

E. L. Derby, Jr. I continued to have charge of the Geological Department as Chief Geologist. A large part of my time, as in the past, 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 explorations at the Canisteo, Dean and Hill Mines on the Mesaba Range in Minnesota, the Eureka Exploration by Messrs. W. G. Mather and J. E. Jopling West of Marquette, and the Summit Exploration at the Tilden Mine; underground drilling in the Cliffs Shaft, Holmes and Virgil Mines; and geological surveys in the Athens, Cliffs Shaft, Gardner-Mackinaw, Holmes, Maas, Morris-Lloyd, Negaunee and Virgil Mines. I personally made underground geological surveys of the new development work in Maas and Virgil mines as well as in a portion of the Cliffs Shaft Mine.

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

In January, I made a revised estimate of the ore on the Race Course tract of the Maas Mine based on the most recent developments on the 4th level of the mine. This is outlined in a special report. I went to our office in Hibbing and examined all the maps, sections and other records of the Canisteo, North and South Eddy mines and prepared approximate tonnage estimates that were embodied in Mr. Barber's reports on these properties.

In February, I wrote a detailed report on the Eddy properties and an estimate of the cost of stripping for the entire operation at the Holman-Brown, Bingham and North star properties, allocating these costs to each separate property. The latter was covered by a report to Mr. Barber. I examined an old pit in Section 21, 48-25, about two miles West of Marquette for Messrs. W. G. Mather and J. E. Jopling. The Eureka exploration, so-called, was later conducted in this vicinity, by one of our drills, for these gentlemen. I accompanied Mr. Elliott to Iron River and interviewed Mr. W. H. Selden, Jr., relative to the sale of our Erickson lease.

In March, I went to Duluth and Hibbing in the interest of the Canisteo Mine offer, also to visit the drilling at the Hill Mine.

In April, I spent three weeks at our Cleveland office making a present value estimate of the Company's entire iron ore estate, in conjunction with Mr. A. W. Gaumer, Consulting Engineer of Washington, D. C. The results of this work were embodied in a very complete report. While in Cleveland, I spent parts of two days with Mr. Geffine reviewing the March 1, 1913 value of the Cliffs Shaft Mine with Mr. Gordon, Internal Revenue department valuation engineer from Washington. An attempt is being made to have this property revalued for depletion purposes.

In May, I spent three weeks on the Mesaba range classifying the old drill hole samples from the Canisteo mine and posting the results on cross sections of the property. Mr. Bolthouse assisted me. During this time, also, I examined a property, Land Offer 1736, located in Section 18, 52-23 and Section 13, 52-24, along the North boundary of Aitkin county and reported on same.

In June, I started a detailed estimate of ore and stripping on the Canisteo property then went to the Mesaba range and supervised, and classified some of the samples from, the drilling on this property which was begun in May. While in Hibbing, I looked over reports, maps and cross-sections of the Dean-Itasca mine located in Section 15, 58-19, just East of Buhl which was offered to this Company. On my return I joined with Mr. Eaton in a report to Mr. Elliott, dated June 10th, on the New York mine and the relation it bore to the old No.3 and Cliffs Shaft mine workings and the nice run of good ore recently discovered in this vicinity in underground drill

hole No.406.

In July, I spent about half the time on the Mesaba range completing the detailed estimate on the Canisteco property and classifying additional samples from our check drilling here, as well as going into the Dean-Itasca proposition in more detail. I also examined the new auxiliary jigging plant at Butler Bros. Patrick washing plant and reported on same.

In August, I spent about half my time on the Mesaba range. While there I classified additional drill samples from the Canisteco drilling, checked over recent ore reserve estimates on the Trumbull and Wade mines and arranged for the inauguration of a campaign of check drilling at the Dean mine after we had taken an option on it. At Ishpeming, I spent more or less time, as Chairman of the Refreshment Committee for the Company's Safety Picnic to be given on Labor Day, attending to details pursuant to this event.

In September, I continued to spend half my time in Hibbing attending to the drilling at both the Canisteco and Dean mines, classifying drill samples from them, etc. I examined and reported on the Shiras mine offered us by the Wanless Iron Company and visited the Rheolaveur auxiliary experimental plant at Butler Bros'. Harrison washing plant.

In October, I went to our Cleveland office, then, with Mr. Geffine, on to Washington, D. C., where we interviewed Mr. Gordon, Engineer of the Iron Ore section of the Income Tax unit of the Internal Revenue Department, relative to the revaluation of the Cliffs Shaft mine. I had prepared a set-up of valuation figures in Cleveland. I also spent a day in Cleveland on my return on the same mission. I then went to the Mesaba range for several days where I went over the drilling at the Canisteco and Dean mines and classified the current samples. I also examined the maps, cross-sections and other data of the Whiteside mine owned by the Shenango Furnace Company in connection with the possibility of including this property in the Dean mine operation. Mr. W. L. McMorris was engaged to assist me on all of my Mesaba range activities and he began work on October 1st. I layed out a tentative program for him at this time.

In November, Messrs. Geffine and Saddler of our Cleveland office, and Mr. Gordon, Income Tax Unit engineer from Washington, D. C., spent two days in my office going over all the data relating to the proposed revaluation of the Cliffs Shaft mine for depletion purposes. Messrs. Jackson and Stakel joined me in the resulting calculations and we prepared a joint report to cover same. I then spent two weeks on the Mesaba range classifying the balance of the samples from the Dean mine drilling which was completed in October and made a detailed estimate of ore remaining in this property with a report on same to Mr. Barber.

In December, I made an underground inspection of the new development in ore at the Hartford-Cambria mine in Negaunee along and in the vicinity of the North boundary line of the Jackson mine property. I spent two days in Chicago going over, with Mr. L. W. Fargo, the various Minnesota mineral acreages in which he is interested and is preparing to present to this Company in a formal offer. I then went on to Minneapolis where I spent one day attending a meeting of the Minnesota Section of the American Institute of Mining and Metallurgical Engineers at the Mining Department and the Experimental Station of the University of Minnesota. Following this, I spent several days on the Mesaba range classifying the balance of the samples

from the Canisteco drilling recently completed and ^{on} a new operating set-up on the proposed Dean mine operation. On my return to Ishpeming I prepared a report with Mr. Jackson on the present value of the Dean mine fee and the underlying lease interest as a basis for negotiations for the purchase, recently suggested, of both these interests.

A. H. Tillson. Mr. Tillson continued as Assistant Geologist throughout the year. He made regular underground geological surveys in the Cliffs Shaft, Gardner-Mackinaw, Holmes and Morris-Lloyd mines and occasional surveys in the Maas and Negaunee mines. He posted all these surveys on the geological maps and cross-sections of the several properties and periodically posted the current mine extensions on the geological maps and cross-sections of the Athens and Virgil mines.

He made up a new set of geological tracing maps of the Cliffs Shaft mine workings on Lot 2, Section 3, 47-27, known as the Bancroft lease which we hold from the Oliver Iron Mining Company. These are to be used once each year to supply the Oliver Company with prints of the operation in accordance with our lease from them. He assisted in collecting and testing about forty samples of ore from stopes in the Cliffs Shaft mine for the purpose of determining a more accurate density factor of this ore. He checked over the plotting of all the miscellaneous drill data that was received by this office during the year in the form of land offers, outside explorations, etc.

Gustav Afuhs. Mr. Afuhs continued as our Draftsman throughout the year. His work, as in the past, has, in part, consisted in preparing cross-sections of all current drilling done by, or for, the Company and of all the drill results that have been submitted to this office in the form of land offers or outside explorations.

During the first part of January, most of his time was taken up in coloring the annual report exploration sheets and legends. Much of his time, immediately following this and up to the end of April, was spent completing a geological tracing map and making a number of white prints of the locality around Lake Michigamme and Three Lakes showing the lands of the Michigamme Company and the American Iron Mining Company. This work was commenced during the latter part of 1928. He plotted several curves of tax valuations for the cities of Marquette, Ishpeming and Negaunee which Mr. Elliott used in his tax negotiations and prepared several white prints of a map of the Race Course and vicinity for Mr. Elliott's report to Mr. Mather of February 23rd.

He started to prepare a series of white print maps of the iron ranges of the Lake Superior district for index maps showing all the various information we have on file in this office. It is an herculean job but he will devote as much time to it as opportunity permits until it is completed. He also prepared a set of white print maps to accompany the report on the valuation of the Company's mineral estate made by Mr. A. W. Gaumer of Washington, D. C. and myself at our Cleveland office.

He prepared a white print map showing the workings in the New York mine and their relation to the Cliffs Shaft and old No.3 mines to accompany a joint report by Mr. Eaton and me to Mr. Elliott mentioned elsewhere in this report. He also made a complete new set of geological tracing maps of the Cliffs Shaft mine to replace an old set which were about worn out.

He colored two sets of white print cross-sections of the Canisteco mine pit to accompany my estimate of the ore reserves in this property and checked over all the calculations in this estimate. He also made a white print map of the Hartford-Cambria mine workings in their relation to the North part of the Jackson mine property to accompany my report on the subject.

He spent much of December posting the past year's extensions on the special sets of geological cross-section tracings of the Athens, Cliffs-Shaft, Morris-Lloyd and Negaunee mines which are photographed each year to accompany the annual ore estimates submitted to the Michigan State Tax Commission. He also assisted Mr. Tillson at times in posting the current extensions on the geological maps and cross-sections of our several mines. The rest of his time was spent on 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 particularly in making the estimates of ore in stock at the several mines. He drove the Engineering Department truck at various times. The major part of his time, however, was spent in collecting, sampling, Labelling and filing the diamond drill samples from the current explorations and making tests for the dip and bearing of holes with the Maas Compass whenever this data was required.

Frequently, he classified and reported on the core and sludge samples from the current explorations during my absences. He made all of the thin sections of rocks which were examined under the microscope. He also made the regular monthly carbon report, assisted Mr. Tillson in a number of his underground geological surveys and helped Mr. Cooney make the annual inventory of diamond drill equipment.

C. SURFACE GEOLOGICAL SURVEYS.

No detailed surface geological surveys were made during the year.

D. UNDERGROUND GEOLOGICAL SURVEYS.

D-1. ATHENS MINE:

The geological surveys at the Athens mine were made periodically by Mr. C. W. Allen, engineer at the property. We have kept this information posted on both the geological maps and cross-sections. The horse of jasper just South of and in contact with the main East-West dike and between the 6th and 8th levels, first encountered in 1928, was found to increase steadily in horizontal section as mining progressed downward. Another horse of jasper was discovered just above the 4th level about on the axis of the ore structure and on the hanging side. Although its limits have not been determined, developments on the 260' sub-level above preclude its extending up that high.

South of the Southwesterly trending fault dike, the ore above the 6th level ran up along the dike higher than was anticipated. The hanging wall of this ore above the 4th level was found to flatten considerably in its dip to the South resulting in a widening of the horizontal section of this ore in this vicinity.

D-2. CLIFFS-SHAFT MINE.

We have kept the Cliffs-Shaft geology up to date by making surveys each month coincident with those made by the engineers. Both the geological maps and cross-sections were posted regularly.

The Bancroft lease, or Lot 2 Section 3, continued to be the most important development during the year. Work was done on each level in "A" shaft from the 1st to the 8th inclusive. Encouraging developments were also experienced in the Easterly extension of this ore on Company property. The Westerly extension of old No.3 mine ore in the main vein continues to open up promisingly on the 5th and 6th levels in "A" shaft.

In "B" shaft, on the 7th level and Northeast of the shaft, there is a stope of good ore being opened that promises to continue through to the 5th level "A" shaft. The isolated ore on the Southwest side of the 13th level continues good. Work was resumed late in the year in the rock drift on the 15th level heading Northeasterly toward the Section 3 soft ore deposit. Fifty eight feet had been drifted to January 1, 1930 making about 500' altogether.

D-3. GARDNER-MACKINAW MINE.

During 1929 the Mackinaw shaft was sunk to the 5th level elevation, 100' below the 4th level then another 45' for a skip pit. The new level was opened up with about 850' of drift in ore along the strike of the vein. Then raises were put up to the 4th level and mining started. The vein on the 5th level is already considerably longer than on the 4th and the Northwest end not yet reached. Also the width shows indications of being greater. The sulphur content is about the same, - still high. About half the Mackinaw ore mined came from the new area between the 4th and 5th levels and the rest from above the 4th level. Geological surveys of the new 5th level development were made regularly and the results posted on the geological maps and cross-sections.

The Gardner mine furnished the bulk of the ore from this property. The larger part came from above the 1st level, the rest from the 3rd up to the 1st. The Gardner is now nearly exhausted.

D-4. HOLMES MINE.

We have made regular geological surveys at this mine during the year and have kept the geological maps and cross-sections posted to date. The new 5th level development was completed and the work of opening up a sub-level half way between the 4th and 5th levels started. The ore boundaries so far encountered are about those anticipated from the cross-sections. The other operations at the Holmes have consisted wholly of stoping in previously developed areas.

D-5. MAAS MINE.

The ore above the 2nd level was exhausted during the year and mining is now being pushed with all possible speed between the 2nd and 3rd levels. All this work is on the footwall side of the deposit. Mining was continuous above the 4th level under the hanging wall.

The 4th level itself was extended lengthwise of the Race Course property. Most of this ~~ore~~ work was in hanging where ore had been expected which we attribute to the steepening of the pitch of the ore to the West from the Maas mine proper. A new main level haulage way is being driven on this level

Southeasterly, parallel to and 150' East of the drift along the East boundary of the Race Course to take the place of the latter when mining under the hanging on the Race Course side saves it.

Ore in the North footwall drift on the Race Course North of a fault dike was followed up in two test raises to within about 30' of the 3rd level. One of the raises was still in good ore when stopped. This represents a new riser or finger from the main body and a drift into it on the 3rd level has been planned.

The shaft was sunk to the new 5th level elevation, 125' below the 4th, and the new level shaft plat started. It was all in footwall quartzite. Mr. Moulton, engineer at the Maas, collected geological data periodically and Mr. Tillson and I both made occasional surveys of the new development work. All of this information was posted on the geological maps and cross-sections.

D-6. MORRIS-LLOYD MINE.

We have made geological surveys regularly at this mine and have kept the geological maps and cross-sections posted to date.

The principal development at this property during 1929 was the opening of the 8th level at the Morris which was commenced a year ago. A drift was driven Southwesterly to crosscut the main deposit. The ore was found to be as wide as expected but was more or less contaminated by several parallel seams of jasper and lean ore along the bedding or strike. It is likely this will prove to be only a local condition. Raises are now being put up in the ore along this crosscut.

Work is being pushed on this level in a West footwall drift and had reached a point 1500' West and 800' South of the shaft at the end of the year. Drill stations are also being cut at 200' intervals along this drift and a campaign of drilling will soon be started. There were no new developments in the Lloyd and Lloyd East deposits during the year.

D-7. NEGAUNEE MINE.

Mr. Moulton, engineer at the Negaunee, has collected the essential geological data at this property regularly and we have kept the geological maps and cross-sections posted to date. Development of the 12th level continued and a number of raises put up. The ore outlines were found about as anticipated. Practically all mining is now below the 10th level as only one sub-level remains above it.

D-8. REPUBLIC MINE.

Although no mining was done in this abandoned property, there was such a demand for hard ore that several men were engaged in picking over the rock pile for stray pieces of ore and other pieces that were separated from rock adhering to them by sledging. In this manner 4316 tons basic lump ore and 34 tons of basic crushed ore were shipped, - a total of 4450 tons.

D-9. TILDEN MINE.

The Tilden mine was brought into initial production as a producer of Siliceous ore early in the spring of 1929. It is worked as an open pit and produced and shipped approximately 442,000 tons. Geological data was collected and mapped by Mr. Allen, engineer at the property. No unexpected conditions developed.

D-10. VIRGIL MINE.

Regular geological surveys were made at the Virgil during the year, sometimes by myself and, whenever this work was impossible, by Mr. Fellow, engineer at the property. Captain Rogers, who is unusually well informed concerning the erratic nature of this deposit, from daily observations, continued to assist us by noting conditions between periods of our surveys which otherwise would be obliterated by the daily progress of stoping. He deserves much credit for the intelligence he has displayed in this work.

The narrow finger of new ore a short distance East of the Northeast limb of the main ore body on the 6th level referred to in my annual report a year ago joined the main ore body on the 165' sub-level as predicted at that time. Development of the main ore body upward from the 6th to 4th levels was continuous during the year. The ore areas on several sub-levels were slightly larger than anticipated and another supporting pillar had to be provided on the 6th level and above and classed as unavailable ore for the present. The high sulphur ore on the 4th level began to appear around the periphery of the main ore body on the 380' sub-level. This was anticipated from the geological cross-sections.

The 8th level was extended Westerly about 90' and two raises put up. Two small subs were opened, one from each raise, at -130' and -165' elevations, respectively. A campaign of drilling was carried on from these subs and the 8th level to outline the ore and sample it, particularly for sulphur. Most of it continued to be high in sulphur. The greater part of this sulphur appears to be contained in narrow seams of black graphitic slate interbedded with the ore. I believe this to be a footwall phenomenon.

E. OPTIONS AND LEASES.

An option to explore and lease the Canisteo mine, an open pit property, at Coleraine, Minnesota, on the West end of the Mesaba range was acquired in April from the Canisteo Mining Company of Duluth. This covered, among other auxiliary washing plant, tailings basin lands, etc, the following descriptions:

$S\frac{1}{2}-SW\frac{1}{4}$, Section 29, 56-24		
$SW\frac{1}{4}-SE\frac{1}{4}$, " 29, "		
$NW\frac{1}{4}-NE\frac{1}{4}$, " 30, "		
$S\frac{1}{2}-NE\frac{1}{4}$, " 30, "		
$E\frac{1}{2}-SW\frac{1}{4}$, " 30, "		
Entire $SE\frac{1}{4}$, " 30, "		
$NE\frac{1}{4}-NE\frac{1}{4}$, " 31, "		
$NW\frac{1}{4}-NW\frac{1}{4}$, " 32, "		
$NE\frac{1}{4}-NE\frac{1}{4}$, " 32, "		

This option was exercised and a lease taken, dated July 1, 1929.

An option to explore and lease the Dean-Itasca mine, an open pit property near Buhl, Minnesota on the East central part of the Mesaba range, was acquired in August from Mr. John Dohm of Hibbing. This covers the $S\frac{1}{2}-NE\frac{1}{4}$; $SE\frac{1}{4}-NW\frac{1}{4}$ and the $E\frac{1}{2}-SW\frac{1}{4}$ all in Section 15, 58-19, Minnesota. The Company has elected to exercise its option and a lease has been drawn up but not signed. There are investigations on foot at present to purchase both the fee and Mr. Dohm's underlying lease interest.

TABLE V.

SUMMARY OF DRILLING FOR 1929.

EXPLORATION.	DESCRIPTION. SEC. T. R.	STAND- PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A".	COST PER TON "A".	TOTAL COST "B".	COST PER TON "B".
<u>SURFACE DRILLING.</u>												
Canisteo Mine,	29, 30 & 31, 56-24, Minn	2279	3118½	180	5577½			1734	\$24,845.26	\$4.45	\$22,314.87	\$4.00
Dean Mine,	15, 58-19, "	8	1373	78½	1459½	418	290	280	6,454.30	4.42	5,740.53	3.93
Eureka Exploration,	21, 48-25, Mich	33	7	804	844				1,661.86	1.97	1,417.55	1.68
Hill Mine,	17, 56-23, Minn	249	305½	25	579½	115½		90	1,754.47	3.03	1,650.22	2.65
Tilden (Summit Expl.),	26, 47-27, Mich	17	1	116	134			94	2,924.81	2.18	2,826.19	2.11
Total Surface Drilling,		2586	4905	1203½	8594½	533½	290	2198	\$37,640.70	\$4.38	\$33,949.36	\$3.95
<u>UNDERGROUND DRILLING.</u>												
Cliffs Shaft Mine,	3, 9 & 10, 47-27, Mich			1805	1805	87	10	125	\$5,757.45	\$3.19	\$5,065.45	\$2.82
Holmes Mine,	9, 47-27 "			1190	1190	10	5		2,787.42	2.34	2,568.03	2.16
Virgil Mine,	24, 43-35 "		665	935	1600	699	121	165½	3,282.54	2.05	2,721.88	1.70
Total Underground Drilling,			665	3930	4595	796	136	290½	\$11,827.39	\$2.57	\$10,375.56	\$2.26
Grand Total Drilling,		2586	5470	5133½	13189½	1329½	426	2488½	\$49,468.09	\$3.75	\$44,324.72	\$3.36

NOTE: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.

Cost "B" excludes " " " " " " " " (To compare with contract price).

TABLE VI.

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".
1925	11,708	\$3.22	\$2.84
1926	19,299	3.21	2.86
1927	20,169	3.88	3.30
1928	4,770	3.00	2.63
1929	13,189½	3.75	3.36

F. EXPLORATIONS AND COSTS.

Drilling explorations were carried on during 1929 in the following districts and mines:

F-1. FROM SURFACE.

<u>DISTRICT.</u>	<u>RANGE.</u>
Coleraine	Mesaba
Buhl	"
Marquette	Marquette
Marble	Mesaba
Tilden	Marquette

F-2. FROM UNDERGROUND.

<u>MINE.</u>	<u>DISTRICT.</u>
Cliffs-Shaft	Ishpeming
Holmes	"
Virgil	Iron River

Table V, 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 \$3.95 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 \$4.38 per foot. The average cost of underground drilling in the same way was \$2.26 per foot and \$2.57 per foot, respectively.

Table VI, also shown below, gives a comparative cost per ton of total drilling for the past five years.

The cost per foot of total drilling for the past five years was considerably higher than for 1928 due to the fact that in 1929 the amount of surface drilling done was approximately 65% of the total, where as in 1928 it was only about 12.75% of the total. The surface drilling is always more expensive than the underground; also, most of our surface drilling during the past year was done by contractors. Our cost of underground drilling for 1929 was on the whole considerably less than that for 1928. For example, the total cost per foot, excluding the items mentioned above, amounted to only \$2.26 per foot in 1929 and \$2.46 per foot in 1928. Including these items, the 1929 cost was \$2.57 per foot and in 1928 \$2.82 per foot. I consider the drilling costs for 1929 as a whole very satisfactory.

F-3. DIAMOND DRILL CARBON.

We had on hand January 1, 1929, a total of 388.80 karats of diamond drill carbon which inventoried at \$42,313.93. No new carbon was purchased during the year. We consumed in 1929 a total of 17.56 karats at a cost of \$2,054.05, leaving a balance of carbon on hand December 31, 1929, of 371.24 karats inventoried at \$40,259.88.

F-4. DRILL SECTIONS.

Cross-sections showing a detailed report of the drilling at the Tilden (Summit) exploration and in the Cliffs-Shaft, Holmes and Virgil mines will be found in the Annual Report book labeled: "The Cleveland-Cliffs Iron Company - Ishpeming and Iron River Districts, December 31, 1929". Cross-sections showing a detailed report of the drilling at the Canisteo, Dean and Hill mines will be found in the Annual Report book labeled: "The Cleveland-Cliffs Iron Company - Mesaba District, December 31, 1929". These books are submitted as a part of the annual report of the Engineering and Geological departments.

G. SURFACE EXPLORATIONS.

G-1. CANISTEO MINE - SECTIONS 29, 30, 31 & 32, 56-24, MINNESOTA.

An option to explore and lease the Canisteo mine was acquired from the Canisteo Mining Company, underlying lessees, in April. Shortly afterwards a campaign of churn drilling was started to check drill some of the old holes and to more completely outline the limits of ore on the property. The mine consists of a large open pit which was opened and operated for many years by the Oliver Iron Mining Company, who shipped a total of 19,223,036 tons during that time. Although a considerable tonnage of direct shipping ore was mined, the largest product was a sandy ore which was concentrated by washing. Practically all of the remaining tonnage is wash ore. The Oliver Company surrendered its lease January 1, 1926 and the pit is now filled with water.

All of our drilling has been done under contract. Most of it was done by J. J. Schultze of Grand Rapids, Minnesota, and the rest by the S. E. Atkins Company of Duluth. Schultze drilled all three inch holes with a special kind of tubular churn bit designed by him to preserve the samples in relatively large, unreduced pieces. Holes drilled in this way are called "structure" holes because the original structure of the strata is preserved in the unreduced pieces. The Atkins Company used the ordinary chopping or churn drill equipment and put down the regulation size (2") holes. The cost of the structure holes averaged about \$1.25 more per foot but the results are worth many times this difference. Each contractor employed two drill outfits. We wanted all holes drilled with the structure bit but Schultze had only the two drills and we were pressed for time until the option expired and the lease was taken.

Twenty four holes, in all, were drilled. Only six of these were of the ordinary churn drill type, - the rest "structure" holes. Eleven holes, numbers 601-DS, 603-D, 604-D, and 617-DS to 624-DS, inclusive, were drilled on the South side of the pit. Holes 617-DS and 618-DS were located on the so-called "East Snyder" forty, or the SE $\frac{1}{4}$ -SE $\frac{1}{4}$, Section 30 and holes 619-DS to 624-DS on the so-called "South Bovey", or the NE $\frac{1}{4}$ -NE $\frac{1}{4}$, Section 31.

Eleven holes, numbers 602-DS, 605-DS, 606-D, 607-D, 608-DS and 611-DS to 616-DS, inclusive, were drilled on the East side of the pit, all on the so-called "Hemmens" forty, or the SW $\frac{1}{4}$ -SW $\frac{1}{4}$, Section 29. The remaining two holes, numbers 609-D and 610-D were drilled on the Northeast side of the pit, on the

G. SURFACE EXPLORATIONS (CONTINUED).

G-1. CANISTEO MINE - SECTIONS 29,30,31 & 32, 56-24, MINNESOTA (CONTINUED).

so-called "North Bovey" forty, or the NE $\frac{1}{4}$ -SE $\frac{1}{4}$, Section 30. The letter "S" in the number was used to distinguish the "structure" type holes from the ordinary churn drill holes.

The holes varied in depth from 140' to 309'. A total of 5577 $\frac{1}{2}$ ' was drilled. The results from the check holes,- that is, holes drilled close to the old holes, agreed with the earlier drilling as well as could be expected. The variations were due mainly to the ability of classifying our own drilling more accurately because of the larger samples from the structure type holes and the old samples having been picked over and the larger pieces broken down in numerous earlier classifications by engineers of other companies who held options previous to ours. This drilling was completed about the middle of December and a revised estimate of ore and stripping is being prepared, based on the results from all this work. I don't anticipate much change from our first detailed estimate. It will probably be increased slightly.

G-2. DEAN MINE - SECTION 15, 58-19, MINNESOTA.

We acquired an option to explore and lease the Dean mine from Mr. John Dohm, of Hibbing, underlying lessee, in August. A campaign of churn drilling was started almost immediately to check the old holes and more completely sample the ore banks remaining. The mine consists of an open pit, and some scam to pit workings which now are caved. The M. A. Hanna Company were the last to operate the property and since they completed their mining in 1927, the pit has filled with water. A total of 5,412,226 tons have been shipped. There were two grades of ore produced, one high grade and the other lean in iron but high in alumina. Both grades are high in moisture, running from 14% in the first class ore to 22-24% in the lean ore. The two grades occur each in several layers of mineable thickness alternately interbedded. It is our present plan to sinter the open pit ~~or~~ lean or No.2 ore and ship direct the open pit No.1 ore and as much of the underground No.1 as can be economically scammed to the pit with scrapers.

This drilling was done under contract by the Carlson Exploration Company of Hibbing, using two drill outfits. A total of nine holes, numbers 1-D to 9-D, inclusive, were drilled and all on the North bank of the pit. They were put down with an ordinary chopping bit except that diamonds were used in a few instances where seams of taconite were encountered. The holes were all bottomed in taconite and varied in depth from 144' to 182' for a total of 1459 $\frac{1}{2}$ '.

The results of this work checked the old drilling very closely where a close comparison was possible. The new holes also developed additional ore that we could not estimate with only the former drilling to go by. The work was completed in October and plans of operation are now being worked up.

G-3. EUREKA EXPLORATION - SECTION 21, 48-25, MICHIGAN.

Early in the year options to explore and lease were acquired by Messrs. W. G. Mather and J. E. Jopling on the Clark, Peter White and Cox parcels in Sections 15, 16, 21 and 22, 48-25, a short distance West of the old brewery at Marquette. A good many years ago some 1700 tons of what was then thought to be iron ore were removed from a pit near the Northwest corner of the SW $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Section 21. This was thought to be and probably was the result

G. SURFACE EXPLORATIONS (CONTINUED).

G-3. EUREKA EXPLORATION - SECTION 21, 48-25, MICHIGAN (CONTINUED).

of oxidation of a vein or series of veins of pyrite in the surrounding Moa schist formation. It was too lean in iron and too high in sulphur to be of commercial value.

It was Mr. Jopling's thought that possibly the vein or veins below this pit, and other possible veins in the vicinity, carried values in gold and other precious metals. Accordingly, three incline holes were put down for these gentlemen and at their expense with one of this Company's drill outfits during the summer and fall. The results were all negative and a detail report of the drilling is given in my letter to Mr. Jopling of October 8, 1929.

G-4. HILL MINE - SECTION 17, 56-23, MINNESOTA.

Three Ordinary churn drill holes were put down under contract by J. S. Schultze of Grand Rapids, Minnesota, during March and April from the South bank near the Southeast end of the Hill mine pit in the $SE\frac{1}{4}$ of the $NE\frac{1}{4}$ of Section 17. The object of this drilling was to more definitely outline the limit of ore in this corner which can be economically stripped and mined. When the original drilling was done, the holes were spaced about 300' apart. The present holes were located between the old ones.

The holes varied in depth from 188' to 198' with a total of 579 $\frac{1}{2}$ '. All of them bottomed in taconite. Both direct shipping and wash ores were encountered in mineable thickness and the results proved that this corner of the property can be stripped and mined economically. This stripping has already been about completed.

G-5. TILDEN (SUMMIT) EXPLORATION - SECTION 26, 47-27, MICHIGAN.

Drilling with two of our own outfits was commenced in December to sample the large exposure of lean siliceous ore located in the $NE\frac{1}{4}$ of the $NE\frac{1}{4}$ of Section 26, forming a part of the South slope of Summit Mountain, and about one half mile East of the present Tilden mine pit. It is planned to test this outcrop by drilling two angle holes dipping 60° to the South on each of four North-South cross-sections spaced 300' apart. Only 134' had been drilled up to the end of the year. It is anticipated that practically all of this large outcrop is siliceous ore containing perhaps a little less iron and more silica than the Tilden pit ore but with a much lower phosphorus content. If operations are carried on here the two pits may be worked as one shipping unit, or separately, as desired.

H. UNDERGROUND EXPLORATIONS.

H-1. CLIFFS SHAFT MINE.

One diamond drill was operated intermittently in the Cliffs Shaft mine during the year. The balance of the time the crew was drilling in the Holmes mine. Another crew has now been added so that drilling may be carried on in both mines simultaneously. Thirteen holes were completed and all but one in "A" Shaft,- the other in "B" Shaft. A total of 1805' was drilled. Only four holes encountered ore in mineable thickness, which averaged 22' per hole.

Hole No.398, located on the North side of the 7th level "A" Shaft, and which had just been completed at the beginning of the year, was reopened and deepened but it soon encountered footwall material without finding additional ore. Hole No.399 was also drilled from this level but from the Northeast side and on a course of S. 80° E. to explore for a downward continuation of ore being mined on the 6th in this vicinity. Sixteen feet of ore was encountered averaging 58.82% iron.

Holes Nos. 400, 401, 402, 403, 404, 405, 406, 408, and 409 were all drilled on the 8th level "A" Shaft. Numbers 400 and 401 were drilled from the extreme Southeast end of the level to explore for the Westward continuation down the pitch of the ore mined years ago in the old Incline mine. They did not encounter it. Either the ore pinches out or else there is faulting or structural changes that have changed its trend. Additional drilling is planned to try and solve this problem. Holes numbers 402, 403 and 405 were drilled South from the Southeast deposit drift to explore the territory to the South boundary of the property. Number 404 was drilled North from the same locality to locate the hanging wall. Holes 407, 408 and 409 were drilled from the Northeast end of the level to hole into the bottom of the old Number Three and New York mine workings in order to drain the water from them so that exploring and mining may be carried on safely in that vicinity.

Hole No.406 was drilled North from the Northeast end of the 6th level "A" shaft to explore the ground North of the E-W fault which has allocated much of the recently discovered ore on the Bancroft lease, or Lot 2, Section 3. It encountered 47' of high grade ore averaging 61.15% iron. This ore, in my opinion, bears a close relationship to that mined in the old Number Three mine as well as to the Bancroft deposit.

Hole No.410, the last drilled during the year, was located at the Southeast end of the 1st level "B" shaft, in the South deposit. It was drilled horizontally and due East from approximately S. 1200 and 835 E. to locate and be sure of the true hanging wall of this deposit. After first cutting 5' of good ore averaging 63.54% iron, slate was encountered which proved to be the hanging and it was followed by quartzite in which the hole was bottomed at 187' at the end of the year.

H-2. HOLMES MINE.

Two holes, Nos.30 and 31, were completed and a third, No.32, partially drilled in the Holmes mine during the year. These holes were all located at the end of a drift on the 4th level,- driven Southwest for a distance of about 230' into the quartzite hanging wall.

The object of this exploration is to test the ground at some distance below the 5th level and discover if possible a thickening of the iron formation and a consequent deposit of hard ore similar to that above the 4th level. Drilling had demonstrated that erosion or faulting had cut so deeply into the

H. UNDERGROUND EXPLORATIONS (CONTINUED).

H-2. HOLMES MINE (CONTINUED).

ore bearing rocks just below the 5th level previous to the deposition of the hanging quartzite that all of the ore which may have been deposited there had been removed.

Hole No.30 was drilled vertically and hole 31 with a dip of 60° N. 45° E. and served to locate both the hanging and foot contacts of the iron formation in depth and to more accurately determine their dips for use in the drilling that follows. Hole 32 was then drilled with a dip of 81° S, 41° W. to get lower down into more favorable structure. After drilling through 419' of hanging quartzite with slate seams and 1' of hard ore jasper conglomerate, the hole cut 10' of high grade hard steel ore averaging 59.34% iron. It was drilling in rich hard ore jasper below this ore at a depth of 439' at the end of the year.

Although the ore encountered at the horizon tested is narrow, it is most encouraging to have proved a return to favorable conditions for hard ore in depth at this mine after the disappointing discovery of its discontinuance just below the 5th level. I am hopeful that additional drilling will disclose good hard ore in merchantable quantities a little farther to the West.

H-3. VIRGIL MINE.

Drilling in the Virgil mine was resumed the latter part of May and eleven holes were completed. Eight of these holes were drilled with the Denver rock drill deep hole machine with a chopping bit and the other three, the last ones, with a diamond drill. The Denver machine is not satisfactory in hard ground and its depth capacity is relatively small.

All of the holes were drilled to explore for the limits of the ore encountered near the West end of the 8th level and to sample it. This ore in the main level drift was too high in sulphur to be mined at present but we thought some of it in other parts of the deposit, both on the level and above, might contain much less sulphur.

Two small sub-levels were opened above the level, principally for exploring purposes, at -130' and -165', respectively. Holes Nos. 102 and 103 were drilled from the -165' sub-level. No.102, drilled to the Southeast, had all high sulphur ore. No.103, drilled to the Northwest, had 80' of ore averaging .125% sulphur and the rest, 74' averaged .198% sulphur. Holes Nos.105, 106, 107, 108, 108-A and 109 were all drilled from the -130' sub-level and outlined pretty well the North limb of the ore body. Number 108-A was a diamond drill hole drilled with the same course as, and just under, No.108 but horizontally. The latter had a dip of +15° and had encountered 105' of ore averaging .034% sulphur. Hole 108-A, on the other hand, showed a much higher sulphur content, i.e., from .073% to .162%.

Holes Nos.104, 110 and 111 were drilled from the 8th level itself. The last two were diamond drilled. Hole 104 was all in footwall black slate but 110 and 111 had principally mixed ore with black and ferruginous slates. The runs of ore were all high in sulphur.

At the end of the year the diamond drill had just completed reaming out old underground hole No.10 drilled by the Wickwire people, former operators, from old workings above. This hole was encountered on our 6th level and by cleaning it out we will drain the water from the old workings above and remove this hazard.

I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES.

The explorations and new developments being conducted by other companies which have come to our attention during the past year are as follows:

I-1. MARQUETTE RANGE.

The Inland Steel Company, which started a campaign of drilling in 1928 in search of hard ore in Section 23, 47-28 South of Greenwood, completed its drilling the past Fall. They have found enough good ore, it is claimed, to warrant further exploring, but because of the difficulty of getting diamond drill holes down where they want them, they have announced they will sink an exploration shaft and do additional exploring commencing next Spring.

Pickands, Mather & Company have optioned a number of forties in the vicinity of Humboldt which are underlain by the Negaunee iron formation and they hope the hard ore or upper series of this formation. These descriptions are spread along the quartzite-iron formation contact from the West line of Section 12, 47-29 to the East-West center line of Section 18, 47-28. This embraces, inter-alia, a part of the lands of the old Washington Iron Company. They are in search of hard ore and will start exploring with two diamond drill outfits under contract from the S. E. Atkins Company of Duluth very shortly. Much time has already been spent in the field running magnetic lines and mapping the geological features.

The first shipments of ore from the Blueberry mine of the Ford Motor Company, located in Section 3, 47-28, West of Ishpeming, were made during the past season.

I-2. MENOMINEE RANGE.

The Oglebay Norton Company completed a shaft at its new Brule mine, Sections 33 and 34, 43-35, West of the old Cortland mine at Iron River and are now exploring on the 350' and 500' levels.

The Jones & Laughlin Company has acquired a seven year option to lease 640 acres of land in Sections 23 and 26, 43-32, East of Crystal Falls. They have discovered ore in two drill holes in Section 26 and have two diamond drill outfits working. One of the holes encountered 150' with better than 50% iron but 84' of it was high grade bessemer ore averaging from 66% to 68% iron, according to good authority. This ore, unlike the high phosphorus variety common to Iron County, is found not in the Iron River series of sediments in the Upper Huronian but in a lower horizon corresponding, we think, to the Negaunee iron formation in Middle Huronian rocks. I understand the terms of royalty are a flat thirty-five cents per ton with no minimum the first year, \$1,000 per forty the second year and increasing by \$1,000 each year to the sixth year with a \$10,000 per forty minimum each year after the sixth.

The M. A. Hanna Company has tied up a large acreage under option to lease, variously reported at from 15,000 to 20,000 acres, made up of three or four blocks of land. This tract is roughly Northeast of Mansfield, starting about four miles from there and spreading out in a fan-shaped area. At present, only one drill is being employed and it is merely testing the ledge as a preliminary to an extensive drilling campaign. The Hanna Company has taken an option or lease on the Cardiff mine in Section 22, 43-35, at Iron River which was opened in 1919 by the Buffalo Iron Mining Company, shipped 144,415 tons in 1922 and 1923, and has since been idle. Also their activities include all of the Florence Iron Company's undeveloped lands in Michigan and Wisconsin aggregating something over 4,300 acres.

Coates and Tweed are reported to be coralling several blocks of land aggregating something like 32,000 acres located North and West of Crystal Falls and also South and West of Mansfield. They intend to operate but one drill for the time being and are tying up the land on long term options, up to seven years, and so far as possible on the basis of the payment of taxes only during the life of the option. Coates and Tweed have acted as agents for Pickands, Mather & Company in a number of instances and so it is assumed at present.

On the old Menominee range, the fee owners have completed their extensive campaign of drilling from the bottom of the Chapin mine. A considerable amount of ore material was found at distances below the bottom level up to 1000' and 1200' but the iron content was too low. Apparently some of the iron has been replaced by calcium and magnesium.

I-3. GOGEBIC RANGE.

I have heard nothing further about M. A. Hanna's explorations East and Southeast of Wakefield which have been going on for several years. My last advice was that nothing of importance had been disclosed in any of this work.

I-4. MINNESOTA RANGES.

The M. A. Hanna Company have taken over the Bray-Gordon properties, formerly leased by the Republic Iron & Steel Company, and the unleased reserves of the Great Northern Iron ore properties, all on the Mesaba range. We believe the latter to constitute, principally, Parcel Three, South of the Canisteo, the Mississippi Group, Section 18, and the Draper Annex.

The Hanna Company has also taken from the Northern Pacific Railway the Feigh mine on the North Cuyuna range and all the undeveloped ore lands which the Northern Pacific has on the South Cuyuna range, also the Portsmouth, Meacham, Huntington and Martin mines. The last two were operated formerly by the Whitmarsh Mining Company.

The Oglebay Norton Company has taken a number of miscellaneous properties on the Mesaba range, among which are the fees of the Miller, Mohawk, and James mines and the Greenway mine lease.

The Republic Iron & Steel Company has leased again the Pettit mine on the Mesaba range which it surrendered three years ago and has also taken a lease on the Philbin mine on the same range.

The Inland Steel Company has acquired the Iroquois mine on the Mesaba range. It was formerly operated by Clement K. Quinn & Company. The latter company has taken a lease on the Pennington open pit property on the Cuyuna range formerly held by the Tod-Stambaugh Company.

J. EXAMINATION OF MINERAL LAND OFFERS.

Forty two mineral land offers were received and reported on during the past year as follows:

<u>NUMBER.</u>	<u>DESCRIPTION.</u>	<u>REMARKS.</u>
1733	NW $\frac{1}{4}$ -SW $\frac{1}{4}$, Section 24, 43-35, Mich.	Recommended.
1734	Various in Sections 29,30,31 & 32,56-24, Minn.	Canistec Mine - acquired.
1735	Various in Section 11, 57-21, Minn.	Eddy Mine - declined.
1736	(Various in Section 18, 52-23, Minn. (Various in Section 13, 52-24, Minn.	Declined. Declined.
1737	Various in 44-3 W. and 44-4 W., Wis.	Not offered but recorded.
1744	(Various in 43-34 and 42-35, Mich. (Various in 40-14 E., Wis.	Recommended conditionally. Recommended conditionally.
1745	Tazewell County, Virginia,	Declined.
1746	Bland and Giles Counties, Virginia,	Declined.
1748	Various in 40-29; 42-32; 43-32; 42-33 and 43-35, Mich.	Declined.
1750	(SW $\frac{1}{4}$ -SE $\frac{1}{4}$, Section 29, 48-26, Mich. (SW $\frac{1}{4}$ -NE $\frac{1}{4}$, Section 33, 48-26, Mich.	Declined. Declined.
1752	NE $\frac{1}{4}$ -NE $\frac{1}{4}$, Section 11, 42-35, Mich.	Declined.
1753	Various in 52-23 and 52-24, Minn.	Declined.
1755	Various in Sections 21,22 & 23, 40-30, Mich.	Declined.
1756	Various in Section 13, 62-14, Minn.	Declined.
1757	Various in Section 25, 43-35, Mich.	Declined.
1759	Various in 59-14 and 59-15, Minn.	Declined.
1760	Various in Sections 28,32 & 33,48-29, Mich.	Declined.
1761	Various in Section 26, 42-22, Mich.	Declined.
1765	Various in Section 26, 45-25, Mich.	Declined.
1766	S $\frac{1}{2}$ -NE $\frac{1}{4}$; SE $\frac{1}{4}$ -NW $\frac{1}{4}$ & E $\frac{1}{2}$ -SW $\frac{1}{4}$, Sec.15, 58-18, Minn.	Dean-Itasca Mine - acquired.
1767	4000 acres, Nastapoka Isls, Hudson Bay, Can.	Declined.
1768	SE $\frac{1}{4}$ -NW $\frac{1}{4}$ & NE $\frac{1}{4}$ -SW $\frac{1}{4}$, Section 8, 55-25, Minn.	Declined.
1769	Various in Itasca & Cook Counties, Minn.	Held in abeyance.
1770	Lots 2,3,4 & 8, Section 34, 56-26, Minn.	Declined.
1771	Various in Itasca County, Minn.	Held in abeyance.
1773	Various in Section 2, 46-29, Mich.	Declined.
1775	Various in Sections 1,2 & 11, 55-25, Minn.	Declined.
1776	Lots 2,3 & 4, Section 5, 62-14, Minn.	Declined.
1777	S $\frac{1}{2}$ -SW $\frac{1}{4}$, Section 16, 58-19, Minn.	Shiras Mine - declined.
1778	Various in Sections 13 & 14, 62-14, Minn.	Declined.
1779	1600 acres on Hunter's Island, Canada.	Declined.
1780	SW $\frac{1}{4}$ -NW $\frac{1}{4}$, Section 15, 58-19, Minn.	Whiteside Mine - Recommended conditionally.
1781	(S $\frac{1}{2}$ -SE $\frac{1}{4}$, Section 33, 58-20, Minn. (SW $\frac{1}{4}$ -SW $\frac{1}{4}$, Section 34, 58-20, Minn.	Recommended conditionally. Recommended conditionally.
1782	Various in Sections 27 & 33, 47-29, Minn.	Declined.
1783	Various in 136-26; 135-27; 136-27 and 47-29, Minn.	Declined.
1785	NW $\frac{1}{4}$ -NE $\frac{1}{4}$, Section 14, 58-19, Minn.	Declined.
1788	Various in Sections 4,5,7 & 8, 42-34, Mich.	Declined.
1789	S $\frac{1}{2}$ -NE $\frac{1}{4}$, Section 13, 43-35, Mich.	Declined.
1790	Various in Sections 4 & 5, 44-33, Mich.	Declined.
1791	NW $\frac{1}{4}$ -NW $\frac{1}{4}$, Section 17, 44-35, Mich.	Declined.
1793	NW $\frac{1}{4}$ -NE $\frac{1}{4}$, Section 28, 58-20, Mich.	Declined.
1794	Various in Marquette, Dickinson, & Iron Counties, Michigan, and Florence County, Wis.	Recommended in part.

K. EXPENSE STATEMENTS.

Tables VII and VIII, 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 VII.STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1929.

Salaries, - - - - -	\$13,754.60
Travel and hotel, - - - - -	343.52
Operating automobiles, - - - - -	1,018.25
Supplies, - - - - -	1,127.77
Office expense, - - - - -	0
Total,	\$16,244.14

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

	<u>1929.</u>	<u>1928.</u>	<u>1927.</u>
Salaries, - - - - -	\$13,754.60	\$12,696.77	\$12,976.88
Travel and hotel, - - - - -	343.52	393.93	336.34
Operating automobiles, - - - - -	1,018.25	873.95	761.07
Supplies, - - - - -	1,127.77	694.26	856.49
Office expense, - - - - -	0	5.27	0
Total,	\$16,244.14	\$14,664.18	\$14,930.78

E. L. Derby, Jr.
Geologist.

Safety Department

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11. ACCIDENTS
AND
PERSONAL
INJURY

a. Fatal Accidents:

Accidents caused the lost of four lives at our mines in 1929. The same number occurred in both 1927 and 1928 but the fatality rate is less for 1929 as the mines operated the entire year on a full-time schedule and more men were employed. Falls of ground were responsibility for the four accidents. Statistics covering our fatality record from 1928 to 1929 appear in Tables I to IV of this report.

DESCRIPTION OF FATAL ACCIDENTS.

Accident No.1.

Matt Siik, a miner, was killed at the Negaunee Mine, March 30, 1929, by being buried beneath a run of ore. His body was extracted about six hours after the accident occurred.

This miner and partner, Victor Kalmi, at the time of the accident, were working at the top of a raise, 21 feet above the 11th level. Mining in this vicinity had been abandoned about a year on account of heavy crushing, which stopped haulage on the main level. The raise cribbing, which had been badly crushed, had been replaced and the miners were reopening the top of the raise. They had put up two small sets of timber over the ladderway, blocked them with lagging and had a full-size set over the dirt compartment. They then proceed to prepare room for another large set of timber, over the middle of the raise. Kalmi finished cutting a hitch for the leg on the hanging wall side, and, as Siik was picking for the opposite hitch, he went down the raise to get water for his carbide lamp. He had hardly reached the level before the side of the raise, where Siik was working, caved, catching the latter under a run of fine ore. Kalmi summoned assistance and the work of reaching Siik's body was undertaken without delay. It was necessary to proceed very carefully with the use of spiling poles, which accounted for the time lapsed before the body was recovered.

Siik was a Finn, 39 years of age, and is survived by a widow and six children. The Coroner's Jury rendered the verdict "He met his death through an unforeseen and unavoidable accident". The accident was classified a Trade Risk by the Central Safety Committee.

Accident No.2.

Solomon Ristimaa, a miner, was instantly killed by a fall of ground at the Holmes Mine, September 28, 1929.

When this man was killed he and his partner, Thomas Ikola, were working in a hard ore shrinkage stope, a short distance below the 3rd level. There was a raise extending from the 4th level to the 3rd level through this stope, and a large piece of ore, weighing several tons, fell from the hanging side of this raise, as Ristimaa was sledging chunks of ore. At the time of this fall of ground, Ikola was on the sub-level below assisting the trammers, who were taking ore from the stope. When he returned to the stope he found his partner had been killed instantly.

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11. ACCIDENTS
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a. Fatal Accidents - (Continued)

From an investigation of this accident it was evident that there was no indication that the ground was loose and that it was too large to test by sounding.

Ristimaa was a Finn, 51 years old, and is survived by a widow and three children. The verdict returned by the Coroner's Jury was "He came to his death accidentally by a fall of ground and no blame is attached to any one". The classification given by the Central Safety Committee was a Trade Risk accident.

Accident No.3.

Guido Boz, employed as a timberman's helper, was instantly killed at the Morris-Lloyd Mine, December 10, 1929, by a fall of ground. This fatality occurred in the stub end of a transfer drift in the southwest corner of the 840 foot sub-level, between the 3rd and 4th levels of the East Lloyd section of the mine.

The day before this accident the miners of No. 9 contract blasted a round of heavy holes in a stope adjacent to the transfer drift, which knocked two caps out of position in the stub drift. The miners called the shift boss's attention to this condition and he instructed Albert Hamalainen, a timberman, and his helper, Guido Boz, to repair the damage. It was necessary for these men to replace the caps and securely block them again. While Hamalainen was waiting at the top of a raise for timber, Boz went to the stub drift with John Mongiat, a miner of No. 9 contract. They inspected the timber and decided the first procedure was to remove the lagging and poles from the caps. Boz then started to pull the lagging out of the back of the drift and passed them to Mongiat, who placed them to one side. While engaged at this work a large slab of ore caved from the back, apparently without warning. Mongiat escaped injury but Boz was struck by a pole, killing him instantly.

Boz was an Italian, age 26 years and single. "He came to his death by accident; no blame attached to the Company" was the verdict given by the Coroner's Jury. Our classification was ~~a Trade Risk~~ ~~accident.~~ ~~was~~ preventable.

Accident No.4.

Joseph Paris, a miner, was killed at the Maas Mine, December 14, 1929, by a fall of ground. It occurred on the 160 foot sub-level in No. 24 contract, between the 3rd and 4th levels.

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INJURYa. Fatal Accidents - (Continued)

Paris and his partner were mining ore on the third and last slice northeast of their raise. They were about 50 feet distant from the raise and had been under the hanging wall after the first set of timber. The ore in this territory is of a hard texture although soft ore is encountered. These contacts may be slips which are dangerous for falls of ground.

When the miners reached their working place this day they found a large pile of ore at the breast and that the back required fore-poles. They immediately proceeded to block the back although there was not ample room to do this work safely. Paris took the lead while his partner brought in poles and lagging. After placing several poles from the top of the cap of the last set of timber to the breast and blocking the same, he picked a hitch in the breast of the upper part of the drift, to anchor a scraper block. While in the act of placing a pole in this hitch, ground fell out of the breast and back, killing him before he could move.

Paris was an Italian, 34 years old and is survived by a widow and two children. The Coroner's Jury returned a verdict that it was unavoidable".

TABLE I
Classification of Fatal Accidents 1911 to 1929, inclusive.
By the Central Safety Committee

I	Trade Risks		105
II	Negligence of the Company		
	Violation of Rules	4	
	Failure to Provide Safety Devices	4	
	Improper Method of Doing Work	4	
	Failure to Provide Tools or Safe Place to Work ..	2	
	Failure to Instruct Men	3	17
III	Negligence of Workmen:		
A	Injured Men		
	Improper Method of Work	9	
	Violation of Rules	7	
	Carelessness	6	
	Failure to use Tools or Appliances Provided	4	
	Failure to use Safety Device	1	27
B	Other Workmen:		
	Improper Method of Work	9	
	Violation of Rules	3	
	Carelessness	3	
	Failure to use Tools or Appliances Provided	1	16
	Total		165

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TABLE II

Classification of Causes of Fatal Accidents
from December 1st, 1898 to December 31st, 1929.

A	Fall of Ground or Timber	90	
	Run of Mud or Sand	60	
	Fall of Chunk or Ore from Chute	2	
	Stray Chunk or Stick down Raise or Stope	2	154
B	<u>Shaft Accidents:</u>		
	Falling down Shaft.....	14	
	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	51
C	<u>Use of Explosives:</u>		
	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	<u>Mine and Railroad Cars:</u>		
	Being caught by Haulage Cars	12	
	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	29
E	<u>Miscellaneous Causes:</u>		
	Falling in Raise or Pocket	7	
	Contact with Electric Wire	7	
	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	27
	Total		286

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a. **TABLE III**
Showing number of fatalities and rates per 1000 employees
for thirteen years prior to Safety work and for 19 years
of Safety work.

<u>Year</u>	<u>Fatalities</u>	<u>Rate</u>	<u>Year</u>	<u>Fatalities</u>	<u>Rate</u>
1898	6	5.63	1911	5	1.89
1899	4	3.41	1912	4	1.71
1900	4	2.80	1913	11	4.19
1901	9	6.83	1914	10	4.10
1902	8	5.38	1915	5	2.17
1903	8	5.15	1916	8	2.61
1904	4	2.97	1917	6	1.73
1905	12	5.88	1918	13	3.45
1906	10	4.13	1919	11	2.79
1907	17	6.33	1920	5	1.21
1908	6	2.57	1921	6	2.60
1909	13	5.15	1922	1	.45
1910	20	6.52	1923	6	2.19
			1924	5	1.88
			1925	2	.81
			1926	55	23.90
			1927	4	1.82
			1928	4	2.00
			1929	4	1.89*
121 Avg. 4.96			165 Avg. 3.19		

TABLE IV

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

<u>Year</u>	<u>U.S.</u> <u>Coal Mines</u>	<u>U.S.</u> <u>Metal Mines</u>	<u>Minn.</u> <u>Metal Mines</u>	<u>Mich.</u> <u>Metal Mines</u>	<u>C.C.I.</u> <u>Company</u>
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	2.17
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	.45
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	4.50	3.47	1.67	5.79	23.90
1927		3.10	2.55	2.02	1.82
1928					2.00
1929					1.89*
	4.40	3.56	3.03	3.28	3.19

*Estimated figure

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b. Non-Fatal Accidents:

A total of 85 lost time accidents, other than fatalities were reported from the mines, explorations, Cliffs Power & Light Co., and miscellaneous sources. Similar accidents in 1928 numbered 119. While the reduction is considerable the average severity rate, based on the total days lost by injured men compared to the total man shifts worked, is not favorable. We suffered several very severe accidents by falls of ground which increased very materially our severity rate.

Falls of ground, falling objects other than ground, and glancing objects accounted for 44 of all accidents and the others were due to ten or more causes whose descriptions appear in Table V.

The Mackinaw-Gardner Mine was operated the entire year without sustaining a lost-time accident and the Morris-Lloyd Mine was credited with a similar record on July 22nd. The Athens, Maas, Tilden and Cliffs-Shaft "B" mines during the year completed a six month period each with the honor of having a perfect record.

TABLE V

Classification of all accidents by causes - 1929

By falls of Ground in Stopes, Drifts and Raises	15
By falling Timber, Tools, Stray Chunks, Etc.	12
By glancing objects	9
By haulage	6
By moving Machinery	6
By operating Drill Machines	6
By barring at Chutes	5
By slipping or stumbling	5
By hand Tools	5
By chunks of Ore or Rock rolling down Piles or Banks.	4
By operation of scrapers	4
By projecting Nails	2
By miscellaneous causes	<u>6</u>
Total	85

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TABLE VI

b. Number of Compensable and Non-Compensable Accidents

<u>Mine</u>	<u>Received Compensation</u>	<u>No Compensation</u>	<u>Total</u>
Athens	5	0	5
Cliffs-Shaft	17	8	25
C.P.& L.Co.	0	4	4
Gardner-Mackinaw ..	0	0	0
Hill-Trumbull	6	3	9
Holman-Cliffs	2	0	2
Holmes	7	1	8
Maas	7	0	7
Morris-Lloyd	2	1	3
Negaunee	8	1	9
Spies-Virgil	2	2	4
Tilden	3	1	4
Miscellaneous	4	1	5
Total	63	22	85

TABLE VII

Number of Accidents, number per 1000
Men employed and Percentage Classified
Preventable - 1912 to 1929.

<u>Year</u>	<u>Number of Accidents</u>	<u>Number per 1000 Men Employed</u>	<u>Percentage Classified Preventable</u>
1912	207	88	25
1913	316	120	24
1914	443	181	37
1915	427	185	23
1916	592	193	20
1917	639	184	23
1918	590	156	21
1919	670	172	22
1920	708	175	19
1921	351	170	18
1922	344	168	26
1923	453	166	23
1924	407	152	23
1925	363	152	27
1926	426	185	33
1927	211	90	43
1928	123	77	62
1929	85	40	66

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TABLE VIII

b. Classification of All Accidents 1929
By the Central Safety Committee

1.	Trade Risk. (Incidental and Non-Preventable	29	
II Negligence of Company:			
	1. Failure to use Safety Devices Provided	0	
	2. Failure to use Proper Tools or Appliances Provided	1	
	3. Violation of Rules	1	
	4. Improper Act or Selection of Improper Method of Doing Work (By Foreman	0	
	5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto	1	
	6. Failure to Provide Safety Devices	3	
	7. Failure to Provide Proper Tools, Appliances or Place of Work	<u>4</u>	10
III Negligence of Workmen:			
	1. Failed to use Safety Device Provided	0	
	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 Foreman)	19	
	5. Carelessness (By Workmen)	<u>19</u>	44
Other Workmen:			
	1. Failed to use Safety Devices Provided	0	
	2. Failed to use Proper Appliances or Tools Provided	0	
	3. Violation of Rules	0	
	4. Improper Act or Selection of Improper Method of Doing Work (By Workmen)	1	
	5. Carelessness (By Workmen)	<u>1</u>	2
	Total		85

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INJURYc. Safety Inspection:

A safety inspection of the Company's mines in Marquette County was made each month during the year with the exception of August, when several mines were not visited because the inspector's time for ten days was given to the management of our Labor Day Safety Picnic. Two underground foremen and a shift boss, representing the Cliffs-Shaft, Maas and Morris-Lloyd mines, in the capacity of a foremen safety committee, inspected the local mines in September. The Spies-Virgil mine was inspected in February and September by the inspector. Hydro Electric plants, abandoned properties and explorations were given supervision during the summer months.

A marked improvement in the general conditions of our properties and in the discharge of their duties and responsibilities by our foremen have been achieved, upon which we anticipate that henceforth our accident record will be better than it has been in the past.

TABLE IX

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

<u>Mine</u>	<u>Foremen</u>	<u>Workmen</u>
Athens	8	21
Cliffs-Shaft	13	57
Holmes	9	27
Maas	12	45
Morris-Lloyd	12	60
Negaunee	15	60
Republic	8	42
Idle & Miscellaneous	43	252
	<u>120</u>	<u>564</u>

TABLE X

List and number of all reports for prevention
of Accidents made in 1929

Cage Riders	Daily	3674
Hoisting Ropes	"	3136
Ladderways	Weekly	335
Skip and Cage Roads	"	391
Cage Safety Catches	Monthly	122
Hoists	"	195
Mine Rescue and First Aid	"	197
Safety Inspection	"	70
Fire Hose Equipment	Quarterly	46
Electrical Equipment	"	26
Fire Extinguishers	Semi-Annual	6
		<u>8198</u>

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d. Special Safety Activities:
Central Safety Committee

This Committee held a regular meeting each month of the year and a special one in December, or a total of 13 sessions.

Foremen Safety Conferences:

Our Fifth Safety Conference for all Superintendents and Foremen was held at the North Lake Club House on December 13th, with 92 employees in attendance. Mr. Elliott gave an address and Mr. Moulton presented a comparative accident record by graphs. Two safety motion pictures, entitled "A Chapter of Accidents" and "The Outlaw," were exhibited.

Other Safety Conferences:

The Annual Lake Superior Safety Conference was held at Duluth on June 26th and 27th and our Company had seven representatives present. C. J. Stakel delivered an address on the subject "Safety and Efficiency".

The writer attended the Safety Conference of the Michigan Industrial Commission, which was held at Detroit on May 7th and 8th, and together with Mr. Stakel represented our Company at the Annual Conference of the National Safety Council at Chicago on Oct. 2nd and 3rd. Reports of these conferences were given to the Central Safety Committee.

Safety Bulletin:

In this two page bulletin, which is issued monthly and sent to all foremen, we make a special effort to inform them upon our accident record and to convey safety suggestions and recommendations for the elimination of the recurrence of preventable accidents. Eighty copies are distributed each month.

Bulletin Boards:

The National Safety Council prints a series of 40 safety posters monthly from which we select those that are applicable to our work and post them in our bulletin boards at the mines and plants. Approximately 180 posters were used last year at each board, a change being made each week. These posters have unusual good pictures and many of them are in various colors that command attention and appear very pleasing to the eye.

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d. Safety Flags:

We have ten Safety Flags flying at our Michigan mines and plants to signify to every employee as a symbol of safety it is, the Company policy to prevent accidents. When a flag does not fly it indicates there is a man absent from his work because of an accidental injury.

Special Awards:

For a record of six months without sustaining a lost-time accident all the employees of a mine were presented with a knife, bearing on the handle his name and the words "Awarded for perfect safety record". Six mines accomplished this record, namely,- the Morris-Lloyd, Athens, Maas, Tilden, Gardner-Mackinaw and Cliffs-Shaft "B", in the order named. The Morris-Lloyd and Gardner-Mackinaw mines completed a year's period without suffering a lost-time accident and the men working at these places were given gold buttons stamped with the Company's monogram.

Safety Picnic:

The Company gave a Safety Picnic on Labor Day to employees of the Mining Department and members of their families, working at our Michigan mines and plants. All service, including transportation, a noon-day meal, refreshments, music, intertainment, sports, etc. was free and in addition every employee working on a daily wage scale was given an extra days pay. The attendance, including invited guests and visitors exceeded 10,000 and was estimated as probably close to 12,000.

It was the biggest event of its kind ever held in the Northwest. Due to the excellent work rendered by the Committees in charge of the picnic, combined with an ideal day and the fact that everything was free and there was ample for all, the affair was a huge success. The presence of President Wm. G. Mather and Mr. Wm. P. Belden climaxed the occasion, which will be remembered and referred to as the most happy day for more people on one day than ever was known in this part of the country.

The writer was of the opinion that the addresses delivered at the picnic contained so much valuable information about the past history of the Company that a more permanent record should be in the possession of our people, and with this idea in view, his recommendation that a Safety Bulletin be issued at a later day which will embody the addresses has been approved by the Manager and President. Additional safety data and items of interest concerning the Company, together with appropriate illustration, will be included in this publication.

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d. Ventilation:

Air volume and purity of the same within our mines is good. We have no working places otherwise.

Handling and Use of Explosives:

Our standards controlling this work, adopted in 1928, have resulted in a marked improvement in this hazardous occupation. Our accident record for the year was perfect but this fact gives no assurance for the future insofar as entire exemption from accidents by this cause is concerned. There exists always the hazard of one hole knocking dynamite out from another, which may be concealed in the broken ore and later in transportation with the ore, may explode.

Underground Haulage:

We had six minor accidents by haulage, a remarkable record when consideration is given to the large number of cars of ore and rock that were moved underground. Hazards incident to this work are controlable and a strict observance of our standards is the solution for their prevention. With the exception of the Cliffs-Shaft mine, where many drifts are narrow and winding making unfavorable transportation, all installations are very good.

Scraper Operations:

Safe standards for this work were defined at the special meeting of the Central Safety Committee and they will be distributed to the proper employees early in 1930.

Mining and Timber Methods:

Standards for these important operations were adopted in December and copies of the same will be given to foremen, timbermen and miners as soon as possible in the new year.

Distribution of Rules and Standards:

A total of 396 rule books were given to new employees, of which 311 were in English, 52 Finnish and 33 Italian. Copies of safe standards for the operation of haulage and the use of explosives to the number of 174 were received by men employed at these occupations. The distribution by mines appears in the following pages.

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TABLE XI

e. Distribution of Rule Books:

Cliffs-Shaft	39
Morris-Lloyd	39
Gardner-Mackinaw	28
Tilden	25
Athens	76
Maas	17
Negaunee	46
Holmes	13
Spies-Virgil	18
Hill-Trumbull	<u>95</u>
	396

TABLE XII

Distribution of Haulage Standards:

	Workmen	Foremen
Cliffs-Shaft	18	1
Morris-Lloyd	11	0
Gardner-Mackinaw	0	3
Athens	14	0
Maas	19	0
Negaunee	33	0
Holmes	0	0
Spies-Virgil	2	2
Miscellaneous	<u>0</u>	<u>0</u>
	97	6

TABLE XIII

Distribution of Explosives Standards for Foremen only:

Cliffs-Shaft	13
C. P. & L. Co.	2
Holmes	7
Morris-Lloyd	7
Spies-Virgil	6
Gardner-Mackinaw	5
Athens	8
Maas	9
Negaunee	9
Hill-Trumbull	2
Other properties	<u>3</u>
	71

Explosives standards for workmen, printed in large type on heavy cardboard paper and placed in a glass frame, have been posted at each mine.

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INJURYe. Discipline.

A rigid and impartial enforcement of all safety standards is imperative, and with this object in view it has been necessary to adopt a more severe method in dealing with workmen. An employee who is unwilling or unable to perform his work as instructed by his foreman is subjected to a three days suspension for his first failure or offense and a second violation is considered sufficient reason for his discharge. The decision for a man's dismissal is determined by the superintendent and not by any of his subordinates except in case of willful insubordination.

Underground Fire Protection.

The Company has always been progressive in its policy of fire prevention and fire fighting, and keeping abreast of the times our Manager reached the conclusion that smoking underground should be prohibited. He outlined his position on this subject at the Foremen Safety Conference in December and made the request that the necessity for taking this step be explained by them to the workmen. Opinion was practically unanimous that the hazard ought to be eliminated. The order, therefore, prohibiting smoking underground, in shaft houses and tunnels went into effect on January 1, 1930.

f. First Aid Work.

One of every seven employees is a competent first aid man although the number trained since 1912 bears a much higher proportion, more than one to three. Abandonment of such mines as the Lake, Stephenson and others lost to us many men who had been trained to render this service.

There were two cases of infection reported for the year which may have been the result of a failure to receive first aid treatment. Both occurred at the Cliffs-Shaft mine and the injured men continued at work after receiving slight injuries. Several more infection cases are recorded but in every instance treatment and medical aid were given.

Six complete new first aid teams of five men each, were trained, and in addition to special course was given to men working for the Cliffs Power & Light Co., the Hard Ore Shops and our mine electricians. A total of 78 training lessons were given in which 81 men participated.

First aid supplies cost \$259.73, or 12 cents per employee. The entire sum was charged to the operating mines and plants in proportion to the amounts used.

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INJURYf. First Aid Work - (Continued)TABLE XIVShowing the number of men trained - 1912 to 1929

Number of men receiving training	739
" " " First Aid Certificates ...	563
" " " Deceased	24
" " " Pensioned	6
" " " now employed by Company	332

g. Mine Rescue Work.

We were fortunate in having no underground fire for the entire year.

Training men in the wearing and the practical limits of oxygen breathing apparatus was carried on consistently each month of the year at all of the local mines and once in two months at the Spies-Virgil Mine. In this work we were assisted by the Bureau of Mines Car, which was stationed at the Cliffs-Shart Mine from January 14th to the 25th. Training practices numbered 82 and 77 men took part in the same. It was necessary to drop 24 men from this service because of physical disqualifications.

Maintaining rescue apparatus cost \$159.99 and supplies used in training increased the total expenditure to \$349.94, all being charged to the mines served by this equipment.

TABLE XVShowing the number of men trained in Mine Rescue Work - 1912 to 1929

Number given training	422
" Deceased	17
" Pensioned	2
" Disqualified	133
" left Company's Employment	158
" now employed and qualified to wear the apparatus	112

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TABLE XVI

h. Expenses and Salaries.

Supplies

Printing	53.75	
Safety Magazine for Foremen	48.00	
Safety Exhibit at Duluth	36.83	
Motion Pictures	24.12	
Safety Devices	17.43	
Distribution of Cigars	9.50	
Underground Pictures	6.00	
Laundry	4.21	
Miscellaneous	<u>4.16</u>	204.00

Travelling

Safety Inspector	353.82	
Mine Rescue and First Aid Foreman	296.55	
Superintendents and Captains	<u>198.60</u>	848.97
Salaries		<u>6660.00</u>

GRAND TOTAL 7712.97

Respectfully submitted,

William Cousins
Safety Inspector

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CLIFFS SHAFT MINE:

A leak developed in one of the water cylinders on the Prescott underground pump and we were unable to make repairs that would hold. A new cylinder was ordered and installed on November 20th. This pump is now in good condition.

The pinion shaft bearings on the "A" Shaft hoist gave a little trouble in October. These bearings were re-babbitted as they were very badly worn, and the hoist is now in good condition.

All other mechanical equipment operated satisfactorily during the year.

The "B" Shaft hoist motor gave a little trouble. This motor has been repaired and is now in good condition.

HOLMES MINE:

The gear on the skip hoist drum shaft became loose. Temporary repairs were made and a new key fitted without any delay to operations. This repair may last for some time, but eventually it will be necessary to replace this drum shaft with a new one.

The bearings on the pinion shaft of the Aldrich underground pump became so badly worn that it was necessary to re-babbitt them. A new "Vim" leather belt was put in service on this pump January 31, 1929.

All mechanical equipment is in good condition and operated satisfactorily during the year.

ATHENS MINE:

The brake band on the skip hoist broke on April 21st. Temporary repairs were made and the hoist put in operation. The flanges on the brake drum have been turned off to make room for a wider and heavier brake band.

The cage hoist gave us some trouble. The gear on the drum shaft became loose and it was necessary to replace the old shaft with a new one as the keyway and shaft was so badly worn that it was impossible to repair it.

A leak developed in the cylinder of the 5½"x24" Prescott pump. A new cylinder has been ordered to make this repair.

All other mechanical equipment operated satisfactorily.

MAAS MINE:

The new pump station on the fourth level was completed in March and an 11" x 12" Aldrich triplex pump from the Boeing Mine was installed and put in operation in April. This pump handles the water from the fourth level to the main pump station on the third level.

The head sheaves on the shaft house were moved over in line with the compartment in the shaft. A 6' sheave was installed for a counterweight rope for the cage hoist. This counterweight pipe and counterweight was put in operation in September.

One of the cooling water circulating pumps was moved from the engine

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MAAS MINE: (Cont'd)

house to the heating plant. This change will make a large saving in the amount of city water used.

All mechanical equipment is in good condition and operated satisfactorily during the year.

MAAS CRUSHING PLANT:

The 42" x 40" Allis-Chalmers jaw crusher was dismantled and shipped to the Holman-Cliffs Mine and the #7 $\frac{1}{2}$ McGully gyratory installed in its place.

Crushing was started on April 18th and the plant operated intermittently during the season. Plant was shut down on November 15th.

NEGAUNEE MINE:

A new pump station has been completed on the 12th level, and the Aldrich pumps now in service on the 11th level will be moved down as the water on the 12th level increases.

The addition to the engine house to accommodate the new flywheel hoist set was completed on November the 14th. Foundation for the set will be started as soon as possible.

All the mechanical equipment operated satisfactorily.

LLOYD MINE:

The herringbone gear on the intermediate shaft of the cage hoist gave a little trouble. Repairs were made and this hoist is now in good condition.

All other mechanical equipment operated in a satisfactory manner.

MORRIS MINE:

The intake valve in the high pressure cylinder on #1 Ingersoll-Rand air compressor broke and fell into the cylinder, breaking the piston. A new piston was installed and this compressor is now in good condition. This breakdown did not cause any delay as the Nordberg compressor, which was idle, was put in operation.

The tile intake for the #3 Ingersoll-Rand compressor was cracked by frost and a little sand got into the compressor. This crack was discovered before the sand caused any damage to the cylinder. It was necessary to excavate around this pipe and concrete it in. We do not expect to have any further trouble with this pipe.

A new pump station was cut on the 8th level and the following pumps installed:

One 6"x12" Aldrich vertical triplex, 300 GP.M., 1200' head, formerly used at the Salisbury Mine.

One 5"x10" Aldrich vertical triplex, 150 G.P.M., 1000' head, formerly used at the Spies Mine.

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MORRIS MINE: (Cont'd)

These pumps are taking care of the water from the 8th level to the main pump station on the 4th level.

All mechanical equipment is in good condition.

SECTION 6 SHAFT:

The mechanical equipment at this shaft operated in a satisfactory manner during the year. No changes or additions were made.

GARDNER-MACKINAW MINE:

The cage hoist and motor from the Stephenson Mine was installed in the Gardner engine house on the old hoist foundation to handle the cage and skip in balance. This hoist was put in operation on January 25th.

All mechanical equipment operated satisfactorily during the year.

SPIES-VIRGIL MINE:

The underground haulage set was taken from the underground pump station and installed in the engine house on January the 6th. This was done so the pumpman could be free to take care of the third level pump.

The Deane pump on the third level was overhauled and put in good condition. This was completed on January 28th.

On January 8th the crankshaft on Prescott pump #209 broke. As we had a spare crankshaft on hand, this was again put in operation on January 12th.

On August 14th two field coils on the synchronous motor of the underground haulage set burned out and caused a delay of three shifts. The rotary converter from the Barnes-Hecker Mine was installed temporarily to take care of the haulage until the old motor could be repaired.

All other mechanical equipment operated satisfactorily.

BOBING MINE:

The following equipment was removed from the mine during the year:

<u>DATE</u>	<u>ARTICLE</u>	<u>SHIPPED TO</u>
Dec.	36"x36" drum Cage Hoist & 35 H.P. Motor	Wade Mine for timber shaft.
Nov.	100 G.P.M. Compressor Cooling Water Pump with 2 H.P. Motor.	Holman Pit for priming big pump.
Oct.	Chicago Sump Pump.	Wade Mine.
"	6-ton Elec. Locomotive belonging to Crosby Mine.	North Lake District.
"	9 - Saddle back cars & 4 Timber trucks.	Wade Mine.
July	6-ton Elec. Loco. & 30# Rail	Holman-Cliffs washing plant.
"	1000 G.P.M., 175' Head, Allis-Chalmers pump with 85 H.P. Motor.	Holman-Cliffs Mine.

The watchman left the mine and moved to Taconite in October.

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HILL-TRUMBULL MINE:

In addition to the regular repair work on mine equipment, the shops overhauled the McMyler crane and the Boeing locomotives #104, 105 and 106. The crane was received in May, but due to its age the factory was slow on repair parts, and it was October 1st before overhauling was completed. It was tested out on digging sump at the Holman Mine, but gave so much trouble it was replaced with the 50-ton Industrial and is now at the Hill-Trumbull Mine. Four of the seven 19" x 26" second-hand locomotives purchased from the Oliver Iron Mining Co. in October for the Holman and Canisteeo mines are being overhauled here. They require considerable fire box repairs, which work had to be done inside the shops.

A few breakdowns occurred in the Pit during the season. In May a boom engine crankshaft broke on #26 shovel and an "A" frame leg on #27 shovel. In October, after stripping started with the #28 shovel, a shipper shaft pinion broke. Due to gravel falling from the high bank into padlock sheave and damaging 1-3/8" hoisting cable, it was necessary to replace one cable after three days operation.

The Layne & Bowler pump in Trumbull approach was a complete success. It not only lowered the water in the Trumbull area below any tell-tale drill hole, but during the Fall it was found the water in the Hill area of pit had gone down over 18 feet. This pump operated on second class current all year, most of the time on 12 hours a day, and seems to throw more water with this intermittent operation than when running on 24-hr. schedule. The Kingsbury thrust bearing ran hot on two occasions, but the shoes were repaired in shop and there was practically no delay.

The washing plant started April 22nd and shut down for the season September 28th, washing 411,164 tons. The machinery gave little trouble, but some of it was in bad shape when the season closed. The 36" belt conveyor was worn out, all four 18' turbos needed overhauling and one 25' log washer twisted its log shafts and has to have new ones. It was decided in November to replace the 18' turbos and tables with two Dorr bowl classifiers and add two 4' Symons crushers on concrete piers and have these ready to operate by May 1st next year. The turbos are now being removed and chutes changed ready for new equipment.

Due to tailings sand blowing into Calumet it was necessary to keep water on #1 basin all summer and fall. It is hoped to get away from this trouble by planting oats on the sand surface next Spring.

The 3/4-yd. gas dragline was kept busy for the season. In April it excavated a water supply pond near the office and dug basement for Superintendent's residence; then moved to #1 tailings pond, finished this in July and moved to Holman tailings pond and dug ditches. In September it was moved to Canisteeo and dug discharge ditches for dewatering pumps. In October it was returned to Holman washing plant and was used as crane to assemble 8' and 5' pan conveyors. It was left at Holman washing plant for the winter.

The only new equipment purchased during the year was five 30-yd. Western Wheeled Scraper air-dump cars to replace the old 12-yd. cars that were in too poor condition to repair. A #29 Armstrong all-steel churn drill was received in October, too late to test out last season, but will replace the old worn out Keystone drill that has been in use ten years.

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HOLMAN-CLIFFS MINE:

Pit pumping was the main work at this mine during the first part of the year. The Layne & Bowler pump in shaft, and Cameron centrifugal pump in the pit, lowered the water 17'6" in January; 39' in February; 20' in March and the shaft was pumped dry on April 27th, with 8' of water still under the pit pump. It was found that no seepage occurred between pit and bottom of shaft, and to lower the water for test-pitting in bottom it was decided to dig a large sump 20' deep and float pit pump in it. The only machine that did this sump digging with little trouble was the Industrial crane with orange peel bucket. Considerable time was lost experimenting with other machines, but the sump should be completed in January. Nothing but second class current was used during the year, but due to the sump digging it was necessary to go on first class January 1st, 1930.

The Great Northern Railway promised to have its spur into the washing plant site completed by May 1st, but due to muskeg and swamp troubles did not get a track in until July 18th. In the meantime, a gravel highway was built over tailings dyke to plant site that was completed in July and work started on washing plant foundations. E. W. Coons Company secured contract for excavating and concrete work and started July 16th. During July and August all machinery for plant was received and ready to go in place as the steel work was erected by Worden-Allen Company. The Worden-Allen erecting crew arrived on August 27th and the first car of steel was received August 30th. They completed their work on November 26th. The biggest concrete job was building the reinforced concrete receiving pocket. By September 1st all piers for washing plant, water tank and conveyor belt were completed and sub-base for receiving pocket. By October the 8th all concrete work was completed, the total being close to 1200 yards. The machinery installed was as follows:

- 1 - 8' Pan Conveyor, 60'5" long, bought from Lake Shore Engine Works.
- 1 - 5' " " 22' " " " " " " " "
- 1 - 42"x40" Jaw Crusher, Allis-Chalmers make, bought second hand from Maas Mine.
- 1 - 36" x 192' Belt Conveyor, bought from Robins Conveying Belt Co.
- 1 - 6'x12' Revolving Screen, Allis-Chalmers, bought second hand from Maas Mine.
- 2 - 36" x 20' Picking Belt Conveyors, bought from Robins Conveying Belt Co.
- 2 - 4' Symons Crushers, " " Nordberg Manfg. Co.
- 2 - 25' Log Washers, " " Lake Shore Engine Works.
- 1 - 25' Log Washer, Allis-Chalmers, second hand from Rowe Mine.
- 2 - 17' dia. Bowl x 8' rake Bowl Classifiers - The Dorr Co.
- 2 - 2000 G.P.M., 200' head, Centrifugal Pumps - Allis-Chalmers Manfg. Co.
- 1 - 25,000 gal. Steel Tank on 100' Tower - Chicago Bridge & Iron Works.

Erection work was carried on by Hill-Trumbull washing plant crew until January 1st and sufficient progress made so the mill can be completed next April, ready to run by May 1st.

Equipment purchased during the year for the pit operation is as follows:

- 2 - 120B Electric Shovels - Bucyrus-Erie Co.
- 17 - 30-yd. Air Dump Cars - Western Wheeled Scraper Co.
- 5 - 19"x26" American Locomotives - bought second hand from Oliver Iron Mining Co.

A. Guthrie Company contracted for pit stripping and long fill to washing plant and started erecting 125-ton shovel in March. In November a Model "300" Marion shovel was placed on rock stripping in pit and will work all winter.

The Holman shop equipment was purchased from the Oliver Iron Mining

MECHANICAL DEPARTMENT
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YEAR 1929

HOLMAN-CLIFFS MINE: (Cont'd)

Co, in March and the shop buildings rented. This equipment was idle during the year, but will be needed to overhaul three of the second hand locomotives before shipping starts next year.

GANISTEO-CLIFFS MINE:

In July it was decided to take over this mine, and plans were made to unwater the pit, which was estimated to contain 2-1/2 billion gallons. Two 7,000 G.P.M., 220' head, centrifugal pumps, driven by 600 H.P., 2200 volt motors, were purchased from Allis-Chalmers Manfg. Co. and received November 28th. Three 333 K.V.A. transformers were installed in substation erected near the old boiler plant and transmission line built to pump site. Two scows built of oil barrels and poles and a 16" two-pipe discharge line was constructed in October and ready when pumps arrived. Pumps were installed on scows and floated through an ice channel cut to discharge location. One pump was started December 15th and the second put in operation December 23rd. By January the 1st the water had been lowered about four feet. As second class current is being used, the pumps operate from 6:00 P.M. to 6:00 A.M. on week days and 24 hours on all holidays, as per orders from Minnesota Power & Light Co. It is planned to have the water out by October 1st.

The 16" discharge pipe was secured second hand from Republic Mine.

WADE MINE:

The regular mine pumping was the only work during January, February and March. In April the Dohm Contracting Co. started clean-up work in the open pit with our #14 shovel and #4 Lima locomotive and took out ore until June, when the deposit was exhausted. A. Guthrie Company worked their Model "300" Marion shovel in the pit until August, when they changed the mining system, repaired the Helmer incline and took out the remainder of the ore with a one-yard shovel and trucks that hauled the ore to incline pocket in pit, where it was hoisted with skips in balance through shaft house into Great Northern cars.

In October it was decided to re-open the underground workings, and the remainder of the year was needed to get the mine in shape for production. The drifts were cleaned by hosing the mud into sump and using centrifugal pump to lift it to surface. The 64-cu. ft. saddle back cars from Boeing Mine were installed on second level, with a 6-ton General Electric locomotive, and the subs are practically ready to start mining with 15 H.P. double drum slushers.

DEAN MINE:

This was taken over October 1st and plans made to unwater, but it will be sometime in the new year before any work will start at this property.

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MECHANICAL DEPARTMENT
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ELECTRICAL DEPARTMENT:

The total output of The Cliffs Power & Light Co. electric plants was the greatest that has been produced in any year, exceeding 61,000,000 Kilowatt Hours.

The service in general has been good, although some temporary trouble occurred when part of the units were out.

A new unit was installed at Republic and started March 16th. This is a 500 K.V.A. Westinghouse generator with automatic control. This is very satisfactory.

The plant on the Escanaba River was put in service March the 5th. This is a Westinghouse generator, 2600 K.V.A. capacity, connected to an Allis-Chalmers water wheel. It is arranged for full automatic operation, tripping off when trouble occurs and coming on the line again when re-energized. It is very satisfactory, but in order to get full capacity it will be necessary to concrete line the penstock for a short distance adjacent to the power house. It is planned to do this in the Spring. A special report will cover this item.

The two water wheels at the Carp Plant, which had been in continuous service for seventeen years, were rebuilt early in the year. This resulted in an increase in capacity of about 5%, as well as making the wheels again as satisfactory as when first installed.

On November 28th the #2 generator at the Carp Plant burned out due to age, and on December 7th #1 generator burned out. No. 2 generator was repaired and put in service again on December 30th and #1 should be ready in about a week. This plant should then be in as good condition as when first installed.

A new transformer was added to the Palmer Substation, consisting of a 625 K.V.A. 30000/2300 volt unit, increasing the capacity of this substation by 40%. This was necessary in order to take care of the load at the Tilden Mine.

A considerable number of sectionalizing switches were replaced with higher capacity and new modern switches, and a few high tension lightning arresters installed.

The usual transmission line troubles occurred, but only two caused any interruption of consequence. One was due to lightning which shattered a pole at Gwim, and the other on account of a very severe sleet storm which broke down all lines in that district. No serious trouble was caused by the interruptions, however, as service was re-established in time to keep the mines operative.

Some tests were made in Munising in connection with a sand proposition and the results seemed to be satisfactory.

The new line to serve the Inland Steel Company rock quarry near Manistique is now well under way. Preliminary work was started in September and we now have all right-of-way purchased and the line route located as far as Munising. The Hoosier Engineering Company, who have the contract to build this line, have completed the same approximately from Gwim to Little Lake. The clearing of right-of-way is practically completed to Munising, and all material on the ground or ordered for this section. Poles are erected as far as Carlshend. This line is #3/0 stranded steel core aluminum wire on 50 ft. poles, with Ohio Brass Co. suspension insulators. We anticipate this line will be complete for service about June 1st, 1930. The unusually heavy snow fall has delayed this construction somewhat.

MECHANICAL DEPARTMENT
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YEAR 1929

ELECTRICAL DEPARTMENT: (Cont'd)

A contract was made with the Manising Paper Company for about 1500 K.W. of steam power.

A temporary service connection was made with the Marquette City Plant in November to help them during the repair of their pipe line.

A special report is being made relative to completing the Au Train Plant as originally contemplated.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1929

Electrical Department: (Cont'd)

Summary of Operating Conditions - 1929.

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Precipitation -	2.72	0.86	1.45	2.50	3.02	3.53	5.02	1.14	3.24	5.31	1.20	2.31	
Total Precipitation at Ishpeming during 1929 - 32.28 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 1929,	4,999,026,400
Kilowatt Hours generated in 1929,	11,493,900
Cubic feet water utilized (90 cu. ft. = 1 KWH.)	1,034,451,000
" " " in Carp Storage Basin Jan. 1, 1929,	434,774,200
" " " " " " " Dec. 31, "	299,510,300
" " " taken from storage in 1929,	135,263,900
" " " wasted over Intake Dam in 1929,	544,544,000
Total run-off for the year 1929,	1,423,731,100
Run-off per square mile of drainage area,	21,358,100

	<u>1913</u>	<u>1914</u>	<u>1915</u>	<u>1916</u>	<u>1917</u>	<u>1918</u>	<u>1919</u>	<u>1920</u>	<u>1921</u>
Total Precipitation,	30.11	26.53	38.40	36.83	25.46	31.05	29.50	27.40	30.38
Sec.ft.per sq.mi. run-off	1.03	.67	.93	1.29	.70	.79	.83	.73	.68

	<u>1922</u>	<u>1923</u>	<u>1924</u>	<u>1925</u>	<u>1926</u>	<u>1927</u>	<u>1928</u>	<u>1929</u>
Total Precipitation,	33.67	21.90	22.95	20.71	35.69	29.86	36.06	32.28
Sec.ft.per sq.mi. run-off	1.06	.59	.50	.25	.85	.98	1.11	.67

McCLURE HYDRO-ELECTRIC PLANT:

Drainage area above Intake Dam,	140.52 sq. miles
Cu. ft. Precipitation in 1929, (Hoist Plant 38.75")	12,553,436,000
Kilowatt Hours generated at McClure Plant in 1929,	35,345,400
Cubic feet water utilized (125 cu. ft. = 1 KWH.)	4,418,175,000
" " " wasted over Intake Dam in 1929,	1,752,192,000
" " " in Hoist Storage Basin Jan. 1, 1929,	2,001,203,000
" " " " " " " " Dec. 31, "	1,841,548,000
" " " taken from Hoist Storage in 1929,	159,655,000
" " " in Silver Lake on Jan. 1, 1929,	588,181,000
" " " " " " " " Dec. 31, "	639,045,000
" " " stored in Silver Lake in 1929,	50,864,000
Total run-off for the year 1929,	6,061,576,000
Run-off per square mile of drainage area,	43,146,747

	<u>1920</u>	<u>1921</u>	<u>1922</u>	<u>1923</u>	<u>1924</u>	<u>1925</u>	<u>1926</u>	<u>1927</u>	<u>1928</u>	<u>1929</u>
Sec. ft. per sq. mi. run-off	1.22	1.02	1.54	0.85	0.92	0.52	1.52	1.80	2.22	1.368

THE CLIFFS POWER & LIGHT CO.

SUMMARY OF OPERATIONS - 1929.

	<u>KILOWATT HOURS GENERATED</u>						<u>TOTAL</u>	<u>Used by Auxilia- ries</u>	<u>Delivered to Line</u>	<u>KWH. Sold</u>	<u>Transmission Losses</u>	
	<u>McClure</u>	<u>Carp</u>	<u>Hoist</u>	<u>An Train</u>	<u>Escanaba</u>	<u>Republic</u>					<u>K.W.H.</u>	<u>%</u>
Jan.	2,777,600	986,000	591,000	227,040			4,581,640	15,440	4,566,200	3,939,022	627,178	13.73
Feb.	3 279 000	826 200	678 000	151 660			4 934 860	14 886	4 919 974	4 248 441	671 533	13.64
March	3 457 300	480 400	636 000	136 210	126,000	16,100	4 852 010	13 732	4 838 278	4 149 524	688 754	14.23
April	2 912 800	635 400	697 000	287 730	203 000	96 100	4 832 030	13 729	4 818 301	4 151 438	666 863	13.84
May	2 965 700	1 026 300	646 000	290 200	184 000	109 200	5 221 400	12 841	5 208 559	4 539 257	669 302	12.85
June	2 573 600	1 227 900	635 000	288 110	233 000	126 600	5 084 210	12 823	5 071 387	4 378 526	692 861	13.66
July	2 640 700	1 291 400	570 000	262 720	169 000	116 400	5 050 220	12 861	5 037 359	4 382 056	655 303	13.00
Aug.	3 261 900	1 095 700	948 000	135 560	0	128 400	5 569 560	15 402	5 554 158	4 784 123	770 035	13.86
Sept.	2 911 000	1 197 700	969 000	102 120	142 000	91 100	5 412 920	15 774	5 397 146	4 668.980	728 166	13.49
Oct.	2 868 900	1 132 500	982 000	203 160	332 000	93 100	5 611 660	16 224	5 595 436	4 922 126	673 310	12.03
Nov.	2 643 600	1 188 000	873 000	287 930	515 000	124 900	5 632 430	16 660	5 615 770	4 959 853	655 917	11.68
Dec.	3 053 300	406 400	1 104 000	164 900	337 000	119 100	5 184 700	16 818	5 167 882	4 552 039	615 843	11.91
	35,345,400	11,493,900	9,329,000	2,537,340	2,241,000	1,021,000	61,967,640	177,190	61,790,450	53,675,385	8,115,065	13.13

MECHANICAL DEPARTMENT
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YEAR 1929

Electrical Department (Cont'd)

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

	INSTALLED		CONNECTED
	TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929 JAN. 1, 1930 TOTALS
ANGELINE MINE:			
Hoist	250 HP.		250 HP.
CLIFFS SHAFT MINE:			
Shop	25		
No. 8 Crusher	125		
Screens	15		
Lower Tram #1 (to Tilden car dumper)	30		30
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 Exhaust Fan	$\frac{1}{2}$		
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 " " "	$1\frac{1}{2}$		
Underground Scrapers - 47 - 25 HP. motors	1000	175	
Lower Tram #3	30		
Battery Charging Set - 2nd level "A" Shaft	$7\frac{1}{2}$		
Undg. Haulage Set #1 (to Morris-Lloyd)	100		100
Grinder in Drill Sharpening Shop	$7\frac{1}{2}$		
Battery Charger (stored)	30		30
Rotary Screen	10		
Boiler Feed Pump at Central Office	$\frac{3}{4}$		
Undg. Haulage Set #1 (from Gen. Storehouse)		150	
			4,669 $\frac{3}{4}$
BROWNSTONE SUBSTATION:			
Test Set	$\frac{1}{2}$		
Oil Filter Press	$\frac{1}{4}$		
Battery Charging Motor-Generator Set	3		
Commutator Grinder	1		
Synchronous Condenser	80		
M.G. Set on Voltage Regulator Control	$\frac{1}{4}$		
Large Oil Filter Press	2		
Drill		1	
			88
fwd.	4,841 $\frac{3}{4}$ HP.	326 HP.	160 HP.
			5,007 $\frac{3}{4}$ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1929

Electrical Department (Cont'd)

		INSTALLED TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	CONNECTED JAN. 1, 1930 TOTALS
	brt. fwd.	4,841 $\frac{3}{4}$ HP.	326 HP.	160 HP.	5,007 $\frac{3}{4}$ HP.
HARD ORE SHOPS:					
Machine Shop		10			
Carpenter "		25			
Blacksmith Shop Punch		3			
Armature Banding Machine		2			
" " "		1/2			
" " "		1/8			
Lathe Grinder		1			
Portable Drill		1/4			
" " - Large		1/4			
Commutator Slotter		1/8			
Air Compressor		10 $\frac{1}{2}$			
Water Supply Pump		7 $\frac{1}{2}$			
Blacksmith Shop Blower		1/4			
Hacksaw		1/2			
Small Grinder		1/4			
		<hr/>			
					61 $\frac{1}{4}$
HOLMES MINE:					
Air Compressor		340			
" " Cooling Water Pump		3			
Skip Hoist - 2 - 400 HP. motors		800			
Cage "		400			
Underground Haulage Converter		150			
Top Tram		25			
No. 6 Crusher - 2 - 40 HP. motors		80			
Screens		20			
Laboratory Crusher		2			
Underground Plunger Pump		250			
" Centrifugal Pump		400			
Boiler Feed Pump		5			
Machine Shop		25			
Auxiliary Compressor for Hoist Brakes		7 $\frac{1}{2}$			
5th level Pump - Aldrich sinker		35			
" " " - Dean		10			
		<hr/>			
					2,552 $\frac{1}{2}$
ISHPEMING HOSPITAL:					
Passenger Elevator		7 $\frac{1}{2}$			
Dumb Waiter		3			
Large Washer		2			
Small "		1			
Extractor		2			
Vacuum Cleaner		3			
" Pump (to Brownstone for Drill)		1			1
Water Supply Pump (correction)		2			1
Kray Machine			1/4		
Hot Water Circulating Pump			1/2		
" " Return - high pressure			5		
" " " - low "			1 $\frac{1}{2}$		
Vacuum Pump			3		
		<hr/>			
			<hr/>		29 $\frac{3}{4}$
	fwd.	7,477 HP.	336 $\frac{1}{2}$ HP.	162 HP.	7,651 $\frac{1}{4}$ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

		INSTALLED		CONNECTED
		TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929
				JAN. 1, 1930 TOTALS
	brt. fwd.	7,477 HP.	336 $\frac{1}{4}$ HP.	162 HP.
				7,651 $\frac{1}{4}$ HP.
TILDEN MINE:				
Compressor		150		
Centrifugal Pump		275		
Scraper		15		15
#29 Shovel - Motor-generator Set		110		
" Air Compressor		4 $\frac{1}{2}$		
" Oil Pump		1/4		
" Trip Motor		2		
" Exciter Motor		10		
Cyclone Drills - 2 - 10 HP.		20		
" " - 3 - 15 HP.		15	30	
Car Dumper (from Cliffs Shaft Mine)			30	
Large Crusher			250	
Car Puller - (from Republic Mine)			10	
Sample Crusher " " "			3	
Conveyor Belt (from Princeton)			50	
Secondary Crushers - 2 - 100 HP.			200	
Small Hoist over crusher			3	
#31 Shovel - Motor-generator Set			110	
" Exciter Motor			7 $\frac{1}{2}$	
" Trip " "			1 $\frac{1}{2}$	
" Air Compressor			5 $\frac{3}{4}$	
Drill Sharpener			15	
Pump for Drills			15	
Synchronous Condenser from P.C.P.P.			625	
Exciter Motor-generator Set			15	
Water Supply Pump			5	
Shop Motor (from Republic)			5	
				1,967 $\frac{1}{4}$
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 Pumps - 2 - 400 HP.		800		
Ore Tram - 2 - 50 HP.		100		
Carpenter Shop		20		
Ore Crusher		25		
Battery Charging Motor-Generator Set		1/4		
Udg. Ventilating Fan #2 (from Maas rock tram)		40	50	40
Ingersoll-Rand Compressor		450		
Rock Tram		50		
				3,311 $\frac{1}{4}$
MAAS CRUSHING PLANT:				
Jaw Crusher		100		
Belt Conveyor		50		
Pan Conveyor Motor-Generator Set		50		
				200
	fwd.	11,580 HP.	1,766 $\frac{3}{4}$	217
				13,129 $\frac{3}{4}$ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1929

Electrical Department (Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	CONNECTED JAN. 1, 1930 TOTALS
MAAS MINE:		11,580 HP.	1,766 $\frac{3}{4}$ HP.	217 HP.	13,129 $\frac{3}{4}$ HP.
(Circulating Pump		40			
Turbine Auxiliaries (Injection " "		25			
" (Exciter		33			
Underground Haulage Set		215			
Shop		10			
Underground Centrifugal Pump		350			
" Hoist		50			
" Plunger Pump #1		325			
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		7 $\frac{1}{2}$			
4th Level Pump		50			
Cooling Water Pump		5			
Triplex Pump, 4th Level		50			
Centrifugal Pump, 4th Level		40			
Saw Gunning Outfit in Carpenter Shop		2			
		<hr/>			3,540
NEGLAUNEE MINE:					
Underground Haulage Set #1		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			
Ore Crusher		25			
Ingersoll-Rand Compressor		400			
13th Level Plunger Pump		15			
11th " " Pumps - 2 - 75 HP motors		150			
Exciters for 10th level 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			
Skip Fit Pump		3			
Underground Haulage Set #2		220			
		<hr/>			3,154 $\frac{1}{2}$
	fwd.	18,274 $\frac{1}{2}$ HP.	1,766 $\frac{3}{4}$	217	19,824 $\frac{1}{2}$ HP.

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Electrical Department (Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	CONNECTED JAN. 1, 1930 TOTALS
SOUTH JACKSON CRUSHING PLANT:					
Hoist		75			
Crusher		<u>150</u>			225
BARNES-HECKER MINE:					
Skip Hoist		400			
Underground Haulage Converter (to Spies-Virgil)		<u>150</u>		150	400
LLOYD MINE:					
Skip Hoist		400			
Cage "		400			
Top Tram		40			
Ore Crusher		25			
Water Supply Pump installed underground		50			
Auxiliary Compressor for Hoist Brakes		5			
Top Tram		<u>50</u>			970
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		25			
Underground Haulage Set #2		215			
Aldrich Triplex Pump (from Spies-Virgil)			50		
8th level Pump			<u>100</u>		3,817
SECTION 6 SHAFT:					
Hoist		200			
Water Supply Pump		<u>3</u>			203
GWINN CRUSHING PLANT:					
Crusher		85			
Pan Conveyor		50			
Belt "		40			
Compressor		15			
" Cooling Water Pump			<u>3</u>		193
FRANCIS MINE STOCKPILE:					
Triplex Pump		<u>7½</u>			7½
fwd.		<u>24,087</u> HP.	<u>1,919½</u>	<u>367</u>	<u>25,639½</u> HP.

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Electrical Department (Cont'd)

		INSTALLED TO JAN. 1, 1929	INSTALLED TAKEN OUT IN 1929	IN 1929	CONNECTED JAN. 1, 1930 TOTALS
	brt. fwd.	24,087 HP.	1,919 $\frac{3}{4}$ HP.	367 HP.	25,639 $\frac{3}{4}$ HP.
GARDNER MINE:					
Hoist		400			
Top Tram		50			
Laboratory Crusher		<u>3</u>			
					453
MACKINAW MINE:					
Hoist		400			
Shop		7 $\frac{1}{2}$			
Top Tram		50			
Fire Pump in Engine House		20		20	
Underground Haulage Set		150			
Air Compressor		325			
Compressor Cooling Water Pump		7 $\frac{1}{2}$			
Underground Quintuplex Pump			350		
" Triplex "			<u>75</u>		
					1,365
PRINCETON MINE #2:					
Hoist		200			
Top Tram - 2 - 50 HP. motors		100		50	
Stockpile Loader		<u>25</u>			
					275
PRINCETON MINE #3:					
Hoist		<u>75</u>			
					75
STEPHENSON MINE:					
Skip Hoist		400			
Top Tram - C. & N. W.		50		50	
Rock Tram		25		25	
Ore Tram		50		<u>50</u>	
					400
PRINCETON CENTRAL POWER PLANT:					
(Circulating Pump)		50			
Turbine Auxiliaries (Injection " (Exciter)		40			
		33			
Air Compressor		625		625	
Boiler Room Fan		50			
Coal Handling Machinery		10			
" " "		<u>5</u>			
					188
PRINCETON CENTRAL SHOPS:					
Shop Motor		<u>25</u>			
					25
PRINCETON CENTRAL PUMP STATION:					
Centrifugal Pump		100			
Automatic Pump		<u>30</u>			
					130
REPUBLIC MINE:					
Auxiliary Compressor for Hoist Brakes		5			
Machine Shop (to Tilden Mine)		5		5	
Laboratory Crusher - (to Tilden Mine)		3		3	
#9 Shaft Hoist - 2 - 500HP. motors		1,000			
#9 Shaft Ore Tram 2 - 50 " "		100			
Booster Compressor		<u>200</u>			
					1,305
	fwd.	<u>28,706 HP.</u>	<u>2,344$\frac{3}{4}$ HP.</u>	<u>1,195</u>	<u>29,855$\frac{3}{4}$ HP.</u>

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Electrical Department (Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	CONNECTED JAN. 1, 1930 TOTALS
CARP PLANT:		28,706 HP.	2,344 $\frac{3}{4}$ HP.	1,195 HP.	29,855 $\frac{3}{4}$ HP.
Auxiliaries - 2 - 15 HP pump motors		30			
Water Supply Pump		1			
Air Compressor		<u>5</u>			36
HOIST PLANT:					
Exciter Motor-Generator Set		20			
Oil Pump		3			
Air Compressor		<u>5</u>			28
McCLURE PLANT:					
Water Supply Pump		2			
Exciter Motor-Generator Set		17 $\frac{1}{2}$			
Air Compressor		<u>5</u>			24 $\frac{1}{2}$
ESCANABA RIVER PLANT:					
Air Compressor (stored in C.P.P. boiler house)		100		100	
Centrifugal Pump (to Ishpeming)		125		125	
Compressor Cooling Water Pump		3		3	
Concrete Mixer (to Ishpeming)		7 $\frac{1}{2}$		7 $\frac{1}{2}$	
Portable Hoist " "		7 $\frac{1}{2}$		7 $\frac{1}{2}$	
Grinder (stored at Prin. Cent. Shops)		3		3	
Air Compressor			5		
Oil Pump			5		
Valve Operating Motor			<u>1</u>		11
TOTAL MINING DEPARTMENT		<u>29,040$\frac{1}{2}$ HP.</u>	<u>2,355$\frac{3}{4}$ HP.</u>	<u>1,441</u>	<u>29,955$\frac{1}{4}$ HP.</u>

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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	CONNECTED JAN. 1, 1930 TOTALS
<u>TOTAL MINING DEPARTMENT</u>	29,040½ HP. 2,355¾ HP. 1,441 HP.			29,955½ HP.
PIONEER FURNACE:				
Furnace & Sawmill	<u>1,195</u>			1,195
L. S. & I. RR. CO.				
Shops, Sawmill, Ore Dock & Pumps	<u>800</u>			800
LAND DEPARTMENT:				
Grand Island	<u>10½</u>			10½
LUMBERING DEPARTMENT:				
Dixon Location Water Supply Pump	5			
Tie Mill Saw	75			
" " Conveyers	37			
" " Shop	<u>10</u>			127
MICHIGAN GAS & ELECTRIC CO.:				
Ishpeming	2,170			
Manising	250			
Manising City Pumping	<u>125</u>			2,545
REPUBLIC TOWNSHIP:				
Water Supply Pump	<u>25</u>			25
OLIVER IRON MINING COMPANY:				
Pumps at Angeline & Section 16 Mines	525			
Air Compressor at Section 16 Mine	<u>700</u>			1,225
CITY OF ISHPEMING:				
Booster Pump at Brownstone	<u>15</u>			15
CITY OF NEGAUNEE:	<u>435</u>			435
THE CLIFFS ELECTRIC CO., PRINCETON	100	<u>30</u>		130
PALMER MINING COMPANY:				
Volunteer Mine, Palmer	<u>800</u>			800
EMPIRE-QUINN MINING COMPANY:				
Archibald Mine, Gwinn	<u>1,952</u>			1,952
MUNISING WOODENWARE CO.:	<u>695</u>			695
FORD MOTOR COMPANY:				
Blueberry Mine	<u>1,165</u>			1,165
<u>TOTAL OUTSIDE LOAD</u>	<u>11,089½</u>	<u>30</u>	<u>0</u>	<u>11,119½</u>
<u>GRAND TOTAL CONNECTED LOAD</u>	40,130 HP. 2,385¾ HP. 1,441 HP.			41,074¾ HP.

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YEAR 1929

Electrical Department (Cont'd)

The following motors are not connected to our Power System:

	INSTALLED			CONNECTED
	TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	JAN. 1, 1930 TOTALS
SPIES MINE:				
Underground Triplex Pump	50 HP.			
Crusher	50			
Air Compressor	403			
Grinder in Shop (stored)	3		3	
Compressor Cooling Water Pump	3			
Hoist	400			
Boiler Feed Pump	2			
Circular Saw in Carpenter Shop	25			
Shop	5			
Compressor Cooling Water Pump	3			
Underground Haulage Set (stored)	150		150	
" Plunger Pumps, 8th level (2)	300			
Udg. Haulage Converter from Barnes-Hecker		<u>150</u>		1,391
MESABA RANGE:				
BOEING MINE:				
Sinking Hoist (to Wade)	35		35	
Air Compressor	225			
Underground Haulage Set	150			
Top Tram	50			
Compressor Cooling Water Pump (to Holman)	2		2	
Shop " "	10		10	
Blacksmith Shop Fan	<u>1/4</u>			425 1/4
CANISTEO MINE:				
Centrifugal Pumps 2 - 600 HP motors		1,200		
Priming Pump		<u>3</u>		1,203
CROSBY MINE:				
Log Washer	40			
Screen	20			
Picking Belt	3			
Chip Screen	3			
Tables	20			
Stockpile	7 1/2			
Centrifugal Pump	65			
#2 Turbo	20			
Feeder	<u>20</u>			218 1/2
HOLMAN-CLIFFS MINE:				
Layne & Bowler Pump	350			
Worthington Shaft Pump	150		150	
Bench Grinder		1/4		
Portable Drill		1/4		
Belt Conveyor		75		
Symons Crushers - 2 - 100 HP. motors		200		
Jaw Crusher		100		
Dorr Classifiers 2 - 10 " "		20		
Air Compressor		50		
Screen (from Maas Crushing Plant)		25		
Centrifugal Pumps 2 - 125 HP motors		250		
Picking Belts 2 - 5 " "		10		
	fwd.	<u>2,064 3/4</u>	<u>1,353</u>	<u>200</u>
				3,237 3/4 HP.

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Electrical Department (Cont'd)

	brt. fwd.	INSTALLED		CONNECTED	
		TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	JAN. 1, 1930 TOTALS
		2,084 $\frac{3}{4}$ HP.	1,353 HP.	200 HP.	3,237 $\frac{3}{4}$ HP.
HOLMAN-CLIFFS MINE: (Cont'd)					
Brought forward		500	730 $\frac{1}{2}$	150	
Centrifugal Pump			85		
Carpenter Shop			10		
Machine Shop			30		
Priming Pump			2		
Exhaust Fan				1/2	
Centrifugal Pump			275		
Blacksmith Forge Fan				1/2	
Motor-Generator Set			<u>225</u>		
					1,708 $\frac{1}{2}$
HILL-TRUMBULL MINE:					
Log Washer		25			
" "		40			
Turbos - 4 - 5 HP motors		20			
Crusher		100			
Sand Pump		10			
Sample Crusher		10			
Prescott Plunger Pump		125			
Centrifugal Pump		150			
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 (to Holman-Cliffs)		1/2		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 Fuller		7 $\frac{1}{2}$			
Portable Grinder		1			
North Pit Pump		30			
Air Compressor at Washing Plant		25			
Churn Drill		10			
Boiler Feed Pump		5			
Blacksmith Shop Fan				3	
Chip Screens - 2 - 2 HP motors		4			
Layne & Bowler Pump		125			
Tool Post Grinder		1/4			
Locomotive Water Tank Pump				3	
Electric Welder				15	
Armstrong Drill				15	
Laboratory Heater				1/8	
					1,099 $\frac{1}{8}$
	fwd.	<u>3,648$\frac{3}{4}$</u>	<u>2,747$\frac{1}{2}$</u>	<u>350$\frac{1}{8}$</u>	<u>6,045$\frac{1}{2}$ HP.</u>

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Electrical Department (Cont'd)

	INSTALLED			CONNECTED
	TO JAN. 1, 1929	INSTALLED IN 1929	TAKEN OUT In 1929	JAN. 1, 1930 TOTALS
brt. fwd.	3,648 $\frac{3}{4}$ HP.	2,747 $\frac{1}{2}$ HP.	350 $\frac{1}{2}$ HP.	6,045 $\frac{3}{4}$ HP.
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	3		3	
Top Tram	50			
Clear Water Pump	15			
Blacksmith Shop Fan	3			
Sump Pump		7 $\frac{1}{2}$		
Sinking Hoist		35		
Underground Centrifugal Pump		125		
		<u>7$\frac{1}{2}$</u>		
		<u>35</u>		
		<u>125</u>		
				<u>822$\frac{1}{2}$</u>
<u>TOTAL</u>	4,306 $\frac{3}{4}$ HP.	2,915 HP.	353 $\frac{1}{2}$ HP.	6,868 $\frac{1}{4}$ HP.

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Electrical Department (Cont'd)

The following A.C. motors are on hand, (Dec. 31, 1929), but are not installed:

CLIFFS SHAFT MINE:		
Top Tram (stator only)	50	
Spare Top Tram	50	
" " "	50	
Hoist stator only	500	
Small Conveyor Motor	2	
Scraper Motors - 10 - 25 HP.	250	
Crusher	25	
Battery Charger from Republic	<u>30</u>	
		957 HP.
GENERAL STOREHOUSE:		
Centrifugal Pump from D. R. Storage Dam	3	
Spare from Republic concrete mixer	5	
" General Electric pump	50	
" " " Motor-Generator Set (Morris-Lloyd)	150	
" from Hard Ore #3 plunger pump	35	
" " Holmes Mine crusher	100	
" Top Tram	50	
Bag Cleaner from D. R. Storage Dam	1/2	
Spare for Centrifugal Pump used at North Lake	200	
" from Morris Mine cage hoist	400	
" Haulage Converter from Francis	150	
" Plunger Pump from "	35	
" motor	40	
" Pump from Lake Mine	20	
Winze Hoist from Morris Mine	200	
Compressor from Crosby Mine	50	
Portable hoist from Republic Mine	7 1/2	
Pump motor " " "	10	
" " " Angeline "	<u>100</u>	
		1,606
LAKE MINE CHANGE HOUSE:		
Ventilating Fan from Salisbury Mine	<u>7 1/2</u>	
		7 1/2
ISHPEMING HOSPITAL:		
Spare for Dumb Waiter	3	
" " Hot Water Return	<u>5</u>	
		8
ATHENS MINE:		
Pump Motor	35	
Fan "	<u>40</u>	
		75
MAAS MINE:		
Winze Pump	15	
Pump (from Morris Mine)	50	
" (" Boeing ")	100	
Hoist Motor from Stephenson Mine	<u>75</u>	
		240
NEGAUNEE MINE:		
Flywheel Hoist Set Motor	<u>350</u>	
		350
MORRIS-LLOYD MINE:		
Centrifugal Pump motor (from McClure Plant)	50	
Top Tram	<u>40</u>	
		90
PRINCETON MINE:		
Underground Pump	<u>150</u>	
		150
	fwd.	<u>3,485 1/2</u> HP.

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Electrical Department (Cont'd)

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

	INSTALLED TO JAN. 1, <u>1929</u>	INSTALLED TAKEN OUT <u>IN 1929</u>	INSTALLED TAKEN OUT <u>IN 1929</u>	JAN. 1, 1930 <u>TOTALS</u>
AU TRAIN WATER POWER PLANT:				
Exciters (2)	<u>34</u> KW.			34 KW.
CARP RIVER WATER POWER PLANT:				
Exciters (2)	<u>150</u>			150
HOIST PLANT:				
Exciter	17½			
"	<u>37</u>			54½
McCLURE PLANT:				
Exciters (2)	110			
M.G. Exciter	<u>12</u>			122
MAAS PLANT:				
Motor Driven Exciter	22½			
Turbo " "	22½			
Compressor Motor Exciters (2)	<u>20</u>			65
ESCANABA PLANT:				
Exciter		<u>28</u>		28
PRINCETON CENTRAL POWER PLANT:				
Motor Driven Exciter	22½			
Turbo " "	22½			
Compressor Motor Exciter (to Tilden Mine)	<u>12</u>		12	45
REPUBLIC MINE:				
Exciter in #5 Engine House	7½			
" " Water Power Plant	<u>17</u>			24½
REPUBLIC PLANT:				
Exciter		18		
"		<u>15</u>		33
CLIFFS SHAFT MINE:				
Compressor Motor Exciters (2)	<u>20</u>			20
BROWNSTONE SUBSTATION:				
Battery Charging Set	2			
Line Testing Set	1/2			
Voltage Regulator Control	1/2			
Condenser Exciter	<u>15</u>			18
HOLMES MINE:				
Compressor Motor Exciter	<u>10</u>			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	<u>10</u>			735½
fwd.	<u>1,290½</u> KW	<u>61</u>	<u>12</u>	<u>1,339½</u> KW.

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Electrical Department (Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1, <u>1929</u>	INSTALLED <u>IN 1929</u>	TAKEN OUT <u>IN 1929</u>	JAN. 1, 1930 <u>TOTALS</u>
		1,290 $\frac{1}{2}$ KW.	61 KW.	12 KW.	1,339 $\frac{3}{4}$ KW.
MAAS CRUSHING PLANT:					
Pan Conveyor Generator		35			
" " " Exciter		<u>1$\frac{3}{4}$</u>			36 $\frac{3}{4}$
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		<u>1/2</u>			623 $\frac{1}{2}$
MORRIS MINE:					
Ingersoll-Rand Compressor Motor Exciter		12			
Nordberg " " "		10			
Ingersoll-Rand " " "		<u>10</u>			32
MACKINAW MINE:					
Compressor Motor Exciter		<u>10</u>			10
TILDEN MINE:					
Thrust Generator on Electric Shovel #29		15			
Hoist " " " " "		75			
Swing " " " " "		15			
Exciter " " " " "		5 $\frac{1}{2}$			
" " " " #31			5 $\frac{1}{2}$		
Thrust " " " " "			15		
Hoist " " " " "			75		
Swing " " " " "			<u>16</u>		
		<u>2,103$\frac{1}{2}$ KW.</u>	172 $\frac{1}{2}$	12	2,263 $\frac{3}{4}$ KW.

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Underground Haulage Generators:

	INSTALLED TO JAN. 1 1929	INSTALLED IN 1929	TAKEN OUT IN 1929	JAN. 1, 1930 TOTALS
CLIFFS SHAFT MINE:				
Motor-Generator Set #1 (scrapped)	100 KW.		100 KW.	
" " " #2	100			
" " Charging Set	5			
" " " "	20		20	
" " Set #1		<u>100</u>		
				205 KW.
HOLMES MINE:				
Rotary Converter	<u>100</u>			100
ATHENS MINE:				
Rotary Converter	<u>100</u>			100
MAAS MINE:				
Motor-Generator Set	<u>100</u>			100
NEGAUNEE MINE:				
Motor-Generator Set #1	100			
" " " #2	<u>150</u>			250
BARNES-HECKER MINE:				
Rotary Converter (to Spies-Virgil)	100		<u>100</u>	0
MORRIS-LLOYD MINE:				
Motor-Generator Set #1	100			
" " " #2	<u>100</u>			200
MACKINAW MINE:				
Rotary Converter	<u>100</u>			100
RENEGADE MINE:				
Battery Charging Set for				
TOTAL	1,175 KW	100 KW.	220 KW.	1,055 KW.

Direct Current Motors:

AU TRAIN WATER POWER PLANT:				
Governor Control Motors (2)	<u>1/4</u> HP.			1/4 HP.
CARP RIVER WATER POWER PLANT:				
Rheostat Control (2)	1/4			
Governor " (2)	<u>1/4</u>			1/2
McCLURE PLANT:				
Valve Control (2)	2			
Rheostat Control (2)	<u>1/2</u>			2 1/2
CLIFFS SHAFT MINE:				
Portable Hoist	10			
Car Fuller	6 1/2			
Scraper (taken out)	15		15	
5 Scrapers		<u>75</u>		
fwd.	<u>34 3/4</u>	<u>75</u>	<u>15</u>	<u>91 1/2</u> 94 3/4 KW.

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		INSTALLED		TAKEN OUT		JAN. 1, 1930	
		TO JAN. 1,	INSTALLED	IN 1929	IN 1929	TOTALS	
		1929	IN 1929	IN 1929	IN 1929		
	brt. fwd.	<u>34$\frac{3}{4}$ HP.</u>	75 HP.	15 HP.	<u>94$\frac{3}{4}$ HP.</u>		
HOLMES MINE:							
	Sturtevant Fan	1 $\frac{1}{2}$					
	Scrapers - 7 - 15 HP. motors	<u>105</u>					106 $\frac{1}{2}$
TILDEN MINE:							
	Hoist motor on Electrical Shovel #29	100					
	Swing " " " " "	20					
	Thrust " " " " "	20					
	Swing " " " " #31		20				
	Thrust " " " " "		20				
	Hoist " " " " "		<u>100</u>				280
ATHENS MINE:							
	Skip Hoist	900					
	Ventilating Fans - 5 - 5 HP.	5	20				
	Sullivan Scrapers - 2 - 6 $\frac{1}{2}$ HP.	13					
	" " - 6 - 15 HP.		90				
	Ventilating Fans - 2 - 13 HP.		<u>30</u>				1,058
MAAS MINE:							
	Timber Hoist -.2nd level	10					
	" " - 4th "	10					
	Bilge Pump	5					
	Ventilating Fan (to Athens)	15		15			
	Sullivan Scrapers 8 - 15 HP.	15	105				
	" " 7 - 6 $\frac{1}{2}$ HP.	45 $\frac{1}{2}$					
	Denver " 2 - 7 $\frac{1}{2}$ HP.	7 $\frac{1}{2}$		7 $\frac{1}{2}$			
	Scraper Slide		15				
	Ventilating Fan		5				
	Scraper		<u>25</u>				250 $\frac{1}{2}$
MAAS CRUSHING PLANT:							
	Fan Conveyor	<u>40</u>					40
NEGAUNEE MINE:							
	Skip Hoist	500					
	Cage "	200					
	Timber Hoist - tunnel	10					
	" " - 10th level	10					
	Ventilating Fan	7 $\frac{1}{2}$					
	Scrapers 10 - 7 $\frac{1}{2}$ HP.	75					
	Sullivan Scrapers 10 - 6 $\frac{1}{2}$ HP.	65					
	" " 2 - 25 HP. (1 to Maas)	75		25			
	Ventilating Fan	5					
	Denver Scrapers 3 - 10 HP.	30					
	Sullivan " 7 - 15 HP.		<u>105</u>				1,057 $\frac{1}{2}$
MORRIS MINE:							
	Ventilating Fan, 6th level	15					
	Sullivan Scrapers 7 - 6 $\frac{1}{2}$ HP.	45 $\frac{1}{2}$					
	Denver Rock Drill Scrapers - 7 - 7 $\frac{1}{2}$ HP.	52 $\frac{1}{2}$					
	Sullivan Scrapers 2 - 10 HP.	20					
	" " (corrected) 5 - 7 $\frac{1}{2}$ HP.	19 $\frac{1}{2}$		18			
	" " - 6 15 HP.			90			
	Scraper Slide		<u>15</u>				275 $\frac{1}{2}$
<u>TOTAL</u>		<u>2,477$\frac{1}{2}$ HP.</u>	<u>740$\frac{1}{2}$</u>	<u>55</u>	<u>3,162$\frac{3}{4}$ HP.</u>		

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Electrical Department (Cont'd)

Spare Generators and Exciters on hand December 31st, 1929:

GENERAL STOREHOUSE:			
Old Hoist Exciter		<u>22 KW.</u>	22 KW.
NEGAUNEE MINE:			
Bkip Hoist	(armature only)	500 HP.	
TILDEN MINE:			
Exciter from Synchronous Motor		<u>15</u>	
			<u>15</u>
	<u>TOTAL</u>		<u>37 K.W.</u>

Spare Underground Haulage Generators on hand December 31st, 1929:

GENERAL STOREHOUSE:			
Motor-Generator Set	(from Morris)	100	
Rotary Converter	(" Francis)	<u>100</u>	
	<u>TOTAL</u>		200 K.W.

Spare Direct Current Motors on hand December 31st, 1929:

ATHENS MINE:			
Timber Hoist Motor		10	
Fan		<u>15</u>	25 HP.
MORRIS-LLOYD MINE:			
Crane Motor		10	
Timber Hoist	(new)	7 $\frac{1}{2}$	
Scraper Slide	"	<u>15</u>	32 $\frac{1}{2}$
GENERAL STOREHOUSE:			
Pump Motor		20	
Scraper Motor from Gwinm Distrct		20	
Spare Hoist Motor for Shovel		105	
" Swing " " "		<u>20</u>	165
HOLMES MINE:			
Fan Motors	2 - 1 $\frac{1}{2}$ Hp.	<u>3</u>	
			<u>3</u>
	<u>TOTAL</u>		225 $\frac{1}{2}$ HP.

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Electrical Department (Cont'd)

MESABA RANGE:

Exciters and Generators installed up to December 31st, 1929:

BOHING MINE:
Compressor Motor Exciter 6 K.W.

Underground Haulage Generators installed up to Dec. 31st, 1929:

BOHING MINE:
Motor-Generator Set 115 KW.

HILL-TRUMBULL MINE:
Motor-Generator Set 55

WADE MINE:
Rotary Converter 100

TOTAL 270 K.W.

Direct Current Motors installed up to December 31st, 1929:

HILL-TRUMBULL MINE:
Feeder Motor 60 HP.

HOLMAN-CLIFFS MINE:
Pan Conveyor 40
Log Washers - 3 - 40 HP. 120
160

Total Exciters and Generators installed to December 31st, 1929 - 6 K.W.

" Underground Haulage Generators " " " " " - 270 K.W.

" Direct Current Motors " " " " " - 220 H.P.

SPIES-VIRGIL MINE:

Exciters installed to December 31st, 1929:

Compressor Motor Exciter 10 K.W.

Underground Haulage Generators installed up to December 31st, 1929 - 150 K.W.

Top Tram Larry Cars 2 - 20 HP. 40 H.P.

ISHPEMING DISTRICT:

Total D.C. Generators and Exciters installed to Dec. 31st, 1929 - 2,265 $\frac{3}{4}$ K.W.

" Underground Haulage Generators " " " " " - 1,055 K.W.

" Direct Current Motors " " " " " - 3,162 $\frac{3}{4}$ H.P.

Total Spare D.C. Generators and Exciters on hand " " " - 37 K.W.

" " Underground Haulage Generators " " " " " - 200 K.W.

" " Direct Current Motors " " " " " - 225 $\frac{1}{2}$ H.P.

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Electrical Department (Cont'd)

Substation Transformers installed up to December 31st, 1929:

<u>33000/2300 Volts</u>	<u>Phase</u>	<u>No.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>	
Brownstone Substation	1	3	400	1,200	
Cliffs Shaft-Holmes Substation	1	6	500	3,000	
Morris-Lloyd Substation	1	3	590	1,770	
Princeton "	1	3	250	750	
Republic "	1	3	400	1,200	
Maas "	1	6	590	3,540	
Escanaba Plant "	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 "	1	3	1,900	5,700	
Au Train "	3	1	1,250	1,250	
Palmer Substation	1	3	625	1,875	
Hoist Plant	1	3	667	2,000	
			<u>TOTAL</u>		36,530 K.V.A.
Chatham Substation	1	2	15	30	
Carlshend "	1	1	15	15	
Little Lake "	1	1	15	15	60 "
<u>30000/6600 Volts</u>					
Champion Substation	1	2	25	50	
Eben "	1	1	25	25	75 "
<u>6600/2300 Volts</u>					
Carp Plant	1	6	185	1,110	
Gwinn Substation	1	3	350	1,050	
Mackinaw "	1	3	350	1,050	3,210 K.V.A.

Transformers used for Underground Haulage installed to 12/31/29:

Athens Mine converter	1	3	35	105	
Holmes " "	3	1	100	100	
Mackinaw " "	1	3	35	105	
					310 K.V.A.

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Electrical Department (Cont'd)

Distribution Transformers installed up to December 31, 1929:

<u>2300/220/110 Volts</u>	<u>PHASE</u>	<u>NO.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>
ANGELINE MINE:				
Hoist Control	1	1	<u>7½</u>	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	
Gravel Scraper	1	2 (37)	75	
Underground Scrapers	1	4 (50)	200	
" " "	1	3 (25)	75	
Motor-Generator Set for Battery Charging and 1st Level A Scrapers	1	3 (15)	45	
Rectifiers	1	7 (5)	35	
Lights	1	11 (1½)	16½	
Scraper Lights	1	1	2	
" " "	1	1	<u>3</u>	547
HARD ORE, BROWNSTONE, ETC.				
Light & Power	1	1	15	
Light	1	1	¾	
Light & Power	1	1	7½	
Shop	1	1	30	
Manager's Residence	1	2 (10)	<u>20</u>	73½
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	¾	
Skip " "	1	1	½	
Shaft House Lights	1	1	¾	
Pump " "	1	1	¾	
Change " "	1	1	¾	
Shaft " "	1	1	½	
Engine " "	1	1	7½	
5th level Pumps	1	3 (15)	<u>45</u>	113½
LAKE MINE:				
Engine House Lights	1	1	5	
Shaft Lights	1	1	<u>¾</u>	5¾
			fwd.	747

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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	brt. fwd.	<u>PHASE</u>	<u>NO.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>
					747
TILDEN MINE:					
Pump		1	2 (10)	20	
Lights & Power		1	1	10	
" " "		1	2 (5)	10	
" " "		1	2	2	
Drills		1	3 (10)	30	
Shovel		1	3 (5)	15	
Crusher		1	3 (10)	30	
Synchronous Condenser		1	2 (7½)	15	
Drills		1	2 (20)	40	
					172
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	
" " 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 " "		1	1	2	
" " "		1	1	3	
Rock Tram "		1	1	1	
Heaters in Engine House		1	1	7½	
Top Tram		1	1	2	
4th level Pump		1	3 (5)	15	
					102
MAAS CRUSHING PLANT:					
Lights		1	1	7½	
					7½
NEGAUNEE MINE:					
Shop Light & Power		1	2 (10)	20	
Engine House Lights & Power		1	1	10	
" " " " "		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	
Hoist & Lights - #2 Shaft		1	3 (10)	30	
Engine House Lights & Power		1	2 (15)	30	
					145½
SOUTH JACKSON CRUSHING PLANT:					
Hoist Brake		1	1	5	
Lights		1	1	2	
					7
			fwd.		1,291

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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	brt.	fwd.	PHASE	NO.	K.V.A.	TOTAL K.V.A.
						1,291
BARNES-HECKER MINE:						
Engine House Lights			I	1	5	
" " "			1	1	<u>7½</u>	
						12½
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	<u>5</u>	
						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	<u>5</u>	
						65
SECTION 6 SHAFT:						
Hoist Control			1	1	7½	
Lights			1	2 (2)	<u>4</u>	
						11½
REPUBLIC MINE:						
G.E. Tram			1	1	15	
Lighting			1	2 (2)	4	
Engine House Lights			1	1	7½	
Hoist Control			1	1	25	
Top Tram Controls			1	2 (1)	2	
Office Lights			1	1	3	
Water Power Plant Lights			1	1	<u>1½</u>	
						58
AUSTIN MINE:						
Shop			1	1	<u>10</u>	
						10
GARDNER MINE:						
Cage Hoist Control			1	1	10	
Top Tram			1	1	1	
Power & Lights			1	2 (10)	<u>20</u>	
						31
MACKINAW MINE:						
Machine Shop			1	2 (5)	10	
Hoist Control			1	1	10	
Top Tram			1	1	<u>1</u>	
						21
PRINCETON MINE #2:						
Top Tram Lights			1	1	3	
Stockpile			1	2 (10)	<u>20</u>	
						23
PRINCETON MINE #3:						
Lighting & Bell System			1	1	<u>1½</u>	
						1½
					fwd.	<u>1,551½</u>

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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	brt. fwd.	<u>PHASE</u>	<u>NO.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>
PRINCETON CENTRAL POWER PLANT:					
Coal Crusher		1	3 (7½)	22½	
Power Plant Lights		1	1	<u>10</u>	32½
PRINCETON CENTRAL SHOPS:					
Power & Light		1	2 (10)	<u>20</u>	20
PRINCETON DISTRICT LABORATORY:					
Hot Plates		1	1	<u>10</u>	10
PRINCETON PUMP STATION:					
Power		1	2 (15)	30	
Lights		1	1	<u>5</u>	35
GWINN DISTRICT CRUSHER:					
Power & Lights		1	2 (10)	<u>20</u>	20
AUSTIN BARN:					
Lights		1	1	<u>3</u>	3
GWINN SUBSTATION:					
Lights		1	1	<u>1</u>	1
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	
Lights, Forest Lake Location		1	1	<u>10</u>	35
GARP RIVER WATER POWER PLANT:					
Power & Light		1	1	10	
" " "		1	1	20	
Ramp		1	2 (1)	<u>2</u>	32
HOIST PLANT:					
Power & Light		1	1	7½	
" " "		1	2 (5)	<u>10</u>	17½
McCLURE PLANT:					
Power & Light		1	2 (10)	<u>20</u>	20
ESCANABA RIVER PLANT:					
Power & Light		1	3 (5)	<u>15</u>	15
GRAND TOTAL					<u>1,792½</u>

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Electrical Department (Cont'd)

Distribution Transformers:

	<u>PHASE</u>	<u>NO.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>
THE CLIFFS ELECTRIC COMPANY:				
Austin Location lighting	1	1		10
Gwinn Street Lights	1	2 (1)		2
" " "	1	1		2
" Lighting - near Depot	1	1		1/2
" " - Poplar Alley	1	1		30
" Power - Club House	1	2 (5)		10
" Lighting - " "	1	1		10
" " - Mineral St.	1	1		10
" " - Pine St.	1	1		30
" Power - School	1	3 (5)		15
" Lighting - "	1	1		10
Cyr Location Lighting	1	1		2
Princeton Upper Location Lighting	1	1		10
" Lower " "	1	1		5
New Swanzy " "	1	1		10
Little Lake " "	1	1		5
" " " "	1	1		7 1/2
Chatham Lighting & Power	1	2 (7 1/2)		15
" " "	1	1		10
" " "	1	1		5
" " "	1	1		1
	<u>TOTAL</u>			200

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Spare Transformers on hand December 31st, 1929:

	<u>PHASE</u>	<u>NO.</u>	<u>K.V.A.</u>	<u>TOTAL K.V.A.</u>
ANGELINE MINE:				
General Electric	1	1	<u>1</u>	1
ATHENS MINE:				
Spare	1	1	3	
Spare	1	1	3	
Spare	1	1	<u>7½</u>	13½
REPUBLIC MINE:				
General Electric	1	1 (10)	10	
" "	1	1	4	
Lights & Pump	1	1	<u>10</u>	24
GENERAL STOREHOUSE:				
General Electric for 440 shaft pump	1	1	100	
From Francis Mine converter	1	2 (35)	70	
General Electric	1	1	10	
" "	1	1	7½	
" "	1	1	5	
" " from Republic	1	1	20	
" " " "	1	3 (3)	9	
" " " "	1	1	15	
" " " "	1	2 (7½)	15	
" " " "	1	1	<u>10</u>	261½
GWINN SUBSTATION:				
Spare	1	1	<u>10</u>	10
ESCANABA RIVER PLANT:				
Spare	1	1	<u>10</u>	10
PRINCETON MINE ENGINE HOUSE:				
Surface Lighting	1	1	<u>5</u>	5
PRINCETON CENTRAL POWER PLANT:				
From Injection Pump	1	2 (15)	30	
Spare	1	1	<u>10</u>	30
GWINN STORAGE SHED:				
Princeton Pump House Lights	1	1	2½	
Spare	1	1	2½	
"	1	1	5	
"	1	1	<u>2</u>	10
<u>TOTAL</u>				365 K.V.A.

MECHANICAL DEPARTMENT
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COMPARATIVE TABLES.

<u>YEAR</u>	<u>TONS COAL BURNED</u>	<u>TONS ORE & ROCK HOISTED</u>	<u>CU. FT. AIR USED</u>	<u>CUBIC FT. AIR PER TON HOISTED</u>	<u>GALLONS OF WATER PUMPED</u>
<u>CLIFFS SHAFT MINE</u>					
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
1928	1 008	416 344	804 600 000	1 932	463 182 750
1929	934	451 334	853 572 500	1 891	461 403 025
<u>HOLMES MINE</u>					
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
1928	716	207 754	484 785 000	2 333	82 552 319
1929	712	209 519	348 795 000	1 664	108 313 916
<u>ATHENS MINE</u>					
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
1928	827	241 977	710 640 000	2 936	120 178 303
1929	767	344 534	1 154 380 000	3 350	117 645 969
<u>MAAS MINE</u>					
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
1928	657	272 740	679 005 000	2 489	553 419 346
1929	577	347 232	1 067 265 000	3 074	554 452 221

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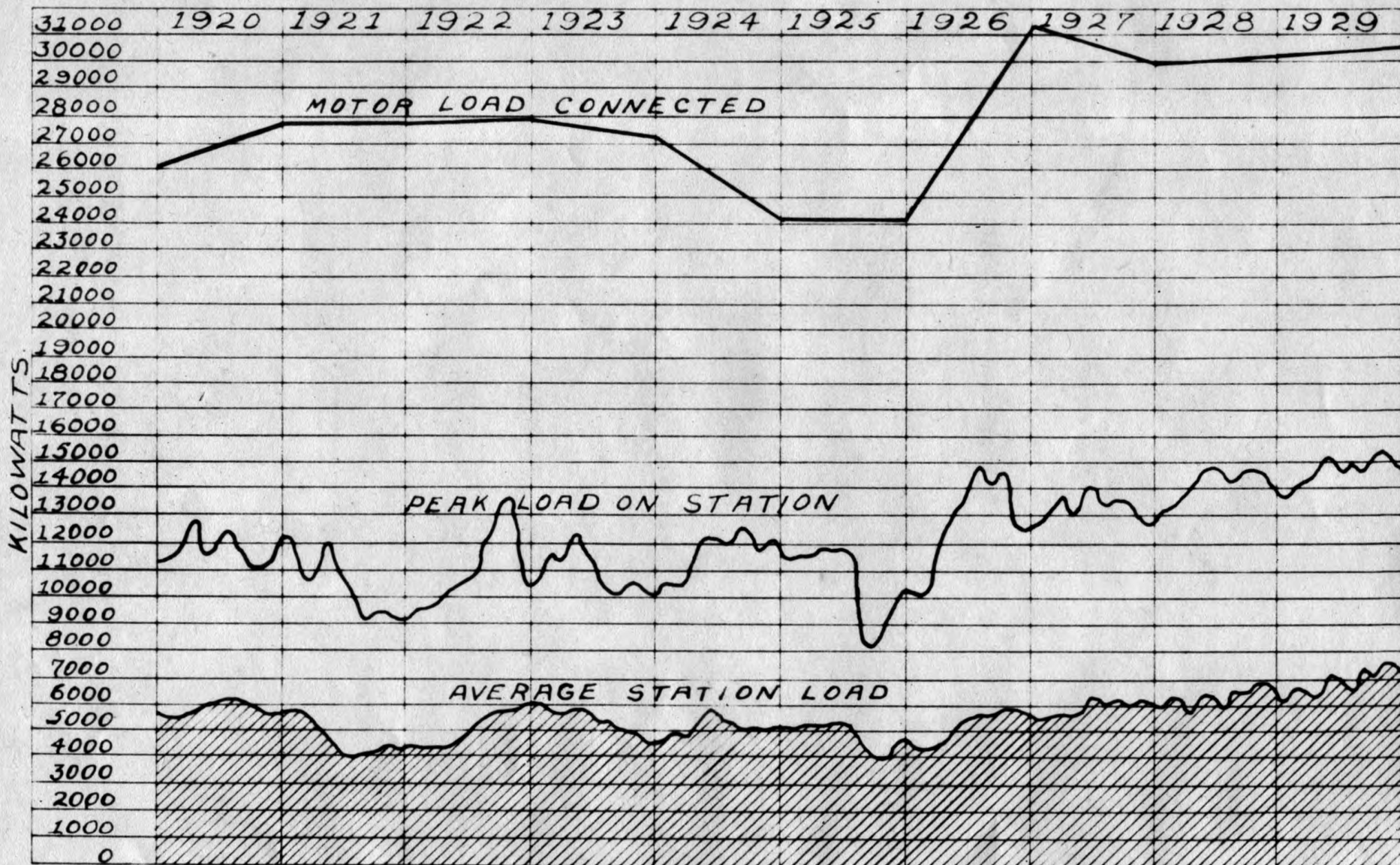
COMPARATIVE TABLES:

<u>YEAR</u>	<u>TONS COAL BURNED</u>	<u>TONS ORE & ROCK HOISTED</u>	<u>CU. FT. AIR USED</u>	<u>CUBIC FT. AIR PER TON HOISTED</u>	<u>GALLONS OF WATER PUMPED</u>
<u>NEGAUNEE MINE</u>					
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	1,392	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
1928	1,278	472,458	1,047,240,000	2,216	629,675,383
1929	1,410	569,489	1,123,840,000	1,973	648,591,436
<u>TILDEN MINE</u>					
1929	625	441,769	— — —	— — —	— — —
<u>MORRIS-LLOYD MINE.</u>					
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
1928	1,295	364,123	693,360,000	1,904	227,752,992
1929	1,243	456,119	947,560,000	2,077	236,012,174
<u>HILL-TRUMBULL MINE</u>					
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	— — —	— — —	— — —
1928		495,748	— — —	— — —	— — —
1929		521,845	— — —	— — —	— — —
<u>SPIES - VIRGIL MINE.</u>					
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	— — —	— — —	— — —
1928	366	184,141	— — —	— — —	— — —
1929	292	168,953	— — —	— — —	— — —

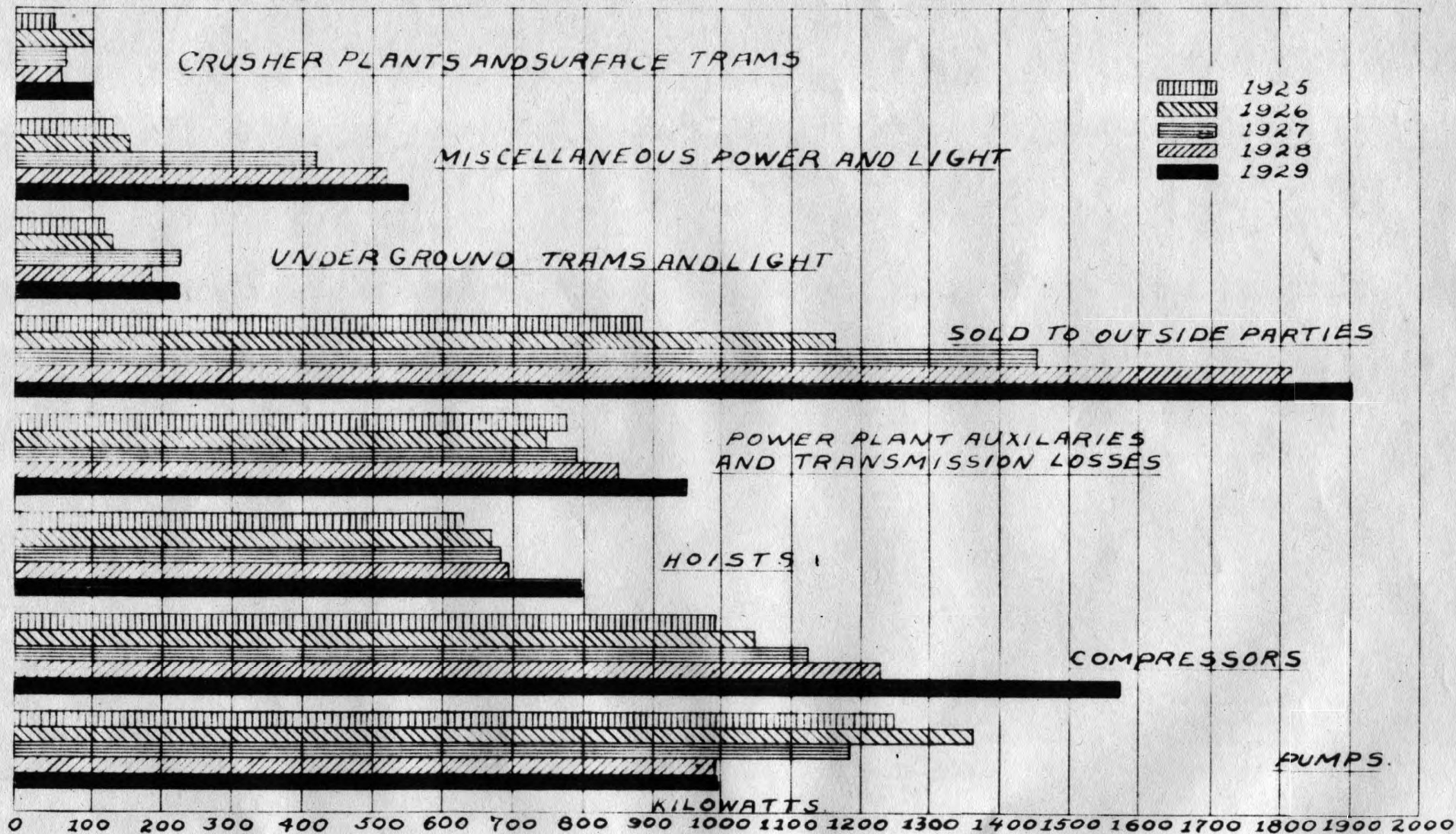
MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1929

COMPARATIVE TABLES:

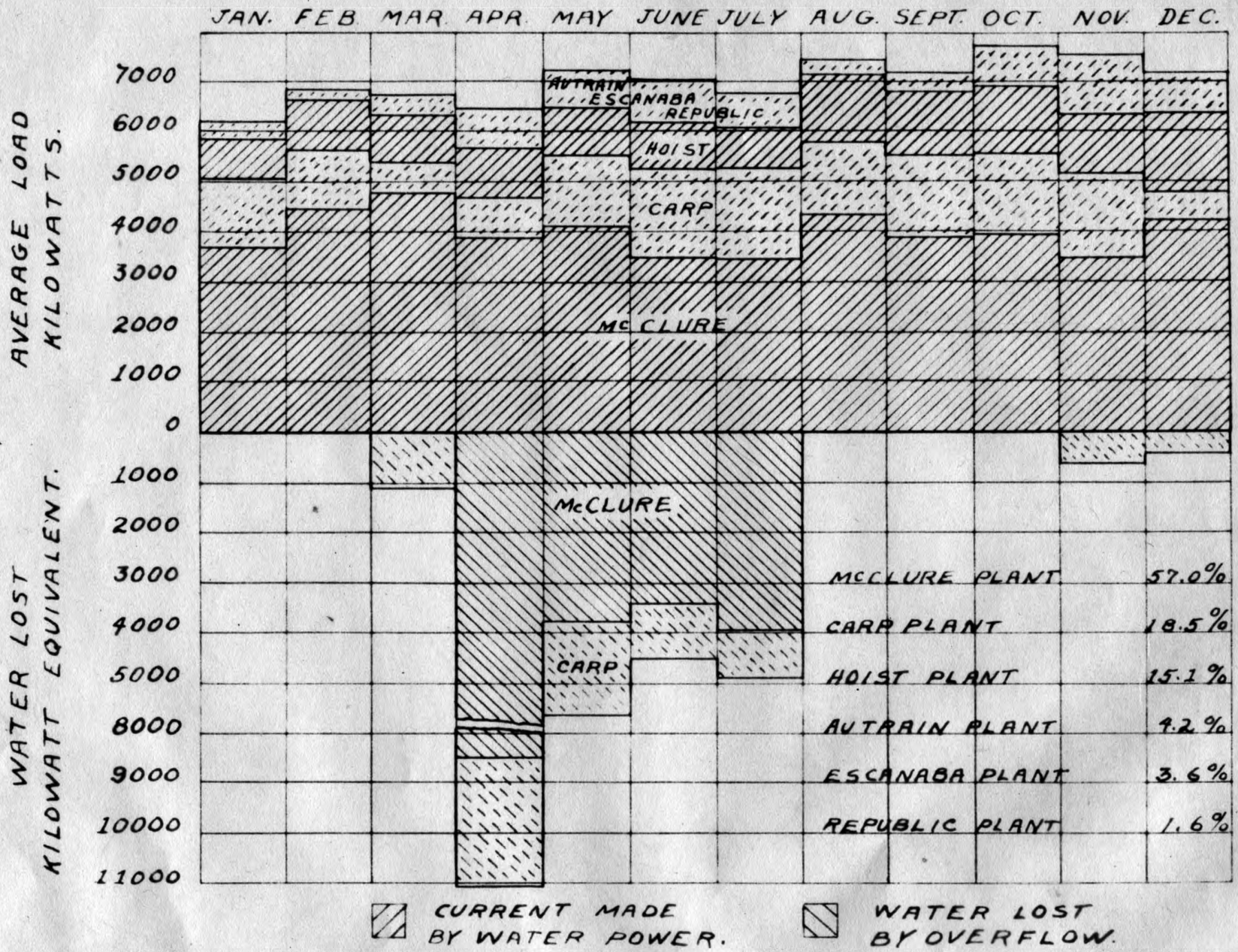
<u>YEAR</u>	<u>TONS COAL BURNED</u>	<u>TONS ORE & ROCK HOISTED</u>	<u>CU. FT. AIR USED</u>	<u>CUBIC FT. AIR PER TON HOISTED</u>	<u>GALLONS WATER PUMPED</u>
<u>GARDNER - MACKINAW MINE:</u>					
1928	336	91,293	214,020,000	2,344	52,760,063
1929	531	119 189	570 635 000	4 703	56 528 157
<u>WADE MINE:</u>					
1929		162,595	-----	-----	-----



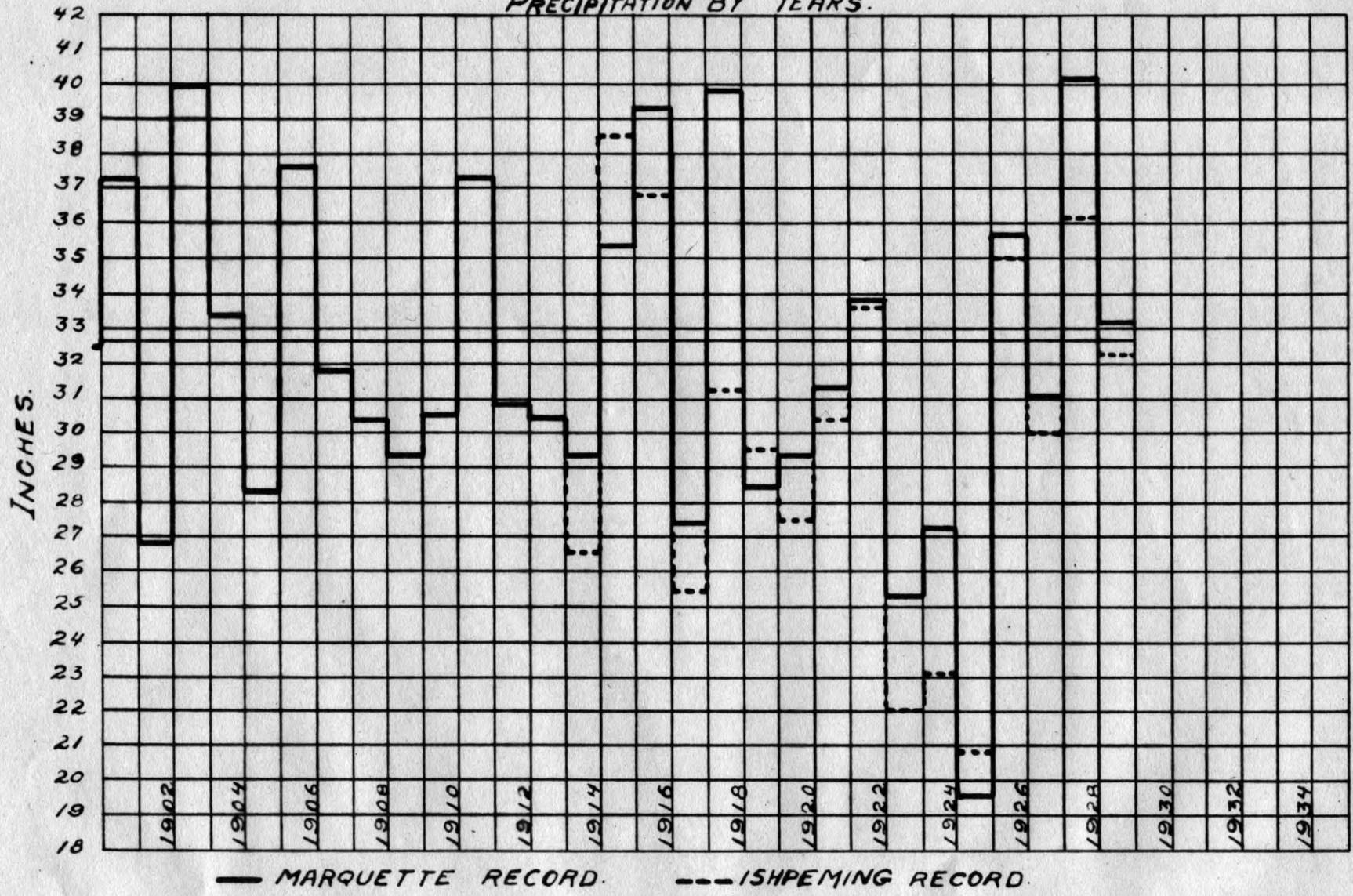
DISTRIBUTION OF ELECTRIC POWER 1925-1926-1927-1928-1929.



1929.

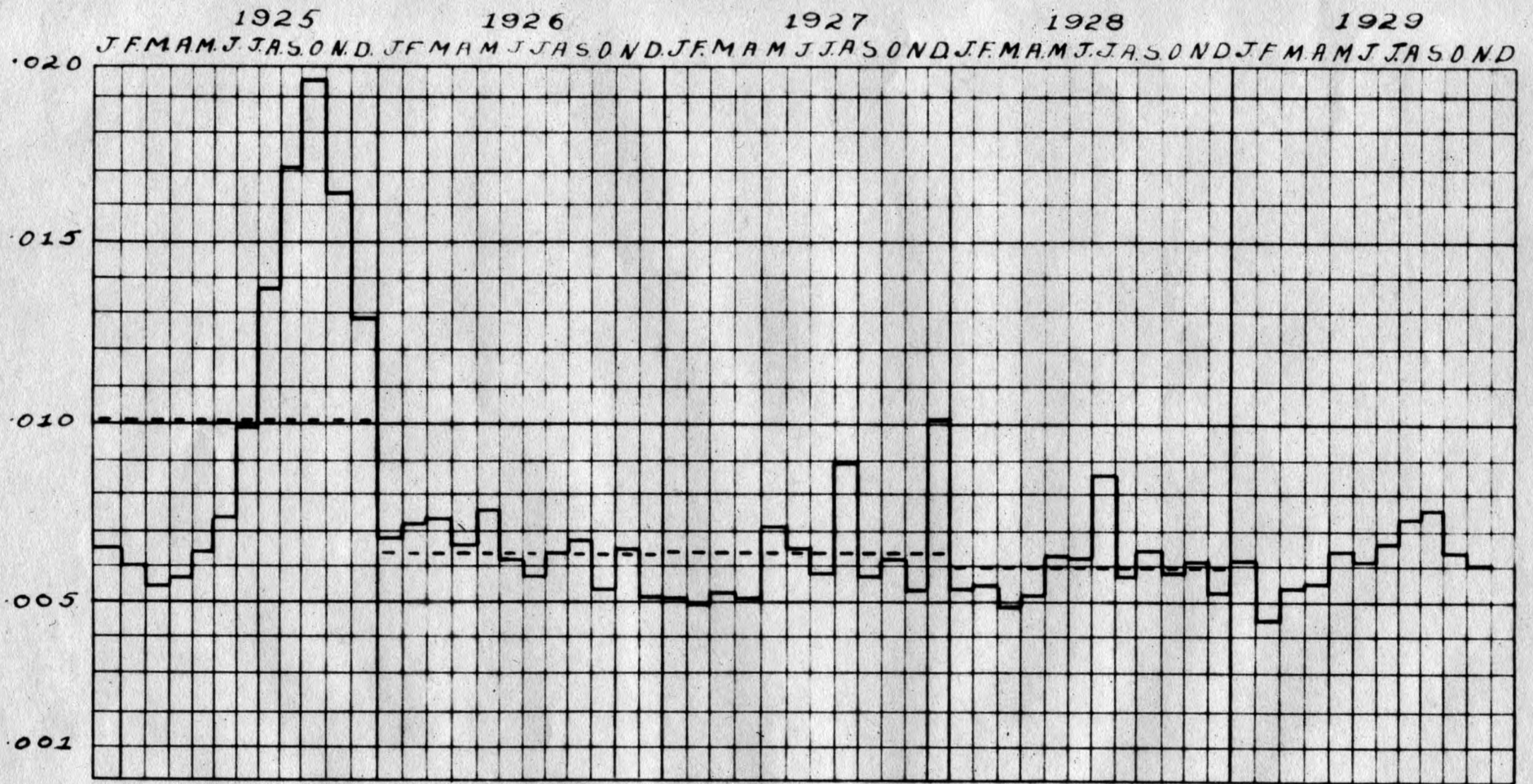


PRECIPITATION BY YEARS.



— MARQUETTE RECORD. - - - ISHPEMING RECORD.

COST DIAGRAM.



21. ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING
DECEMBER 31, 1929.

Ishpeming, Michigan,

January 8, 1930.

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 1929.

The Cleveland-Cliffs Iron Company,
Ishpeming and Iron River Districts.

The Cleveland-Cliffs Iron Company,
North Lake District.

The Cleveland-Cliffs Iron Company,
Mesaba District.

The Cleveland-Cliffs Iron Company,
Negaunee and Gwinn Districts.

These books contain the maps of the Company's mines; two sets of them have been prepared, one for the Cleveland office and the other to be kept in the Engineering office at Ishpeming.

Special books have been prepared for others 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	Mesaba District,	M. H. Barber, Superintendent.
2	Hill-Trumbull, Wade and North Star,	Arthur Iron Mining Company.
5	Hill-Trumbull Mine,	Partners - Mesaba-Cliffs Iron Mining Company.
5	Holman-Cliffs Mine,	Partners - Holman-Cliffs Mining Company.
5	Canisteco Mine,	Partners - Canisteco-Cliffs Iron Mining Co.
1	Negaunee and Gwinn Districts,	W. W. Graff, Superintendent.
1.	North Lake District,	C. J. Stakel, Superintendent.
1	Cliffs Shaft and Holmes Mines,	C. J. Stakel, Superintendent.
1	Spies-Virgil and Tilden Mines,	W. R. Meyers, Superintendent.

LOOSE LEAVES.

Hill-Trumbull, Holman-Cliffs and Canisteco Mines, H. C. Bolthouse, Supt.

B. Maps of the Athens Mine have been sent to the Cleveland office for Pickands, Mather & Company each month. No maps of that part of the Athens Mine known as the Corbit lease were sent out as there was no mining done in this area. The fee owners of the Mitchell lease demanded no maps and none were sent.

For the fee owners of the Negaunee Mine, fourteen sets of the 10th, 11th and 12th levels were sent to the Cleveland office.

Maps of the Roman Catholic Cemetery property at negaunee were sent each month to R. S. Archibald, Engineer in Charge.

The Lessors of the Virgil Mine have been furnished maps in accordance with the terms of the lease.

Maps of the Mackinaw Mine were sent to the Lessors each month beginning October 1, 1929.

S. R. Meyers.

Chief Mining Engineer.

C. REMARKS ON THE ABSTRACTS AND VARIOUS SUBJECTS FOR THE YEAR 1929.

Documents have been entered on the records and copies made where necessary.

MISCELLANEOUS DOCUMENTS ENTERED ON ENGINEERING RECORDS.

The following is a list of the documents received during the year:

	NO. RECEIVED.	LAST FILE NO.
Land Offers, - - -	64	1794
Deeds and Miscellaneous,	30	1084
Easements, - - -	12	164
Rights of Way, - - -	4	211
Water Rights, - - -	1	53
Surface Leases, - -	188	3016
Applications for Sale, -	3	107
Sales, - - - -	16	475
Tax Histories, - - -	0	558
Legal Opinions, - -	0	191

LAND OFFERS.

Most of these were mineral land offers.

DEEDS AND MISCELLANEOUS DOCUMENTS.

These were for Cliffs Power & Light Company and miscellaneous.

RIGHTS OF WAY.

These were for public highways and one to Butler Brothers for railroad right of way.

WATER RIGHT.

This is an easement for a water pipe line.

SURFACE LEASE.

These are principally farm and lot leases.

SALES.

The majority of these were for farms.

ABSTRACT OF TITLE.

There were no new abstracts added during the year. Considerable work was done on the Maas-Negaunee and Hydro Electric abstracts.

MICHIGAN STATE TAX COMMISSION.

Maps and estimates of the various mines were sent to the Tax Commission, as usual.

TAXES.

A revised tax list was prepared and copies sent to the Land Department and the Tax Department. The delinquent tax lists for Marquette, Alger and Iron Counties were checked throughout to be sure there were no mineral or water power lands offered for sale for taxes in these counties.

D. THE FORCE.

The force remains the same as last year.

E. W. Jones was employed during July and August as an engineer's helper.

H. R. Eberle, a Mining Engineer, was employed, together with three helpers and shoppers, for one month in connection with E. & A. No.9 (transmission line surveys). These men are all carried on the Cliffs Power & Light Company pay roll.

The following table shows the personnel of the Department during the year in the order of entrance:

NAME.	POSITION.	PERIOD EMPLOYED.
R. J. Chenneour,	Asst. Chief Engineer,	Entire year.
H. O. Moulton,	Engineer,	" "
J. Trosvig,	"	"m "
T. A. Miller,	"	" "
S. Malmgren,	Helper,	" "
K. C. Pellow,	Engineer,	" "
A. Minnear,	Engineer and Helper,	" "
C. W. Allen,	Engineer,	" "
E. Decaire, Jr.	Helper,	" "

The following table shows the days worked, days sickness, percentage of days worked, etc, for all men in the Department. The vacation column is net, after deducting over time, such as Sundays and holidays worked:

NAME.	DAYS WORKED.	DAYS VACATION.	DAYS SICK.	TOTAL DAYS.	PERCENTAGE DAYS WORKED.
R. J. Chenneour,	274	8	0	266	97
H. O. Moulton,	274	13	0	261	95
T. A. Miller,	274	8	10	256	93
K. C. Pellow,	244½	7½	1	236	97
J. Trosvig,	274	11	0	263	96
C. W. Allen,	274	4½	0	269½	98
A. Minnear,	274	0	0	275½	101
S. Malmgren,	274	0	1	273	100
E. Decaire, Jr.	266½	0	0	270½	102

The following table shows the number of days lost because of vacation and sickness for the last five years by the men in the Department:

NAME.	1925.		1926.		1927.		1928.		1929.	
	VACATION.	SICK.	VACATION.	SICK.	VACATION.	SICK.	VACATION.	SICK.	VACATION.	SICK.
R.J.Chenneour,	6	0	7	3½	8	0	4	0	8	0
H.O.Moulton,	6½	2	8½	2	8½	0	10½	½	13	0
T. A. Miller,	9	3	9½	4½	9½	0	9½	0	8	10
K. C. Pellow,	0	6	5	4	5	5	9	3½	7½	1
J. Trosvig,	11½	0	0	1	7	5	4	5½	11	0
C. W. Allen,	0	0	½	½	4½	0	14	0	4½	0
A. Minnear,	8	1½	0	0	0	21	0	32½	0	0
S.Malmgren,	0	4	0	7½	0	0	0	2½	0	1
E.Decaire, Jr.,			0	0	0	0	0	0	0	0

n The following table gives the names of the men in the Department, the date of their employment and the years of service:

NAME.	EMPLOYED.	YEARS OF SERVICE.
R.J.Chenneour,	January 1903,	27
H. O. Moulton,	April 1910,	19 3/4
J. Trosvig,	June 1911,	18¼ - left employ 3 months
T. A. Miller,	January 1916,	14
S. Malmgren,	May 1916,	12½ - laid off one year
A. Minnear,	June 1917,	11½ - laid off one year
K. C. Pellow,	January 1918,	12
C. W. Allen,	June 1925,	4½
E. Decaire, Jr.,	October 1926,	3¼

THE WORK PERFORMED BY EACH MAN IN THE DEPARTMENT IS DESCRIBED BRIEFLY AS FOLLOWS.

Reginald J. Chenneour, Assistant Chief Engineer, has had charge of the office during the year, supervising the office work, field and underground surveys. He was underground 8½ days and spent 56½ days in the field.

In May, he made an estimate of the Cleveland-Cliffs Iron Company's ore in stock at the Algoma Steel Corporation plant at Sault Ste. Marie, Ontario.

At the Spies-Virgil Mine, he made surveys while K. C. Pellow was away on a leave of absence.

For E. & A. No.9 (transmission line to the Inland Lime & Stone Company plant) he spent considerable time in connection with surveys for the proposed line.

In the office, he did miscellaneous abstract work, helped prepare the 1929 tax list of Mining Department lands; helped check the delinquent tax lists of Marquette, Alger and Iron Counties in so far as the lists affected the Cleveland-Cliffs Iron Company's mineral and water power lands. He also prepared maps and lists of Company tenement houses for insurance purposes. He assembled the annual report and Tax Commission maps and had them bound in books.

Below is a table showing the percentage of his time spent underground, in the field and in the office:

UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
3	21	76	100

Henry O. Moulton, Engineer, has been in charge of the engineering work at the Maas and Negaunee Mines for the entire year.

For the Negaunee Mine, he made weekly surveys and noted and posted the geology. He gave lines for the 12th level sump and gauged the skip and cage compartment runners to check the allowable clearance, made stockpile estimated and estimated the coal on hand.

In the office, in addition to the regular work, he made the Tax Commission estimate and maps and prepared the annual report maps for this mine.

For the Maas Mine, he made weekly surveys and noted and posted geology. He also gave lines for sinking the shaft to the proposed 5th level. In addition to the regular work, he made the Tax Commission estimate and maps and prepared the annual report maps.

In the latter part of April and the first part of May, he made estimates of ore in stock at the Trumbull-Cliffs and Bourne-Fuller Furnaces.

He spent 92½ days underground and 31½ days in the field.

Below is a table showing the percentage of his time spent at the Negaunee and Maas Mines and on miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Negaunee,	13	2	20	35
Maas,	23	2	30	55
Miscellaneous,	0	8	2	10
Total,	36	12	52	100

Tom A. Miller, Engineer, did the engineering work at the Cliffs Shaft and Holmes Mines for the entire year.

For the Cliffs Shaft Mine, he made regular surveys, located all diamond drill holes and assisted the geologists with their underground surveys.

On surface, he made stockpile estimates and estimated the coal on hand. He also gave lines for a new stocking trestle.

In the office, in addition to the regular work, he made the Tax Commission estimate and maps and prepared the annual report maps.

For the Holmes Mine, he made regular surveys and noted and posted geology. He also gauged the skip and cage compartment runners to check the allowable clearance.

On surface, he made stockpile and coal estimates and gave lines for a new stocking trestle.

In the office, in addition to the regular mine work, he made the Tax Commission estimate and maps and prepared the annual report maps.

He was underground $80\frac{1}{2}$ days and spent $12\frac{1}{2}$ days in the field.

Below is a table showing the percentage of time spent on Cliffs Shaft and Holmes Mine and miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Cliffs Shaft,	22	2	43	67
Holmes,	10	2	19	31
Miscellaneous,	0	1	1	2
Total,	32	5	63	100

Kenneth C. Pellow, Engineer, did the engineering work at the Mackinaw-Gardner and Spies-Virgil Mines.

For the Mackinaw-Gardner Mine, he made regular surveys and gave the necessary lines for new stopes on the 5th level.

In the office, in addition to his regular mine work, he made the Tax Commission estimate and maps and prepared the annual report maps.

For the Spies-Virgil Mine, he made regular surveys, located diamond drill holes and estimated the ore and coal in stock.

In the office, in addition to his regular mine work, he made the Tax Commission estimate and maps and prepared the annual report maps.

He assisted in making the ore estimates at the Algoma Steel Corporation plant.

He made surveys for the re-location of the transmission line in the vicinity of Gwinn.

He was underground 57 days and spent 19 days in the field.

Below is a table showing the percentage of his time spent on Mackinaw-Gardner and Spies-Virgil Mines and miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Mackinaw-Gardner,	16	0	26	42
Spies-Virgil,	8	1	34	43
Miscellaneous,	0	7	8	15
Total,	24	8	68	100

John Trosvig, Engineer, did the engineering work for the Morris-Lloyd Mine the entire year. At this mine, he made weekly surveys and assisted the geologists with their underground surveys. He gave lines for cutting the new 8th level pump room and sump.

On surface, he made stockpile and coal estimates and laid out the stocking trestle.

In the office, in addition to his regular work, he made the Tax Commission estimate and maps and prepared the annual report maps.

He was underground $87\frac{1}{2}$ days and spent 13 days in the field.

Below is a table showing the percentage of his time spent on the Morris Mine and miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Morris,	33	4	61	98
Miscellaneous,	0	1	1	2
Total,	33	5	62	100

Charles W. Allen, Engineer, did the engineering work at the Athens and Tilden Mines for the entire year.

For the Athens Mine, he made weekly surveys and noted and posted geology. He also gauged the skip and cage compartment runners to check them for allowable clearance.

On surface, he made stockpile and coal estimates.

In the office, he made the Tax Commission estimate and maps and prepared the annual report maps.

For the Tilden Mine, he made surveys for tracks and buildings, located churn drill holes and computed the powder necessary for the various blasts.

In the office, he prepared the annual report maps.

In addition to the above, about 7% of his time was spent on other work.

He was underground $55\frac{1}{2}$ days and spent 61 days in the field.

Below is a table showing the percentage of his time spent on Athens and Tilden Mines and miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Athens,	20	1	32	53
Tilden,	0	20	20	40
Miscellaneous,	0	2	5	7
Total,	20	23	57	100

Archibald Minnear, Engineer and Engineer's Helper, assisted the engineers with their underground and surface surveys and office work. About one third of his time was spent in connection with E. & A. No.504 (moving Maas houses) and E. & A. No.9 (Cliffs Power & Light Company transmission line).

He was underground $31\frac{1}{2}$ days and spent 126 days in the field.

Below is a table showing the percentage of his time spent on E. & A. No.504, E. & A. No.9 and miscellaneous work:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
E. & A. No.504,	0	21	1	22
E. & A. No. 9,	0	14	4	18
Miscellaneous, mines, 11		11	38	60
Total,	11	46	43	100

Sextus Malmgren, Helper, assisted the engineers with their underground and surface surveys, took care of steel tapes and made blue prints and prepared the annual report prints.

He was underground 94 days and spent $26\frac{1}{2}$ days in the field.

Below is a table showing the percentage of his time spent underground, in the field and in the office:

UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
34	10	56	100

Ernest Decaire, Jr., was employed as a helper and truck driver the entire year. He drove the truck and helped the engineers make their underground and surface surveys.

In the office, he made blue prints and assisted in making annual report prints.

He was underground $63\frac{1}{2}$ days and spent 118 days in the field.

Below is a table showing the percentage of his time spent underground, in the field and in the office:

UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
23	44	33	100

- E. The following table shows the percentage of time spent underground, in the field and in the office for mines in this district:

	UNDERGROUND.	FIELD.	OFFICE.	TOTAL.
Athens, - -	30	9	61	100
Maas, - -	29	12	59	100
Negaunee, - -	26	13	61	100
Cliffs Shaft, -	45	5	50	100
Holmes, - -	35	9	56	100
Tilden, - -	0	53	47	100
Morris-Lloyd, -	31	11	58	100
Spies-Virgil, -	17	4	79	100
Mackinaw-Gardner,	42	4	54	100
Average,	30	13	57	100

- F. The following table shows the distribution of time and the cost to the various mines and other work for the last three years:

MINES.	1927.			LABOR.	1928.			LABOR.	1929.			PERCENT INCREASE.	PERCENT DECREASE.
	LABOR.	TIME IN DAYS.	PER-CENT.		TIME IN DAYS.	PER-CENT.	TIME IN DAYS.		PER-CENT.				
Athens,	\$2315.46	273 $\frac{1}{2}$	10.2	\$1850.71	226 $\frac{1}{2}$	7.8	\$2177.13	238 $\frac{1}{2}$	9.2	1.4			
Maas,	2427.82	249 $\frac{1}{2}$	10.7	2524.21	243	10.6	2799.35	293 $\frac{1}{2}$	11.9	1.3			
Negaunee,	2229.98	227 $\frac{1}{2}$	9.8	2230.27	215 $\frac{1}{2}$	9.3	2130.33	205 $\frac{1}{2}$	9.0		0.3		
Cliffs Shaft,	2416.19	303 $\frac{1}{2}$	10.6	2514.94	286 $\frac{1}{2}$	10.5	3062.45	340 $\frac{1}{2}$	13.0		2.5		
Holmes,	1724.57	201 $\frac{1}{2}$	7.5	1695.74	192 $\frac{1}{2}$	7.1	1455.70	156	6.2		0.9		
Ogden,	602.18	85	2.7	417.63	53 $\frac{1}{2}$	1.8	0	0			1.8		
Tilden,	54.80	6	0.2	850.53	113	3.6	1385.01	159 $\frac{1}{2}$	5.9		2.3		
Barnes-Hecker,	133.07	19	0.6	0	0	0	0	0					
Morris-Lloyd,	3230.06	363	14.1	3546.91	372	14.8	3425.78	346 $\frac{1}{2}$	14.5		0.3		
Republic,	1018.38	113 $\frac{1}{2}$	4.5	396.52	43 $\frac{1}{2}$	1.7	143.87	13	0.6		1.1		
Spies-Virgil,	2298.37	260 $\frac{1}{2}$	10.1	2126.83	217 $\frac{1}{2}$	8.9	1628.21	158	6.9		2.0		
Mackinaw-Gardner,	85.11	8	0.4	1081.53	119 $\frac{1}{2}$	4.5	1765.76	184 $\frac{1}{2}$	7.5		3.0		
Total,	\$18535.99	2108	81.4	\$19235.82	2082	80.6	\$19973.59	2096 $\frac{1}{2}$	84.7		4.1		
<u>GWINN DISTRICT.</u>													
Austin,	\$124.71	14 $\frac{1}{2}$	0.5	\$34.96	4 $\frac{1}{2}$	0.1	0	0			0.1		
Francis,	0	0	0	110.22	12 $\frac{1}{2}$	0.5	44.73	5	0.2		0.3		
Princeton,	137.11	13	0.6	0	0	0	0	0					
Stephenson,	235.98	28 $\frac{1}{2}$	1.0	107.97	12	0.5	110.36	12	0.4		0.1		
Gwinn sewer,	34.10	3	0.2	0	0	0	0	0					
Gwinn Townsite,	0	0	0	99.31	7 $\frac{1}{2}$	0.4	0	0			0.4		
Total,	\$531.90	59	2.3	\$352.46	36 $\frac{1}{2}$	1.5	\$155.09	17	0.6		0.9		
<u>WATER POWER.</u>													
Cliffs Power & Light Co.,	\$709.64	58	3.1	\$644.77	60 $\frac{1}{2}$	2.7	\$390.37	30	1.6		1.1		
C.P. & L.Co. E. & A. #7,	0	0	0	0	0	0	50.85	4	0.2		0.2		
C.P. & L.Co. E. & A. #9,	0	0	0	0	0	0	976.85	114	4.2		4.2		
Total,	\$709.64	58	3.1	\$644.77	60 $\frac{1}{2}$	2.7	\$1420.07	148	6.0		3.3		
<u>SURVEYS & CONTOURS.</u>													
Tilden Exploration,	\$165.17	22 $\frac{1}{2}$	0.7	0	0	0	\$47.14	4 $\frac{1}{2}$	0.2		0.2		
Section 22, 47-27,	423.68	55	1.9	0	0	0	0	0					
Section 23, 47-27,	28.00	4	0.1	0	0	0	0	0					
Section 24, 47-27,	23.90	3 $\frac{1}{2}$	0.1	0	0	0	0	0					
Section 25, 47-27,	736.44	139 $\frac{1}{2}$	3.3	264.81	50	1.1	0	0			1.1		
Section 26, 47-27,	163.83	24 $\frac{1}{2}$	0.7	0	0	0	0	0					
Section 31, 48-26,	0	0	0	0	0	0	255.47	39 $\frac{1}{2}$	1.1		1.1		
Total,	\$1541.02	248	6.8	\$264.81	50	1.1	\$302.61	44	1.3		0.2		
<u>NESABA DISTRICT.</u>													
Boeing,	\$70.93	9 $\frac{1}{2}$	0.3	\$22.06	3	0.1	0	0			0.1		
Hill-Trumbull,	69.99	9 $\frac{1}{2}$	0.3	76.21	10 $\frac{1}{2}$	0.3	71.71	8 $\frac{1}{2}$	0.3		0.1		
Wade,	0	0	0	66.88	9	0.3	40.24	5 $\frac{1}{2}$	0.2		0.1		
Pontiac,	2.69	$\frac{1}{2}$	0	0	0	0	0	0					
Holman-Cliffs,	0	0	0	0	0	0	42.79	5	0.2		0.2		
Ganis-Cliffs,	0	0	0	0	0	0	28.85	3 $\frac{1}{2}$	0.1		0.1		
Total,	\$143.61	19 $\frac{1}{2}$	0.6	\$165.15	22 $\frac{1}{2}$	0.7	\$183.59	22 $\frac{1}{2}$	0.8		0.1		
<u>MISCELLANEOUS.</u>													
City of Negaunee,	0	0	0	\$53.16	9	0.2	\$26.67	3 $\frac{1}{2}$	0.1		0.1		
E. & A. 504, Moving houses,	\$771.85	95	3.4	\$25.51	2	0.1	\$407.60	63	1.7		1.6		
Abstracts,	237.25	19 $\frac{1}{2}$	1.0	1033.04	74	4.3	450.29	28 $\frac{1}{2}$	1.9		2.4		
E. & A. 513, Moving houses,	0	0	0	1110.71	175	4.7	17.39	2 $\frac{1}{2}$	0.1		4.6		
Maas Mine Trestle E. & A. 527,	0	0	0	648.59	54	2.7	0	0			2.7		
Ore Estimates,	306.33	25 $\frac{1}{2}$	1.4	264.69	22	1.1	422.74	34 $\frac{1}{2}$	1.8		0.7		
Maintenance of Locations,	0	0	0	0	0	0	176.58	14 $\frac{1}{2}$	0.8		0.8		
Miscellaneous,	0	0	0	70.70	5	0.3	48.23	5 $\frac{1}{2}$	0.2		0.1		
Total,	\$1315.43	140	5.8	\$3206.40	341	13.4	\$1549.50	152	6.6		6.8		
Grand total,	\$22777.59	2632 $\frac{1}{2}$	100.0	\$23869.41	2592 $\frac{1}{2}$	100.0	\$23584.45	2480	100.0				

H. AUTOMOBILES.

The Dodge touring car was operated the entire year; the Dodge truck was operated up to and including December 14, 1929, at which time it was turned in for credit and a new Ford Station Wagon purchased.

I. MINES.ATHENS MINE.

Weekly surveys were made and all geology noted and posted. The skip and cage compartment runners were gauged to check allowable clearance. The stockpiles were estimated.

MAAS MINE.

Regular weekly surveys were made and all geology noted and posted. Surveys were run to give lines for sinking the shaft to the 5th level. Stockpile estimates were made.

NEGAUNEE MINE.

Regular weekly surveys were made and all geology noted and posted. Surveys were made to give lines for the new 12th level sump. The skip and cage compartment runners were gauged to check allowable clearance. The stockpiles were estimated.

CLIFFS SHAFT MINE.

Regular surveys were made and all diamond drill holes surveyed for location and dip. The geologists were assisted with their underground work. The skip runners were gauged in both "A" and "B" shafts to check allowable clearance. On surface, the stockpiles were estimated and stocking trestle laid out.

HOLMES MINE.

Regular surveys were made and diamond drill holes surveyed to show location and dip. The skip and cage compartment runners were gauged to check allowable clearance. On surface, the ore in stock was estimated and stocking trestle laid out.

TILDEN MINE.

Regular surveys were made to locate churn drill holes and estimate the stripping. Computations were made to determine the powder necessary for each blast.

MORRIS-LLOYD MINE.

Regular weekly surveys were made and all geology noted and posted. On surface, estimates were made of the ore and coal in stock.

SPIES-VIRGIL MINE.

Regular surveys were made and all drill holes were located. On surface, the ore and coal in stock were estimated.