends around to the Southeast and I imagine that it is in Township 47 Range 44. The geological structure is very complicated in this area and the Hanna people are quite optimistic from the results already obtained. I have not heard, however, that any important commercial ore has been encountered.

I understand that exploring, including considerable diamond drilling, will be resumed shortly at the West end of the Gogebic Range near Mellen, Wisconsin. This is chiefly a magnetite area where large bunches of lean magnetite ore have already been developed and some concentrating by magnetic separation done in years gone by.

There has been quite a little drilling activity on the Cuyuna Range the past year. The old Preston property, the N½ of the NW¼ of Section 27, 47-29 and other lands, Southwest of the Milford property on the North Range were optioned by the Hanna Company early in the year and a few holes put down. They relinquished their option and it has since been taken up by the C. K. Quinn Company, who is now drilling it. The North Hill-Crest property, located in Section 10, 46-29, was check-drilled by the R. M. Adams Company. It was then optioned to Butler Brothers, who are now doing more drilling. A body of open pit manganiferous and iron ore has already been developed on the property. Other scattered drilling has been done on the Cuyuna Range the past year but I understand it was of little economic importance and I do not have the detailed information as to location or results. It is rumored, however, that considerable drilling activity is anticipated during the coming year.

J. EXAMINATION OF MINERAL LAND OFFERS.

Twenty five mineral land offers, whose records of drilling or other exploring were examined, have been covered by special reports during the year. A few of the more important ones are as follows:

No.1639 comprises Lots 2 and 3 and the SE¼ of the NW¼ of Section 30, 46-28, C row Wing County, Minnesota. This is known as the Adams Mine and it is estimated to contain one and a half million tons of iron ore averaging 56.00% iron. The offer was declined.

GEOLOGICAL DEPARTMENT.

No.1642 covers the Benedictine Sisters forty, or the SW¼ of the NW¼ of Section 34, 47-29, Crow Wing County, Minnesota. This property adjoins the Pontiac Mine on the West. We acquired an option on this property and explored it during 1927. As no ore of importance was discovered, the option has been relinquished.

No.1643 is the Mathisen property, which is the NW¼ of the SW¼ of Section 34, 47-29, Crow Wing County, Minnesota, and adjoins the Benedictine Sisters forty on the South. We also acquired an option to explore on this property and drilled it during 1927. No ore of importance was disclosed and we relinquished the option.

No.1644 is the Joan No.3 property. It comprises the eighty acres adjoining the Pontiac Mine on the East and is the S½ of the NE¼ of Section 34, 47-29, Crow Wing County, Minnesota. We acquired an option on this property and drilled it during 1927. We have since taken a lease on the property dated January 1, 1928 and are negotiating to buy the fee. The results of this exploration are given in detail elsewhere in this report.

No.1646 comprises the Silverman Mine on the Vermilion Range, which is the NE¼ of the SW¼ of Section 26, 63-12, St. Louis County, Minnesota. The offer also included about 800 acres of land near the Eastern end of the Mesabi Range in Sections 1 and 12, 59-14. This offer was declined.

No.1648 covers an undivided half interest in the mineral rights underlying 1964.68 acres in Sections 1, 25, 26, 27, 30, 31, 32, 33, 34, 35 and 36, Township 47-34, Baraga County, Michigan, the price being $500 cash. This offer was recommended and I understand the purchase has been made. The property is very closely linked with lands of the Michigan Mineral Land Company and it is thought that this acquisition may help materially in disposing of the holdings of the latter company.

No.1652 covers the Hillcrest property, the Ferro group and the Mangan group of properties, all located on the Cuyuna Range in Crow Wing County, Minnesota. The offer was declined.

No.1659 covers the W½ of the NW¼ of Section 15, 56-23, Itasca County, Mesabi Range, Minnesota. This is a wash ore property near Snowball Lake and I estimated it to contain 600,000 tons of concentrates recoverable from an open pit area which would require the removal of 1,265,000 cubic yards of surface. I do not know what disposal was made of this offer but think it was declined.

No.1660 comprises the NE¼ of the NW¼ of Section 33, 47-29, Crow Wing County, Minnesota. This is the Algoma Mine on the Cuyuna Range and contains black manganiferous ore similar to that in the Pontiac and Joan No.3 properties. I have no record as to the disposition of this offer but believe it has been declined.

No.1679 covers the Mary Charlotte Mine located in Sections 7 and 8, 47-26, just South of the City of Negaunee on the Marquette Range. This property was offered and an examination made of it and covered by a special report in April 1925. An examination was again made and a detailed report written in August 1927. I have no record of the disposition of this offer but believe it was declined.

No.1682 comprises 2100 acres held by the Gogebic Iron Syndicate and others and located on the Southwesterly extension of the Gogebic Range in 45-1 E. and 45-1 W., Wisconsin, in both Iron and Ashland Counties. As I understand it, no definite offer has been made covering this property but the information was presented to us by Mr. B. C. Neely of Crystal Falls withnthe idea of interesting us

and if so, he would try and make us a definite offer. I do not believe that he was encouraged in this, although my records do not show the ultimate outcome of the negotiations.

K. EXPENSE STATEMENTS.

Tables VI and VII, which follow, show a detailed statement of charges to geological expense for the year and a comparative statement of these charges for the last three years. They are self-explanatory:

TABLE VI.

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1927.

Salaries, - - - - -	$12,976.88
Travel, - - - - - -	336.34
(1) Operating automobiles, -	761.07
(2) Supplies, - - - -	856.49
Office expense, - - -	0
Total,	$14,930.78

(1). DETAIL OF COST OF OPERATING AUTOMOBILES.

ITEMS.	STUDEBAKER.	½ PROP. DODGE TRUCK.
Gasoline, oil & grease,	$119.84	$51.41
Tires and chains,	64.40	22.08
Tools, - - -	9.52	1.25
Repairs, - - -	113.16	26.38
Miscellaneous, -	0	0
Insurance, - -	# 173.39	2.58
License, - - -	35.20	12.80
Depreciation, -	0	54.06
Painting, - -	75.00	0
Total,	$590.51	$170.56

Included in this amount is $161.21 covering insurance not charged in previous years.

(2). THE MORE IMPORTANT CHARGES TO SUPPLIES.

Childs Art Gallery (1/3 prop. 1926 invoice)	$210.63
Maas Compass rental, - - - - - -	50.00

TABLE VII.

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT FOR LAST THREE YEARS.

	1927.	1926.	1925.
Salaries, - - - - -	$12,976.88	$18,982.40	$18,509.26
Travel, - - - - - -	336.34	329.57	102.52
Operating automobiles, -	761.07	833.58	918.93
Supplies, - - - - -	856.49	878.79	927.03
Office expense, - - -	0	3.42	13.24
Total,	$14,930.78	$21,027.76	$20,470.98

GEOLOGICAL DEPARTMENT. E. L. Derby, Jr. Geologist.

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II. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents:

Accidents in and about the mines caused four deaths in 1927. There have been but two years since 1912 when the number was less, namely one in 1922 and two in 1925. The average number of men employed was 2007, and the fatality rate per 1000 men employed was therefore 2.00. Lower annual fatality rates were established in seven of the years since 1911, but there were more men employed each of those years than in 1927. The first fatality occurred in shaft sinking at the Morris-Lloyd Mine, the second at the Stephenson Mine headframe, the third at the Ogden Mine Electric Shovel, and the last one at the Maas Crusher. There was no fatality due to extracting of ore in situ. The four accidents were classified preventable by the Central Safety Committee, and occurred as follows:

Accident No. 1.

John Niemie was instantly killed at the Morris-Lloyd Mine, 2:15 p.m., April 13, 1927, by falling from the 7th level of the Morris shaft to the skip pit, a distance of 60 feet. Niemie was employed as a bucket lander for the shaft sinking that was in progress below the 7th level.

Capt. Wm. Nault had instructed the timber foreman to send down timber bearers to the 7th level station for the shaft crew. The foreman went to the tunnel at 1:00 p.m., on the day of this accident, for the purpose of loading the bearers and he sent his assistant to the 7th level to land them. A long bearer was hung to the bottom of the cage and lowered to the level. The assistant timber foreman, failing to locate a long timber hook that had been provided for landing long pieces of timber, made an attempt to pull the bearer from the cage compartment of the shaft with a blow pipe, which was 8 feet in length and bent at one end. Niemie, who was close by, picked up a short timber hook, grabbed hold of the bearer and gave it a strong tug, which caused it to swerve away from the blow pipe. The heavy stick of timber continued to spin and Niemie lost his hold on it. He reached forward to again hook it, lost his balance and fell headlong down the shaft.

A search was made for the long hook after the accident and it was found under a pile of drills, which had been thrown on the floor of the station by the shaft crew. If this hook had been used instead of the blow pipe, the accident probably would have been avoided.

Niemie was of Finnish descent, aged 21 years, and lived with his parents on a farm near North Lake. He had worked seven months at the Morris-Lloyd Mine.

Accident No. 2.

Lorenzo Delbello was fatally injured at the Stephenson Mine, 7:30 p.m., June 20, 1927, by being crushed between a railroad car and the steel headframe. He died shortly after the accident occurred.

Delbello and Guido Dello Corte, pocket men, started work on the night shift at 7:00 p.m. The latter went to the top landing and the former gave attention to the cars at the shaft pocket. He completed loading a car, lowered it a few feet and left an empty one under the pocket.

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II. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents - (Continued)

He then proceeded to drop two more empty cars from the yard to the pocket. There was no witness of the accident but apparently from the evidence that developed later, he lost control of the cars due to a defective brake. In an attempt to reach the brake of the second car, he was caught between the car and the shafthouse.

Delbello was an Italian, aged 60 years, and is survived by a widow and three children. He had worked seven years at the pockets of the Gwinn District Mines.

Accident No. 3.

Louis Thatreau, employed as an oiler and pitman, was electrocuted at the Ogden Mine, 3:15 p.m., June 29, 1927. His duties kept him occupied around the electric shovel.

When this accident occurred the shovel was idle, while cars were being switched. Edward Maloney, the shovel operator, was sitting on the running board and Thatreau was within the shovel. As a train of empty cars was approaching the shovel, Maloney scented a peculiar odor and observed smoke rising from under the shovel. He suspected that something was wrong and immediately ran to the switch on the main line and threw off the current. Returning to the shovel, he discovered the body of Thatreau with his hands in contact with the distributing rings. His death had been instantaneous.

An investigation proved that Thatreau had dropped a small wrench through a crack in the floor of the shovel and that he had crawled up under the bottom, searching for it. when he came in touch with the rings. The day was exceedingly hot and the motor generator was kept idle while cars were switched. This fact may have accounted for his failure to bear in mind that the current came through that part of the shovel. He had climbed over the cable reel and had grabbed hold of the outer distributing rings to pull himself forward when he received one phase of 2300 volts directly through the body.

Thatreau had been employed two seasons at the Ogden Mine and had been carefully instructed in the hazards of his work. He was a Frenchman, aged 50 years, and is survived by a widow and five children.

Accident No. 4.

Nels Fish, an engineer employed at the Maas Crusher, was instantly killed 7:15 A.M., September 28, 1927, by being caught in the gear of the belt conveyor.

A few minutes before the accident occurred the crushers and revolving screen were set in motion by Fish and the plant foreman, Sidney Harvey. Fish then climbed the stairway to the room where the motor, that runs the belt conveyor, is located. When he reached the head of the stairway, he signalled Emil Laak, the crusher feeder, to throw the switch for starting the belt conveyor. Laak walked into the engine room and turned on the current.

It had been the practice for several months to block the oil switch of the belt conveyor, which is located at the top landing. This procedure

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II. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents - (Continued)

saved the engineer from climbing to the top floor when starting the belt, and was usually followed when it was necessary to clean the crusher pit. Ore would be loaded on the belt by hand labor and the belt could be moved and stopped again for more ore without the delay and labor involved by using two switches. It was necessary to clean the pit between shifts, as the crushers were operated both day and night. When the night crew quit work, on the day of this accident, the switch in the engine room was closed but the upper switch was blocked.

After Fish gave the signal for the current, he passed by the upper switch but, apparently, did not heed that it was open. He proceeded around the motor and stepped upon the timber bearer, between the belt and the main gear wheel. While he was screwing a grease cup, the gear started to rotate and he was thrown forward against the pinion shaft.

Fish was a Frenchman, aged 45 years, and is survived by a widow and three children. He had been employed 12 years by our Company.

TABLE I

Classification of Fatal Accidents 1911 to 1927, inclusive, By the Central Safety Committee

I	Trade Risks		102
II	Negligence of the Company		
	Violation of Rules	4	
	Failure to Provide Safety Devices	4	
	Improper Method of Doing Work	3	
	Failure to Provide Tools or Safe Place to Work	2	
	Failure to Instruct Men	1	14
III	Negligence of Workmen:		
A.	Injured Men		
	Improper Method of Work	8	
	Violation of Rules	6	
	Carelessness	6	
	Failure to use Tools or Appliances Provided	4	
	Failure to Use Safety Device	1	25
B	Other Workmen:		
	Improper Mthod of Work	9	
	Violation of Rules	3	
	Carelessness	3	
	Failure to Use Tools or Appliances Provided	1	16
	Total		157

TABLE II

Classification of Causes of Fatal Accidents from December 1st, 1898 to December 31st, 1927

A.	Fall of Ground or Timber	85
	Run of Mud or Sand	60

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II. ACCIDENTS AND PERSONAL INJURY

a. Classification of Causes of Fatal Accidents from December 1st, 1898 to December 31st, 1927 - (Continued)

Fall of Chunk or Ore from Chute	2	
Stray Chunk or Stick down Raise or Stope	2	149
B. Shaft Accidents:		
Falling down Shaft	13	
Rock or Timber falling down Shaft	2	
Being struck or caught by Cage, Skip, Bucket or Tool	8	
Falling from Cage, Skip or Bucket	11	
Falling from Ladder in Shaft	5	
Being carried or pushed into Shaft by Car	3	
Attempting to jump on or off Cage, Skip or Bucket	3	
Being struck by Crosshead	5	50
C. Use of Explosives:		
Explosion of Powder	14	
Premature Blast	3	
Fall of Ground or Timber due to a Blast	4	
Being overcome by Gas	3	
Miscellaneous Causes	1	25
D. Mine and Railroad Cars:		
Being caught by Haulage Cars	11	
Riding or attempting to ride Cars	6	
Falling with Car from Trestle	4	
By being run over by Railroad Car	6	
By Miscellaneous Causes	1	28
E. Miscellaneous Causes:		
Falling in Raise or Pocket	7	
Contact with Electric Wire	6	
Falling from Ladder, Trestle or Stage	4	
Falling with Machine or Tripod	2	
Being caught under Pump Rod	2	
Asphyxiation from Mine Fires	3	
Being pulled into Moving Machinery	2	26
Total		278

TABLE III

Showing number of fatalities and rates per 1000 employees for thirteen years prior to Safety work and for 17 years of Safety work.

Year	Fatalities	Rate	Year	Fatalities	Rate
1898	6	5.63	1911	5	1.89
1899	4	3.41	1912	4	1.71
1900	4	2.80	1913	11	4.12
1901	9	6.83	1914	10	4.10
1902	8	5.38	1915	5	2.15
1903	8	5.15	1916	8	2.61
1904	4	2.97	1917	6	1.73

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II. ACCIDENTS AND PERSONAL INJURY

a/ Showing number of fatalities and rates per 1000 employees for thirteen years prior to Safety work and for 17 years of Safety Work - (Continued)

Year	Fatalities	Rate	Year	Fatalities	Rate
1905	12	6.54	1918	13	3.45
1906	10	4.13	1919	11	2.79
1907	17	5.97	1920	5	1.21
1908	6	2.52	1921	6	2.60
1909	13	5.15	1922	1	.45
1910	20	6.88	1923	6	2.19
			1924	5	1.88
			1925	2	.81
			1926	55	22.30
			1927	4	2.00
	121 Avg.	4.95		157 Avg.	3.26
Tons of ore mined per fatality.....		176,000			311,600

TABLE IV

Comparison of Fatality Rates for Coal Mines, Metal Mines, Etc.

Year	U. S. Coal Mines	U. S. Metal Mines	Minn. Metal Mines	Mich. Metal Mines	C. C. I. Company
1911	4.97	4.45	5.46	4.28	1.89
1912	4.46	4.09	3.15	3.22	1.71
1913	4.70	3.72	3.16	3.12	4.19
1914	4.66	3.92	2.93	3.97	4.10
1915	4.44	3.89	2.71	3.74	2.16
1916	3.94	3.62	2.59	3.76	2.61
1917	4.25	4.44	3.04	3.40	1.76
1918	3.94	3.57	3.25	3.31	3.45
1919	4.27	3.43	3.09	2.99	2.79
1920	3.62	3.16	2.61	3.25	1.21
1921	4.11	3.09	2.51	3.63	2.60
1922	4.89	3.54	3.03	2.17	.43
1923	4.39	3.01	2.08	2.03	2.19
1924	4.80	3.51	5.61	2.30	1.88
1925	4.65	2.99	2.16	2.33	.81
1926					22.30
1927					2.00
	4.40	3.60	3.15	3.16	3.26

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II. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents:

The number of injuries by accidents in 1927 was the lowest since 1912. A total of 207 lost time accidents of more that one day each were reported by the mines, shops, explorations and electric plants, as compared with 347 for the same operations in 1926. These figures represent a reduction of 40 per cent. Accidents, that were classified preventable by the Central Safety Committee, were 43 per cent. of the total, the highest proportion for a year since the Committee started to function. No injury for the year was so serious that it was impossible for the workman to return to his regular occupation, nor was there a permanent partial disability sustained, excepting the loss of fingers.

Accidents by falls of ground and haulage head the reduction list, each cause showing approximately 50 per cent. reduction. Chunks rolling down dirt piles, the handling of tools and flying objects were responsible for less accidents by reductions that vary from 20 to 30 per cent. Compensable accidents, that is those that caused the injured workmen to loose more than six days work, numbered 68 per cent of the total., as compared with an annual average of 62 per cent for the years 1919 to 1926, inclusive. There was one accident per 14 men employed on surface and one per 8 men employed underground.

The reduction in the number of accidents and the increase in those that were regarded preventable are results that were accomplished because the superintendents, captains and bosses have taken a keener interest in the problem of accident prevention. Credit for the more active cooperation being shown in this phase of mining is due the Manager, whose personal appeals to these men, and also to the workmen, were an incentive to work for better results.

Many preventable accidents occur at our mines but mining is a business that involves numerous hazards. The four fatalities for the year were caused by hazards that had not been revealed until the loss of lives attracted attention to them. The records of the Republic Mine for the year illustrates how a single hazard accounts for many injuries. Of the 12 accidents that occurred at this property, 10 of them were sustained by men in the act of loading large chunks of ore at filling places in the stopes. The other two were caused by men lifting heavy objects. These 12 accidents resulted in finger and feet injuries and strained limbs. At the Cliffs-Shaft Mine the hazard of loading large chunks of ore is involved in hand tramming and loading cars at chutes. In the soft ore mines, handling heavy timbers is labor that accounts for many hand and foot injuries and also sprains.

There were 201 slight injuries reported last year that were treated by physicians but they caused no loss of time other than the day an injured man went to a hospital for treatment. There were 301 of these accidents in 1926. The number of slight injuries that caused no loss time and those that received treatment by physicians but were given first aid at the mines, probably exceed the combined number that were reported as slight and serious. It is frequently necessary for our first aid men to dress repeatedly a slight injury, as dirt and moisture quickly ruin a bandage.

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II. ACCIDENTS AND PERSONAL INJURY

TABLE VI

B. Classification of all accidents by causes - 1927

By falls of ground in stopes, drifts and raises	33
By squeezing fingers or feet when handling ore, timber, etc...	27
By being struck by falling objects other than ore	21
By the operation of mine and railroad cars	18
By chunks of ore rolling down ore piles	17
By being struck by glancing objects	15
By falling from ladders, stages, etc.	15
By moving machinery, ropes, etc.	11
By men stumbling and slipping	10
By men incurring strains, wrenches, etc. from various causes..	8
By the use of hand tools	7
By the use of explosives	2
By infection	6
By miscellaneous causes	11
Total	211

TABLE VII

Number of Compensable and Non-Compensable Accidents

Mine	Received Compensation	No Compensation	Total
Austin	7	1	8
Athens	11	4	15
Boeing	9	10	19
Cliffs-Shaft	22	9	31
Hill-Trumbull	3	1	4
Holmes	12	5	17
Maas	9	3	12
Morris-Lloyd	13	12	25
Negaunee	21	2	23
Republic	7	5	12
Spies-Virgil	10	2	12
Stephenson	10	8	18
Ogden	1	0	1
Miscellaneous	9	5	14
	144	67	211

TABLE VII

Number of Accidents, number classified Preventable and Percentage Preventable

1912 ----1927

Year	Number of Accidents	Preventable Accidents	Percentage Preventable
1912	207	51	25
1913	316	77	24
1914	443	118	37
1915	427	97	23
1916	592	120	20
1917	639	149	23
1918	590	124	21
1919	670	159	22

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II. ACCIDENTS AND PERSONAL INJURY

b. Number of Accidents, number classified Preventable and Percentage Preventable 1912 -- 1927 (Continued)

Year	Number of Accidents	Preventable Accidents	Percentage Preventable
1920	708	132	19
1921	351	63	18
1922	344	90	26
1923	453	104	23
1924	407	92	23
1925	363	101	27
1926	426	140	33
1927	211	94	43

TABLE VIII

Injuries per 1000 Workers:

	1916 to 1920	1921	1922	1923	1924	1925	1926	1927
C. C. I. Co.	175	170	168	166	152	152	155	103
Mich. Metal Mines	235	251	225	191	208	229		
All U.S.Metal Mines	241	249	268	275	278	283		

TABLE IX

Classification of All Accidents 1927 By The Central Safety Committee

I. Trade Risk. (Incidental and Non-Preventable) 120

II. Negligence of Company:
1. Failure to Use Safety Devices Provided 0
2. Failure to Use Proper Tools or Appliances Provided 0
3. Violation of Rules 0
4. Improper Act or Selection of Improper Method of Doing Work (By Foreman) 2
5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto 0
6. Failure to Provide Safety Devices 1
7. Failure to Provide Proper Tools, Appliances or Place to Work..... 3 — 6

III. Negligence of Workmen:
1. Failed to Use Safety Device Provided 2
2. Failed to Use Proper Appliances or Tools Provided..... 3
3. Violation of Rules 3
4. Improper Act or Selection of Improper Method of Doing Work ...(By Workmen) 33
5. Carelessness ..(By Workmen) ..... 35 — 76

A. Injured Men

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b. Classification of All Accidents 1927
By The Central Safety Committee

B. Other Workmen	1.	Failed to Use Safety Devices Provided	0	
	2.	Failed to Use Proper Appliances or Tools Provided	1	
	3.	Violation of Rules	1	
	4.	Improper Act or Selection of Improper Method of Doing Work ..(By Workmen)	3	
	5.	Carelessness ...(By Workmen)	4	9
		Total		211

TABLE X

Accident Frequency and Severity Average for All Properties for Accidents occurring in the year named.

Rate per 1000 Days of Labor	Number of Accidents 1925	1926	1927	Days Lost 1925	1926	1927
January	.399	.560	.530	3.340	4.482	3.779
February	.629	.582	.480	9.606	9.740	5.522
March	.534	.585	.330	9.849	12.010	7.676
April	.554	.775	.401	13.138	11.533	8.975
May	.792	.612	.253	14.924	14.563	8.656
June	.619	.731	.339	16.181	17.927	7.905
July	.546	.466	.327	13.737	16.570	9.947
August	.642	.659	.477	15.216	14.765	11.454
September	.504	.549	.221	14.957	16.955	11.032
October	.624	.576	.207	18.563	15.459	10.456
* November	.541	.449	.231	22.113	16.872	10.877

*Eliminating Barnes-Hecker in November, 1926.

Note: Complete figures for December not available at the time of writing this report.

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c. Safety Inspection:

The Company's Safety Inspector, William Conibear, visited all the local mines regularly each month of the year, either as an inspector or as secretary for the safety committees. He made three inspections of the Spies-Virgil Mine.

Committees of workmen inspected the local mines in July. The surface and mechanical equipment of the same mines was inspected in September by a committee consisting of Ernest Keast, Mechanical Department, Arthur Olson, Electrician, Negaunee District, and John Peel, Surface Foreman, Negaunee Mine. A Foreman committee, consisting of Shift Bosses, William Olds, Cliffs-Shaft Mine, Harry Scarffe, Morris-Lloyd Mine and William Oliver, Athens Mine, inspected the local mines in October.

The number of safety inspection reports that are made each year by men employed at the mines is in the thousands. It is the duty of this department to receive these reports, review them and inform the mine superintendents when inspections are not being made. If unsatisfactory conditions are reported, they are investigated by the Inspector.

TABLE XI

Showing the number of Foremen and Workmen by mines, who have served on Safety Inspection Committees.

Mine	Foremen	Workmen
Athens	7	21
Austin	1	13
Cliffs-Shaft	11	57
Holmes	8	27
Maas	10	45
Morris-Lloyd	10	60
Negaunee	15	60
Republic	8	42
Stephenson	9	50
Idle & Miscellaneous	32	189
	111	564

TABLE XII

List and number of all reports for prevention of Accidents made in 1927

Cage Riders	Daily	3,418
Hoisting Ropes	"	3,185
Ladderways	Weekly	439
Skip and Cage Roads	"	474
Cage Safety Catches	Monthly	121
Hoists	"	239
Mine Rescue and First Aid	"	218
Safety Inspectorancy Committees		75
Fire Hose Equipment	Quarterly	47
Electrical Equipment	"	25
Fire Extinguishers	Semi-Annual	32
		8,273

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d. Special Safety Measurers:

Central Safety Committee

The members of this committee last year were Messrs. Elliott, Jackson, Graff, Eaton, McClure, Rough, Stakel, Meyers, Moulton and Conibear. Mr. Jackson was chairman and Mr. Moulton secretary. A session was held each month excepting November and the meeting time was changed from 10:00 a.m. to 2:00 p.m., thus more time is available for the discussion of important subjects.

Foremen Safety Conference.

A safety conference for foremen was held at the Central office July 9th, with 101 men present. They represented all of the Company's mines. Mr. Elliott presided and opened the conference with an earnest appeal for the more active cooperation of the superintendents, captains and bosses in every phase of accident prevention. Mr. Moulton presented and interpreted charts that showed comparative severity and frequency rates of accidents, compensation costs, loss in wages, etc. Mr. Eaton read a paper on the "Top-Slicing Method of Mining" and the safety inspector presented one entitled "Some Dangerous Aspects of the Top-Slicing Method of Mining". These and kindred subjects were discussed freely and at length by the Superintendents and captains. A buffet luncheon was served at the conclusion of the conference.

A second conference was held at the North Lake Club House December 16th, and approximately 85 men from the local mines were present. Mr. Elliott reviewed our accident record for this year and made another appeal for more efficient work in preventing men being injured while at work. Motion pictures films of safety at mines were received from the U. S. Bureau of Mines and exhibited. Light refreshments were served.

These conferences are very effective in promoting the cause of safety at our mines. The men appreciate very highly the opportunity of meeting with the Manager and other officials, and thus are imbued with the thought that they are considered important in the organization. A spirit of good will is created that enhances their value to the Company.

District Foremen Conferences.

Plans are under way for each superintendent to hold conferences with the foremen who are under his jurisdiction for the study of the various methods of doing specific work, such as mining methods of extracting ore, haulage, handling explosives, etc. Superintendents Graff and Stakel have arranged to hold their first meetings in January, 1928, when haulage operations will be considered. The safety aspect of this work will be presented by the inspector, who has collected much information that has been published in recent years by various institutions. A general conference, at a later day, will be called and standards that are applicable at all mines will be formulated.

Safety Conferences of other Organizations.

The Lake Superior Section of the National Safety Congress held its annual conference at Duluth, June 22 and 23rd, 1927. Messrs. Barber, Brewer, Bolthouse, Prudom, Gaffney and Andrews, of our Minnesota mines, and Capt. Rough represented this company. The safety inspector, who was unable to attend, prepared a paper which was presented by Mr. F. C. Gregory, District Engineer for the U. S. Bureau of Mines.

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d. Safety Conferences of Other Organizations - (Continued)

The first annual meeting of the Michigan Industrial Safety Congress was held at Ann Arbor, Michigan, June 28, 29 and 30th. President Wm. G. Mather presided over the mining session. Superintendent Eaton presented a paper outlining the safety activities of our company, which was based largely on data given to him by the safety inspector.

The annual meeting of the National Safety Congress was held at Chicago, September 27-30th. The safety inspector was the company's delegate at this conference and a report of the same was given to the Central Safety Committee.

Visits to Mines of Other Companies.

When inspecting the Spies-Virgil Mine in September, the inspector was accompanied with Captains Ware and Tamblin, and an inspection was made of the Berkshire and Caspian Mines. Messrs. Eaton, Stakel, Tamblin and Nault visited a number of the Gogebic Range Mines on October 21 and 22nd. The primary object for these trips was to get first hand information about the progress being made by other companies in promoting safety and to observe new applications in mining methods. The attendance at safety conferences and inspection visits to mines of other companies by the superintendents and captains is desirable because they afford opportunities for enlightment that cannot be obtained always by the perusal of reports.

Safety Flags.

The National Safety Flag, a white flag in a green back ground, now flies at each of our mines as long as a mine is exempted from a serious accident. These flags were raised in October, and, with the presentation of a flag to a mine, Mr. Elliott explained its signification and at the same time informed the men, who had been assembled for the occasion, that he expected every employee of the company to do his utmost in avoiding accidental injury. The rule governing the flying of the flag is that "each accident that causes a loss of time of two weeks necessitates that the flag be lowered a week".

Two Banner Flags, made of white star with a blue boarder, will fly at the two mines that have the most satisfactory record. They will be retained at one time for a month. During January, 1928, the Athens and Republic Mines will fly these flags.

Distribution of Cigars to Employees.

The Negaunee Mine Employees were given cigars in April for having had the best safety record for the first quarter of the year. The men of the Maas Mine were likewise remembered in July, for establishing a praiseworthy record during the first half of the year, when 30,506 days of labor were performed and one accident occurred. It involved a loss of 4½ days. Cigars were distributed to the employees of the Athens and Republic Mines at the end of the year in recognition of good records from August to December, as each mine had but one slight accident during this period.

Hoisting Cables and Skip Bails and Clevices.

The importance of proper lubrication of hoisting cables and careful inspection of cables, skip bails and clevices were outlined by the Manager and additional regulations governing this work were adopted.

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d. Hard Hats for Miners.

According to the U. S. Bureau of Mines, two of every five accidents that occur underground at metal mines are by falling objects. To guard against head injuries by falling objects, a number of the copper mines of Arizona and New Mexico have adopted a rule making it compulsory for miners to wear hard hats. A "hard boiled" hat, made of fiber, pressed together, is manufactured by the E. D. Bullard Co., Los Angeles, Cal. This hat is now being worn by many Cliffs-Shaft miners, the shaft crews at the Morris-Lloyd and Holmes Mines, and also by many of the bosses at other mines. Two serious head injuries already were prevented by their use.

Illumination.

More illumination is being provided within the mines by white washing shaft stations, safety zones in haulage drifts, and ventilation doors and the sides and tops of the drifts adjacent thereto. Flood lights are being placed at the top of the long raises in the Athens Mine, in which the air circulation is strong.

Safety Admonitions.

The posting of safety bulletins at the mines and shops was carried out weekly. A card, calling attention to a particular hazard or duty, is mailed weekly to each of the company's truck drivers. The Holmes Mine truck transports the Ogden Mine employees and the Morris-Lloyd is used in the winter months for the same purpose. A card must be kept in the dash board, where the driver can see it, until replaced by another one.

Miscellaneous Devices.

Low cars for hand loading and tramming ore have been introduced at the Cliffs-Shaft Mine.

A device for preventing end dump cars falling back on the fingers of the trammers was invented by a Morris-Lloyd Mine employee.

Linemen's safety belts have been furnished the pipemen of the soft ore mines.

Various types of goggles for the prevention of eye injuries at industrial occupations were received by request from the makers, and two types were selected for our men, to be worn when sledging ore, starting drill holes in hard ore and loading ore at chutes.

Raises at the Morris-Lloyd Mine are completely sealed with boards that fit within the cribbing, above the grating, when scrapers are idle.

Carbide is treated with kerosene before distributed to miners. This process eliminates dust, and hence is a conservation measure as well as a safety precaution.

Leather gloves were provided for men who are compelled to handle wire rope when hoisting timber.

Much progress has been made at all mines in a general cleaning-up program.

Unsafe practices, such as carelessness in the storage of tools, working under scraper booms when scrapers are operated, making up explosives with carbide lamps attached to hats, etc. have been outlawed.

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e. Rules and Regulations.

278 Company rule and regulation books were distributed. 193 were in the English language, 56 in Finnish and 29 Italian.

TABLE XIII

Distribution of Rule Books by Mines:

Cliffs-Shaft	58
Negaunee	49
Athens	38
Spies-Virgil	36
Boeing	29

f. First Aid Work.

Accurate figures are not available giving the number of injuries that were treated by employees who have been trained for this purpose. That the number exceeds by a very large margin the injuries reported is apparent if an inspection is made by an observing person of the frequent calls made at first aid rooms. First aid dressings do not wear long in the dirt and water of underground work, and many bandages are frequently needed for one slight injury.

New first aid teams were organized in March at the mines of the Ishpeming, Negaunee and North Lake Districts. Training instructions was suspended at the Republic and Stephenson Mines early in the year. A total of 74 training practices were given, under the supervision of J. H. Williams, who also was in charge of the mine rescue equipment and training. Since this department has been without an office clerk, Mr. Williams has been assisting with this work.

First aid supplies cost $231.67 for the year, which was charged to the mines and other plants.

TABLE XIV

Showing the number of men trained - 1912 to 1927

Number of men receiving training	666
" " " " First Aid Certificates	534
" " " Deceased	18
" " " Pensioned	6
" " " now employed by Company	343

g. Mine Rescue Work.

There was but one underground fire reported for the year. Smoke of burning timber was detected in the Holmes Mine September 15th and was traced to a burning leg of a set of timber on the 3rd level. It was only smoldering and was easily extinguished. It's origin was probably the flame of a carbide lamp, held against the leg by a miner, as he leaned against it in a standing position.

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g. Mine Rescue Work - (Continued)

90 lessons in mine rescue training, in which 78 men participated, were rendered and crews at all the local mines were trained monthly. The Republic Mine apparatus was transferred to the Spies-Virgil Mine in August, and since then a squad has been given seven practices in its use. The equipment of the Gwinn District is kept intact and will be installed at the Mackinaw-Gardner Mine.

Mine rescue supplies and repairs cost $331.72 for the year, the major portion of which was charged to the mines where crews were trained.

TABLE XV

Showing the number of men trained in Mine Rescue Work - 1912 to 1927.

Number given Training	407
" Deceased	17
" Pensioned	1
" Disqualified	106
" left Company's Employment	138
" now employed and qualified to wear the apparatus	145

h. Expenses and Salaries.

TABLE XVI

Supplies			
Printing, safety flags, cigars, calenders, etc.		$157.45	
Mine rescue and first aid supplies		11.11	$168.56
Travelling			
Inspector		460.51	
Mine Rescue Foreman		284.96	
Members of Committees		13.83	759.30
Salaries			7501.93
	Total		$8429.79

Respectfully submitted,

William Gribbal

Safety Inspector.

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CLIFFS SHAFT MINE:

A new Falk herringbone gear and pinion was installed on the 5-1/8" x 36" Prescott underground pump on February 21st to replace a set of gears which were worn out.

All the mechanical equipment at this mine operated satisfactorily, with no serious trouble or breakdown during the year.

A new stator for the "A" Shaft hoist motor has been purchased to replace the old stator, which broke down due to overload.

HOLMES MINE:

We had some trouble with the Aldrich quintuplex underground pump caused by carelessness of the pumpman. The crankshaft bearings were burned out, making it necessary to rebabbitt all the bearings.

The skip hoist at this mine has been changed considerable. As the original motor was overloaded, it was necessary to add additional power. We also increased the rope speed 100 feet per minute. This change was made in the following manner. Two new pinions, with 16 teeth, were purchased to fit the original gear. One of these pinions was attached to the original motor and the other pinion was installed with the motor from the Salisbury Mine hoist, engaging the same gear. This hoist is now driven by two 400 H.P. motors.

A 35 cubic foot General Electric air compressor was installed in the power house to take care of the air brakes on the hoists.

All the mechanical equipment at this mine is operating satisfactorily.

OGDEN MINE:

The electric shovel started loading on April the 18th and closed down on October the 21st.

The air compressor gave us a little trouble, but did not cause any delay to mining operations.

All mechanical equipment is in good condition at this mine.

HARD ORE SHOPS:

Please refer to the Annual Report for 1926. Conditions have not changed any in the past year.

ATHENS MINE:

Some trouble developed with the Ingersoll-Rand air compressor. The low pressure cylinder on this machine was rebored, relined and a new piston with new rings fitted. It is now operating satisfactorily.

On May 13th a bad wreck occurred at this mine. In some manner the skip got away from the hoisting engineer. The loaded skip pulled the empty one up into the head sheave, breaking the sheave and hoisting rope and doing considerable damage to the headframe. One of the sheave girders was completely wrecked and another very badly twisted. One of the pulley stands was pulled over, completely wrecking it and making it necessary to order a com-

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ATHENS MINE (Cont'd)

plete new stand. This wreck was cleaned up and the mine again put in operation on May 23rd.

The cage hoist at this mine also gave us a little trouble. In June one of the drum spiders became loose on the drum shaft. This has been repaired and is in good condition. We also found the gear loose on the shaft, making it necessary to get a new shaft. This shaft has been received and it will be installed when necessary.

All other mechanical equipment at this mine operated satisfactorily.

MAAS MINE:

On May the 3rd it was necessary to start the steam turbine on account of a burnout at the McClure Plant. This Plant was operated from May 3rd to May 6th and also from May 24th to May 28th.

A new concrete cooling pond was built at this mine to replace the old cooling tower, which was about ready to fall down.

All mechanical equipment operated satisfactorily during the year.

MAAS CRUSHING PLANT:

Considerable repairing and changing was done at this plant. The receiving pocket, which has given us a lot of trouble, was rebuilt. This eliminated most of our trouble at this point. The #1 belt conveyor was changed and the slide for the fine material was rebuilt. Improvements to the belt and slide worked out very good. The slide feeding the rotating screen was changed, which was also a big improvement. The usual amount of changing of concaves and general repairs were made during the summer. The pan conveyor, which was in very poor condition, is being rebuilt this winter and it will be ready for operation when the season opens.

NEGAUNEE MINE:

An axle in one of the head sheaves at this mine broke during the year. The supports for the bearing of this sheave have been moved in close to the hub, which should stop any further trouble at this point.

All the mechanical equipment at this mine operated satisfactorily during the year.

SOUTH JACKSON CRUSHING PLANT:

This plant was idle the entire year.

BARNES-HECKER MINE:

This mine was abandoned on January the 12th.

LLOYD MINE:

All mechanical equipment at this mine operated in a satisfactory manner during the year.

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MORRIS MINE:

On April 3rd a new spur pinion and intermediate shaft was installed on the cage hoist. This hoist gave us more trouble on April 25th, when a tooth broke out of the spur gear. It was then decided to rebuild this hoist, which was done in the following manner. The spur gear was replaced by a herringbone gear and pinion taken from the Salisbury Mine hoist and the intermediate gear and pinion were discarded, changing this hoist to a single reduction by moving the motor up in line with the intermediate shaft. The old skip hoist motor was used in making this change as the old cage hoist motor was not in very good condition. This hoist has operated very satisfactorily since this change was made.

A #6 McCully crusher was installed in the shaft house. This crusher was taken from the Holmes Mine and replaced by a #5 crusher from the Cliffs Shaft Mine which was not in service. The skip dumps were raised about 15 feet in order to make room for the installation of a grizzly for this crusher.

All other mechanical equipment operated in a satisfactory manner.

SECTION 6 SHAFT:

There were no changes or additions to the mechanical equipment at this shaft. All equipment operated satisfactorily.

AUSTIN MINE:

The mechanical equipment at this mine gave good service during the year. This mine was closed down on September 22nd.

GWINN MINE:

This mine was taken over by the C. K. Quinn Company on May the 19th.

GWINN CRUSHING PLANT:

All mechanical equipment is in good condition except the pan conveyor. This conveyor will be repaired before the crushing season opens.

MACKINAW MINE:

This mine is being reopened, bailing operations having been started on December the 14th. The water was down 616 feet on December 31st. All mechanical equipment operating satisfactorily.

PRINCETON MINE:

The pumps were shut down on June the 18th and the mine allowed to flood. The motor, switchboard and belt on the Aldrich plunger pump #4340 were taken to surface and stored in the engine room. The pump itself was well greased and left in the mine.

All mechanical equipment is in good condition at this mine.

PRINCETON CENTRAL POWER PLANT:

The steam turbine was operated from May 4th to 13th and from May 23rd to 30th on account of a breakdown at the McClure Plant.

The compressor was shut down on November 1st.

All mechanical equipment in this plant is in good condition.

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PRINCETON PUMP STATION:

The equipment in this station gave good service during the year.

In December the boilers were drained and an electric heater put in the pump room. We now have only one pumpman in this station.

STEPHENSON MINE:

All of the underground equipment was removed to surface and the mine abandoned on August 15th. All of the electric equipment from underground was placed in the Gwinn Storage Shed.

REPUBLIC MINE:

All mechanical equipment is in fair condition. Operation was satisfactory during the year.

SPIES-VIRGIL MINE:

A complete set of tubes were put in the heating boiler as the old tubes were in very poor condition.

The crankshaft on one of the Prescott vertical pumps broke on December the 18th. A new shaft has been ordered and will be installed assoon as received.

All other mechanical equipment operated in a satisfactory manner.

BOILER INSURANCE:

All boiler insurance has been cancelled. We are now making semi-annual inspections with the assistance of an experienced boiler maker.

BOEING MINE:

In January the second level pump station was completed, with the expectation of its lasting approximately two years. It contained two centrifugal pumps, one from the Crosby Mine, size 6", Type S., 1000 G.P.M., 175 foot head, Allis-Chalmers, driven by an 85 H.P., 2200 volt, 1800 R.P.M. motor, and one pump from pit, size 6", H.Y.C., 800 G.P.M., 325 foot head, driven by 125 HP. motor. These only pumped 100' elevation between the levels, and while they were of too high head for this work they were used as no others were available.

In May the first level mining was completed and two 6-ton locomotives and cars brought to surface. During the same month the pit shaft house was removed and the 50 H.P. electric hoist stored on surface, ready for shipment where needed.

By the end of July all second level tracks, trolley lines and cables were completed and top tram equipment put in good condition, ready for fast tramming during the winter. While this work was being carried on the compressor ran 24 hours a day.

Repair crews were put on pit equipment March 28th. The smoke box screen on the three locomotives was changed to 3/16 x 1-1/4" mesh by orders from the State Forestry Department. On the #28 shovel the point sheaves were rebushed and brake band casting on main engine welded where expansion cracks developed. By April 23rd repair work was finished and #28 shovel started on

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BOEING MINE (Cont'd)

clean-up work April 25th. With the exception of breaking a 6-yard bucket dipper bail in May and putting on a new back in the same dipper June 29th, this shovel required no additional repairs.

Trouble in pit started in August, when two slides in the north bank pushed the shovel off the tracks and buried one side too deep to revolve. After the second slide it was necessary to rent a 1350 G.P.M., 350 foot head, Cameron centrifugal pump, driven by a 150 H.P. motor, from the Wabigon Mine and install it in east end of pit to take care of water until shovel completed loading ore October 19th. When the first slide occurred the second level pump house raise was cut off, but by digging a dog hole from second level to pump house the pumpman was rescued unharmed.

After this ground movement it was decided that further mining was unsafe, so preparations were started to close the mine. A one-yard shovel, on caterpillar traction, was rented from the Oliver Iron Mining Co. to clean up the ore #28 shovel could not reach. It worked from September 10th to October 2nd. Three 6-ton electric locomotives were completely overhauled and stored near tracks, ready for shipment. All underground equipment was removed and dismantling of #28 shovel was started on October 22nd, when the 40-ton crane was secured from the Hill-Trumbull Mine. Pumping was discontinued on November 15th and all pumping equipment removed from the first and second levels. The Aldrich triplex pole pump, 850 G.P.M., 350' head, was stored along the railroad track near the shaft house, while four centrifugal pumps were drained and stored in the engine house. All electric equipment for these pumps was boxed separately and tagged, ready for shipment.

The pit machinery consisting of three locomotives, #28 shovel, two 12-yard dump cars, one flat car and the 40-ton locomotive crane, together with the two 60-ton Marion shovels used to load out the two stockpiles, were shipped to the Hill-Trumbull Mine for storage. The only machinery removed from the mine buildings before boarding up the windows was the 1½" power driven bolt threading machine needed in the Hill-Trumbull shops. All heating equipment was drained and current cut off at Substation in December, surface lights being secured from the Susquehanne Mine.

HILL-TRUMBULL MINE:

On orders from the State Forestry Department the smoke box screens on all locomotives were changed to 3/16 x 1-1/4" mesh to eliminate fire hazard. Besides the regular overhauling of locomotives and cars, the shop crew put the gas drag line, purchased the previous year, in first class condition. This drag line paid for itself during the season by building up #1 basin of tailings pond with a dyke high enough to hold all tailings for the season, and also dug a ditch to let drainage water from Calumet run around the basin instead of through it. After finishing this work in August, the caterpillar treads were overhauled and then it was moved to the north bank of pit and cleaned a drainage ditch, finishing and moving back to shop in November.

Operations at Washing Plant were started April 25th. It was operated all season without using the chip screens and tables. By cutting out the chip screens the turbo product was improved and the tailings iron content reduced from 20 to 15%. Improvements added during the year were 25 new Sacon rollers under 36" conveyor belt. A new set of coils was put in the 150 H.P. centrifugal pump motor at Ishpeming. The 20" pipe line was elevated so it could be painted and repaired on all sides. The 8 ft. pan conveyor was overhauled. Changing the

HILL-TRUMBULL MINE (Cont'd)

shape of discharge opening in receiving pocket also improved conditions, but it was found during the season that the 8 ft. pan conveyor needed new pan links as the old ones were stretched out of gauge and did not mesh with drive sprocket properly. Work to correct this trouble was started after the shipping season this fall and will be completed during the winter. The old compressor was found to be too small and a new machine was purchased from the Sullivan Machinery Company of the following description: size 9" x 8", Class W.G.6,R.P.M.270, 176 cu. ft. per minute. This was installed in the basement. It is belt connected to 25 H.P. motor removed from 25 ft. log.

A pneumatic rock picker was added to the 5-ft. pan conveyor, eliminating the hard work at this point and reducing the number of men from four to two. A rock plow is being added this winter at this point to eliminate all men when oversize is all rock, which occurs in some sections of pit crude ore.

During February the washing plant crew installed a drainage pump on the north bank of pit and put in 600 feet of 10" discharge pipe. The pump was second-hand from Ishpeming of the following description: Allis-Chalmers Type "S", Size 10, 2000 G.P.M., 40 ft. head, factory #2074, driven by 30 H.P. motor at 865 R.P.M. This is operated during Spring bfeak-up and heavy summer rains, and has given no trouble.

During the month of May a 2200 volt transmission line was extended to the east end of pit for churn drill operation. Two drills are now used, as the Boeing Mine drill was transferred to the Hill-Trumbull in March. A drum shaft broke on #27 shovel in July, tying it up for a week, as a spare had to come from Milwaukee. This was the only bad pit break-down during the summer. The other shovel supplied the washing plant, so there was no delay.

At the shops the only changes were adding a 42" swing second-hand Pratt & Whitney lathe with bed 28 ft. long; installing a small electric pole pump from the Wade to feed the heating boiler; adding some more heat coils to carpenter shop; buying a portable electric grinder for blacksmith shop and moving the 1½" power bolt threading machine from the Boeing to this shop.

WADE MINE:

Underground pumping continued during the year. In May some of the pump house timbers had to be renewed. Due to a sand run in April it was necessary to clean the sump and renew the wearing rings in the centrifugal pump, as well as seats and valves in the pole pump. The underground saddleback cars were removed from the mine and shipped to the Boeing Mine in July for use on the second level.

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Electrical Department:

The year 1927 has been a satisfactory one for The Cliffs Power & Light Co. and in the general electrical service for mines and other activities.

The total output of the electric plants is the largest since the start of the system. The total of over 52,000,000 Kilowatt Hours generated exceeds the best previous year by more than 1,000,000 Kilowatt Hours.

There seems to be a gradual change in the character of our load with a more complete mechanization of mining operations and an extension of commercial service, the former tending to increase our peaks and the latter to improve the load factor, so that the result is a quite satisfactory condition in general excepting some valleys which we hope to fill. With this in view a contract is being made with the Munising Paper Company for off-peak service, with the hope that we may dispose of the power available during present light load periods.

If the above mentioned arrangement proves satisfactory and profitable we should provide an additional circuit from Gwinn to Au Train, and also build the permanent dam at the Au Train Plant.

New equipment installed and put in service during the year is as follows:

A 2,000 K.V.A., 30,000 volt, Substation at the Hoist Plant, consisting of three 667 K.V.A. General Electric transformers with high tension circuit breakers and arresters and other necessary apparatus. This changed the Hoist transmission line from 13,000 volts, as originally built, to 30,000 volts.

A 50 K.V.A. Substation for service at Champion and Michigamme.

A 50 " " " " " Chatham.

A 25 " " " " " Carlshend.

A 25 " " " " " Little Lake.

All these small installations are for rural service.

New oxide film arresters were installed at the McClure Plant, Carp Plant, North Lake and Republic Substations, replacing obsolete apparatus and giving modern protection throughout the transmission system.

A synchronous condenser, rated at 1500 K.V.A., was installed and put in service at the Brownstone Substation. This installation was made to improve regulation and reduce transmission losses. With an increase of 30,000,000 K.W.H. in output over that of ten years ago we show the smallest transmission loss of any year during this period and the regulation is very much improved, being about as perfect as possible with present load.

Four new high tension circuit breakers were installed at the Brownstone, giving individual protection on each circuit. This reduces the delay in re-establishing service in the event of line failure and prevents some interruptions, as well as adding to safety in operation.

A connection was made at the Barnes-Hecker for service to the Blueberry Mine of the Ford Motor Company. They built the extension and provided a 1500 K.V.A. Substation, practically in accord with our standards.

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Electrical Department (Cont'd)

A 25 K.V.A. Substation has been ordered for Eben to serve Trenary and the territory toward Rapid River.

The right-of-way on practically all our transmission lines was cleared during the year, and as far as possible all defective insulators were replaced. This work was carried on practically throughout the good weather period of the year.

The Barnes-Hecker Substation was disconnected from the line, no service being supplied at this point.

The re-opening of the Archibald and Mackinaw mines at Gwinn has given us a fair load at the Gwinn Substation.

It is apparent that new business secured has more than made up that lost through the closing down of depleted mines.

The most serious breakdown occurred at the McClure Plant, where both generators burned out on May the 3rd. We were fortunate in having the Hoist Substation ready,and with the additional output from this plant and help from the steam plants we carried the load fairly well during the time repairs were under way at the McClure Plant.

The #1 generator at the Hoist Plant was also repaired, and all are now in good condition.

One transformer at the Maas Substation burned out, apparently due to foreign matter getting into the case. This did not cause any serious delay in mining operations.

A bad leak developed in the Carp wood pipe line, about 3,000 feet below the dam. This was repaired by putting a concrete filler over the defective portion.

The Escanaba River development is underway, with the construction line built and in service. A small crew of men are driving the intake tunnels. It is not intended to increase the working force until Spring, when more favorable weather conditions will permit better progress. Practically all necessary material has been ordered and should be on the ground when needed.

In all mining applications and other power applications we feel that the service has been unusually good and probably above the usual average in such use.

The gradual increase of scrapers and loaders in the mines and the increase in depth of hoisting, with the tendency to concentrate load in short periods, requires careful supervision and study to maintain efficiency and safety with economical operation. This tendency will likely mean a gradual increase in total load, which, together with the probable increase in sales to outside parties with greater domestic utilization, should enable us to maintain a good and increasing output.

The tendency to concentrate load in short periods in mining operations has made it necessary to develop the Escanaba River. At the time our present system was under development the mines were operating almost entirely on two ten-hour shifts per day and with a smaller unit output than at present. Now these mines operate on one shift of eight hours in general and mostly five days per week, instead of six. At that time the average depth of hoist was materially less than at present, probably about 25% less than now. The total output per

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Electrical Department (Cont'd)

mine has not decreased although the working hours have been shortened. There is no doubt but the present method is far more efficient than the former. It is, therefore, obvious that we must provide facilities to carry the peaks due to changed conditions, and that we endeavor to fill in the valleys as may be possible.

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Electrical Department: (Cont'd)

Summary of Operating Conditions - 1 9 2 7 .

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation -	0.84	0.83	1.93	1.43	6.59	1.84	6.63	0.95	2.35	1.78	2.28	2.41"

Total Precipitation at Ishpeming during 1927 - 29.86 inches.
Average " " Marquette - 32.8 " (46 year record)

CARP RIVER HYDRO-ELECTRIC PLANT:

Drainage area above Intake Dam,		66.66 sq. miles.
Cubic feet Precipitation in 1927,	4,624,192,382	
Kilowatt Hours generated in 1927,	10,715,900	
Cubic feet water utilized (90 cu. ft. = 1 KWH.)	964,431,000	
" " " in Carp Storage Basin Jan. 1, 1927,	398,216,400	
" " " " " " Dec.31, "	390,904,800	
" " " taken from " "	7,311,600	
" " " wasted over Intake Dam in 1927,	1,106,642,000	
Total run-off for the year 1927,	2,063,761,400	cu. ft.
Run-off per square mile of drainage area,	30,959,518	" "

	1913	1914	1915	1916	1917	1918	1919	1920	1921
Total Precipitation,	30.11	26.53	38.4	36.83	25.46	31.05	29.50	27.4	30.38
Second ft. per sq.mile,	1.03	.67	.93	1.29	.70	.79	.83	.73	.68

	1922	1923	1924	1925	1926	1927
Total Precipitation,	33.67	21.90	22.95	20.71	35.69	29.86
Second ft. per sq.miles,	1.06	.59	.50	.25	.85	.98

McCLURE HYDRO-ELECTRIC PLANT:

Drainage area above Intake Dam,		140.52 sq. miles.
Cu. ft. Precipitation in 1927, (Hoist Plant 35.51")	11,595,719,393	
Kilowatt Hours generated at McClure Plant in 1927,	30,379,700	
Cubic feet water utilized (125 cu. ft. = 1 KWH.)	3,797,462,500	
" " " wasted over Intake Dam in 1927,	4,380,148,000	
" " " in Hoist Storage Basin Jan. 1, 1927,	1,601,178,288	
" " " " " " Dec.31, "	1,601,178,288	
" " " taken from " "	0	
" " " in Silver Lake Jan. 1, 1927,	691,715,900	
" " " " " " Dec.31, "	491,785,500	
" " " taken from "	199,840,400	
Total run-off for the year 1927,	7,977,770,100	cu. ft.
Run-off per square mile of drainage area,	56,773,200	" "

	1920	1921	1922	1923	1924	1925	1926	1927
Second ft. per sq. mile,	1.22	1.02	1.54	0.85	0.92	0.52	1.52	1.8

THE CLIFFS POWER & LIGHT CO.

SUMMARY OF OPERATIONS - 1927.

	KILOWATT HOURS GENERATED								Used by Auxiliaries	Delivered to Line	KWH. Sold	Transmission Losses	
	McClure	Carp	Hoist	Au Train	Maas	Princeton	Republic	TOTAL				K.W.H.	%
Jan.	2,381,600	887,500	574,000	229,690	0	0	0	4,072,790	10,060	4,062,730	3,531,456	531,274	13.07
Feb.	2 588 000	787 700	560 000	168 000	0	0	0	4 103 700	9 730	4 093 970	3 538 355	555 615	13.57
Mar.	2 580 400	844 500	574 000	197 120	0	0	0	4 196 020	12 130	4 183 890	3 645 342	538 548	12.87
Apr.	2 486 500	999 400	608 000	275 960	0	0	0	4 369 860	9 230	4 360 630	3 811 940	548 690	12.58
May	1 857 300	1 101 900	756 000	354 770	37,200	96,350	4,700	4 208 220	27 040	4 181 180	3 673 564	507 616	12.35
June	2 088 300	1 580 200	710 000	242 110	74 000	138 500	0	4 833 110	35 420	4 797 690	4 193 560	604 130	12.59
July	2 664 200	1 029 000	405 000	279 260	0	0	0	4 377 460	10 720	4 366 740	3 780 737	586 003	13.39
Aug.	2 894 900	866 400	605 000	145 760	0	0	0	4 512 060	11 906	4 500 154	3 876 505	623 649	13.85
Sept	2 834 100	670 700	962 000	76 580	0	0	0	4 543 380	15 494	4 527 886	3 912 671	615 215	13.74
Oct.	2 718 800	666 800	862 000	176 910	0	0	0	4 424 510	13 966	4 410 544	3 822 550	587 994	13.33
Nov.	2 766 700	525 400	916 000	172 830	0	0	0	4 380 930	15 128	4 365 802	3 814 381	551 421	12.63
Dec.	2 518 900	756 400	837 000	222 000	0	0	0	4 334 300	15 236	4 319 064	3 800 882	518 182	11.99
	30,379,700	10,715,900	8,369,000	2,540,990	111,200	234,850	4,700	52,356,340	186,060	52,170,280	45,401,943	6,768,337	12.97

MECHANICAL DEPARTMENT

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Electrical Department (Cont'd)

The following alternating current motors are installed and operating as needed:

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
ANGELINE MINE:				
Hoist	250 HP.			250 HP.
CLIFFS SHAFT MINE:				
Shop	25			
No. 8 Crusher	125			
Screens	15			
Lower Tram #1 (Correction)	35	(Should be 30)	5	
Top Tram	100			
Hoist for "A" Shaft	500			
Underground Plunger Pump #1	180			
" Centrifugal Pump	250			
Allis-Chalmers Compressor	175			
Hoist for "B" Shaft	500			
Underground Plunger Pump #2	200			
Laboratory Crusher	5			
Coal Crushing Plant	15			
" " " Exhaust Fan	½			
Cooling Water Pump for Compressors	10			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Lower Tram #2	50			
Heating Plant Condensing Water Pump	2			
Underground Haulage Set #2	215			
Small Hoist in Crusher Building	15			
Conveyor Belts - New Crushing Plant, 2 motors	40			
Jaw Crusher - " " "	75			
Feeder Belt - " " "	5			
Magnetic Separator " " "	1½			
Underground Scrapers - 36 - 25 HP. motors	550	350		
Crusher	30			
Battery Charging Set - 2nd level, "A" Shaft	7½			
Underground Haulage Set #1	100			
Grinder in Drill Sharpening Shop		7½		4,379
HARD ORE SHOPS:				
Machine Shop	10			
Carpenter Shop	25			
Blacksmith Shop Punch	3			
Armature Banding Machine	2			
" " "	½			
" " "	1/8			
Lathe Grinder	1			
Portable Drill	1/4			
" " - Large	1/4			
Commutator Slotter	1/8			
Air Compressor	10½			
Water Supply Pump	7½			
Blacksmith Shop Blower	1/4			
Hacksaw	1/2			
Small Grinder	1/4			61-1/4
fwd.	4,337¾ HP.	357½ HP.	5 HP.	4,690-1/4 HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
brt. fwd.	4,337¾ HP.	357½ HP.	5 HP.	4,690¼ HP.
BROWNSTONE SUBSTATION:				
Test Set	1/2			
Oil Filter Press	1/4			
Battery Charging Motor-Generator Set	3			
Commutator Grinder	1			
Synchronous Condenser		80		
M.G. Set on Voltage Regulator Control		1/4		
				85
HOLMES MINE:				
Air Compressor	340			
" " Cooling Water Pump	3			
Skip Hoist - Salisbury motor added	400	400		
Cage "	400			
Underground Haulage Converter	150			
Top Tram	25			
No. 6 Crushers - 2 - 40 HP. motors	80			
Screens	20			
Laboratory Crusher	2			
Underground Plunger Pump	250			
" Centrifugal Pump	400			
Boiler Feed Pump	5			
Machine Shop	25			
				2,500
SALISBURY MINE:				
Hoist	400		400	
				0
OGDEN MINE:				
Compressor	150			
" Cooling Water Pump	2			
Electric Shovel Motor-Generator Set	110			
" " Air Compressor	4½			
" " Oil Pump	1/4			
" " Trip Motor	2			
" " Exciter Motor	10			
Scrapers (2)	50			
Pump	100			
Cyclone Drills - 2 - 10 HP.		20		
" " - 1 - 15 HP.		15		
				463¾
ISHPEMING HOSPITAL:				
Passenger Elevator	7½			
Dumb Waiter	3			
Large Washer	2			
Small "	1			
Extractor	2			
Vacuum Cleaner	3			
" Pump	1			
Water Supply Pump	2			
				21½
fwd.	7,292¾ HP.	872¾ HP.	405 HP.	7,760½ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
brt. fwd.	7,292¾ HP.	872¾ HP.	405 HP.	7,760½ HP.
ATHENS MINE:				
Cage Hoist	400			
Compressor - Nordberg	325			
Compressor Cooling Water Pump	3			
Auxiliary Compressor for Hoist Brakes	5			
Underground Ventilating Fan #1	15			
Sinking Pump - 2400' station	50			
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Converter	150			
Skip Pit Pump	2			
Laboratory Crusher	5			
Underground Plunger Pump #1	400			
Ore Tram - 2 - 50 HP. motors	100			
Carpenter Shop	20			
Underground Plunger Pump #2	400			
Ore Crusher	25			
Battery Charging Motor-Generator Set	1/4			
Underground Ventilating Fan #2	40			
Ingersoll-Rand Compressor	450			
Rock Tram	50			
				3,301¼
MAAS MINE:				
Turbine Auxiliaries (Circulating Pump	40			
Turbine Auxiliaries (Injection "	25			
Turbine Auxiliaries (Exciter	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist	50			
" Plunger Pump #1	320			
Compressor Cooling Water Pump	5			
Ore Tram - 2 - 50 HP. motors	100			
Coal Crushing Plant	15			
Underground Plunger Pump #2	250			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Rock Tram	50			
Skip Hoist	700			
Cage "	400			
Boiler Room Fan	1/2			
Skip Hoist Rheostat Pump	2			
Carpenter Shop Saw	15			
Auxiliary Compressor for Hoist Brakes	7½			
4th Level Pump	50			
Cooling Water Pump	5			
Triplex Pump, 4th Level	50			
				3,493
MAAS CRUSHING PLANT:				
Jaw Crusher	100			
Belt Conveyor	50			
Secondary Belt Conveyor	50			
Screen	50			
Pan Conveyor Motor-Generator Set	50			
Secondary Crusher	100			
				400
fwd.	14,487 HP.	872¾ HP.	405 HP.	14,954¾ HP.

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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
brt. fwd.	14,487 HP.	872¾ HP.	405 HP.	14,954¾ HP.
NEGAUNEE MINE:				
Underground Haulage Set	215			
"Ilgner" Hoist Set	450			
Top Tram - 2 - 50 HP. motors	100			
Laboratory Crusher	5			
Auxiliary Compressor for Hoist Brakes	3			
U.G. Plunger Pumps - 2 - 300 HP. motors	600			
" Centrifugal Pump	350			
" Suction Pumps - 2 - 15 HP. motors	30			
Compressor Cooling Water Pump	3			
Nordberg Air Compressor	325			
Shop	15			
Skip Pit Pump	5			
Ore Crusher	25			
Ingersoll-Rand Compressor	400			
13th Level Plunger Pump	15			
11th Level Plunger Pumps - 2 - 75 HP. motors	150			
Exciters for U.G. Pump Motors (2)	40			
Signal System Motor-Generator Set	1/2			
Timber Hoist - #2 Shaft	25			
Ventilating Fan - #2 Shaft	150			
Gravel Hoist	15			
Saw in Carpenter Shop	15			
				2,936½
SOUTH JACKSON CRUSHING PLANT:				
Hoist	75			
Crusher	150			
				225
BARNES-HECKER MINE:				
Cage Hoist	400			
Skip "	400			
Water Supply Pump	10			
Underground Haulage Converter	150			
" Centrifugal Pump - 2nd Level	400		400	
" " " - 3rd "	400		400	
" Plunger " - " "	350		350	
Top Tram (Stored at Morris Mine)	50		50	
Location Water Supply Pump	2			
Centrifugal Pump at Cave-in (to Gen.Storehouse)	30		30	
				962
LLOYD MINE:				
Skip Hoist	400			
Cage "	400			
Top Tram - 2 - 40 HP. motors	80			
Ore Crusher	25			
Water Supply Pump installed underground	50			
				955
fwd.	20,795½ HP.	872¾ HP.	1,635 HP.	20,033¼ HP.

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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
brt. fwd.	20,795½ HP.	872¾ HP.	1,635 HP.	20,033¼ HP.
MORRIS MINE:				
Skip Hoist	600			
Cage "	400			
Shop	25			
Ingersoll-Rand Compressor #1	250			
4th Level Plunger Pumps - 2 - 350 HP. motors	700			
7th " " Pump	100			
" " Centrifugal Pump	175			
Laboratory Crusher	5			
Carpenter Shop	25			
Nordberg Air Compressor	325			
Compressor Cooling Water Pump	5			
Top Tram - 2 - 50 HP. motors	100			
Underground Haulage Set #1	150			
Centrifugal Water Supply Pump	50			
Heating Plant Condensing Water Pump	2			
Ingersoll-Rand Compressor #2	500			
Planer in Carpenter Shop	15			
Crusher (from Cliffs Shaft)		25		
Underground Haulage Set #2 (from Cent.P.Plant)		215		
Winze Hoist - 7th Level (" Spies Mine)		200		
				3,867
SECTION 6 SHAFT:				
Hoist	200			
Water Supply Pump	3			
				203
AUSTIN MINE:				
Laboratory Crusher	3			
Hoist (Stored)	200		200	
Top Tram (to Mackinaw Mine)	50		50	
				3
GWINN MINE: (All sold to C.K.Quinn Co.)				
Skip Hoist	400		400	
Cage "	400		400	
Underground Centrifugal Pump	400		400	
" Plunger "	350		350	
Ore Tram	37		37	
Rock Tram	10		10	
Underground Haulage Set	150		150	
Shop	5		5	
11th Level Plunger Pump	50		50	
" " Centrifugal Pump	50		50	
" " Ventilating Fan	100		100	
				1,3[illegible]0
GWINN CRUSHING PLANT:				
Crusher	85			
Pan Conveyor	50			
Belt "	40			
				175
GARDNER MINE:				
Top Tram	25			
				25
fwd.	26,830½ HP.	1,312¾ HP.	3,837 HP.	24,306¼ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
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Electrical Department (Cont'd)

		INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
	brt. fwd.	26,830½ HP.	1,312¾ HP.	3,837 HP.	24,306¼ HP.
MACKINAW MINE:					
Hoist		400			
Compressor Cooling Water Pump	(to Cataract)	3		3	
Shop		7½			
Water Supply Pump	(to Francis stockpile)	7½		7½	
Top Tram	(from Austin)		50		
Fire Pump	(stored)	20		20	
Underground Haulage Set	(from Stephenson)		150		
Air Compressor	(from Cliffs Shaft)		325		
					932½
PRINCETON MINE #2:					
Hoist		200			
Top Tram -	2 - 50 HP. motors	100			
Underground Plunger Pump	(stored)	150		150	
" Centrifugal Pump	(to Cataract)	125		125	
					300
PRINCETON MINE #3:					
Hoist		75			
					75
STEPHENSON MINE:					
Skip Hoist		400			
Cage "		400			
Top Tram - Bessemer		50			
" " - C. & N. W.		50			
" " - #2 Bell		50			
Rock Tram		25			
Aldrich 5th level Plunger Pump	(Stored in Gwinn)	250		250	
Prescott " " " "	" " "	250		250	
5th level Centrifugal Pump	" " "	275		275	
6th " " "	" " "	50		50	
8th " Plunger Pump	" " "	50		50	
U.G. Haulage Converter	(to Mackinaw)	150		150	
5th level Centrifugal Pump	(Stored in Gwinn)	400		400	
6th " " "	" " "	125		125	
Underground Hoist	" " "	75		75	
6th level Aut.Pumps - 2 - 30 HP.	" " "	60		60	
Air Compressor	(to Cataract)	100		100	
Ore Tram		50			
					1,025
PRINCETON CENTRAL POWER PLANT:					
Turbine Auxiliaries	(Circulating Pump	50			
	(Injection "	40			
	(Exciter	33			
Underground Haulage Set	(to Morris Mine)	215		215	
Air Compressor		625			
Compressor Cooling Water Pump		7½			
Boiler Room Fan		50			
Coal Handling Machinery		10			
" " "		5			
					820½
PRINCETON CENTRAL SHOPS:					
Shop Motor		25			
Grinder		3			
					28
	fwd.	31,792 HP.	1,837¾ HP.	6,142½HP.	27,487¼ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
brt. fwd.	31,792 HP.	1,837¾ HP.	6,142½ HP.	27,487¼ HP.
PRINCETON CENTRAL PUMP STATION:				
Centrifugal Pump	100			
Automatic " (From Stephenson)		30		
				130
REPUBLIC MINE:				
Screen at #9 Shaft	25			
Crusher	100			
Auxiliary Compressor for Hoist Brakes	5			
Pump in Engine House	7½			
Centrifugal Pump in Engine House	20			
Coal Tram	7½			
Pump, bottom level #9 Shaft	20			
Machine Shop	5			
Pump - 4th Level	15			
" - 3rd "	50			
Pascoe Shaft Underground Pump, cross-over	50			
#9 Shaft Rock Tram	15			
Portable Hoist	7½			
Laboratory Crusher	3			
Picking Belt	5			
Screen at Crusher	10			
Carpenter Shop	20			
#9 Shaft Hoise - 2 - 500 HP. motors	1,000			
Motor-Generator Set for U.G. Haulage	30			
U.G. Hoist - 7th level Pascoe Shaft	100			
" " - 8th " " "	50		50	
#9 Shaft Ore Tram - 2 - 50 HP. motors	100			
Pump - 11th level Pascoe Shaft	10		10	
Drill Hoist - 7th level Pascoe Shaft	7½			
Booster Compressor	200			
				1,803
CARP PLANT:				
Auxiliaries - 2 - 15 HP. pump motors	30			
Water Supply Pump	1			
				31
HOIST PLANT:				
Exciter Motor-Generator Set	20			
Oil Pump		3		
				23
McCLURE PLANT:				
Water Supply Pump	2			
				2
DEAD RIVER STORAGE DAM:				
Air Compressor (to Cataract)	50		50	
				0
ESCANABA RIVER WATER POWER:				
Air Compressor (from D.R.Storage Dam)		50		
" " (" Stephenson Mine)		100		
Centrifugal Pump (" Princeton ")		125		
Compressor Cooling Water Pump (from Mackinaw)		3		
				278
TOTAL MINING DEPARTMENT fwd.	33,858 HP.	2,148¾ HP.	6,252½ HP.	29,754¼ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
TOTAL MINING DEPARTMENT	33,858 HP.	2,148¾ HP.	6,252½ HP.	29,754¼ HP.
PIONEER FURNACE:				
Furnace & Sawmill	1,195			1,195
L. S. & I. RR. CO.				
Shops, Sawmill, Ore Dock & Pumps	800			800
LAND DEPARTMENT:				
Sawmill at Munising - 2 motors	125			
Grand Island	10½			135½
LUMBERING DEPARTMENT:				
Dixon Location Water Supply Pump	5			
Tie Mill Saw		75		
" " Conveyors		37		
" " Shop		10		127
MICHIGAN GAS & ELECTRIC CO., MUNISING				
City Pumping	125			125
REPUBLIC TOWNSHIP:				
Water Supply Pump	25			25
OLIVER IRON MINING COMPANY:				
Pumps at Angeline & Section 16 Mines	525			
Air Compressor at Section 16 Mine	700			1,225
CITY OF ISHPEMING:				
Booster Pump at Brownstone Substation	15			15
CITY OF NEGAUNEE:	435			435
THE CLIFFS ELECTRIC CO., PRINCETON	100			100
MICHIGAN GAS & ELECTRIC COMPANY:				
Ishpeming	2,170			
Munising	250			2,420
PALMER MINING COMPANY:				
Volunteer Mine, Palmer	800			800
EMPIRE-QUINN MINING COMPANY:				
Empire Mine, Palmer	135			
Archibald Mine, Gwinn	1,952			2,087
MUNISING WOODENWARE COMPANY:	695			695
TOTAL OUTSIDE LOAD	10,062½ HP.	122 HP.		10,184½ HP.
GRAND TOTAL CONNECTED LOAD	43,920½ HP.	2,270¾ HP.	6,252½ HP.	39,938¾ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

The following motors are not connected to our Power System:

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
SPIES MINE:				
Hoist Motor used on Scraper (to Morris)	200 HP.		200	
Underground Triplex Pump	50			
Crusher	50			
Air Compressor	403			
Grinder in Shop	3			
Compressor Cooling Water Pump	3			
Hoist	400			
Boiler Feed Pump	2			
Top Tram	25			
3rd level Aldrich Pump (stored)	50		50	
Shop	5			
Compressor Cooling Water Pump	3			
Underground Haulage Set	150			
" Plunger Pump #1 - 8th level	150			
" " " #2 - " "	150			
" Centrifugal Pump	400		400	
				1,394 HP.
MESABA RANGE:				
BOEING MINE:				
Sinking Hoist	35			
Air Compressor	225			
U.G.Plunger Pump - 1st level (stored)	100		100	
" Centrifugal Pump " " "	125		125	
" Haulage Set	150			
Hoist	200			
Top Tram	50			
Compressor Cooling Water Pump	2			
Shop	10			
U.G.Centrifugal Pump - 2nd level (stored)	125		125	
" " " - 1st " "	125		125	
Blacksmith Shop Fan	1/4			
Churn Drill (to Hill-Trumbull)	10		10	
Tool Post Grinder	1/4			
Winze Hoist (stored)	50		50	
Circular Saw	3			
Centrifugal Pump - 2nd level (stored)	85		85	
				675½
CROSBY MINE:				
Log Washer	40			
Screen	20			
Picking Belt	3			
Chip Screen	3			
Tables	20			
Stockpile	7½			
Centrifugal Pump	85			
				178½
HELMER MINE:				
Hoist	200			200
fwd.	3,718 HP.		1,270 HP.	2,448 HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

		INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	CONNECTED JAN. 1,1928 TOTALS
	brt. fwd.	3,718 HP.		1,270 HP.	2,448 HP.
HILL-TRUMBULL MINE:					
Log Washer		25			
" "		40			
Turbos -	4 - 5 HP. motors	20			
Chip Screens -	2 - 2 HP. "	4		4	
Crusher		100			
Sand Pump		10			
Sample Crusher		10			
Prescott Plunger Pump		125			
Centrifugal Pump	(correction)	125	25 (should be 150 HP.)		
Tables		20			
Shops		30			
Punch & Shear Machine in Shop		5			
Band Saw in Carpenter Shop		5			
Compressor in Shop		50			
Screen		20			
Conveyor		100			
Planer in Shop		2			
Variety Saw in Shop		5			
Forge Fan		1/2			
Electric Drill		1/4			
Motor-Generator Set		65			
Blacksmith Shop Fan		1/4			
Drill		1/4			
Keystone Drill		15			
Tailings Pump		50			
Blacksmith Shop Fan		3			
Picking Belt		5			
Car Puller		7½			
Portable Grinder			1		
North Pit Pump			30		
Air Compressor at Washing Plant			25		
					919¾
WADE MINE:					
Hoist		125			
Air Compressor		150			
Compressor Cooling Water Pump		2			
Underground Haulage Set		150			
Machine Shop		10			
Underground Triplex Pump		50			
" Centrifugal Pump		100			
Sump Pump	(Correction)	5	(Should be 3 HP.)	2	
Top Tram		50			
Locomotive Water Pump	(to Hill-Trumbull)	5		5	
Clear " "		15			
Blacksmith Shop Fan	(to Hill-Trumbull)	3		3	
					655
	TOTAL	5,225¾ HP.	81 HP.	1,284 HP.	4,022¾ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

The following A.C. motors are on hand (Dec. 31, 1927), but are not installed:

CLIFFS SHAFT MINE:		
Top Tram (stator only)	50	
Spare Top Tram	50	
Top Tram	50	
New Hoist Stator only	500	
Small Conveyor Motor	2	
		652 HP.
GENERAL STOREHOUSE:		
Centrifugal Pump from D. R. Storage Dam	3	
Spare Motor-Generator Set	15	
" from Republic Concrete Mixer	5	
" General Electric pump	50	
" Westinghouse Motor-Generator Set	220	
" " " " " (Angeline)	150	
" General Electric " " " (Morris-Lloyd)	150	
" from Stephenson Mine plunger pump	250	
" " Hard Ore #3 centrifugal pump	150	
" " " " " plunger "	35	
" General Electric	7½	
" from Holmes crusher	100	
" Shop motor	10	
" Bag Cleaner from D. R. Storage Dam	1/2	
" from Centrifugal Pump used at North Lake	200	
" " " " " " " "	5	
" Centrifugal Pump	30	
" from Morris cage hoist	400	
" Haulage Converter from Francis	150	
" Plunger Pump " "	35	
" motor	40	
" Pump motor	25	
" " "	275	
" Top Tram from Austin	25	
" " " " Mackinaw	25	
		2,356
LAKE MINE CHANGE HOUST:		
Ventilating Fan from Salisbury Mine	7½	
		7½
MAAS MINE:		
Winze Pump	15	
Oil Pump	2	
Pump (from Morris Mine)	50	
		67
NEGAUNEE MINE:		
Flywheel Hoist Set motor	350	
		350
ATHENS MINE:		
Pump motor	35	
		35
MORRIS-LLOYD MINE:		
Pump Motor	40	
Centrifugal Pump Motor (from McClure Plant)	50	
Top Tram	50	
		140
fwd.		3,607½ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

brt. fwd.		3,607½ HP.
GWINN STORAGE SHED:		
Stephenson 5th level Plunger Pump	250	
" " " " "	250	
" 6th " Centrifugal Pump	50	
" 8th " Plunger "	50	
" 5th " Centrifugal "	400	
" 6th " Centrifugal "	125	
" Underground Hoist	75	
" 6th level Automatic Pump	30	
" 5th " Centrifugal Pump	275	
		1,505
PRINCETON MINE:		
Underground Pump	150	
		150
MACKINAW MINE:		
Quintuplex Pump	350	
Triplex "	75	
		425
STEPHENSON MINE:		
Layne & Bowler Pump #2	350	
		350
REPUBLIC MINE:		
Spare	10	
"	30	
" Pump motor	10	
		50
ISHPEMING HOSPITAL:		
Spare for Dumb Waiter	3	
		3
TOTAL		6,090½ HP.

Spare motors at Spies Mine:		
Aldrich Triplex Pump	50	
Prescott Centrifugal Pump	400	
TOTAL		450 HP.

Spare motor on Mesaba Range:		
BOEING MINE:		
Sump Pump	7½	
		7½
HILL-TRUMBULL MINE:		
Conveyor	50	
Screen	20	
Pump	3	
Shop	5	
Sump Pump	5	
Spare	3	
Plunger Pump	50	
Picking Belt	2	
		138
WADE MINE:		
Pump	5	
Skip Pit Pump	5	
Centrifugal Pump	20	
Ventilating Fan	15	
		45
TOTAL		190½ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

Total C. C. I. Co. load connected to Power System -	29,754¼ HP.
" Outside " " " " " " -	10,184½
TOTAL CONNECTED LOAD	39,938¾ HP.
Total connected load at Spies Mine -	1,394 HP.
" " " " Mesaba Range mines -	4,022¾ HP.
Total spare motors on hand 12/31/27 - Ishpeming District -	6,090½ HP.
" " " " " " - Spies Mine -	450 HP.
" " " " " " - Mesaba Range -	190½ HP.

The following direct current generators and exciters are installed and operating as needed:

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	JAN. 1,1928 TOTALS
AU TRAIN WATER POWER PLANT:				
Exciters (2)	34 KW.			34 KW.
CARP RIVER WATER POWER PLANT:				
Exciters (2)	150			150
HOIST PLANT:				
Exciter	17½			
"	37			54½
McCLURE PLANT:				
Exciters (2)	110			110
MAAS PLANT:				
Motor Driven Exciter	22½			
Turbo " "	22½			
Compressor Motor Exciters (2)	20			65
PRINCETON CENTRAL POWER PLANT:				
Motor Driven Exciter	22½			
Turbo " "	22½			
Compressor Motor Exciter	12			57
REPUBLIC MINE:				
Exciter in #5 Engine House	7½			
" " Water Power Plant	17			24½
CLIFFS SHAFT MINE:				
Compressor Motor Exciters (2)	20			
" " Exciter	10		10	20
BROWNSTONE SUBSTATION:				
Battery Charging Set	2			
Line Testing Set	1/2			
Voltage Regulator Control		1/2		
Condenser Exciter		15		18
fwd.	527½ KW.	15½ KW.	10 KW.	533 KW.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	JAN. 1,1928 TOTALS
brt. fwd.	527½ KW.	15½ KW.	10 KW.	533 KW.
HOLMES MINE:				
Compressor Motor Exciter	10			10
ATHENS MINE:				
Nordberg Compressor Motor Exciter	10			
Flywheel Set Exciter	15			
Skip Hoist Generator	700			
Battery Charging Motor-Generator Set	1/2			
Ingersoll-Rand Compressor Motor Exciter	10			735½
NEGAUNEE MINE:				
Skip Hoist Generator	400			
Cage " "	150			
Flywheel Set Exciter	25			
Exciters for Underground Pump Motors (2)	28			
Ingersoll-Rand Compressor Motor Exciter	10			
Nordberg " " "	10			
Bell Signal Set	1/2			623½
MAAS CRUSHING PLANT:				
Pan Conveyor Generator	35			
" " " Exciter	1¾			36¾
MORRIS MINE:				
Ingersoll-Rand Compressor Motor Exciter	12			
Nordberg " " "	10			
Ingersoll-Rand " " "	10			32
MACKINAW MINE:				
Compressor Motor Exciter		10		10
OGDEN MINE:				
Thrust Generator on Electric Shovel	15			
Hoist " " " "	75			
Swing " " " "	15			
Exciter " " "	5½			110½
TOTAL	2,075¾ KW.	25½ KW.	10 KW.	2,091¼ KW.

Underground Haulage Generators:

CLIFFS SHAFT MINE:				
Motor-Generator Set #1	100 KW.			
" " " #2	100			
Motor-Generator Charging Set	5			205 KW.
HOLMES MINE:				
Rotary Converter	100			100
ATHENS MINE:				
Rotary Converter	100			100
MAAS MINE:				
Motor-Generator Set	100			100
fwd.	505 KW.			505 KW.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	JAN. 1,1928 TOTALS
brt. fwd.	505 KW.	0	0	505 KW.
NEGAUNEE MINE:				
Motor-Generator Set	100			100
BARNES-HECKER MINE:				
Rotary Converter	100			100
MORRIS-LLOYD MINE:				
Motor-Generator Set #1	100			
" " " #2 (from C.P.Plant)		100		200
GWINN MINE:				
Motor-Generator Set (Sold)	100		100	0
PRINCETON CENTRAL POWER PLANT:				
Motor-Generator Set (to Morris Mine)	100		100	0
STEPHENSON MINE:				
Rotary Converter (to Mackinaw Mine)	100		100	0
MACKINAW MINE:				
Rotary Converter (from Stephenson)	100	100		100
REPUBLIC MINE:				
Battery Charging Set for Storage Battery Locomotives	20			20
TOTAL	1,125 KW.	200 KW.	300 KW.	1,025 KW.

Direct Current Motors:

AU TRAIN WATER POWER PLANT:				
Governor Control Motors	(2)	¼ HP.		¼ HP.
CARP RIVER WATER POWER PLANT:				
Rheostat Control	(2)	1/4		
Governor "	(2)	1/4		½
McCLURE PLANT:				
Valve Control	(2)	2		
Rheostat Control	(2)	1/2		2½
CLIFFS SHAFT MINE:				
Portable Hoist		10		
Re-crushing Plant Conveyor		2		
Car Puller		6½		18½
HOLMES MINE:				
Sturtevant Fan		1½		1½
OGDEN MINE:				
Hoist Motor on Electric Shovel		100		
Swing " " " "		20		
Thrust " " " "		20		140
fwd.		163¼ HP.		163¼ HP.

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Electrical Department (Cont'd)

		INSTALLED TO JAN. 1 1927	INSTALLED IN 1927	TAKEN OUT IN 1927	JAN. 1,1928 TOTALS
	brt. fwd.	163¼ HP.	0	0	163¼ HP.
ATHENS MINE:					
Skip Hoist		900			
Ventilating Fan	(to Maas Mine)	15		15	
" Fans		15		10	
Sullivan Scrapers	2 - 6½ HP.		13		
					918
MAAS MINE:					
Timber Hoist - 2nd level		10			
" " - 4th "		10			
Bilge Pump		5			
Ventilating Fan	(from Athens)		15		
Sullivan Scraper			15		
" Scrapers	5 - 6½ HP.		32½		
					87½
MAAS CRUSHING PLANT:					
Pan Conveyor		40			
					40
NEGAUNEE MINE:					
Skip Hoist		500			
Cage "		200			
Timber Hoist - Tunnel		10			
" " - 10th level		10			
Ventilating Fan		15	7½	15	
" Fans	3 - 5 HP.	5	10		
Denver Electric Scrapers -	8 - 7½ HP.	45	15		
Sullivan " -	10 - 6½ HP.	13	52		
" Scraper			25		
					892½
MORRIS MINE:					
Ventilating Fan - 6th level		15			
Sullivan Scrapers -	7 - 6½ HP.	32½	13		
Denver Rock Drill Scraper -	7 - 7½ HP.	7½	45		
Sullivan Scraper	-		10		
					123
GWINN MINE:					
Hoist - 9th level		15		15	
Ventilating Fan	(to Spies Mine)	15		15	
" "		15		15	
					0
PRINCETON MINE:					
Bilge Pump		5		5	
					0
TOTAL		2,061¼ HP.	253 HP.	90 HP.	2,224¼ HP.

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Electrical Department (Cont'd)

Spare Generators and Exciters on hand December 31st, 1927:

GENERAL STOREHOUSE:		
Old Hoist Exciter	22 KW.	
Motor-Generator Set used for battery charging in Hard Ore Shop	10	
Spare Exciter	18	
		50 KW.
NEGAUNEE MINE:		
Skip Hoist (armature only)	500 HP.	
TOTAL		50 KW.

Spare Underground Haulage Generators on hand December 31st, 1927:

GENERAL STOREHOUSE:		
Motor-Generator Set	150	
" " " (from Angeline)	100	
" " " (from Morris)	100	
Rotary Converter (from Francis)	100	
TOTAL		450 KW.

Spare Direct Current Motors on hand December 31st, 1927:

ATHENS MINE:		
Fan Motor	15 HP.	
Timber Hoist Motor	10	
Fan Motor	15	
" "	15	
		55 HP.
MORRIS-LLOYD MINE:		
Crane Motor	10	
		10
GWINN MINE:		
Pump Motor	20	
		20
HOLMES MINE:		
Fan Motors - 2 - 1½ HP.	3	
		3
TOTAL		88 HP.

Electrical Department (Cont'd)

MESABA RANGE:

Exciters and Generators installed up to December 31, 1927:

BOEING MINE:
Compressor Motor Exciter — 6 KW.

Underground Haulage Generators installed up to Dec. 31, 1927:

BOEING MINE:
Motor-Generator Set — 115 KW.

HILL-TRUMBULL MINE:
Motor-Generator Set — 55

WADE MINE:
Rotary Converter — 100

TOTAL — 270 KW.

Direct Current Motors installed up to December 31, 1927:

HILL-TRUMBULL MINE:
Feeder Motor — 60 H.P.

Total Exciters and Generators installed to December 31, 1927 - 6 K.W.
" Underground Haulage Generators " " " " " - 270 K.W.
" Direct Current Motors " " " " " - 60 H.P.

SPIES MINE:

Exciters installed up to December 31, 1927:

Compressor Motor Exciter — 10 K.W.

Underground Haulage Generators installed up to December 31, 1927 - 150 K.W.

ISHPEMING DISTRICT:

Total D.C. Generators and Exciters installed to Dec. 31, 1927 - 2,091¼ K.W.
" Underground Haulage Generators " " " " " - 1,025 K.W.
" Direct Current Motors " " " " " - 2,224¼ H.P.
Total Spare D.C. Generators and Exciters on hand " " " - 50 K.W.
" " Underground Haulage Generators " " " " " - 450 K.W.
" " Direct Current Motors " " " " " - 88 H.P.
Spare Direct Current Motor Armature " " " " " - 500 H.P.

Electrical Department (Cont'd)

Substation Transformers installed up to December 31, 1927:

	PHASE	NO.	K.V.A.	TOTAL K.V.A.	
33000/2300 Volts					
Brownstone Substation	1	3	400	1,200	
Cliffs Shaft-Holmes Substation	1	6	500	3,000	
Morris-Lloyd Substation	1	3	590	1,770	
Barnes-Hecker "	1	3	250	750	
Republic "	1	3	400	1,200	
Maas "	1	6	590	3,540	
Princeton "	1	3	590	1,770	
Gwinn "	1	3	625	1,875	
Munising "	1	3	200	600	
McClure Plant	3	2	5,000	10,000	
Carp Plant	1	3	1,900	5,700	
Au Train Plant	3	1	1,250	1,250	
Ogden Mine Substation	1	3	75	225	
Palmer "	1	2	625	1,250	
Hoist Plant	1	3	667	2,000	
			TOTAL		36,130 K.V.A.
Chatham Substation	1	2	15	30	
Carlshend "	1	1	15	15	
Little Lake "	1	1	15	15	
					60 "
30000/6600 Volts					
Champion Substation	1	2	25	50	
					50 "
6600/2300 Volts					
Carp Plant	1	6	185	1,110	
Gwinn Substation	1	3	350	1,050	
Mackinaw "	1	3	350	1,050	
			TOTAL		3,210 K.V.A.

Transformers used for Underground Haulage installed to 12/31/27:

Athens Mine converter	1	3	35	105	
Holmes " "	3	1	100	100	
Barnes-Hecker "	3	1	110	110	
Mackinaw "	1	3	35	105	
					420 K.V.A.

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Electrical Department (Cont'd)

Distribution Transformers installed up to December 31, 1927:

2300/220/110 Volts	PHASE	NO.	K. V. A.	TOTAL K.V.A.
ANGELINE MINE:				
Hoist Control	1	1	7½	7½
CLIFFS SHAFT MINE:				
Office Lights	1	1	10	
" "	1	1	15	
Laboratory	1	1	5	
"A" Shaft Hoist	1	1	7½	
"B" " "	1	1	10	
Coal Crusher	1	2	(7½) 15	
Pump Station Lights	1	1	1	
Crusher House Lights	1	2	(1) 2	
Crushers	1	3	(10) 30	
Underground Scrapers	1	2	(15) 30	
" "	1	4	(50) 200	
" "	1	3	(25) 75	
Motor-Generator Set for Battery Charging	1	3	(3) 9	
Rectifiers	1	4	(5) 20	
Lights	1	2	(1½) 3	432½
HARD ORE & BROWNSTONE:				
Light & Power	1	1	15	
Light	1	1	3/4	
Light & Power	1	1	7½	
Shop	1	1	30	53¼
HOLMES MINE:				
Shop Power	1	3	(10) 30	
Engine House Lights & Power	1	1	5	
Skip Hoist Control	1	1	10	
Cage " "	1	1	10	
4th level Pump Station Lights	1	1	2	
Cage Bell Circuit	1	1	3/4	
Skip " "	1	1	1/2	
Shaft House Lights	1	1	3/4	
Pump " "	1	1	3/4	
Change " "	1	1	3/4	
Shaft " "	1	1	1/2	
Engine " "	1	1	7½	68½
LAKE MINE:				
Engine House Lights	1	1	5	
Shaft Lights	1	1	3/4	5¾
SALISBURY MINE:				
Eng. Ho. Lights & Circulating Pump	1	1	5	
" " " " " "	1	1	2	
Lights	1	1	1/2	7½
			fwd.	575

Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.	K. V. A.	TOTAL K.V.A.
brt. fwd.				575
ATHENS MINE:				
Machine Shop	1	2	(10) 20	
Surface Lights & Lab. Hot Plates	1	3	(10) 30	
Pump Station Lights	1	1	5	
" " "	1	1	2	
100 G.P.M. Pump	3	1	40	
Signal System	1	1	1	
Engine House Lights	1	1	5	
" " "	1	1	4	
Top Tram	1	1	2	
Top Tram Control	1	1	1	
				110
MAAS MINE:				
Lights & Injection Pump	1	3	(10) 30	
Coal Crusher & Shop	1	2	(10) 20	
Signal System	1	1	1/2	
3rd level Pump Station	1	2	(5) 10	
Bell Signal at 55 Winze	1	1	1	
Cage Hoist Control	1	1	10	
Skip Hoist "	1	1	2	
" " "	1	1	3	
Rock Tram "	1	1	1	
Heaters in Engine House	1	1	7½	
Top Tram	1	1	2	
				87
MAAS CRUSHING PLANT:				
Lights	1	1	7½	
Screen	1	3	(10) 30	
				37½
NEGAUNEE MINE:				
Shop Light & Power	1	1	7½	
" " " "	1	2	(10) 20	
Engine House Lights & Power	1	2	(10) 20	
" " " " "	1	1	5	
Signal System	1	1	1/2	
Pump Station Lights, etc.	1	3	(7½) 22½	
12th level Pump	1	3	(5) 15	
Barn	1	1	5	
Gravel Pit	1	1	7½	
Hoists & Lights - #2 Shaft	1	3	(10) 30	
				133
SOUTH JACKSON CRUSHING PLANT:				
Hoist Brake	1	1	5	
Lights	1	1	2	
				7
BARNES-HECKER MINE:				
Lights	1	1	5	
"	1	1	7½	
Top Tram Control	1	1	1	
Skip Hoist Control	1	1	10	
Cage " "	1	1	10	
Water Supply Pump	1	1	2½	
Location Lights	1	1	10	
				46
			fwd.	995½

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.	K. V. A.	TOTAL K.V.A.
brt. fwd.				995½
LLOYD MINE:				
Cage Hoist Control	1	1	7½	
Skip " "	1	1	7½	
Water Supply Pump House Lights	1	1	2	
Engine House Lights & Bell Signal	1	1	5	
Shaft House Lights	1	1	5	
				27
MORRIS MINE:				
Skip Hoist Control & Lights	1	1	10	
Cage " " " "	1	1	7½	
Signal System Lights	1	1	1/2	
Shop & Lights	1	3	(10) 30	
7th level Pump Station Lights	1	1	2	
Location Lights	1	1	10	
Club House Lights	1	1	5	
				65
SECTION 6 SHAFT:				
Hoist Control	1	1	7½	
Lights	1	2	(2) 4	
				11½
AUSTIN MINE:				
Lights	1	1	10	
Top Tram	1	2	(10) 20	
Shop	1	1	10	
				40
GARDNER MINE:				
Top Tram	1	3	(10) 30	
				30
MACKINAW MINE:				
Machine Shop	1	2	(5) 10	
Hoist Control	1	1	7½	
Signal System	1	1	1	
Top Tram	1	3	(10) 30	
				48½
PRINCETON MINE:				
Top Tram Lights	1	1	3	
Pump House Lights	1	1	2½	
				5½
PRINCETON CENTRAL POWER PLANT:				
Coal Crusher	1	3	(7½) 22½	
Power Plant Lights	1	1	10	
Injection Pump	1	2	(15) 30	
Boiler Room Fan	1	2	(10) 20	
				82½
PRINCETON CENTRAL SHOPS:				
Power & Light	1	2	(10) 20	
				20
PRINCETON DISTRICT LABORATORY:				
Hot Plates	1	3	(10) 30	
				30
			fwd.	1,355½

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.	K. V. A.	TOTAL K.V.A.
brt. fwd.				1,355½
STEPHENSON MINE:				
Rock Tram	1	3	(10) 30	
Skip Hoist Control	1	1	10	
Cage " "	1	1	10	
				50
REPUBLIC MINE:				
G. E. Tram	1	1	(15) 30	
Lighting	1	3	(2) 6	
" & Pump	1	1	10	
" " "	1	1	10	
Engine House Lights	1	1	7½	
Hoist Control	1	1	25	
Top Tram Controls	1	2	(1) 2	
Office Lights	1	1	3	
Motor-Generator Set & Pumps	1	3	(7½) 22½	
Pascoe Shaft Hoist Control	1	1	7½	
#9 Shaft - 3rd and 4th levels	1	3	(20) 60	
Power & Lights on Surface	1	3	(10) 30	
Water Power Plant Lights	1	1	1½	
Screen Motor & Lights	1	3	(3) 9	
Portable Hoist	1	1	10	
				234
AU TRAIN WATER POWER PLANT:				
Power Plant Lights	1	1	1	
Operator's Dwelling Lights	1	1	2	
Control	1	1	2	
Power & Lights, Dixon Location	1	2	(5) 10	
" " " Grand Island	1	2	(5) 10	
				25
CARP RIVER WATER POWER PLANT:				
Power & Light	1	1	10	
" " "	1	1	20	
Pump	1	2	(1) 2	
				32
HOIST PLANT:				
Power & Light	1	1	7½	
" " "	1	2	(5) 10	
				17½
McCLURE PLANT:				
Power & Lights	1	2	(10) 20	
				20
ESCANABA RIVER WATER POWER:				
Power & Lights	1	2	(1) 2	
" " "	1	2	(1) 2	
				4
		GRAND TOTAL		1,738 K.V.A.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

Electrical Department (Cont'd)

Spare Transformers on hand December 31, 1927:

	PHASE	NO.	K. V. A.	TOTAL K.V.A.
GENERAL STOREHOUSE:				
General Electric	1	1	15	
Allis-Chalmers (from Lake Mine)	1	1	7½	
General Electric	1	2	(5) 10	
" "	1	1	3	
				35½
ANGELINE MINE:				
General Electric	1	1	1	
				1
ATHENS MINE:				
Spare	1	1	3	
Spare	1	1	3	
Spare	1	1	7½	
				13½
REPUBLIC MINE:				
General Electric	1	3	(10) 30	
" "	1	1	4	
				34
		GRAND TOTAL		84 K.V.A.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

COMPARATIVE TABLES:

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	PER TON HOISTED	GALLONS OF WATER PUMPED
CLIFFS SHAFT MINE:					
1918	5 135	382 804	861 374 720	2 276	315 252 828
1919	3 494	277 901	907 895 024	2 402	298 889 689
1920	3 854	334 347	872 225 408	2 638	262 308 003
1921	2 094	67 454	273 648 228	4 057	274 901 402
1922	891	138 702	419 382 000	3 023	399 874 439
1923	2 359	305 727	734 645 710	2 403	377 383 675
1924	2 224	309 996	784 461 617	2 530	388 257 675
1925	2 900	322 928	824 005 547	2 551	327 655 585
1926	1 470	350 604	801 351 000	2 285	379 727 700
1927	957	426 830	766,647 000	1 796	440 517 425
HOLMES MINE:					
1918	700	130 295	368 456 686	2 840	--- --- ---
1919	947	173 178	521 145 000	3 009	*25 471 515
1920	682	260 118	448 965 000	1 726	26 099 690
1921	832	191 147	275 057 000	1 439	38 456 053
1922	911	231 306	346 466 000	1 497	73 009 389
1923	704	289 984	431 820 000	1 489	82 640 803
1924	879	170 228	296 460 000	1 741	75 235 295
1925	679	172 507	253 125 000	1 446	56 962 287
1926	768	178 296	267 795 000	1 502	83 223 451
1927	816	186 436	333 180 000	1 787	79 829 181
ATHENS MINE:					
1918	609	101 394	498 600 000	- ---	--- --- ---
1919	740	155 643	414 045 000	2 660	85 503 850
1920	593	214 601	505 035 000	2 353	82 794 824
1921	515	177 065	359 055 000	2 027	73 114 028
1922	683	193 711	456 615 000	2 357	86 235 708
1923	971	246 704	635 535 000	2 576	103 329 157
1924	685	246 352	581 130 000	2 359	116 161 813
1925	789	214 510	468 900 000	2 186	131 715 395
1926	869	226 229	547 650 000	2 421	140 788 044
1927	790	233 221	679 815 000	2 914	127 086 869
MAAS MINE:					
1918	9 351	312 634	935 128 335	2 991	510 265 180
1919	9 639	343 810	644 597 449	1 874	573 373 848
1920	5 097	351 521	571 224 659	1 625	513 176 403
1921	735	211 616	373 275 000	1 764	517 238 661
1922	628	219 676	458 010 000	2 083	516 431 109
1923	548	228 528	472 220 000	2 066	509 330 141
1924	682	224 291	470 880 000	2 099	522 683 088
1925	670	144 408	372 735 000	2 581	480 918 511
1926	829	245 992	420 930 000	1 711	508 242 996
1927	767	274 586	521 730 000	1 900	534 129 791

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

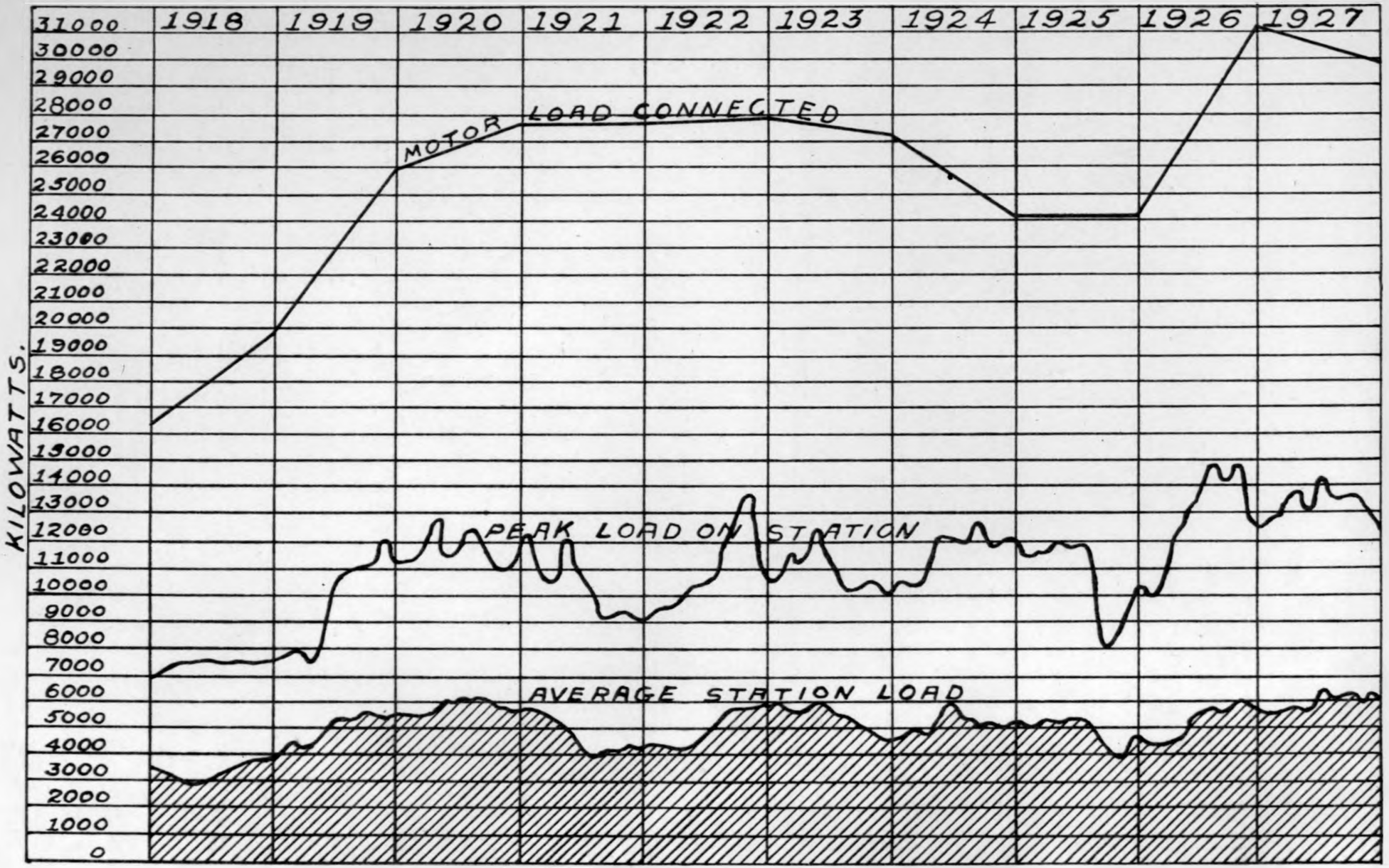
COMPARATIVE TABLES:

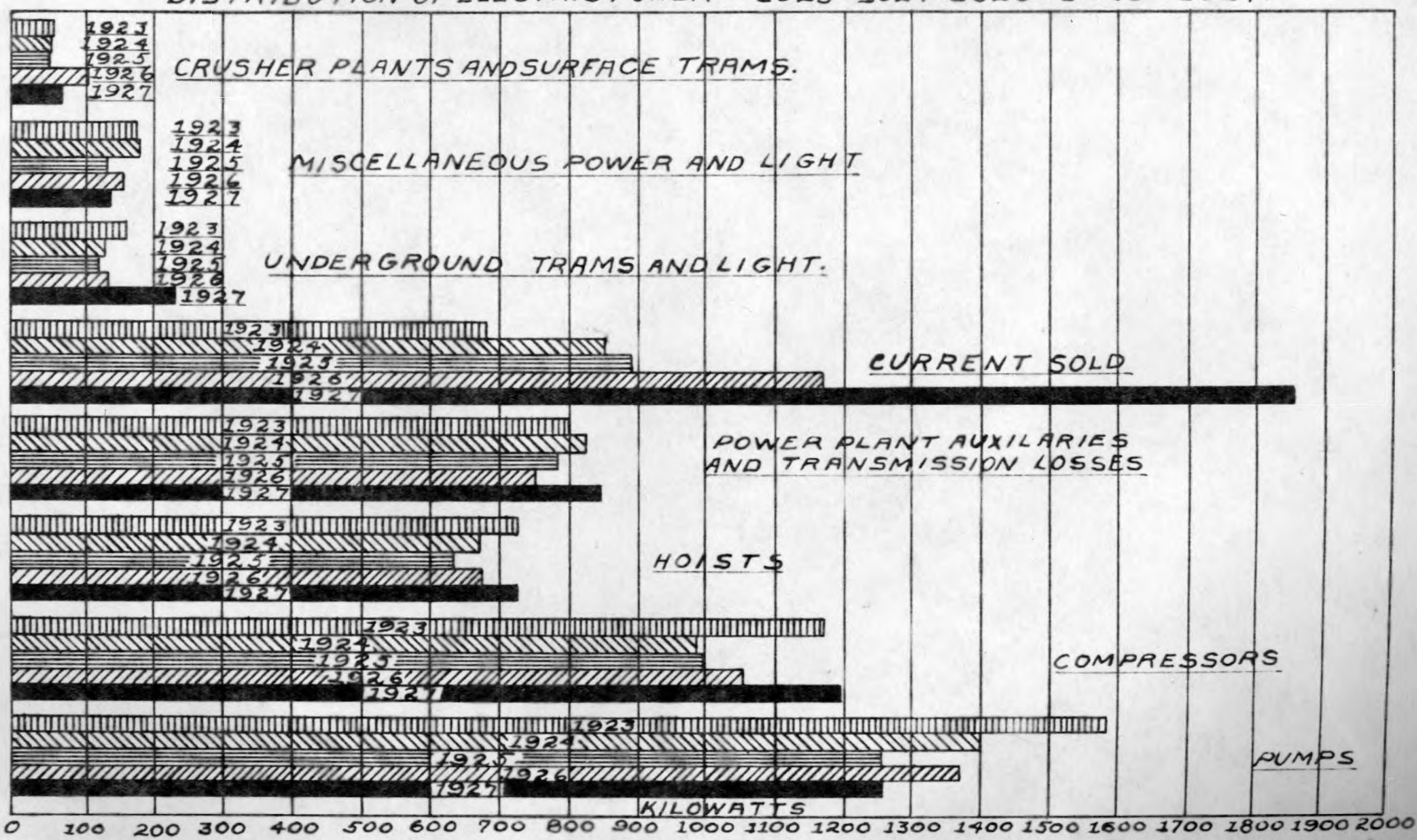
YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	PER TON HOISTED	GALLONS OF WATER PUMPED
NEGAUNEE MINE:					
1918	1 293	524 869	443 996 750	845	828 575 874
1919	1 320	525 894	591 104 600	1 185	603 198 543
1920	1 095	569 895	729 139 000	1 279	610 132 854
1921	838	258 967	306 315 000	1 183	597 401 853
1922	1 075	300 041	414 765 000	1 382	613 603 672
1923	996	383 914	655 695 000	1 708	582 912 109
1924	1 156	322 705	558 980 000	1 732	502 525 354
1925	1 100	342 824	660 600 000	1 927	436 422 253
1926	1 229	374 004	602 010 000	1 609	440 271 619
1927	1 139	501 516	895 680 000	1 785	603 746 976
OGDEN MINE:					
1925	- ---	61 514	--- --- ---	- ---	--- --- ---
1926	- ---	146 501	--- --- ---	- ---	--- --- ---
1927	- ---	174 106	--- --- ---	- ---	--- --- ---
MORRIS-LLOYD MINE:					
1918	859	299 360	681 964 000	2 378	315 454 220
1919	1 132	313 887	936 264 700	2 982	340 883 130
1920	971	283 400	802 952 000	2 832	311 061 125
1921	848	234 809	681 918 000	3 067	321 064 176
1922	931	241 065	596 225 500	2 473	276 149 791
1923	1 031	273 124	826 038 000	2 460	267 210 477
1924	894	229 968	381 573 000	1 659	221 874 604
1925	919	258 062	611 836 920	2 371	172 168 518
1926	1 190	291 852	469 265 000	1 608	203 411 761
1927	1 096	333,736	688 545 000	2 062	223 631 596
HILL-TRUMBULL MINE:					
1922	3 447	352 651	--- --- ---	- ---	--- --- ---
1923	4 096	311 012	--- --- ---	- ---	--- --- ---
1924	3 049	322 823	--- --- ---	- ---	--- --- ---
1925	3 364	521 382	--- --- ---	- ---	--- --- ---
1926	3 738	522 017	--- --- ---	- ---	--- --- ---
1927	**4 149**	544 405	--- --- ---	- ---	--- --- ---
REPUBLIC MINE:					
1919	5 709	185 383	1 228 202 000	6 625	34 770 380
1920	3 972	181 0588	1 347 129 000	7 440	35 559 650
1921	1 436	79 761	954 242 000	11 964	35 132 398
1922	1 302	113 108	1 112 788 000	9 838	41 620 635
1923	1 816	137 181	1 279 058 000	9 329	37 204 860
1924	2 668	87 668	1 158 600 000	13 215	33 955 020
1925	2 275	90 773	871 386 000	9 599	27 210 960
1926	2 218	76 867	1 053 268 000	13 702	31 117 828
1927	**1 743**	71 499	928 003 000	12 979	41 876 020

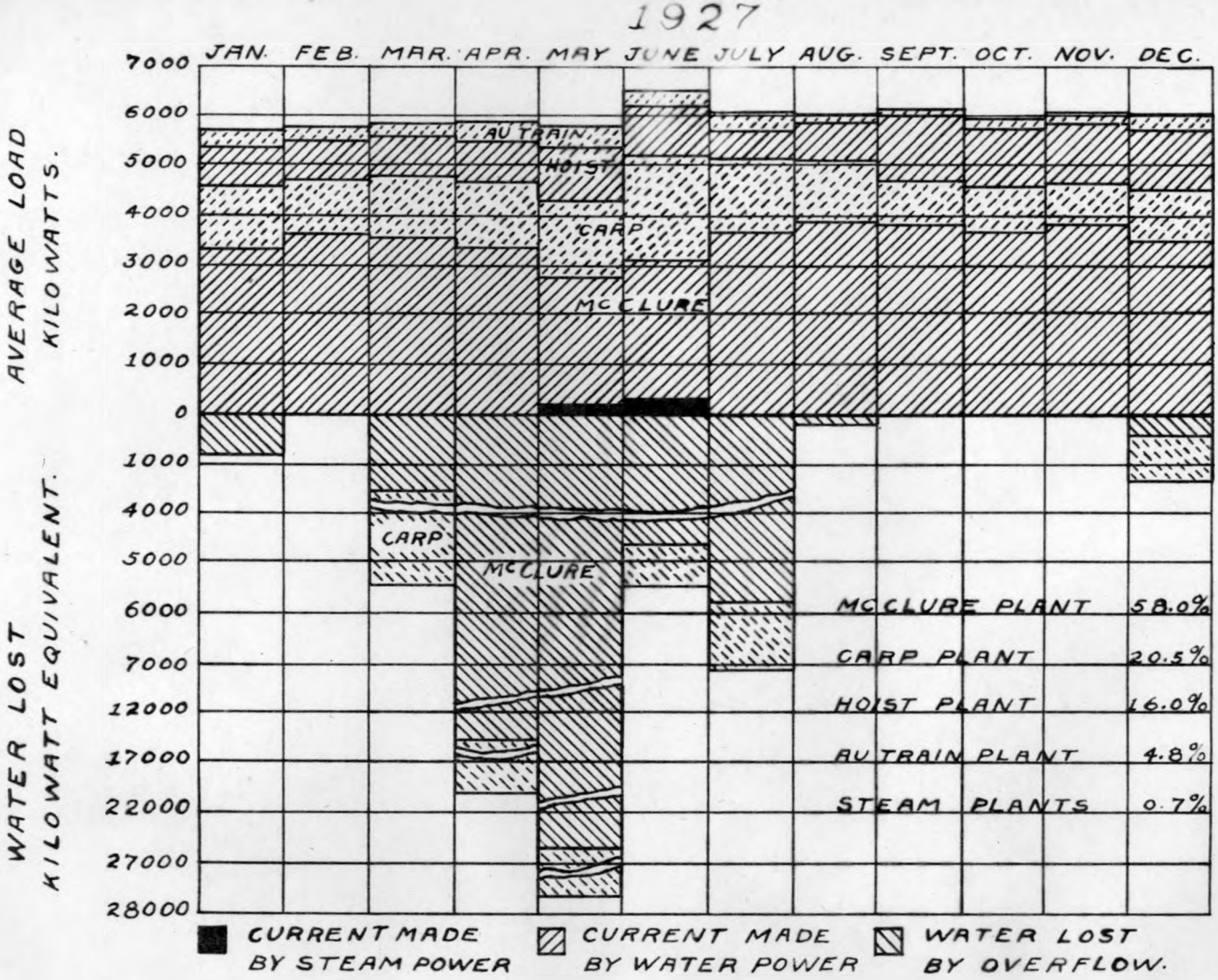
MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1927

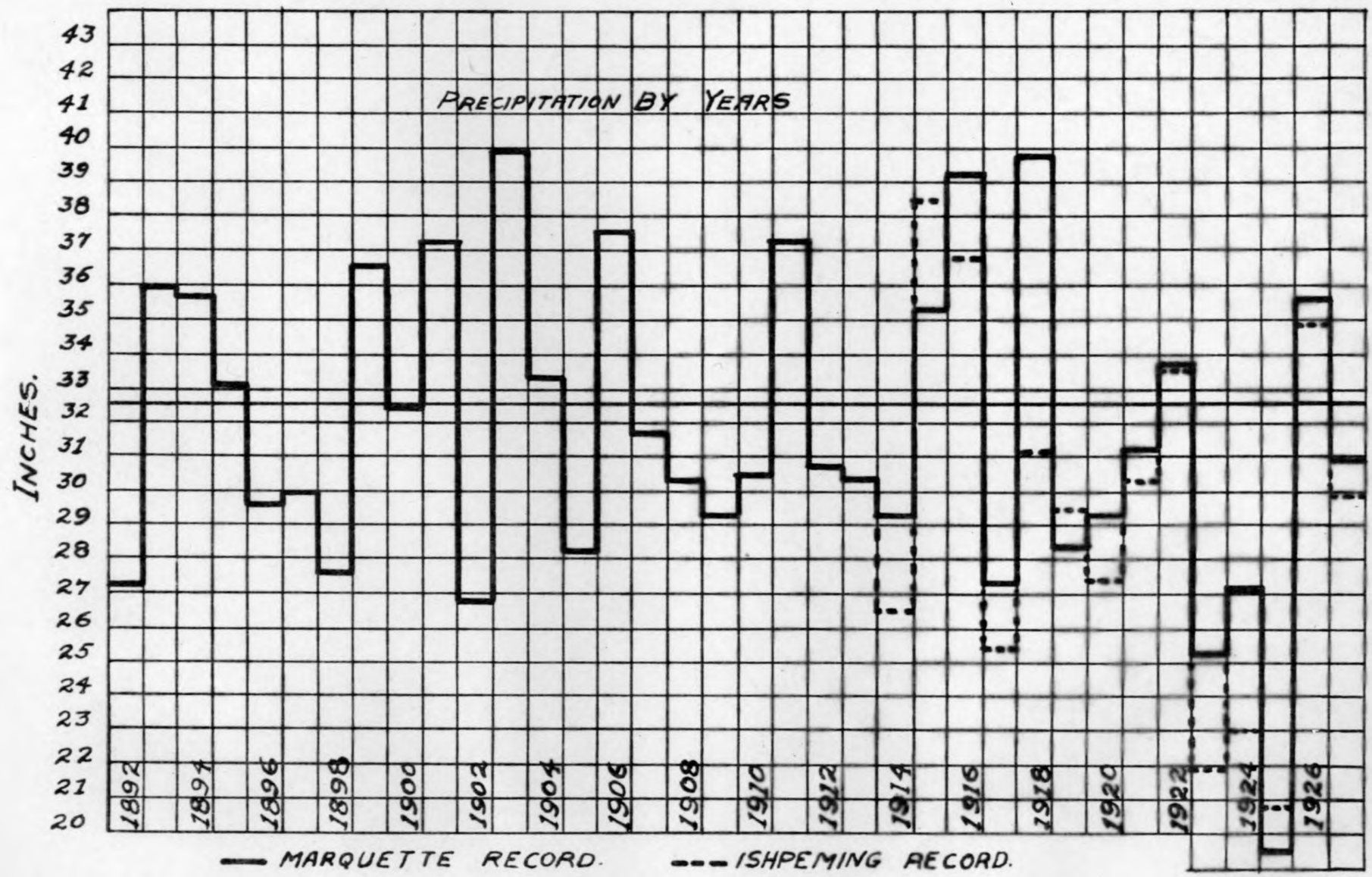
COMPARATIVE TABLES:

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
SPIES & VIRGIL MINES:					
1919	962	71 000	--- --- ---	- ---	--- --- ---
1920	377	93 519	--- --- ---	- ---	--- --- ---
1921	350	46 878	87 360 300	- ---	--- --- ---
1922	192	5 432	--- --- ---	- ---	--- --- ---
1923	495	19 732	--- --- ---	- ---	--- --- ---
1924	272	55 953	--- --- ---	- ---	--- --- ---
1925	313	72 542	--- --- ---	- ---	--- --- ---
1926	392	92 407	--- --- ---	- ---	--- --- ---
1927	424	163 911	--- --- ---	- ---	--- --- ---

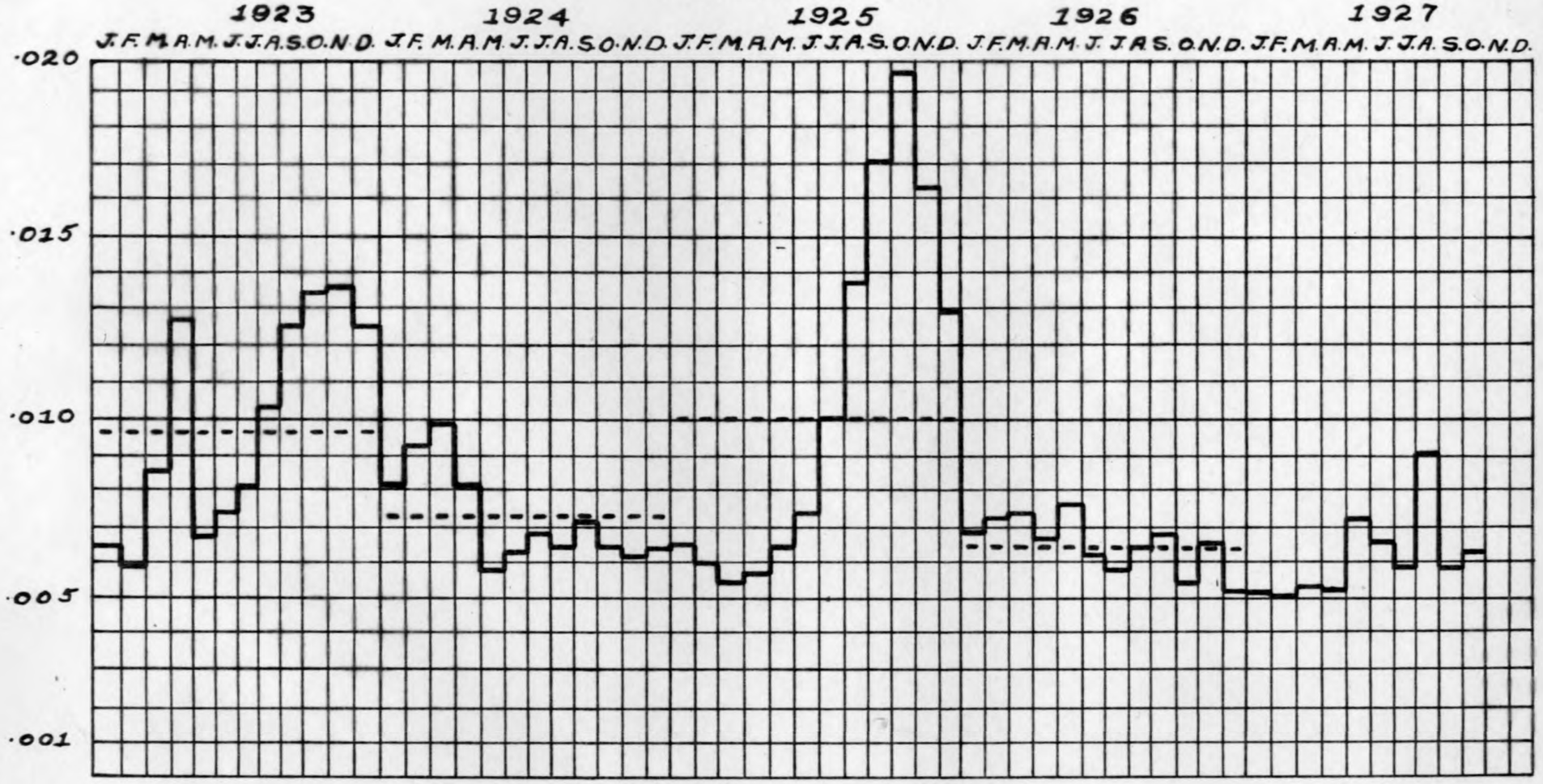

KILOWATTS.
31000
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
MOTOR LOAD CONNECTED
PEAK LOAD ON STATION
AVERAGE STATION LOAD


DISTRIBUTION OF ELECTRIC POWER 1923-1924-1925-1926-1927.
1923
1924
1925
1926
1927
CRUSHER PLANTS AND SURFACE TRAMS.
MISCELLANEOUS POWER AND LIGHT
UNDERGROUND TRAMS AND LIGHT.
CURRENT SOLD
POWER PLANT AUXILARIES AND TRANSMISSION LOSSES
HOISTS
COMPRESSORS
PUMPS
KILOWATTS
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000


1927
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
7000
6000
5000
4000
3000
2000
1000
0
1000
4000
5000
6000
7000
12000
17000
22000
27000
28000
AVERAGE LOAD
KILOWATTS.
WATER LOST
KILOWATT EQUIVALENT.
AU TRAIN
HOIST
CARP
McCLURE
CARP
McCLURE
McCLURE PLANT 58.0%
CARP PLANT 20.5%
HOIST PLANT 16.0%
AU TRAIN PLANT 4.8%
STEAM PLANTS 0.7%
CURRENT MADE BY STEAM POWER
CURRENT MADE BY WATER POWER
WATER LOST BY OVERFLOW.


PRECIPITATION BY YEARS
INCHES.
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
1892
1894
1896
1898
1900
1902
1904
1906
1908
1910
1912
1914
1916
1918
1920
1922
1924
1926
MARQUETTE RECORD.
ISHPEMING RECORD.

COST DIAGRAM.



21. ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1927.

Ishpeming, Michigan,

January 17, 1928.

ENGINEERING DEPARTMENT.

The following is the report of the Engineering Department. The photographic maps and views which form part of this report have been bound and the books labeled as follows:

A. LIST OF ANNUAL REPORT MAP BOOKS FOR 1927.

Cleveland-Cliffs Iron Company,
Ishpeming, Republic & Iron River Districts.

Cleveland-Cliffs Iron Company,
North Lake District.

Cleveland-Cliffs Iron Company,
Gwinn District.

Cleveland-Cliffs Iron Company,
Mesaba District.

Cleveland-Cliffs Iron Company,
Negaunee District & Hydro-Electric System.

These books contain the maps of the Company's mines; two sens of them have been prepared, one for the Cleveland office and the other is to be kept in the vault in this office.

Special books have been prepared for the other companies which are interested in The Cleveland-Cliffs Iron Company's mines and also books and loose prints have been given to the superintendents of the various districts as follows:

BOOKS.

NO.	MINE OR DISTRICT.	FOR WHOM.
1	Negaunee Mine,	Bethlehem Iron & Steel Corporation
1	Athens Mine,	Pickands, Mather & Company.
1	Boeing Mine,	Colonel J. B. Cavanaugh.
1	Mesaba District,	M. H. Barber.
5	Boeing & Hill-Trumbull Mines,	Directors, Mesaba-Cliffs Iron Mining Co.
2	Boeing, Hill-Trumbull & Wade Mines,	Arthur Iron Mining Company.
1	N egaunee District,	W. W. Graff.
1	Gwinn District,	W. W. Graff.
1	North Lake District,	C. J. Stakel.
1	Republic & Iron River Districts,	W. R. Meyers.