

SUNDRY ITEMS BY J. E. JOPLING.

WATER POWER.

The principle survey in connection with water power was that of the proposed storage basin of the Dead river with a storage dam at the Hoist. The result of this survey has been described by Mr. Brewer above. Mr. J. M. Longyear has been furnished with a map showing the proposed flowage line resulting from these surveys. Mr. Longyear has made purchases in the Holyoke basin, which is embraced in the proposed scheme, and the deeds have been entered on the books in this office. As negotiations are still pending with Mr. Longyear regarding his rights in the proposed storage and additional falls, no lands have yet been acquired outside the limits of the Holyoke basin except those which had to be purchased with other lands in the Holyoke.

At the Au Train proposed storage basin the question of the flowage line came up when the sale was made by the Land department of the lands lying to the Northeast of the basin and the contours were determined on the NW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 5, 45-20.

TRANSMISSION LINES.

The route of the transmission line to Republic was laid out by Mr. Charles Cummings, who was employed by the Company for this purpose. This occupied most of the spring and early summer. The line was built during 1918.

The route of the proposed pole line from the Pioneer Furnace to the L. S. & I. Railway shops was also surveyed by Mr. Cummings, according to the line designated by Mr. A. B. Eldredge, late President of the D. S. S. & A. Railway. This line was not constructed in 1918.

PYRITES.

The following offers of pyrites were received during the year:

No.136, W. H. Webb, Sault Ste. Marie, Ontario, property on the Algoma Central Railway, same as offer No.86.

No.137, Stanley N. Graham, Cobalt, Ontario, offered us the Woodney exploration West of Port Arthur. This was examined for the Company by

Mr. J. E. Marks of Port Arthur, Ontario.

No.138, M. L. Foley, Toronto, Ontario, offered us the same lands as in No.80.

No.139, G. H. Wyckoff, New York City, offered us a property at Rainey Lake.

No.140, Ozark Smelting & Manufacturing Company, Cleveland, Ohio, made an offer of land in New Mexico.

No.141, W. N. Smith, Platteville, Wisconsin, offered us some land in that neighborhood.

No.142, W. S. Jackson, Fort William, Ontario, offered an exploration $2\frac{1}{2}$ miles East of Schreiber, North of Lake Superior.

No.143, J. E. Marks; Port Arthur, Ontario, offer was 70 miles East of Superior Junction.

No.144, A. D. Mackay, through the Cleveland office, offered some land in Nova Scotia.

No.145, J. E. Marks made an offer of land near Michipicoten.

No.146, J. E. Marks called our attention to the lands of Pumpelly and Smyth at Straw Hat Lake, which had been held under lease by the U. S. Steel Company. Mr. J. H. Farrell made an examination.

No.147, E. B. Pratt, through the Cleveland office, made an offer of the Craig mine, Hastings County, Ontario, which is the same as Nos. 38, 59 and 88.

No.148, L. E. Ferretti, through the Cleveland office, made an offer of land in Illinois.

No.149, J. E. Marks offered a property West of Port Arthur.

No.150, J. E. Marks also offered us some land showing pyrites in Graphite.

Of the above, two properties were examined. All of them were declined.

LAKE SUPERIOR IRON COMPANY.

No thorough examination was made of the workings of Section 16 mine, which is the only property now operating. In connection with the increased

ENGINEERING DEPARTMENT.

flow of water at the Holmes, Captain Rough and I went through part of the Section 16 mine.

REGENT IRON COMPANY.

The only matter in connection with the Regent Iron Company, the lease of which had been surrendered, was the old contract with the C. & N. W. Railway relative to changes in Partridge creek at the Blue mine. An examination of this ditch was made with the Superintendent and Engineer of the Breitung interests and later with those of the Oliver Company and some changes were made in the ditch which will be completed later.

MICHIGAN STATE TAX COMMISSION.

The estimates of ore tonnages in the Company's mines were made as usual and Mr. O. W. Wheelwright, Engineer for the Tax Commission, spent part of March going over the estimates with the superintendents.

MARBLE.

Mr. Charles Cummings completed running out the lines for this Company which he had begun last year. The survey of the marble outcrops on the Company's lands has not yet been finished. The railway to the Michigan Verde Antique Company's quarry was built in 1918.

MINES ON THE MESABI RANGE.

Mr. M. H. Barber was in this office several times during the year and estimates were made of various properties, mostly those of the Great Northern Company.

COUNTY ROADS.

On June 27th, Mr. K. I. Sawyer, Engineer of the County Road Commission, and I visited the proposed crossing of Dead river near the Hoist dam for the proposed Baraga County highway. Later Mr. Sawyer made new surveys for this highway crossing.

IMPERIAL MINE.

On September 26th, Mr. Chinn, Superintendent of Pickands, Mather & Company, and Mr. Ross, Engineer, were with me to the Imperial mine to make a report.

ENGINEERING DEPARTMENT.

GENERAL.

Owing to the war and the consequent lack of help in the office we could only accomplish the work that was strictly necessary. There was no opportunity to continue the surveys and examination of the Company's mineral lands nor the examination of lands offered in the neighborhood.

THE CLEVELAND CLIFFS IRON COMPANY.

REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1918.

STAFF.

The staff of the Geological department for 1918 is given in Table I below. Mr. F. R. Mitchell left the department April 5th to join the U. S. Naval Aviation Service. Mr. Leif Erickson was engaged as collector of core, etc, and began his duties April 29th. He was given a leave of absence from December 6th to the 22nd, inclusive, to act as Orderly at the Gwinn Club House during the epidemic of Spanish Influenza, following which he was himself taken ill. Mr. Peter N. Denn of the Engineering department was engaged December 6th to collect the core in Mr. Erickson's place and continued in this capacity the remainder of the year.

TABLE I.

STAFF OF GEOLOGICAL DEPARTMENT IN 1918.

NAME.	OCCUPATION.	DURATION OF EMPLOYMENT IN 1918.	DAYS LOST. SICKNESS.	VACATIONS.	% OF WORKING DAYS WORKED.
E.L.Derby, Jr.	Geologist in charge of department.	Entire year.	0	0	100.0
Fred Royce	Assistant Geologist.	Entire year.	4	4	97.1
F.R.Mitchell	Assistant Geologist.	2 months.	0	$\frac{1}{2}$	99.0
Gustaf Afuhs	Draftsman.	Entire year.	$\frac{1}{2}$	$6\frac{1}{4}$	97.6
E. A. Allen	Collecting core, etc; also assisting geologists.	Entire year.	0	$9\frac{1}{2}$	96.6
Leif Erickson	Collecting core, etc.	8 months.	6	0	96.5
Peter N.Denn	Collecting core, etc.	$\frac{1}{2}$ month.	0	0	100.0

The year was divided into the factors shown in Table II.

TABLE II.

Total days of eight hours worked	- - -	276 days.
Sundays	- - - - -	52 "
#Days resulting from 45 Saturday afternoons not worked	-	$22\frac{1}{2}$ "
Holidays	- - - - -	$14\frac{1}{2}$ "
Total		<u>365 days.</u>

#The Geological department worked seven Saturday afternoons during the months of January and February.

The following Table, No. III, shows the average number of men regularly employed on the staff of the Geological department during the past five years:

TABLE III.

<u>YEAR.</u>	<u>AVERAGE NUMBER OF MEN.</u>
1914	5.74
1915	3.96
1916	3.17
1917	3.35
1918	4.85

DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

H. L. Smyth. The work of the Geological department continued under the direction of Mr. H. L. Smyth as Consulting Geologist.

E. L. Derby, Jr. My time during the year has been chiefly taken up with general oversight and supervision of the work of the department. This has included, besides certain office routine work, surface drilling explorations in the Ishpeming, Negaunee, Gwinn districts and the Mesabi Range; underground drilling in the Athens, Bunker Hill, Cliffs Shaft, Fowler, Francis, Holmes, Jopling, Lake, Morris and Republic mines; surface geological surveys in the Ishpeming district; underground geological surveys in the Athens, Bunker Hill, Cliffs Shaft, Francis, Gwinn, Holmes, Jopling, Maas, Mackinaw-Gardner, Morris-Lloyd, Negaunee, Princeton, Republic and Spies mines; and in visiting and reporting on the explorations of other companies on the Michigan and Wisconsin iron ranges.

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

In January, I made a complete estimate of the ore at the Wade mine, then the Great Northern ore property, and assisted Mr. Barber in preparing a report on it.

In February, I prepared ore and stripping estimates on the several Great Northern ore, or so-called Hill properties, submitted to this Company in land offer No. 1113 Mesabi Range.

In March, I made additional estimates of ore and stripping on these Hill lands to supplement and add to the ones previously made. Also, in the

absence of Mr. Stakel on his vacation, I went over the Republic mine maps and his estimate of ore reserves with Mr. Wheelwright, Geologist representing the Michigan State Tax Commission.

In April, I accompanied the above Mr. Wheelwright on his examination of the Spies mine workings.

In May, I prepared an estimate of ore on the York forty of the Hill Iron Company, covered by land offer No. 1104 Cuyuna Range. I made with Mr. Jopling a joint examination and a report of the Michigan Verde Antique Marble Company's marble quarry, otherwise known as Carter's Quarry, and an examination relative to marble possibilities of the Company's land crossed by the Marble Company's railway right of way. I also made a joint examination with Messrs. Jopling and Brewer of the surface and equipment of the Empire mine, Palmer district. Furthermore, I examined and reported on Mr. Denny Jewell's farm on the Escanaba river, Northeast of Gwinn, covered by land offer No. 1108 Marquette County. Finally I assisted Mr. Jopling in reporting on various other land offers and in preparing cost and valuation tables to be used in connection with the so-called "fifteen year estimates" made by the superintendents of the Company's various properties.

In July, in company with Mr. Frank Trebilcock, I examined several gold-quartz veins which he had discovered in the Kitchi schists North of Ishpeming in the SW $\frac{1}{4}$ of Section 33, 48-27. They proved of no commercial importance.

In September, I joined with Mr. Jopling in conducting Messrs. Chinn and Rose, of Pickands, Mather & Company, on a tour of inspection and examination of the Athens, Imperial, Portland and Webster mines.

In October, I made an estimate of the stripping necessary to mine by open pit or milling the ore on the Longyear No. 2 property of the Hill lands on the Mesabi Range. This has since been leased by the Company and is known as the Bourne mine.

In December, I prepared an estimate of the ore remaining in the Isabella mine on the Cascade Range at Palmer, Michigan.

Mr. Fred Royce. Mr. Royce has spent most of his time making underground surveys and posting the maps and cross-sections of the Company's operating mines in the Ishpeming, Negaunee, North Lake and Gwinn districts, with the exception of the Angeline, Lake and Salisbury mines at Ishpeming. Since Mr. Mitchell left, the first part of March, Mr. Royce has been the only assistant in the department available for this class of work so that it has been impossible to keep the geological surveys up to date at all of these properties. He has also assisted me in practically all of the ore estimates which I made during the year and has prepared maps and cross-sections of them. He spent the rest of his time in the office routine work.

F. R. Mitchell. Mr. Mitchell spent the first two months of the year in making underground geological surveys at the Maas and Negaunee mines and posted the geological maps and cross-sections. He also assisted in the general routine work of the department. He left the Company's employ on March 5th to join the Aviation Branch of the U. S. Navy, in which he was later commissioned an ensign and placed in the Observation Balloon Section.

Gustaf Afuhs. Mr. Afuhs continued as draftsman throughout the year. His work has been chiefly that of preparing cross-sections of drilling, monthly drill reports, geological maps and cross-sections but he has also assisted in making several ore estimates, etc.

E. A. Allen. Mr. Allen spent the first five months of the year collecting and labeling core and sludge from all the various current explorations, filing samples of these in the core room and surveying of the holes where necessary. During May, the fifth month, he trained Mr. Leif Erickson to do this work and for the remainder of the year acted as regular geologist's assistant, both in making the underground geological surveys and laying out new tracings to be used as geological maps and cross-sections, etc. He continued making all the rock slides or thin sections required; also the regular monthly carbon statement. He visited all the outside explorations being conducted on the Michigan and Wisconsin iron ranges. He also made a compass survey of all the

serpentine marble outcrops on the Company's lands North of Ishpeming in the vicinity of ~~at~~ Carter's Michigan Verde Antique Marble Quarry.

Leif Erickson. Mr. Erickson was engaged by this department on April 29th to take the place of Mr. Allen in the core room and in collecting core from the drills, surveying the drill holes, etc. This he has very ably accomplished after a month's training under Mr. Allen's guidance. On December 6th he was called to Gwinn during the Influenza epidemic there and because of his previous experience in hospital work was made an Orderly. He returned to the department December 23rd but was himself taken ill and unable to resume work during the rest of the year.

Peter N. Denn. Mr. Denn's services were loaned to the Geological department by the Engineering department from December 6th to the end of the year. He collected the core from the diamond drills in Mr. Erickson's absence and assisted Mr. Allen in the core room, the latter having temporarily assumed a portion of Mr. Erickson's work during his absence.

SURFACE GEOLOGICAL SURVEYS.

Very little surface geological work was done the past year. It was as follows:

ISHPEMING DISTRICT.

In September, Mr. Allen made a compass survey of all the serpentine marble outcrops on the Company's lands and along the new C. & N. W. Railway Company's spur into the Michigan Verde Antique Marble Company's Quarry, North of Ishpeming, and in the vicinity of the old Ropes gold mine. This survey was run from transit lines previously established by Mr. Charles Cummings of Marquette for the Engineering department and is preliminary to a more careful study, including the determination of its commercial value, of the marble on the Company's land in this vicinity.

MARQUETTE RANGE GENERAL.

During the year Mr. Afuhs prepared two large surface tracings on a scale of 600' to the inch. One of these covers the North part of the Marquette Range from the East end of the Negaunee basin to a point half

way between Ishpeming and North Lake and the other from the latter point to the West side of the old Chase mine. In addition to general surface information, these maps show all drill holes, test pits, open pits, caves, rock outcrops, etc, and are designed to serve as base maps for a set of detailed surface geological maps of the productive part of the Marquette Range.

UNDERGROUND GEOLOGICAL SURVEYS.

There has been a decided improvement during the last year in the condition of underground geological surveys but it was not possible to bring them all up to date. It is probable this might have been done if a competent assistant geologist could have been employed to take the place of Mr. Mitchell at the time he left the early part of March. An effort will be made the coming year to supply this deficiency and should be entirely possible now that so many desirable men are being released from government service.

ANGELINE MINE.

The Happy Hollow or Side Hill deposit and the East End pit were worked steadily during the summer; also continued throughout the fall and winter. Practically all ore removed from the former was taken from underground by milling. During the shipping season the ore at the East End pit was won by steam shovel but after the season closed scrambling of ore in the banks to the pit was resorted to and placed in stockpile. Mr. Janzen, engineer, posted the geology of both pits.

The work of exploring ore pillars remaining in the Middle Deposit of the old Lake Angemine mine was commenced the middle of the year and progressed steadily. This work has not gone far enough, however, to demand the attention of this department.

ATHENS MINE.

Opening up main level drifts on the 4th, 8th, 9th and 10th levels at this mine progressed steadily during the year. During the last few months several sub-levels have been started above the 8th level in an attempt to define the hanging jasper and commence actual mining operations.

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tions. Detailed geological surveys have been made and posted regularly by Mr. Royce and myself and assisted by Mr. Allen.

BARNES-HECKER MINE.

The Barnes-Hecker shaft, which was started in October 1917 but temporarily discontinued early in January of the present year to erect the head frame, was resumed in April and continued throughout the rest of the year. It is located approximately 1700' West and a little North of the center of the ore body. The geology is being posted by Mr. Trosvig, engineer.

BUNKER HILL MINE.

The first opening on this property was occasioned by the extension of the 10th level Athens mine approximately 70' over the line. A cross-cut North about 160' long and another South about 140' long were driven from this drift. From these two crosscuts drilling explorations were conducted to determine the depth of ore below the level at the boundary between the two properties. This work was geologized in connection with the surveys of the Athens mine.

CLIFFS SHAFT MINE.

The Cliffs Shaft mine worked continuously during the year. The only geological surveys made were of new development work in the West end of the "B" shaft workings on the 10th to 14th levels inclusive. This was done by Mr. Royce and myself. Much of the geological work in the other mines has been done at the expense of the Cliffs Shaft realizing that the latter workings remain open practically indefinitely and that the work here can be caught up as opportunity permits. The Cliffs Shaft work is highly essential, however, and an attempt will be made to catch it up as soon as additional assistance is acquired.

FRANCIS MINE.

This mine worked continuously throughout the year. The ore horizon is considerably folded and mixed with lean ore so that a periodic geological survey is imperative. Both Mr. Royce and myself have kept this work up to date.

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GWINN MINE.

This mine also produced continuously throughout the year. Mr. Royce has kept the geological surveys of all main level developments and the principal sub-levels posted. I also assisted in some of this work and Mr. Sterling, engineer at the property, has supplied us with the necessary geological data of the remaining workings.

HOLMES MINE.

The Holmes mine operated regularly during the past year and Mr. Royce kept the geological surveys fairly well posted. Mr. Allen assisted in this work.

JOPLING MINE.

The work at this property for the year consisted in raising the shaft several hundred feet and driving two sub-levels to explore the iron formation. These sub-levels are ^{the} 260 and 540 respectively. The results on the former were very discouraging and the work on the latter is progressing at present in the direction of the ore found a short distance above this level in surface hole No. 37. Mr. Royce geologized the sub-levels and Mr. Sterling, engineer, mapped the geology of the shaft raise.

LAKE MINE.

This mine operated continuously throughout the year but no geological surveys were made other than a few details collected by Mr. Janzen, engineer at the property. The mine of course is very nearly worked out.

MAAS MINE.

Mr. Mitchell, until he left, kept the Maas mine geology fairly well posted and from the middle of the year on Mr. Royce kept this work up to date on the main levels and principal development sub-levels. Mr. Moulton, engineer at the property, assisted in all this work and did what he could in the time permitted to keep the most important sections of the mine posted during the interval between Mr. Mitchell's departure and Mr. Royce's initial survey.

MACKINAW-GARDNER MINES.

The work at these properties during the year consisted in raising the Gardner shaft from the 4th level drift connecting with the Mackinaw shaft and developing the ore on this level. A start was also made on the 3rd level drift. Thus far the ore has been disappointingly narrow and, more unfortunate still, has been found to be quite generally high in sulphur. The sulphur is chiefly in the form of gypsum or calcium sulphate and so thoroughly penetrates the ore mass in thin films and plates that removal by direct solution seems economically impossible. Mr. Royce and myself have kept the geology posted up to date. Mr. Allen has assisted Mr. Royce in this work.

MORRIS-LLOYD MINES.

These mines have worked continuously throughout the year and Mr. Royce has kept the geology fairly well posted. Both Messrs. Allen and Trosvig, the latter engineer at these properties, have assisted Mr. Royce underground.

NEGAUNEE MINE.

Mr. Mitchell posted the geology at this property once before leaving the Company. Mr. Cheneour, engineer, after this collected all the data he could in the limited time he had. This was mapped by the Geological department. During the latter part of the year, however, both Mr. Royce and I geologized the current developments on the main levels. Mr. Allen at times also assisted in this work.

REPUBLIC MINE.

Except for a small amount of work that I was able to do while examining some of the new developments on the bottom levels of this mine, no geological surveys were made during the year. Fortunately, like the Cliffs Shaft mine, the workings remain accessible for a long time and with an increased force we can bring this work up to date.

SALISBURY MINE.

No geological surveys were made at this property during the year, although the mine worked continuously. This can only be explained by lack of help as there are several portions of the mine which should be geologized.

SPIES MINE.

It was possible to make but one geological survey at this mine during the year, this early in November, but both Mr. Royce and I made quite a thorough observation at that time and have the geology reasonable well up to date.

STEPHENSON MINE.

No geological work was done in this mine during the year as it remained flooded with water. Slow progress has been made, however, in attempting to unwater it and should be accomplished within another year.

EXPLORATIONS.

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

FROM SURFACE.

<u>DISTRICT.</u>	<u>RANGE.</u>
Ishpeming,	Marquette.
Negaunee,	"
North Lake,	"
Gwinn,	"
Aurora,	Mesabi.
Kinney,	"

FROM UNDERGROUND.

<u>MINES.</u>	<u>DISTRICT.</u>
Athens,	Negaunee.
Bunker Hill	"
Cliffs Shaft,	Ishpeming.
Fowler,	Aurora.
Francis,	Gwinn.
Holmes,	Ishpeming.
Jopling,	Gwinn.
Lake,	Ishpeming.
Morris,	North Lake.
Republic,	Republic.

No options for explorations were executed or relinquished in 1918. The only option in force is from the Spies Mineral Land Company. It is No.98 and comprises the E $\frac{1}{2}$, the NW $\frac{1}{4}$ of the NW $\frac{1}{4}$, the NE $\frac{1}{4}$ of the SW $\frac{1}{4}$ and the SE $\frac{1}{4}$, all in Section 24, 43-35.

Mining leases were acquired on the Wade and Helmer mines in the Kinney district of the Mesabi Range and explorations from surface by drilling were conducted at both the properties.

Table IV 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 \$3.56 per foot, excluding certain items from the drilling done by the Company in order to compare these results with the contract drilling costs. By including these items, the average cost was \$3.72 per foot. The average cost of underground drilling in the same way was \$3.30 per foot and \$3.45 per foot respectively. The average cost of all the drilling was \$3.49 per foot and \$3.65 per foot respectively. The increase of these costs over those of last year is no greater than the proportionate higher wages and increased cost of supplies makes it in spite of the noticeable decrease in efficiency of some of the classes of labor involved.

TABLE IV.
SUMMARY OF DRILLING FOR 1918.

EXPLORATION.	DESCRIPTION.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A".	COST PER FT. "A".	TOTAL COST "B".	COST PER FT. "B".
<u>SURFACE DRILLING.</u>												
Angeline	15, 47-27	44	10	108	162			1	\$1,163.40	\$7.18	\$1,144.27	\$7.06
Barnes-Hecker	2, 47-28	207			207				693.73	3.35	693.73	3.35
Golf Club	N $\frac{1}{2}$ 2, 47-27	327	21	2646	2994		26	100	9,670.55	3.23	9,175.18	3.06
Helmer	14, 58-19		280.5	311.5	592	223	55.5	10	2,437.44	4.11	2,389.00	4.04
Ishpeming Sec. 3	3, 47-27	852		54	3857		20	73	17,848.06	3.75	16,942.63	3.56
" "	" 4	342		26	3052		45	165	16,162.43	4.72	15,247.10	4.46
" "	" 5	103		8	1328		59	59	6,907.06	4.80	6,496.91	4.51
Jackson	1, 47-27	43	34	5691	5768	45	116	215	23,139.74	4.01	21,836.70	3.79
Meadow	3, 58-15	421	89	1363	1873		4	36	7,710.83	4.11	7,636.74	4.07
South Jackson Pit	1, 47-27	211	2306	814	3331		50	712	9,633.73	2.89	9,104.12	2.73
Stephenson Sec. 29	29, 45-25	1329	4	52	1385				3,383.68	2.44	3,339.80	2.41
Union Park	SE $\frac{1}{4}$ 2, 47-27	157	4	2573	2734				9,155.98	3.35	8,738.97	3.20
Wade	13, 58-19	2617	811	1174.5	4602.5	545	212	185	15,749.03	3.42	15,554.25	3.38
Total Surface Drilling		6653	3647.5	22970.0	33270.5	813	587.5	1556	\$123,655.66	\$3.72	\$118,299.40	\$3.56
<u>UNDERGROUND DRILLING.</u>												
Athens	5 & 6, 47-26			819	819	5	32	55	3,178.79	3.88	3,125.84	3.82
Bunker Hill	6, 47-26			354	354	65			1,620.38	4.58	1,578.39	4.46
Cliffs Shaft	9 & 10, 47-27			1670	1670	247	110	101	4,740.39	2.84	4,568.41	2.74
Fowler	3, 58-15		14.5	35.5	50	25	10		203.12	4.06	190.75	3.82
Francis	27, 45-25			1050	1050	45	115	20	1,874.48	1.79	1,811.15	1.73
Holmes	9, 47-27		11	1284	1295	178	80	80	5,905.18	4.56	5,742.57	4.43
Jopling	28, 45-25			809	809		13	57	2,395.46	2.96	2,326.14	2.88
Lake	10, 47-27			520	520	0	0	0	1,877.70	3.61	1,269.20	2.44
Morris	1, 47-28		2	2424	2426	149	149	235	9,757.29	4.02	9,476.64	3.91
Republic	7, 46-29			1874	1874	37.5	1	85	5,887.38	3.14	5,784.79	3.09
Total Underground Drilling			27.5	10839.5	10867	751.5	510	633	37,440.17	3.45	35,873.88	3.30
Grand Total Drilling		6653.0	3675.0	33809.5	44137.5	1564.5	1097.5	2189	\$161,095.83	\$3.65	\$154,173.28	\$3.49

NOTE: Cost "A" includes taxes, office expense, engineering, analysis, legal, and personal injury.
Cost "B" excludes " " " " " " " " (to compare with contract price).
Cost "B" also excludes cost of cutting the drill station for the Lake mine drilling, \$608.50.
The contract drilling for the year comprised the surface drilling at the Helmer and Wade explorations, done by the Duluth Diamond Drilling Company, and at the Meadow done by the Cole & McDonald Exploration Company; also the underground drilling in the Fowler mine done by the Cole & McDonald Exploration Company.

SURFACE EXPLORATIONS.

MARQUETTE RANGE.

ISHPEMING DISTRICT.

GOLF CLUB, N¹, SECTION 2, 47-27.

The Golf Club exploration was commenced in August 1917 and completed the last of July 1918.

The object here was to explore the iron formation above the lower or footwall greenstone sheet and particularly immediately North of the East-West fault zone separating this area from the so-called East New York area to the South.

The basin was cross-sectioned by a series of eight holes on the 12000 West Meridian and was also drilled in four other places. It was found to be disappointingly flat and shallow and contained no commercial ore; also very little evidence of enrichment.

UNION PARK, SE¹, SECTION 2, 47-27.

Drilling on this description continued until the middle of July without encountering a merchantable body of ore. The 30' of ore found in hole No.23 in December 1917 is apparently a local concentration of no great extent on a small dike within the main East-West fault zone.

SECTION 3, 47-27.

This exploration was continued throughout the year. The drill which formerly employed on Section 4 [^] was moved over the line on this section the very last of 1917, was used to sink three holes, Nos.10, 13 and 15, along the strike. These were all located in the NW¹/₄ of the NW¹/₄ of the section and approximately 400' apart to explore for possible ore on the slate footwall. Nothing was found, however, and the drill returned to Section 4 the latter part of May.

Five additional holes were drilled by the other outfit in the basin to the South, Northeast of Lake Bancroft and lying on the greenstone. This is a Westerly continuation of the formation explored in the Golf Club basin. The results here in Section 3 ~~are~~ ^{were} likewise very disappointing as no merchantable ore was found.

GEOLOGICAL DEPARTMENT.

Hole No.18, which was drilling at the end of the year, is located in the SE $\frac{1}{4}$ of the NW $\frac{1}{4}$, about 500' North of No.7 and approximately 430' South and 200' East of the old Union hole. The drilling at hole No.23 Section 4 and vicinity demonstrated a fault which is apparently striking Southeasterly. This discovery, together with the enriched character of the bottom of the old Union hole, which had a few feet of first class ore, warranted a deeper hole at about No.18 location. The latter was drilling in soft ore jasper at 792' on the last of the year.

SECTION 4, 47-27.

Exploring on this section was suspended until the end of May while the drill was being used on Section 3, as explained above. For most of the time after that, however, two drills were used on this section. Standpiping to locate the slate-jasper contact was completed late in 1917 so that the work this year has been mainly to explore the iron formation down to the slate at regular intervals along its strike. A small amount of lean and second class material was encountered but no merchantable ore and nothing sufficiently encouraging to follow up on the strike with deeper holes. Drilling at regular intervals along the strike, however, will be continued across the entire section and hole No.28, located on the North-South center line, was just starting at the end of the year.

Two holes were also drilled in the vicinity of the old Isaac's pit in the SW $\frac{1}{4}$ of the NE $\frac{1}{4}$ and one of them, No.27, at an incline which carried it below the pit bottom. It is reported that several hundred tons of good ore were removed from this pit many years ago but no ore was found in the present drilling.

The off set in the slate-jasper contact that was discovered by standpiping in 1917 and spoken of in my last year's report was explored by two holes, Nos.23 and 26. No merchantable ore was found but, as mentioned above, No.23 demonstrated a Southeasterly striking fault that may prove of importance in locating an ore body in the vicinity of No.18 Section 3.

SECTION 5, 47-27.

The work of exploring on this section was started the last of July with one drill. The program here is similar to the one followed along

the strike of the iron formation in Section 4 with holes at regular intervals, about 400' apart in this case, to encounter the slate at from 600' to 800' in depth. Hole No.1 was completed and No.2 drilled to a depth of 563' and still in soft ore jasper on the last of the year. Fourteen feet of 50% material and 40' of 52% material; also some lean ore, were encountered in No.1 but no merchantable ore has thus far been found in either hole. The general appearance and character of the iron formation in this section, however, is much more promising than the ground so far explored in Section 4.

ANGELINE SURFACE, SECTION 15, 47-27.

During the course of removing ore from the East Side of the Angeline East End pit the past summer, Captain Rough was rather inclined to think that the ore extended considerably farther East than the limits established by recent drilling. Accordingly, in order to assist him in his plan of operation, one additional hole was drilled somewhat Northeast of a line connecting holes Nos.14 and 61 and between them. Nothing but greenstone was encountered, which confirmed our original ore limits.

One more hole was drilled in this basin of iron formation to complete the systematic search for another pocket of ore. It was located near the Southeast corner of the area and just North of the Lake Angeline fault. Iron formation was found and it extended to a depth of 48' but was not enriched.

NEGAUNEE DISTRICT.

JACKSON EXPLORATION, SECTION 1, 47-27.

Drilling has been continuous throughout the year at this property and since the first of August two drills have been employed. Hole No.102, which was drilling on the first of the year, was completed, as were also two other holes, Nos.107 and 108. No.119 was cementing a vug at 1245' and the machine employed at No.108 was moving to a new location about 450' North of No.107 at the end of the year. All holes except No.108 are located North of the County Road and East of the Cornishtown location, the latter just South of the County Road and in the same vicinity.

Hole No.107 encountered 40' of good ore in two runs, one of 25' and one of 15' divided by 15' of soft ore jasper and 5' of 51% material. This zone is at a depth of from 1645' to 1705' and virtually rests on a greenstone sheet or dike. It was hoped to catch this ore at a higher elevation in hole No.119, which is located about 380' to the Southwest. Considerable trouble was experienced cementing two vugs encountered in the latter hole and the delays entailed prevented the drill from reaching the ore zone by the end of the year. This ore will be followed up during the coming year by holes to the North and East of No.107.

SOUTH JACKSON PIT, SECTION 1, 47-27.

Drilling in connection with the South Jackson pit was continued until the latter part of November. The holes were all West of the actual pit area but in ground more or less tributary to it. Drilling was done with the Keystone churn drill outfit. The holes were comparatively shallow and spaced regularly in checker-board fashion where possible, the object being to explore for ore of the South Jackson mangiferous grade that could be readily stripped and mined either in an open pit or by a milling system. One hole, No.106, however, was deepened with a diamond drill to 1210' to test this formation at depth but no high grade ore was found.

Twenty three of these churn drill holes were drilled and added approximately 125,000 tons of 39.6% combined iron and manganese material to the South Jackson reserves.

ATHENS MINE SURFACE, SECTION 6, 47-26.

Holes Nos.1, 2, 4, 5, 7, 8, 10, 11, 12, D, E, F, I, K, and L were during the summer plugged with cement to cut off the surface water from the underground workings.

MAAS MINE SURFACE, SECTION 6, 47-26.

Hole No.9 was also plugged with cement during the summer.

NEGAUNEE MINE SURFACE, SECTION 6, 47-26.

Hole No.10 was likewise plugged with cement.

NORTH LAKE DISTRICT.

BARNES-HECKER MINE SURFACE, SECTION 2, 47-28.

Holes Nos. 51, 67, 68, 85, 86, 87, 88 and 89 were plugged with cement during the summer and the standpipes where found pulled. There was no standpipe in No. 82 but an attempt was made to sink another and recover the old hole to plug it with cement. Ledge was reached practically at the collar of the old hole but a piece of old standpipe was found broken off in it which made it impossible to get into it.

GWINN DISTRICT.

STEPHENSON MINE SURFACE, SECTION 29, 45-25.

Twelve standpipes, Nos. 54 to 65 inclusive, were sunk on the N $\frac{1}{2}$ of this description between the last of January and the middle of May. Enough drilling was done at each location to determine the depth of surface and character of ledge. The object of this work was to contour the ledge basin which held the water that flooded the Stephenson mine.

MESABI RANGE.

AURORA DISTRICT.

MEADOW MINE SURFACE, SECTION 3, 58-15, MINNESOTA.

The work of systematically exploring the N $\frac{1}{2}$ of the NW $\frac{1}{4}$ of Section 3, West of the Meadow mine workings, which was commenced late in November, 1917, was completed the last of March. This work was done under contract by the Cole & McDonald Exploration Company. No merchantable ore was encountered.

KINNEY DISTRICT.

HELMER PIT, SECTION 14, 58-19, MINNESOTA.

When the Company assumed control of this mine it was known from the old drilling that some ore remained below the present bottom in the E $\frac{1}{2}$ of the pit. To more accurately determine the amount and its depth, since the old holes were a considerable distance apart, 17 holes were drilled and were all bottomed in taconite. An average of 15' of ore was found over the area, although in places it was from 25' to 33' thick.

GEOLOGICAL DEPARTMENT.

WADE MINE SURFACE, SECTION 13, 58-19, MINNESOTA.

The Wade mine was leased from the Great Northern interests early in the year. From the last of March until the early part of November two drills, under contract from the Duluth Diamond Drilling Company, were employed on the $N\frac{1}{2}$ of the $NW\frac{1}{4}$ of Section 13, checking the old drilling done by the Oliver Company and outlining the West ore body more completely. Fourteen holes were drilled. The results were more or less conformable to the old drilling but the developed tonnage was considerably increased by the outside holes.

Two holes were drilled outside of two of the previous outside holes on the East deposit, which also slightly increased its tonnage.

Seven holes were also drilled near the Southeast corner of the $NE\frac{1}{4}$ of the $NW\frac{1}{4}$ of Section 13 to follow up the ore extending on to the property from the Deacon mine ore body. A small tonnage increase was also recorded here.

UNDERGROUND EXPLORATIONS.

ATHENS MINE.

The first drilling in this mine was done during 1918, the work commencing in July. Two horizontal radiating holes were drilled from the first Northwest crosscut on the 8th level through the main East-West dike to test the iron formation on the North side. Hole No.1 was stopped after drilling 12' of soft ore jasper on the North side of this dike due to its encountering an excessive flow of water too great to be handled by the mine pumping equipment in use at that time. The hole was immediately plugged. A water pressure of 625 pounds per square inch was registered at this point. Hole No.2 had drilled 82' of iron formation on the North side of the dike when the ground caved so badly that a connection was probably made with the water course penetrated by the first hole so that the second hole had to be temporarily abandoned. It encountered enriched ground, however, on the North side of the dike, 5' of which was good ore averaging 57.40% iron and .101% phosphorus. It was bottomed in 55% material.

Hole No.3, the last hole drilled in this mine during the year, was located at the South end of the 4th level. It was drilled horizontally and practically due South to test for the true slate footwall. It encountered no additional merchantable ore.

BUNKER HILL MINE.

The first drilling in this mine was started early in November and continued for the rest of the year. The first hole was drilled horizontally and practically due South from the South end of the 10th level to test the slate footwall as far as the South boundary of the property and also to expose any possible fold that might contain ore.

Following hole No.1, a series of holes was planned from the North crosscut, which runs parallel to the North-South boundary between the Athens and Bunker Hill properties, to determine the limits of ore in depth along this line. The first of these holes, No.2, was drilling in dike at 161' at the end of the year. It was drilling vertically from a point about 40' South of the main East-West dike and had encountered 65' of good ore starting at the level.

CLIFFS SHAFT MINE.

Drilling in this mine was resumed the middle of January but was discontinued late in March in order to drill a few holes in the Holmes mine. Drilling was again resumed the last of August, however, and continued the rest of the year.

Ten holes were completed and the eleventh, No.293, drilled to a depth of 125' during this time. The first three holes were drilled to explore the slate hanging contact on the 1204' and 1220' sub-levels above the 1st level "B" shaft. The others were located, five on the 4th level, two on the 5th level and one on the 6th level, all in "A" shaft. A total of 247' of first class ore, 110' of second class ore and 101' of lean ore were encountered, which is a little less proportionally to the total drilling, than encountered in 1917.

FOWLER MINE.

Two shallow vertical drill holes were sunk in this mine on contract by the Cole & McDonald Exploration Company, but both of them caved badly and the results are consequently of little value.

FRANCIS MINE.

Three holes, all horizontal, were drilled in this mine during the year. The first was drilled Southwest across the formation from the 4th level shaft plat but was in hanging wall material all the way. The other two were drilled on the 5th level to aid in the development of both the North and South limbs of ore. The South limb so far has proved much leaner than the North on any given elevation, very little of it being merchantable.

HOLMES MINE.

Six holes were drilled in this mine from the last of March to the middle of November.

One hole was drilled horizontally and Southwest from the West end of the second level to explore the iron formation to the hanging wall. Only 5' of good ore was encountered. Two inclined holes were also drilled from the second level, one at -30° and the other at -60° , both on a Northeast course, crosscutting the formation and exploring principally for a downward continuation of the soft ore on the level. The upper hole found very little commercial ore and it was of a mixed character but the 60° hole encountered 104' of good ore averaging 62.97% iron and .083% phosphorus, a most encouraging development.

The other three holes were drilled horizontally and practically due North, two on the 570' and one on the 660' sub-level, to explore the iron formation back to the greenstone footwall. One hole on the 570' sub-level, No. 9, found a little hard ore but none of the holes encountered merchantable soft ore.

JOPLING MINE.

The first drilling in this mine was done during 1918. It consisted of four horizontal holes which were drilled between the last of March and the last of May.

Three of these holes were drilled from the 260' sub-level to explore the iron formation but found no enrichment. The fourth hole was drilled Southwest from the 7th level shaft plat across the entire jasper formation from foot to hanging walls. Mixed lean and second class ore was

GEOLOGICAL DEPARTMENT.

encountered but none of a merchantable grade.

LAKE MINE.

Drilling from the 5th or bottom level of this mine was begun the last of November. The object of this drilling is to test the iron formation just North of the Lake mine fault and below the main greenstone or diorite sheet which is the footwall of the Lake ore body. From the information we have it appears probable that this horizon of iron formation rests in turn on a lower greenstone sheet and is also dammed up on the South side of the Lake fault by greenstone, thus forming a second or lower crotch much the same as that containing the Lake ore body. The first hole No.502, was still in the upper greenstone sheet at a depth of 520' on the last of the year.

MORRIS MINE.

Drilling was carried on continuously in this mine except for the period between the middle of March and the middle of July.

The deep hanging wall hole, No.41, which was being drilled vertically from the 6th level at the beginning of the year, was deepened in interrupted stages so that it was 1513' deep at the end of the year. It was still in soft ore jasper. No attempt was made to drill in it continuously when the machine was needed in other parts of the mine and no ore has been encountered in it.

A series of six holes was laid out at the West end of the 6th level to test the fault crotch in which good ore was found below the 6th level by surface hole No.4. Two holes were drilled to the North to the slate footwall, one horizontally and the other on a dip of $-61\frac{1}{2}^{\circ}$. The former encountered no merchantable ore but the latter, or inclined hole, encountered 30' averaging 59.98% iron and .157% phosphorus.

Two holes were then drilled to the South, one horizontally and the other dipping $-61\frac{1}{2}^{\circ}$, principally to locate and determine the attitude of the fault dike forming the supposed crotch. No ore was expected or found in the first hole but the inclined hole encountered 20' averaging 60.26% iron and .256% phosphorus; also considerable second class ore.

One hole was then drilled Westerly dipping into the crotch at -50° . It encountered 40' of good ore averaging 61.80% iron and .085% phosphorus ^{so} but quite high up in the crotch ~~was~~ a second hole is being drilled North-westerly and a little flatter, $-43\frac{1}{2}^{\circ}$, to try and catch the ore deeper and farther to the West. It struck good ore at 275' and was still in it at 330' on the last of the year. This ore averaged 61.11% iron and .242% phosphorus.

REPUBLIC MINE.

Drilling was carried on in this mine until the middle of May when it was discontinued for the rest of the year. Ten new holes were completed and one old one deepened during this period. One hole, No.404, was drilled vertically from the 2080' level No.9 shaft expressly to determine the dip of the quartzite hanging wall contact about 150' below the 2080' level in order to plan the position of a vertical winze from this level. The rest of the holes, all horizontal, were drilled for general exploratory purposes and in connection with the development work along the ore lenses.

Seven holes were drilled from 1335' level to the West of the Pascoe shaft, but the first, No.406, was the only one to find ~~the~~ a commercial quantity of merchantable ore. It encountered 23' averaging 67.00% iron and .070% phosphorus. Since then the ore has been practically stoped out above the level. Additional drilling will be done from this level to more thoroughly explore the West Republic basin after a drift has been driven well out into the hanging wall.

The results from drilling in the Republic mine will never be spectacular with regard to the discovery of ore except perhaps in special cases where exploratory drifts are first driven well out into the hanging from which radiating holes may be drilled back to the quartzite-jasper or hanging wall contact. By this I do not insinuate that drilling is not necessary, - it is by all means in locating the smaller lenses back towards the footwall.

GEOLOGICAL DEPARTMENT.

It is a clearly demonstrated fact that most, yes practically all, of the large ore lenses in this mine are found to be very close to the hanging or jasper-quartzite contact. This region on a new elevation or level cannot be advantageously reached by drilling from levels above so drifts must be driven along it. It is therefore by this slow and expensive means and not by drilling that the larger ore bodies will be discovered. Smaller ore lenses are found farther back in the footwall which jasper and they are the ones ~~was~~ depend on drilling for discovery and development. The hanging contact drifts also serve as good locations from which the footwall formation can be advantageously explored by drilling.

EXPLORATIONS BY OTHER COMPANIES.

Mr. Ernest Allen continued to visit the explorations of other companies on the Michigan and Wisconsin iron ranges. He has prepared maps of these explorations and also written special reports covering each visit, giving detailed information thus acquired.

This entire work, as given in the accompanying table, No.V, cost \$254.22, of which \$147.79 was Mr. Allen's salary while engaged in it and the balance, \$106.43, his travelling expenses.

Mr. Afuhs has copied for our files all outside exploration results of any importance which have come to this office in the form of land offers, etc. The proportional time required was so small that no separate cost of this work was kept.

TABLE V.

DETAIL STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1918.

GEOLOGICAL DEPARTMENT.

<u>Salaries.</u>	<u>Travel.</u>	<u>Operating Auto.</u>	<u>Supplies.</u>	<u>Office Expense.</u>	<u>Total.</u>
\$16,694.85	\$329.64	\$796.56	\$1,409.31	\$4.89	\$19,235.25

DETAIL OF THE LARGER ITEMS GROUPED AS SUPPLIES.

1 Special steel filing cabinet	-	-	\$103.50
Labor and material making filing case	123.02		
Rental of Maas Patent Drill Hole			
Compass	50.00		

EXPENSES OF H. L. SMYTH.

<u>Travel.</u>	<u>Supplies.</u>	<u>Misc.</u>	<u>Total.</u>
\$661.14	\$17.72	\$85.00	\$763.86

EXPENSES ACCOUNT VISITING OUTSIDE EXPLORATIONS.

<u>Salaries.</u>	<u>Travel.</u>	<u>Total.</u>
\$147.79	\$106.43	\$254.22

SUMMARY.

Expenses of Geological department	-	\$19,235.25
Expenses of H. L. Smyth	-	763.86
Expenses a/c visiting outside explo- rations	-	254.22
Grand total		\$20,253.33.

TABLE VI.

COMPARATIVE STATEMENT OF CHARGES TO THE GEOLOGICAL DEPARTMENT FOR THE

LAST THREE YEARS.

	<u>1918.</u>	<u>1917.</u>	<u>1916.</u>
Salaries - - - - -	\$16,694.85	\$13,130.41	\$13,282.44
Travel - - - - -	329.64	221.55	30.02
Operating auto - - - - -	796.56	286.49	0
Supplies - - - - -	1,409.31	1,043.59	961.20
Visiting outside explorations -	254.22	105.49	110.55
Miscellaneous - - - - -	4.89	12.23	125.36
Total	\$19,489.47	\$14,799.76	\$14,509.57
Expenses of Mr. H. L. Smyth, i.e. travel, supplies and miscellaneous	763.86	569.05	764.80
Grand total	\$20,253.33	\$15,368.81	\$15,274.37

The increase in the item of salaries is of course due to two reasons:

1. The larger force employed as seen from Table III.
2. The war time increases in individual salaries.

The remaining items also show increases over the previous years from perfectly obvious causes, namely, excessive war time expenses of travelling, costs of supplies, etc; also the much greater volume of work handled by this department in 1918.

ANGELINE MINE

The changing of the old hoist for electric drive was completed and the hoist put in service in May. The electric equipment consists of a 250 H.P., 600 R.P.M., General Electric, wound rotor motor, with full magnetic control. The motor is coupled to intermediate herringbone gears formerly used on the hoist at the Cliffs Shaft Mine. This outfit has given excellent service. A view of this is shown on Plate # 161.

A motor-generator set was installed for the underground haulage. This is a 100 K.W. set made by the Westinghouse Electric & Manfg. Co., with 150 H.P. synchronous motor coupled to and mounted on common bedplate with 250 volt compound wound generator. The usual standard switchboard equipment is provided. This outfit is shown on Plate #: 162.

A gravity top tram system was installed, using a 10 H.P. motor from the Holmes Mine for pulling back the empty car.

A 5" four-stage Cameron centrifugal pump was installed on the second level. This has a capacity of 500 gallons per minute against 500 ft. head. It is driven by an Allis-Chalmers induction motor rated at 100 H.P., 1800 R.P.M., 2200 volts. Shaft cable for this is our standard submarine armored type, three conductor, #6 gauge.

CLIFFS SHAFT MINE

The equipment at this mine has been satisfactory and few changes were necessary.

The 20 H.P. lower tram motor was taken out and replaced by a 35 H.P. motor.

As a safeguard reinforcing spiders were installed inside the main hoisting drums, increasing the strength of the shells sufficiently to withstand strains.

HARD ORE

There were no changes or additions made to the Shops or Heating Plant.

HOLMES MINE

The apparatus has operated well with a few exceptions. Some trouble developed in the Laidlaw-Dunn-Gordon compressor, apparently due to high temperatures. It appears that this will eventually be corrected.

A safety limit switch device to prevent overwind when the lower chutes in the skip compartment are used was made and installed. This prevented at least one accident due to over-travel of skip.

On account of increased flow of water in the adjoining mine it became necessary to make an immediate installation of pumping equipment in December. This was done by the installation of 1000 G.P.M., 1000 ft. head, centrifugal pump borrowed from the Mackinaw Mine. A plunger pump with capacity of 150 G.P.M. against 1000 ft. head has been ordered for this service and it is hoped to install this the first part of the year. This will release the large centrifugal pump.

The 10 H.P. motor driving the screens was taken out and replaced by a 20 H.P. motor from the Cliffs Shaft Mine.

LAKE MINE

The mechanical equipment at this mine operated satisfactorily and no changes or additions were made during the year.

SALISBURY MINE

The mechanical equipment at this mine operated satisfactorily and no changes or additions were made during the year.

ATHENS MINE

A horizontal duplex pump made by The Prescott Company of Menominee was installed on the 2400 ft. level. This pump has a capacity of 500 G.P.M. against 2400 ft. head and is one of the highest lifts for which a pump has been built. Some trouble occurred due to defective castings, but these have been replaced and the pump is very satisfactory. It is driven by a Westinghouse wound rotor motor, 400 H.P., 514 R.P.M., direct coupled to counter shaft and through herringbone gears to pump shaft. This pump was started up on November the 1st. This unit is shown on Plate # 163 .

Two of our standard single sheave top tram plants were installed. These are driven by 50 H.P. Westinghouse motors at 600 R.P.M. and are supplied with magnetic primary control. These plants were started up in April.

A General Electric 100 K.W. synchronous converter with transformers was installed on the 2400 ft. level, taking current at 2300 volts from the shaft cable. This avoids the installing of an expensive shaft cable for the underground haulage and is our first installation underground of this class of equipment. It is satisfactory. This converter was started up in April.

A 30 H.P. motor was installed in Carpenter Shop to drive saw, and a small motor in Laboratory for the crushing rolls.

MAAS MINE

Considerable trouble has occurred in the boiler plant due to the excessive demand for steam to operate the turbine, which has been in service nearly the whole year. The hard firing destroys the fire arches and walls.

The cage hoist has not stood up well and caused about five days delay. This must be replaced by an electric drive as soon as it can be done.

A quintuplex belt driven Aldrich pump was installed on the second level to care for additional water underground. This has a capacity of 600 G.P.M., against 1200 ft. head, and is belt driven by a 250 H.P. General Electric motor. It is entirely satisfactory. This pump was started on October 16th and is shown on Plate # 164 .

MAAS CRUSHING PLANT

No changes were made and plant operated satisfactorily.

NEGAUNEE MINE

All of the equipment at this mine gave good service during the year.

The underground ventilating fan was taken out and sent to the Athens Mine.

SOUTH JACKSON CRUSHER PLANT

The crusher was only operated during the month of may. The compressor was run nearly the whole year furnishing air for the work in the pit.

BARNES-HECKER MINE

The permanent cage hoist was installed the latter part of the year and will be put in service in January. This is a Lake Shore Engine Works hoist, with 10' x 7' drum winding 2000 ft. of 1 $\frac{1}{4}$ " rope. It is driven by a General Electric 400 H.P., 2200 volt, 360 R.P.M., motor with single reduction herringbone gears. The motor has full magnetic control. A view of this is shown on Plate # 165.

LLOYD MINE

All equipment operated satisfactorily.

New herringbone gear and pinion were put on the skip hoist.

MORRIS MINE

Motor on top tram was changed from a 25 H.P. to a 50 H.P.

New gear and pinion were put on #1 underground pump.

Other apparatus operated satisfactorily.

SECTION 6 SHAFT

No changes were made in the equipment at this plant and everything operated satisfactorily.

AUSTIN MINE

This mine, due to its flooded condition, has been shut down the whole year.

In March a 500 G.P.M. Prescott sinking pump was started operating in one skipway and in April a 1000 G.P.M., 300 ft. head, Worthington electric driven sinking pump was started in the second skipway. With these pumps throwing approximately 1750 G.P.M. the water fell very slowly, and in conjunction with the pump operating in the Stephenson shaft the water has at times been lowered to a depth of 176 ft. below the collar of the Austin shaft.

FRANCIS MINE

In August the 6-3/8" x 36" Prescott Pot Form Mine Pump was installed on the 1060 ft. level and put into operation. This has a capacity of 1000 G.P.M., against 1100 ft. head, and is driven by a 350 H.P., 2200 volt, 3 phase, 60 cycle, 600 R.P.M., synchronous motor at 580 R.P.M. The pump worked very satisfactorily after some minor adjustments and alterations were made. A view of this is shown on Plate # 167.

During August a serious overwind occurred on the skip hoist, considerable damage resulting. The hoisting engineer frankly admitted that he was at fault as he neglected even trying to stop the hoist until it was too late.

In November the installation of the cage hoist counterbalance pipe was completed. The installation of the hoist was also completed. This was furnished by the Lake Shore Engine Works. It has a 10' x 7' drum and is driven by a 400 H.P., 360 R.P.M., 2200 volt, 3 phase, Type I, General Electric induction motor. This is shown on Plate # 166.

FRANCIS MINE

(Cont'd)

During the year the 100 K.W. synchronous converter for the underground haulage system was installed in the engine room. This will be put into operation, with two locomotives underground, shortly after the 1st of January.

In September the rotor burst on the 400 H.P., 1760 R.P.M., motor driving the 1000 G.P.M., 1060 ft. head, Allis-Chalmers centrifugal pump on the 800 ft. level. The motor was repaired at the Hard Ore Shops and returned to the mine. In the meantime the pump was moved to the 1060 ft. level where the permanent pump station is located. A view of this pump is shown on Plate # 168.

The rock crusher which was loaned to the McClure Plant for construction work was returned and re-installed for crushing rock for the Township highways.

GARDNER MINE

During the month of June the hoist was shipped up with the cage and skip in balance, which was the original plan for the permanent equipment.

In the month of August the construction of the underground haulage system was completed and its operation started. Electric current for operating this is taken from the Mackinaw underground haulage system.

A top tram plant of the gravity type, with the loaded cars running out from the shaft house on an inclined track and the tram engine drawing them back, was installed in the month of December.

MACKINAW MINE

In February the 10" pump discharge column to the 800 ft. level was installed.

In May a 200 G.P.M., 1000 ft. head, Aldrich triplex pump, driven by a 75 H.P. Westinghouse motor, was installed in a temporary pump house on the 800 ft. level. This pump was intended to operate while the permanent pump house and sumps were being cut and the permanent pumps were being installed.

MACKINAW MINE

(Cont'd)

The main pump houses and sumps are now completed and the 1000 G.P.M., 1000 ft. head, Aldrich quintuplex plunger pump is being installed.

GWINN MINE

During the month of October a 30 H.P. electric driven 36" x 36" Lake Shore Engine Works hoist was installed on the 9th level for hoisting from the 10th level. This is driven by a direct current motor taking current from the underground haulage system.

No other installations and no changes were made at this mine.

GWINN CRUSHING PLANT

No changes or alterations were made at this plant during the year. Its operation was entirely satisfactory.

GWINN SUBSTATION

This station stands as completed in 1917, with no changes. Its operation is satisfactory.

JOPLING MINE

Nothing in the mechanical or electrical line was done at this mine during 1918.

PRINCETON MINE NO. 1

The old hoist and motor was removed from this shaft and taken to the new engine room at Princeton #3. The underground pumps are all that is left of the mechanical equipment at this shaft.

PRINCETON MINE NO. 2

A rotary dump for emptying the underground haulage cars into the skip loading pockets on the 5th level was installed during the year. This was furnished by the Wood Equipment Company of Chicago. It works very

PRINCETON MINE NO. 2 (Cont'd)

well and very much facilitates and cheapens the process of handling and dumping the loaded cars, particularly so with the sticky ore such as this mine produces.

One of the tram plants at the Stephenson Mine was dismantled and moved to Princeton #2 during the summer. It is one of the 8 ft. sheave type, operated with a 50 H.P. motor and used for spotting the cars at the loading pocket for shipping.

A permanent pump house is being cut on the 376 ft. level, with storage sumps, etc. Permanent pumps will be located here for pumping the water from the Princeton #1 and 2 shafts. After these are installed the old pump house and pumps at #1 Shaft will be discarded.

PRINCETON MINE NO. 3

At this shaft a headframe of wood construction was erected and an engine house built. The old hoist from Princeton #1 was rebuilt and installed, with the cage in balance. It is used principally for lowering timber.

PRINCETON CENTRAL POWER PLANT

A coal crushing plant was installed and placed in operation during the month of February. This was built by the Link-Belt Company. Its purpose is to crush all coal for the Murphy stokers to slack size and deliver it into the hoppers above the stokers. Its operation is all that could be desired.

A small centrifugal pump of 50 G.P.M. capacity, 30 ft. head, driven by a 3 H.P. motor, was taken from the Mackinaw Mine and installed at this Plant for pumping circulating water through the water jackets of the Allis-Chalmers air compressor when the compressor circulating pump became worn out. This installation is only temporary. A 50 G.P.M., 50 ft. head, 7 H.P., centrifugal pump has been ordered for this place, which will be the permanent equipment.

PRINCETON PUMP STATION

No changes were made in this plant during the year.

STEPHENSON MINE

Up until July no headway was made in unwatering the Stephenson or Austin mines.

In March a 500 G.P.M. Prescott steam sinking pump was installed in the Austin shaft and in April a 1000 G.P.M. electric driven sinking pump was installed in this same shaft. These two pumps have since operated continuously.

An air lift in the Stephenson shaft delivers 250 G.P.M. and a Prescott steam sinker 500 G.P.M.

With the above pumping equipment handling 2450 G.P.M., and the bailers operating continuously in the Stephenson shaft, the water stood at 129'6" below the collar of the Stephenson shaft on July 1st and was practically at a standstill.

On July 19th a 2000 G.P.M. Layne & Bowler turbine pump was started at the Stephenson and the water lowered 8 ft. after approximately a weeks run.

Much trouble was encountered with the belt driving this pump. Many changes were made in the setting, bettering it to a certain degree, but it was found impossible to get the pump up to speed and capacity and keep it there for any length of time. After running about two weeks the belt failed entirely and a new one was ordered. During this time the water had on two occasions been lowered 8 ft., but both times rose to 129'6" below the collar of the shaft when the pump was stopped.

A new 7-ply Dick belt was ordered, also a larger pulley. These were installed on August 28th, but it was found with the larger pulley and the stiffer and heavier belt that it was impossible to keep the belt on the pulleys with the higher belt speed.

By changing back to the smaller drive pulley on the motor the pump

STEPHENSON MINE (Cont'd)

was finally gotten into continuous operation on September 6th. At the end of September, after a continuous run of 24 days and pumping approximately 4500 to 4700 G.P.M., the water was lowered to 146'7" below the collar of the Stephenson shaft, representing a fall in the water level of 18'1". Since this date the pumping has gone on as continuously as possible, with all pumps working and throwing approximately 4500 to 4700 G.P.M., and the water has been going down very slowly.

At the end of the year the water stood 159 ft. below the collar of the Stephenson shaft, with little hopes of any betterment in the situation until other pumps arrive to materially increase our pumping capacity.

CROSBY MINE

On October 18th a Sullivan, Class W.G.4, 12" x 12", compressor was shipped from the Hard Ore Yard to the Crosby Mine. This was originally used on construction work at the Hoist Plant. It will be driven from one of the pump motors in the power house.

No other additions were made and there were no changes in the mechanical equipment.

HELMER MINE

In January a second hand Platt Iron Works centrifugal pump was bought for this mine. This has capacity of 1000 G.P.M. against 230 ft. head, and is driven by 100 H.P. General Electric, Type I, 3 phase, 60 cycle, 2200 volt, slip ring motor.

MEADOW MINE

Another gasoline locomotive was purchased for this mine.

WADE MINE

The equipping of this mine was commenced early in the year. The temporary equipment is steam driven. The permanent equipment will all be electric driven. The power house is a brick structure.

SHAFT HOUSE

This is wood structure, with steel dump plates and chutes. Four head sheaves were secured from the Imperial Mine.

BOILER PLANT

Two 72" x 18' Freeman boilers, with all necessary fittings, were secured from the South Jackson Plant.

TEMPORARY HOIST

A Webster, Camp & Lane double drum steam hoist was shipped from the Francis Mine in March. This was originally bought for underground use at the Lake Mine, was afterwards used in sinking the Maas Mine shaft and later used in sinking the Francis Mine shaft. The drums are 48" x 48".

PERMANENT HOIST

This will be a 5' x 5' single drum Lake Shore Engine Works hoist, and will be driven by a 125 H.P. Westinghouse motor. This outfit will probably be received and installed early in 1919.

TEMPORARY COMPRESSOR

A Sullivan straight line compressor, Class W.B.2, steam cylinder 18" x 20", air cylinder 12 $\frac{1}{2}$ " x 20", was shipped from the Imperial Mine in April.

PERMANENT COMPRESSOR

A Sullivan duplex, belt driven, two stage, compressor, driven by a 150 H.P. Westinghouse motor, will be shipped from the McClure Plant early in 1919.

ELECTRIC HAULAGE

A General Electric 100 K.W. synchronous converter, three 6-ton General Electric locomotives and 10 - 65 cu. ft. Lake Shore Engine Works tram cars were ordered for the haulage system. All of this equipment was received and will be installed early in 1919.

UNDERGROUND PUMP

An Aldrich 10" x 10" triplex pump, capacity 600 G.P.M. against 250 ft. head, was received on November 23rd. A 50 H.P. Westinghouse motor for driving this was shipped from the General Storehouse on December 10th.

VENTILATING APPARATUS

A #10 exhauster, driven by a 15 H.P. General Electric motor, was purchased from the Buffalo Forge Company for underground ventilation.

A 10 H.P. General Electric motor was purchased for operating the shop equipment.

Current for operating the electrical equipment will be purchased from the Great Northern Power Company.

IMPERIAL MINE

This mine has been completely dismantled with the exception of the hoist and steel headframe. All of the coal was removed and shipped to the Maas Mine. One compressor was shipped to the Wade Mine and the other to the Hard Ore Yard for storage.

REPUBLIC MINE

A brick power house was built at #9 Shaft during the year.

The new hoist for #9 Shaft has not yet been received. The two 500 H.P. General Electric motors for driving this hoist were received. This hoist will be delivered and installed early in 1919.

REPUBLIC MINE

(Cont'd)

A small hoist, with 5' x 5' drum, was ordered from the Lake Shore Engine Works for the Pascoe Shaft winze. This will be driven by the 150 H.P. motor now driving the Austin Mine hoist.

A small hoist, with 4' x 6' drum, was ordered from the Lake Shore Engine Works for the #9 Shaft winze. This will be driven by a 50 H.P. motor from General Storehouse stock.

These two hoists will be installed early in 1919.

SPIES MINE

There were no changes or additions to the equipment at this mine.

DEAD RIVER HOIST PLANT

A leak developed in the pipe line between the surge tank and the power house at the Hoist Plant. This pipe line is about 250 ft. long and was built over a sand hill which sloped steeply to the power house at an angle of 45°. At the top of this hill a leak developed which undermined the pipe line, causing it to settle badly and threatening its destruction. It was thought best to remove the pipe line and wash the hill down hydraulically and rebuild it on ledge. This necessitated washing down the hill to a depth of 50 ft. in one place. The pipe line was removed and the river opened up, which washed out the sand to the ledge and the pipe was then rebuilt on the ledge. This makes a thoroughly good job, without possibility of similar trouble occurring. This work caused a shut down of the plant for two weeks time.

MCCLURE PLANT

Work continued throughout the entire year. Progress was disappointingly slow on account of labor shortage and extremely poor class of men available.

The dam is complete with exception of some backfilling on north end and closing in a 10 ft. gap through which water now passes. This gap will be closed when we are ready to fill pipe line.

The wood pipe people pronounce their pipe ready for test. The surge tank, which is located on this portion of the line, is complete. The steel pipe is about 80% complete.

The power house and machinery is in readiness to operate as soon as pipe line is tested and water available.

Backfilling on pipe and cleaning up various odd jobs will take about seven months more with comparatively small force of men.

ELECTRICAL DEPARTMENT

The year 1918 has been a very hard year for the operation of the Electric Plants and a continual strain to supply power sufficient for our needs.

The amount of power called for has at times been in excess of the amount we could produce. In January and February it was necessary to occasionally shut down part of the mine service, although we had installed an extra boiler plant at the Meas Mine to furnish additional steam for the operation of the turbine. Fortunately later in the year precipitation somewhat above the average gave some relief and a very mild winter, starting late in the season, also helped us to get through. Practically we were short of power throughout the year.

Two burnouts in the generator at the Hoist Plant, causing shut downs, and a break in the pipe line at the same plant added to the embarrassment.

The Au Train Plant was in full service and gave us nearly a maximum output throughout the season. Had it not been for this service we would not have been able to carry the load. This plant gave excellent service throughout.

The call for men for army service at times disturbed our operating force, requiring the use of men of limited experience to fill their places.

Considerable transmission line trouble developed due to insulator failures, but by the end of the year this had been pretty well corrected.

Our transmission losses increased quite appreciably due to various causes; partly on account of the impossibility of having close inspection of meters and other apparatus on account of shortage of competent help for this class of work, also the addition of large transformer capacity at new Substations, giving fixed transformer losses without the additional load to reduce the percentage. As the year closes we are correcting this condition and expect to have our losses down to normal again within a short time.

The usual educational work in this department was not taken up on account of the influenza epidemic, but arrangements have been completed for

ELECTRICAL DEPARTMENT (Cont'd)

a series of illustrated lectures starting after the first of the year.

A high tension transmission line was built from the North Lake Substation to the Barnes-Hecker Mine. This consists of two 30,000 volt circuits on 35 ft. cedar poles, using #6 copper wire. A high tension circuit breaker and lightning arrester, together with two sets of transfer switches, were installed at the North Lake Substation, giving a flexible service. The Substation at the Barnes-Hecker Mine was put into service the latter part of the year. This consists of pole structure, transfer switches on a steel tower structure, lightning arrester and three 250 K.V.A., 30,000/2300 volt outdoor transformers and a steel outdoor meter cabinet.

One circuit of this line has been built through to Republic, using 30 ft. cedar poles and #6 wire. The Substation at Republic Mine is a steel tower structure with lightning arrester and three 400 K.V.A. outdoor transformers. This Substation has not yet been put in service.

The generator which was installed at the Water Power Plant at Republic in 1917 has been giving good service handling the electrical load at this mine. It will be connected up with our main system when the Substation is connected in.

The line from Gwinn to Au Train was finished up and some necessary changes made, which could not be done last year on account of our need for power.

The line from Au Train to Munising has been changed from 13,000 to 30,000 volts and Substation equipment installed at Munising. This consists of three 200 K.V.A., 30,000/2200 volt, General Electric outdoor transformers and steel tower structure with switches and lightning arrester. Two outdoor metering stations have been provided. This station was not put in service on account of a shortage of power.

The insulators taken from the Au Train line were used to improve the line from the Carp River line to the Pioneer Furnace, and since putting on these high voltage insulators we have had no trouble on this line.

ELECTRICAL DEPARTMENT (Cont'd)

A primary line was built and put in service from the Brownstone Substation to the new Ishpeming Hospital and we are supplying power and light for this institution.

The work of changing Gwinn feeders into Gwinn Substation was completed.

Everything considered we are well pleased with the operation of the Electric Plant during the year.

During the year the following additions were made to pole lines and circuits.

	<u>NEW LINES BUILT</u>	<u>POLE LINE</u>	<u>CIRCUIT</u>	<u>WIRE</u>
North Lake to Republic	- #6	70,000 ft.	80,000 ft.	240,000 ft.
McClure Plant to tower line	- #2	42,200	42,200	126,600
Au Train to Munising	- #2	75,000	75,000	225,000
(rebuilt & taken into system)		187,200 ft.	197,200 ft.	591,600 ft.

Total miles High Tension 3 phase line	-	105.
" " " " " " wire	-	436
" number " " Towers	-	377
" miles 3 phase Primary Line	-	37
" " " " " wire	-	113
" " Primary Pole Line	-	37

ELECTRICAL DEPARTMENT (Cont'd)

CARP RIVER HYDRO-ELECTRIC PLANT

SUMMARY OF OPERATING CONDITIONS - 1918

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation	1.65	1.61	0.45	1.19	4.76	2.47	2.28	2.84	4.75	3.74	3.80	1.51
Total precipitation for 1918 (Ishpeming)	- 31.05 inches.											
Average " at Marquette	- 32.8 " (46 years record)											
Drainage area above Intake Dam,	66.66 sq. mi.											
Cubic feet Precipitation in 1918,	4,808,000,000											
K. W. Hrs. generated at Carp River Plant in 1918,	16,043,300											
Cubic feet water utilized (90 cu. ft. = 1 K.W.H.)	1,443,897,000											
" " " in Storage Basin Jan. 1, 1918,	155,727,000											
" " " " " " Dec. 31, "	266,608,000											
" " " stored in 1918 - not used,	110,981,000											
" " " wasted over Intake Dam in 1918,	122,976,000											
Total run-off for the year 1918,	1,677,854,000 cu. ft.											
Run-off per sq. mile of drainage area,	25,173,364 " "											

ELECTRICAL DEPARTMENT (Cont'd)

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

	<u>INSTALLED</u> <u>TO JAN. 1,</u> <u>1918</u>	<u>INSTALLED</u> <u>TAKEN OUT</u> <u>IN 1918</u>	<u>CONNECTED</u> <u>JAN. 1, 1919</u> <u>TOTALS</u>
CARP RIVER POWER HOUSE -			
Auxiliaries - 2 - 15 HP pump motors	30 HP.		
Water Supply Pump	<u>1</u>		
			31 HP.
ANGELINE MINE -			
Hoist		250 HP.	
Underground Haulage Set	150		
Top Tram (from Holmes)	10		
Underground Centrifugal Pump	100		
"Happy Hollow" Hoist (from Negaunee #2 Shaft)	<u>25</u>		
			535
CLIFFS SHAFT MINE -			
Shop	25		
No. 8 Crusher	125		
No. 5 Crushers - 2 - 25 HP. motors	50		
Screens	15		
Top Tram	50		
Lower Tram	<u>20</u>		
Underground Haulage Set	100		
Hoist "A" Shaft	500		
Underground Plunger Pump No. 1	180		
" Centrifugal Pump	250		
Compressor	175		
Hoist "B" Shaft	500		
Underground Plunger Pump No. 2	200		
Laboratory Crusher	5		
Coal Crushing Plant	15		
" " " Exhaust Fan		$\frac{1}{2}$	
Lower Tram		<u>35</u>	
			2,225 $\frac{1}{2}$
HARD ORE -			
Machine Shop	7 $\frac{1}{2}$		
Carpenter Shop	25		
Blacksmith Shop Punch	<u>3</u>		
			35 $\frac{1}{2}$
HOLMES MINE -			
Air Compressor	340		
" " Cooling Water Pump	3		
Skip Hoist	400		
Cage "	400		
Underground Haulage Converter (correction)	125 +	25	
Machine Shop	7 $\frac{1}{2}$		
Top Tram	25		
No. 8 Crusher	100		
No. 6 Crushers - 2 - 40 H.P. motors	80		
Screens (sent to Angeline)			10
" (from Cliffs Shaft)		20	
Laboratory Grusher (correction)	3 minus		1
Underground Centrifugal Pump (from Mackinaw)		<u>400</u>	
			1,927 $\frac{1}{2}$
	3,740 HP.	1,015 $\frac{1}{2}$ HP. (30)	<u>4,754$\frac{1}{2}$ HP.</u>
fwd.,	<u>less 1</u>		
	3,739 HP.		

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1918	INSTALLED IN 1918	TAKEN OUT IN 1918	TOTAL CONNECTED DEC. 31, 1918
	brt. fwd.	3,739 HP.	1,015½ HP.	(30)
				4,754½ HP.
LAKE MINE -				
Underground Haulage Set	215			
Surface Drainage Pumps - 2-30 H.P. motors	60			
" " Pump	50			
" " "	20			
Underground Plunger Pump	75			
" Centrifugal Pump	125			
" Ventilating Fan	40			
Ore Crusher	25			
Surface Drainage Pump	5			
Coal Crushing Plant	<u>15</u>			
				630
SALISBURY MINE -				
Hoist	400			
Underground Centrifugal Pump	400			
" Plunger "	100			
Compressor	150			
Underground Ventilating Fan	7½			
Compressor Cooling Water Pump (correction)	2			(previously reported 5 HP)
Surface Drainage Pump	<u>30</u>			
				1,089½
ATHENS MINE -				
Cage Hoist	400			
Compressor	325			
" Cooling Water Pump	3			
Auxiliary Compressor (for hoist brakes)	5			
Rock Hoist (on hand)			25	
Underground Ventilating Fan (correction)	7½ +		7½ (should be 15 HP)	
Sinking Pump (1080 ft. station)	35			
" " (2400 " ")	50			
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Converter		150		
Skip Pit Pump		2		
Laboratory Sample Crusher		5		
Underground Plunger Pump		400		
Top Tram - 2 - 50 H.P. motors		100		
Carpenter Shop (from McClure Plant)		<u>20</u>		
				2,371½
MAAS MINE -				
(Circulating Pump)	40			
Turbine Auxiliaries (Injection)	25			
(Exciter)	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist	50			
" Plunger Pump	320			
Winse Pump (4th level)	15			
Cooling Water Pump	5			
Skip Pit Hoist	15			
Top Tram - 2 - 50 HP. motors	100			
Induced Draft Fan (on hand)			40	
Coal Crushing Plant	15			
" " " Exhaust Fan				
Underground Plunger Pump (from Holmes)		<u>250</u>		
				1,443½
	fwd.	8,338 HP.	1,950½ HP.	(95)
				10,288½ HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1918	INSTALLED IN 1918	TAKEN OUT IN 1918	TOTAL CONNECTED DEC. 31, 1918	
	brt. fwd.,	8,338 HP.	1,950½ HP.	(95)	10,288½ HP.
MAAS CRUSHING PLANT -					
Crusher	100				
Pan Conveyor	50				
Belt Conveyor	<u>50</u>				
					200
NEGAUNEE MINE -					
Underground Haulage Set	215				
"Ilgner" Hoist Set	450				
Top Tram - 2 - 50 HP. motors	100				
Laboratory Crusher	5				
Auxiliary Compressor (for hoist brakes)	3				
U.G. Plunger Pumps - 2 - 300 HP. motors	600				
" Centrifugal Pump	350				
" Suction Pumps - 2 - 15 HP. motors	30				
Compressor Cooling Water Pump	5				
Air Compressor	325				
Shop	15				
Skip Pit Pump	5				
Underground Hoist	35				
Ore Crusher	25				
U.G. Ventilating Fan (sent to Athens)				15	
Timber Hoist - #2 Shaft (sent to Angeline)				25	
					2,163
SOUTH JACKSON CRUSHER PLANT -					
Hoist	75				
Compressor	50				
Crusher	<u>150</u>				
					275
BARNES-HECKER MINE -					
Cage Hoist			<u>400</u>		
					400
LLOYD MINE -					
Skip Hoist	400				
Cage "	400				
Top Tram	40				
" "	40				
Ore Crusher	<u>25</u>				
					905
MORRIS MINE -					
Skip Hoist	400				
Cage "	400				
Shop	25				
Water Supply Pump	40				
" " "	50				
Air Compressor (Ingersoll-Rand)	250				
U.G. Plunger Pumps - 2 - 350 HP. motors	700				
Laboratory Crusher	5				
Top Tram (on hand)				25	
" "	25				
" " (ordered for Barnes-Hecker)			50		
Underground Haulage Set	150				
Air Compressor (Nordberg)	325				
" " Cooling Water Pump	5				
Underground Hoist	200				
Winze Pump	50				
Centrifugal Pump	50				
Triplex Pump	<u>50</u>				
					2,775
	fwd.,	<u>14,606 HP.</u>	<u>2,400½ HP.</u>	(160)	<u>17,006½ HP.</u>

MECHANICAL DEPARTMENT

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1918	INSTALLED IN 1918	TAKEN OUT IN 1918	CONNECTED DEC. 31, 1918	TOTAL
SECTION 6 SHAFT -	brt. fwd.,	14,606 HP.	2,400½ HP.	(160)	17,006½ HP.
Hoist	200				
Water Supply Pump	<u>3</u>				203
AUSTIN MINE -					
Hoist	150				
Top Tram	25				
Laboratory Crusher (correction)	3			(previously reported 5 HP.)	
Vertical Sinking Pump		<u>150</u>			328
FRANCIS MINE -					
Underground Ventilating Fan (correction)	7½			(previously reported 7 HP.)	
Air Compressor	403				
Underground Centrifugal Pump	400				
Skip Hoist	400				
Compressor Cooling Water Pump	3				
Shop (correction)	5			(previously reported 10HP.)	
Top Tram	50				
Underground Haulage Converter		150			
Cage Hoist		400			
Underground Plunger Pump		350			
Rock Crusher (from McClure Plant)		<u>25</u>			2,193½
GWINN MINE -					
Skip Hoist	400				
Cage "	400				
Underground Centrifugal Pump	400				
" Plunger "	350				
Top Tram - Ore	37				
Underground Haulage Set	150				
Rock Tram	10				
Auxiliary Compressor (for hoist brakes) (stored at Central Shops)				3	
Shop	5				
9th Level Pump	35				
Underground Ventilating Fan		<u>15</u>			1,802
GWINN CRUSHING PLANT -					
No. 7½ Crusher	85				
Pan Conveyor	50				
Belt Conveyor	<u>40</u>				175
GARDNER MINE -					
Hoist	400				
Sinking Pump	35				
Top Tram		<u>25</u>			460
MACKINAW MINE -					
Hoist	400				
Sinking Pump	35				
Compressor	325				
Shop	7½				
Sinking Pump	7½				
Top Tram		25			
Underground Haulage Converter		150			
" Triplex Pump		100			
" " "		<u>75</u>			1,125
fwd.,		<u>19,427½</u> HP.	<u>3,865½</u> HP.	(163)	23,293 HP.

ELECTRICAL DEPARTMENT

(Cont'd)

	brt. fwd.,	INSTALLED TO JAN. 1, 1918	INSTALLED IN 1918	TAKEN OUT IN 1918	TOTAL CONNECTED DEC. 31, 1918
PRINCETON MINE NO. 1 -		19,427½ HP.	3,865½ HP.	(163)	23,293 HP.
Hoist (sent to #3 Shaft)				75	
Underground Plunger Pump		50			
" Centrifugal Pump		<u>50</u>			100
PRINCETON MINE NO. 2 -					
Hoist		200			
Top Tram		50			
" " (from Stephenson)			<u>50</u>		300
PRINCETON MINE NO. 3 -					
Hoist (from #1 Shaft)			<u>75</u>		75
STEPHENSON MINE -					
Underground Plunger Pump (under water)				250	
" Centrifugal " " "				275	
Top Tram (sent to Princeton)				50	
" " (on hand)				37	
" "		50			
6th Level Centrifugal Pump (on hand)				50	
Layne & Bowler Sinking Pump			250		
Centrifugal " "			<u>125</u>		425
PRINCETON CENTRAL POWER PLANT -					
(Circulating Pump)		50			
Turbine Auxiliaries (Injection " (Exciter)		25			
Underground Haulage Set		215			
Compressor		625			
Boiler Room Fan		25			
Coal Crushing Plant		15			
" " " Ventilating Fan				1½	
Circulating Pump				7½	
" " (from Mackinaw)				<u>3</u>	999
PRINCETON CENTRAL SHOP -					
Shop Motor		25			25
DEAD RIVER-McCLURE PLANT (Construction Work) -					
Air Compressor		150			
Pump		10			
Centrifugal Pump (on hand)				50	
Rock Crusher (sent to Francis)				25	
" " (" " Athens)				20	
					160
ISHPEMING HOSPITAL -					
Passenger Elevator				7½	
Dumb Waiter				3	
Large Washer				2	
Small "				1	
Extractor				2	
Vacuum Cleaner				3	
" Pump				<u>1</u>	19½
ATHENS MINE - (additional)					
U.G. Ventilating Fan (from Negaunee)			15		15
fwd., TOTAL,		<u>21,000½ HP.</u>	<u>4,411 HP.</u>	(995)	<u>25,411½ HP.</u>

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1918	INSTALLED IN 1918	TAKEN OUT IN 1918	TOTAL CONNECTED DEC. 31, 1918
brt. fwd.,	21,000 $\frac{1}{2}$ HP.	4,411 HP.	(995)	25,411 $\frac{1}{2}$ HP.
FURNACE DEPARTMENT (connected to our system)				
Motor-generator Set at Furnace	750			
Sawmill - 8 motors	445			
GRAND TOTALS,	<u>22,195$\frac{1}{2}$ HP.</u>	<u>4,411 HP.</u>		<u>1,195</u> 26,606 $\frac{1}{2}$ HP.

The following motors are on hand (Dec. 31st, 1918), but are not installed:

GENERAL STOREHOUSE -			
Spare Hoist Motor		400 HP.	
" Motor-Generator Set		150	
" " " "		15	
"		50	
" (from Maas Fan)		40	
"		30	
"		25	
"		10	
"		10	
" (from McClure Plant)		7 $\frac{1}{2}$	
"		<u>5</u>	
			742 $\frac{1}{2}$ HP.
ATHENS MINE -			
Rock Hoist		<u>25</u>	
			25
BARNES-HECKER MINE -			
Skip Hoist		400	
Water Supply Pump		<u>10</u>	
			410
MORRIS MINE -			
Top Tram		<u>25</u>	
			25
NEGAUNEE MINE -			
Flywheel Set		350	
Underground Triplex Pump		15	
Compressor for Charging Air Chambers on U.G. Pumps		<u>2</u>	
			367
AUSTIN MINE -			
Hoist		200	
Spare		<u>3</u>	
			203
FRANCIS MINE -			
Centrifugal Pump (at McClure Plant)		50	
(Loaned to Munising Woodenware Co.)		<u>100</u>	
			150
GWINN MINE -			
Auxiliary Air Compressor (at Central Shops)		3	
Top Tram (for Francis)		<u>37</u>	
			40
	fwd.		1,962 $\frac{1}{2}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

Motors on hand. brt. fwd., 1,962½ HP.

MACKINAW MINE -			
Underground Plunger Pump		<u>350</u> HP.	350
STEPHENSON MINE -			
U.G. Plunger Pump (under water)	250		
" Centrifugal " " "	275		
" Plunger Pump	250 *		
" Centrifugal "	275 *		
" " " - 6th Level	50		
" Plunger " - (at General Storehouse)	<u>50</u>		
		<u>1,150</u>	
Total on Hand 12/31/18,			<u>3,462½</u> HP.

The following motors have been ordered, but not received:

CLIFFS SHAFT MINE -			
Air Compressor	400		
" "	<u>400</u>		800 HP.
HOLMES MINE -			
Underground Plunger Pump	<u>50</u>		50
LAKE MINE -			
Air Compressor	<u>400</u>		400
MAAS MINE -			
Air Compressor	<u>400</u>		400
NEGAUNEE MINE -			
Air Compressor	400		
Underground Pump	75		
" "	<u>75</u>		550
BARNES-HECKER MINE -			
Underground Plunger Pump	350		
" " "	<u>50</u>		400
PRINCETON MINE -			
Underground Plunger Pump	150		
" Centrifugal Pump	<u>125</u>		275
STEPHENSON MINE -			
Vertical Motor for L. & B. pump	250		
" " " " "	<u>350</u>		
		<u>600</u>	
Total Ordered 12/31/18,			<u>3,475</u> HP.

Motors connected Dec. 31st, 1918 (including Furnace)		26,606½ HP.
" on hand " " " (not installed)		<u>3,462½</u> "
" ordered " " " (not received)		<u>3,475</u> "
	GRAND TOTAL,	<u>33,544</u> "

* Note:-
To replace motors lost when mine was flooded.

ELECTRIC POWER SYSTEM

SUMMARY OF OPERATIONS - 1918

Month	KILOWATT HOURS GENERATED						Used by Auxiliaries	K. W. H. TRANSMISSION		Cost Per K. W. H. (Incl. Depr.)
	Carp	Dead	Au Train	Maas	Princeton	TOTAL		Sold	Losses	
Jan.	1,065,600	378,300	138,036	556,600	279,850	2,418,386	81,440	2,011,290	13.93%	\$.01329
Feb.	818 800	288 150	100 600	647 200	250 400	2 105 150	83 925	1 712 012	15.30	.01646
March	1 214 500	451 500	186 810	360 400	269 050	2 482 260	62 175	2 121 434	12.34	.01170
April	1 456 200	621 700	614 880	3 200	0	2 695 980	7 680	2 218 232	17.49	.00560
May	1 630 100	589 525	535 460	12 950	0	2 768 035	8 580	2 340 782	15.17	.00548
June	1 705 600	279 225	517 420	299 300	54 200	2 855 745	33 390	2 358 613	16.43	.00861
July	1 418 900	473 750	346 160	464 250	46 900	2 749 960	37 680	2 335 095	13.91	.00889
Aug.	1 370 900	403 850	262 880	471 700	285 250	2 794 580	64 330	2 374 220	13.04	.01152
Sept.	1 286 500	483 150	546 640	406 300	242 750	2 965 340	63 940	2 352 014	18.94	.01156
Oct.	1 312 400	525 900	547 600	380 150	223 900	2 989 950	67 825	2 393 352	18.10	.01056
Nov.	1 235 500	549 900	642 000	266 800	147 100	2 841 300	46 080	2 173 270	22.25	.01120
Dec.	1 528 300	490 775	628 080	301 350	1 550	2 950 055	31 660	2 412 862	17.32	.01739
TOTALS	16,043,300	5535 725	5,066 566	4,170,200	1,800,950	32,616,741	588,705	26,803,176	16.31	\$.010902

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>CLIFFS SHAFT MINE</u>					
1905	7,421	204,645	271,587,404	1,355	353,087,800
1906	9 204	272 735	451 440 636	1 794	--- --- ---
1907	8 880	302 924	692 018 970	2 239	242 599 222
1908	7 991	228 886	541 729 740	2 367	240 000 000
1909	7 328	242 573	680 932 960	2 796	166 079 249
1910	8 895	252 793	904 379 312	3 577	156 948 550
1911	8 095	246 334	898 424 112	3 647	165 101 640
1912	8 047	276 211	810 020 228	2 932	218 555 480
1913	8 027	295 105	833 987 419	2 826	276 582 240
1914	7 496	316 986	1 054 320 348	3 326	281 392 090
1915	5 181	347 955	889 280 382	2 555	283 489 900
1916	5 226	388 090	878 041 710	2 262	398 818 855
1917	4 500	377 177	885 993 944	2 349	345 847 725
1918	5 135	382 804	861 374 720	2 276	315 252 828
<u>SALISBURY MINE</u>					
1905	3 750	154 017	219 765 211	1 423	76 346 425
1906	3 909	152 034	219 345 241	1 461	77 100 543
1907	3 892	139 986	215 971 327	1 551	86 056 044
1908	3 606	116 724	218 591 828	1 895	66 957 839
1909	3 537	99 140	218 841 412	2 228	61 699 506
1910	3 308	113 574	162 828 098	1 433	63 430 079
1911	3 158	111 272	148 067 843	1 330	61 654 458
1912	2 788	118 635	154 493 210	1 301	55 855 799
1913	848	125 178	120 039 019	958	51 358 400
1914	583	97 318	94 530 000	971	56 786 400
1915	522	27 150	134 776 200	---	53 503 200
1916	496	100 803	273 558 000	2,713	126 831 364
1917	445	104 082	188 563 500	1 811	104 560 277
1918	436	113 073	166 455 000	1 472	100 958 079

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT./ AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED	
<u>LAKE MINE</u>						
1900	1900	8,218	510,132	376,482,932	740	-- --- ---
	1901	9 117	472 730	393 632 563	840	62,998,188
	1902	8 400	470 728	440 196 332	952	64 188 597
	1903	8 502	468 277	441 329 198	993	70 848 359
	1904	6 983	281 399	355 084 057	1,368	78 662 195
	1905	10 346	505 321	885 737 363	1 753	77 492 105
	1906	11 072	559 377	784 511 853	1 247	80 626 208
	1907	10 934	549 449	773 662 287	1 410	90 105 988
	1908	9 222	357 628	575 642 546	1 671	76 896 881
	1909	9 640	381 060	826 433 227	2 245	81 268 184
	1910	9 892	559 438	820 568 713	1 466	85 118 000
	1911	7 558	309 519	583 930 820	1 886	93 643 210
	1912	7 824	329 344	656 627 987	1 993	109 576 544
	1913	8 059	473 848	962 459 483	2 031	95 007 553
	1914	5 733	324 251	596 066 577	1 838	45 925 949
	1915	6 019	359 185	586 965 354	1 634	96 375 565
	1916	6 708	397 021	637 468 347	1 605	192 033 482
	1917	7 181	497 272	782 431 925	1 573	134 142 986
	1918	6 588	457 399	592 308 718	1 294	145 707 330

HARD ORE #3 HEATING PLANT

1913	729
1914	810
1915	883
1916	922
1917	1,038
1918	955

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>NEGAUNEE MINE</u>					
1905	7,386	245,422	211,667,755	861	345,967,009
1906	10 465	258 354	235 730 810	921	--- --- ---
1907	11 216	315 069	250 046 615	795	707 070 097
1908	10 294	300 007	210 799 982	696	638 488 540
1909	9 088	316 072	263 322 702	911	623 789 512
1910	7 913	364 111	361 923 373	993	610 209 058
1911	7 805	368 352	599 630 043	1,627	634 100 040
1912	8 003	298 308	825 468 516	2 767	696 210 397
1913	7 647	368 956	741 224 169	2 008	789 153 091 (#2 Shaft)
1914	5 269	337 792	613 144 000	1 798	395 877 353
1915	1 703	404 020	363 242 060	933	--- --- ---
1916	1 223	526 237	474 099 050	900	--- --- ---
1917	1 414	548 083	455 525 250	831	780,000,000 (Est.)
1918	1 293	524 869	443 996 750	845	828 575 874
<u>MAAS MINE</u>					
1905	4,066	--- ---	139,268,772	---	311,792,458
1906	4 170	--- ---	260 733 698	---	--- --- ---
1907	5 861	29,690	--- --- ---	---	337 084 264
1908	6 671	83 075	--- --- ---	---	242 151 139
1909	6 494	141 510	291 338 833	2,095	231 101 590
1910	8 219	196 052	541 169 843	2 760	209 688 862
1911	7 252	--- ---	646 245 479	- ---	--- --- ---
1912	6 502	55 603	355 459 673	- ---	--- --- ---
1913	8 903	287 784	915 881 473	3 182	--- --- ---
1914	6 819	213 423	720 319 949	- ---	(3 months) 8 336 357
1915	4 325	85 150	486 626 678	- ---	190 534 750
1916	8 062	272 802	763 134 066	2 797	363 273 050
1917	8 656	333 290	879 808 672	2 639	337 467 390
1918	9 351	312 634	935 128 335	2 991	510 265 180

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>AUSTIN MINE</u>					
1905	1,867	61,878	51,808,300	837	---
1906	-	165 445	56 931 414	374	---
1907	3 863	194 571	58 452 975	300	---
1908	-	204 769	-- --- ---	---	---
1909	-	186 064	181 915 343	985	---
1910	-	69 500	33 411 030	480	---
1911	-	145 360	128 013 967	880	---
1912	-	121 191	153 118 878	1,263	---
1913	-	67 494	---	---	---
1914			(Mine idle entire year)		
1915			" " " "		
1916	-	23 697	---	---	---
1917	-	54 167	---	---	---
1918	-	759	(Mine flooded in January)		
<u>PRINCETON MINE</u>					
1909	3,104	143,620	181,915 352	1,265	144,540,000
1910	2 582	126 047	226 054 113	1 793	138 556 000
1911	570	100 150	171 032 509	1 707	---
1912	184	22 639	48 083 876	2 123	107 537 270
1913	467	74 297	-- --- ---	---	108 366 555
1914	64	772	-- --- ---	---	99 939 295
1915	87	2 833	-- --- ---	---	94 629 250
1916	105	2 636	-- --- ---	---	136 569 170
1917	101	734	-- --- ---	---	109 949 035
1918	334	182 760	-- --- ---	---	112 926 605

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>STEPHENSON MINE</u>					
1909	2,396	140,683	181,915,347	1,313	191,342,376
1910	2 867	217 096	294 935 118	1 358	383 590 401
1911	4 182	239 991	384 041 898	1 600	625 253 183
1912	4 856	241 931	460 478 796	1 903	886 471 232
1913	3 420	283 146	--- --- --- -	- ---	1,028 287 849
1914	2 281	238 739	--- --- ---	- ---	772 327 870
1915	2 220	230 575	--- --- ---	- ---	763 683 450
1916	1 658	327 395	--- --- ---	- ---	785 501 510
1917	3 073	256 756	--- --- ---	- ---	(11 months) 961 713 000
1918	1 560		(Mine flooded in December 1917)		

<u>GWINN MINE</u>					
1909	2,022	---	60,638,452	---	---
1910	5 116	---	143 309 920	---	---
1911	3 400	2 548	136 216 025	---	---
1912)Mine idle entire year(
1913	1 583	14 376	---	---	---
1914	1 400	95 510	---	---	90,245 720
1915	807	151 474	---	---	131 676 720
1916	871	186 839	---	---	131 783 700
1917	976	191 080	---	---	148 022 900
1918	844	177 051	---	---	168 172 800

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
1909	598				137,037,480
1910	545				142 284 450
1911	497				153 854 205
1912	569				158 661 990
1913	633				172 438 180
1914	675				184 799 040
1915	794				202 554 240
1916	814				224 152 095
1917	986				275 717 100
1918	917				262 232 600

PRINCETON PUMPING STATION

<u>PRINCETON CENTRAL POWER PLANT</u> (output)		
1909	44,630	606,384,494
1910	6 101	697 710 181
1911	7 493	819 304 399
1912	4 104	661 681 550
1913	2 360	--- --- ---
1914	5 900	--- --- ---
1915	7 092	--- --- ---
1916	5 322	1,375 169 052
1917	2 121	1 051 739 302
1918	6 279	971 385 234

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>GROSBY MINE</u>					
1909	1,735	119,410	---	---	---
1910	2 157	204 588	---	---	---
1911	1 493	80 976	---	---	---
1912	1 515	116 818	---	---	---
1913	3 305 (10 mo.)	207 728 (8 mo.)	---	---	---
1914	2 151	23 221	---	---	---
1915	250	-- ---	---	---	---
1916	2 069	127 373	---	---	---
1917	2 504	300 142	---	---	---
1918	3 097	255 787	---	---	---

<u>IMPERIAL MINE</u>					
1909	2,592	82 135	---	---	---
1910	3 665	137 527	---	---	---
1911	2 744	102 831	---	---	---
1912		(Mine idle entire year)			
1913		" " " "			
1914		" " " "			
1915		" " " "			
1916		" " " "			
1917		" " " "			
1918		(Mine equipment dismantled)			

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
			<u>MORRIS-LLOYD MINE</u>	(Includes Sec. 6 Shaft)	
1911	- - -	88,792	- - - - -	- - -	- - - - -
1912	- - -	181 544	- - - - -	- - -	- - - - -
1913	- 726	209 667	- - - - -	- - -	- - - - -
1914	615	242 476	655,119,000	2,701	363,889,057
1915	533	298 816	722 622 750	2 418	322 295 660
1916	1,004	304 849	- - - - -	- - -	320 074 400
1917	886	296 589	667 908 000	2 370	319 198 700
1918	959	299 360	681 964 000	2 378	315 454 220
			<u>SOUTH JACKSON MINE</u>		
1912	381	42,790	- - - - -	- - -	- - - - -
1913	483	1 940	- - - - -	- - -	- - - - -
1914	0	15 281	- - - - -	- - -	- - - - -
1915	0	56 026	- - - - -	- - -	- - - - -
1916	0	0	(No ore take nout)		
1917	0	46 994	- - - - -	- - -	- - - - -
1918	0	15 879	13,203,000	931	- - - - -
			<u>GARDNER & MACKINAW MINES</u>		
1914	303	- - -	221,355,000	- - -	- - - - -
1915		(Mine idle entire year)			
1916		" " " "			
1917	443	29,235	323,595,000	- - -	- - - - -
1918	533	37 883	388 395 000	- - -	- - - - -
			<u>ATHENS MINE</u>		
1914	231	7,404	120,048,750	- - -	- - - - -
1915	385	21 245	242 196 750	- - -	- - - - -
1916	419	26 930	222 840 000	- - -	- - - - -
1917	277	23 988	211 612 500	- - -	- - - - -
1918	609	101 394	498 600 000	- - -	- - - - -

COMPARATIVE TABLES





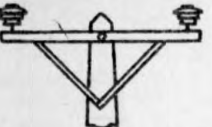


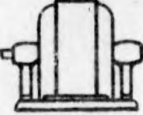
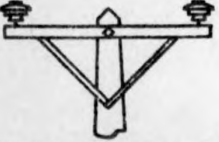


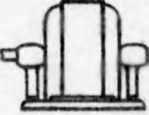
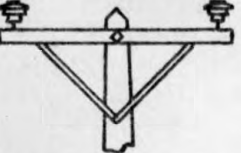
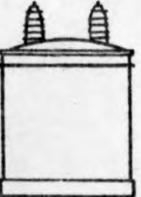

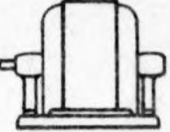
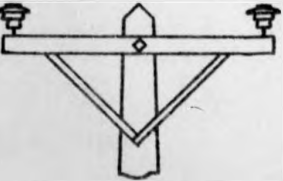

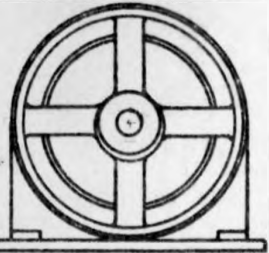
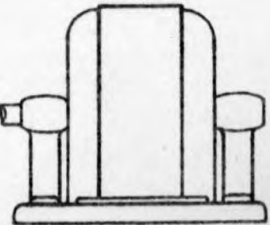
YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>REPUBLIC MINE</u>					
	(8 months)				
1914	5,834	106,663	---	---	---
1915	7 353	244 697	1,711,333,000	6 993	---
1916	8 637	226 797	1 841 863 000	8 033	---
1917	8 755	196 996	1 582 113 000	8 031	---
1918	6 780	172 955	1 141 454 000	6 605	---
<u>FRANCIS MINE</u>					
1915	603	---	---	---	---
1916	3,513	15,656	---	---	---
1917	1 223	21 420	353,070,000	---	66,723,400
1918	796	65 739	565 920 000	---	49 625 600
<u>ANGELINE MINE</u>					
1916	---	5,772	6,128,112	1,060	---
1917	---	38 310	23 257 417	607	---
1918	442	57 814	79 443 122	1 374	---
<u>HOLMES MINE</u>					
1916	729	32,951	---	---	---
1917	739	90 225	425,227 500	4,712	---
1918	700	130 295	368 456 686	2 840	---
<u>MEADOW MINE</u>					
1916	3,241	63,501	---	---	---
1917	3 007	102 519	40,658,040	396	---
1918	3 087	95 353	53 433 980	560	---
<u>SPIES MINE</u>					
1916	1,644	20,308	---	---	---
1917	3 657	80 204	186,701 680	2,327	---
1918	2 154	124 477	---	---	---

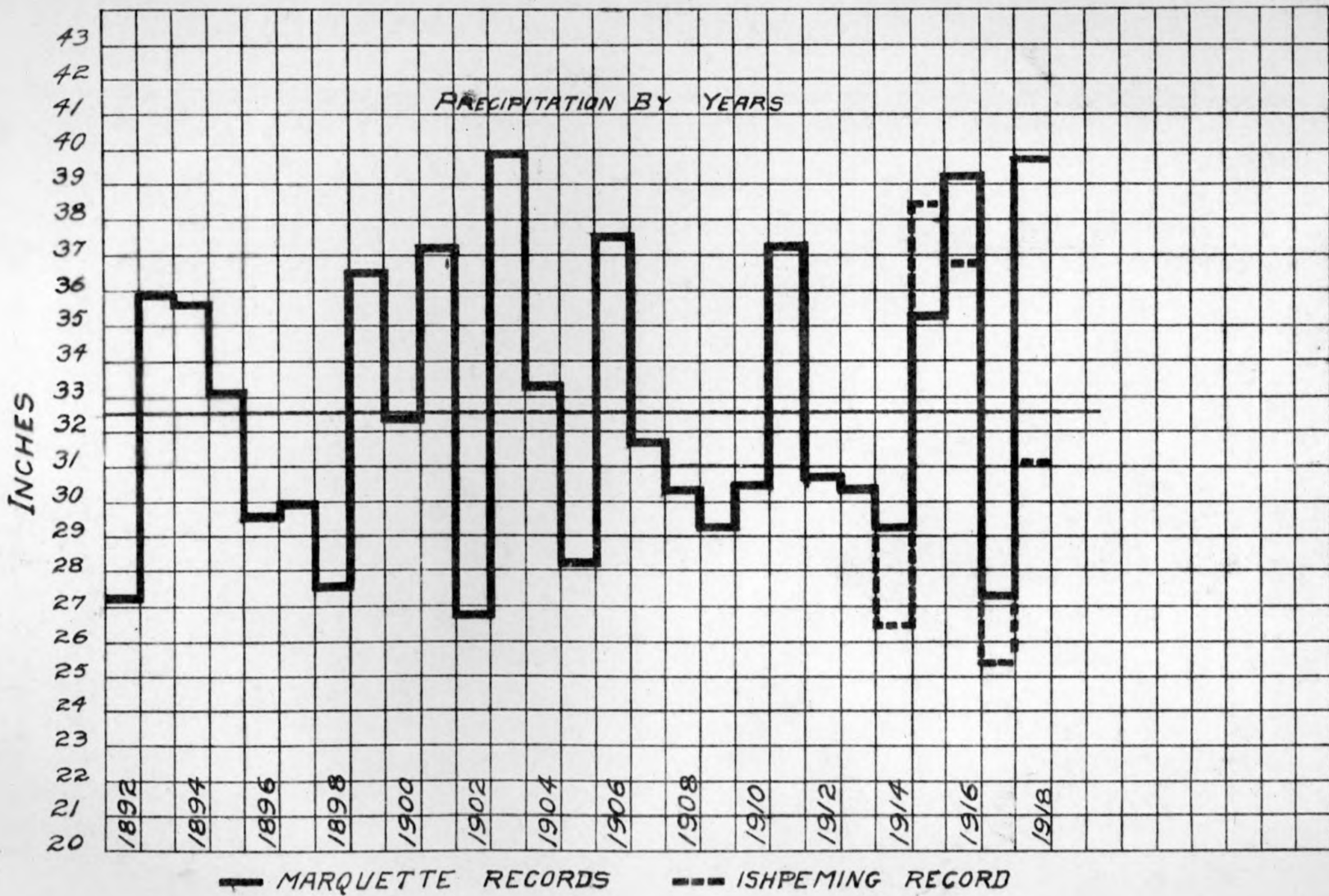
COMPARATIVE TABLES

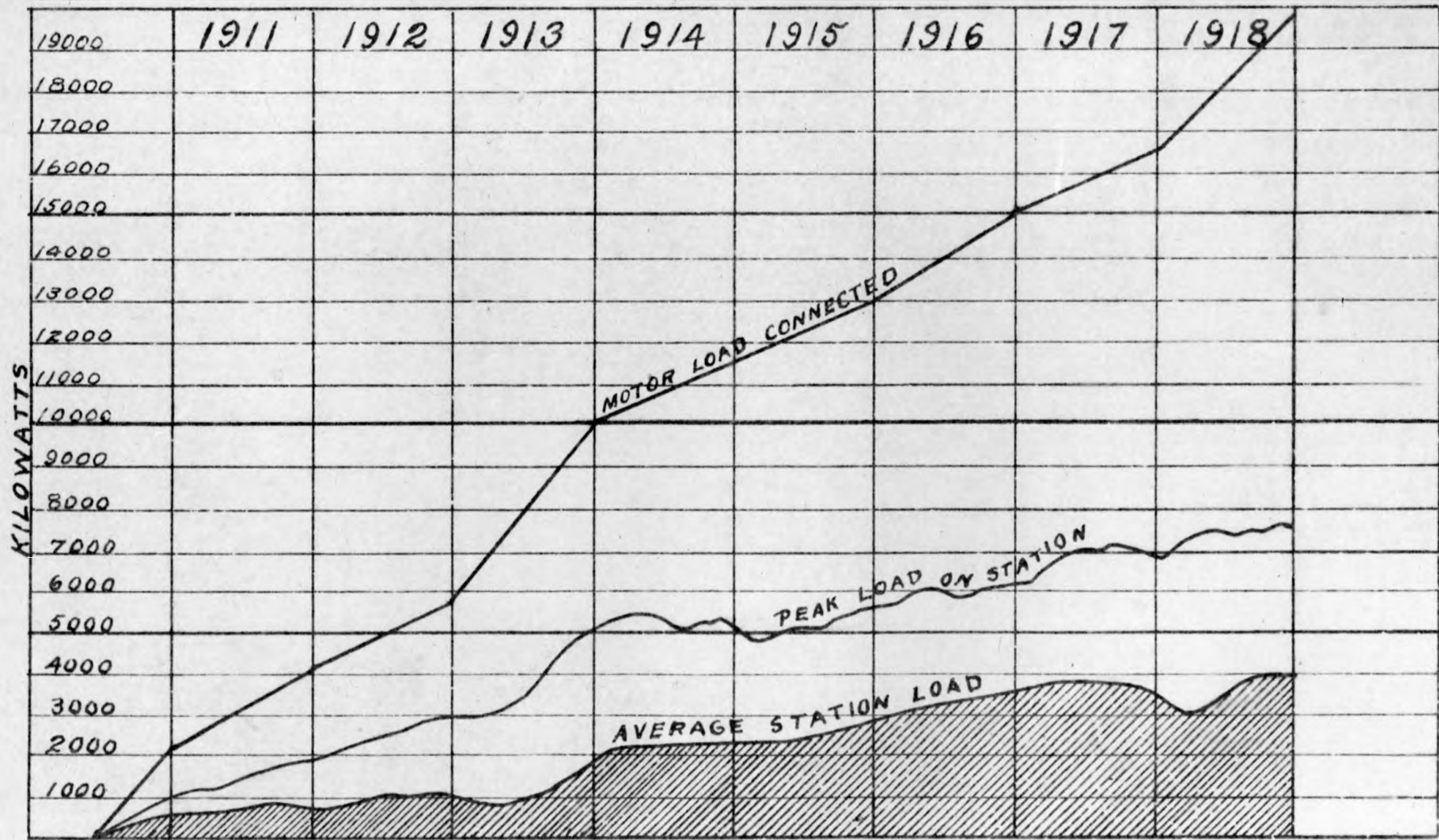
YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>HELMER MINE</u>					
1918	3,125	216,428	---	---	---
<u>WADE MINE</u>					
1918	3,820	72,305	---	---	---
<u>BARNES-HECKER MINE</u>					
1918	646	16,330	221,420,000	---	---

NOTES-

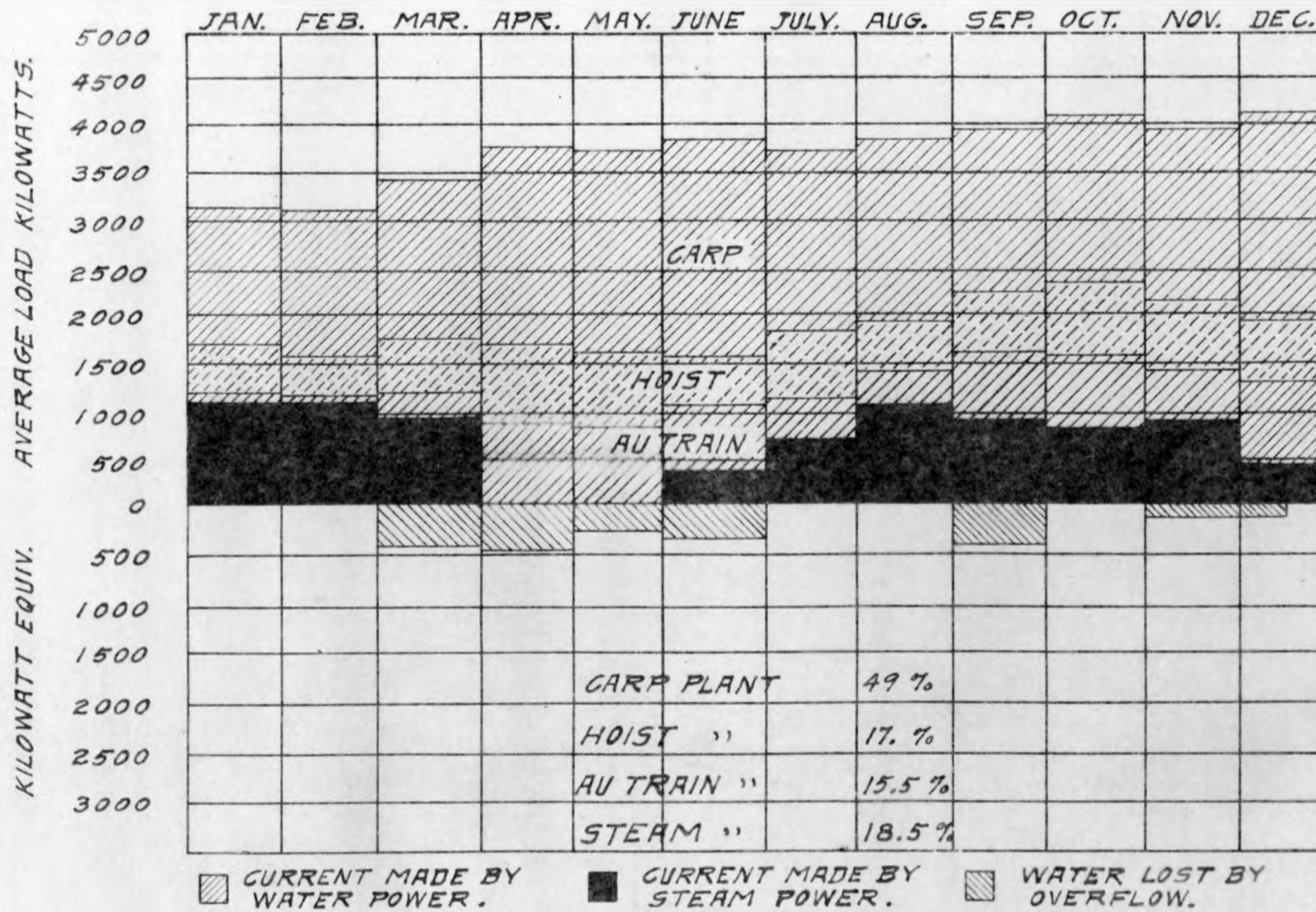
- Lake Mine - - - - --Furnished air to Hard Ore Shops. & Angeline Mine.
- Negaunee Mine - - --Received considerable amount of air from Maas Mine.
- Morris-Lloyd Mine --Furnished air to Barnes-Hecker Mine.
- Austin Mine - - - --Idle on account of being flooded.
- Stephenson Mine - --Idle on account of being flooded.

YEAR.	LINES.	SUB-STATIONS.	MOTORS.	GENERATORS.
1910	 WIRE 228 MILES	 5720 K.V.A.	 3111 H.P.	 2900 K.V.A.
1912	 WIRE 288 MILES	 7380 K.V.A.	 7935 H.P.	 8500 K.V.A.
1914.	 WIRE 306 MILES.	 7970 K.V.A.	 16218 H.P.	 8500 K.V.A.
1916	 WIRE 410 MILES	 11970 K.V.A.	 20175 H.P.	 9750 K.V.A.
1918	 WIRE 536 MILES.	 27645 K.V.A.	 27000 H.P.	 19750 K.V.A.

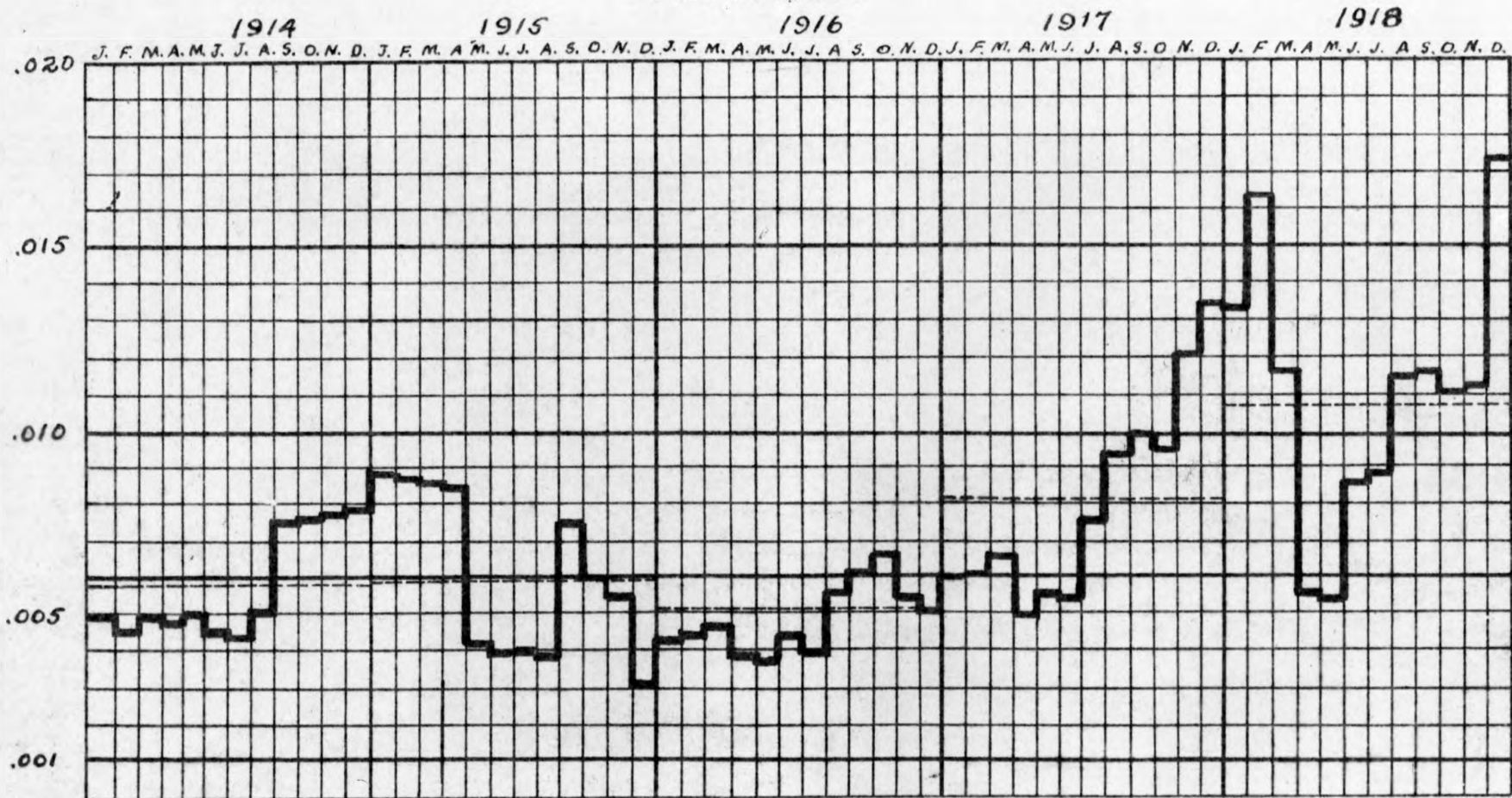




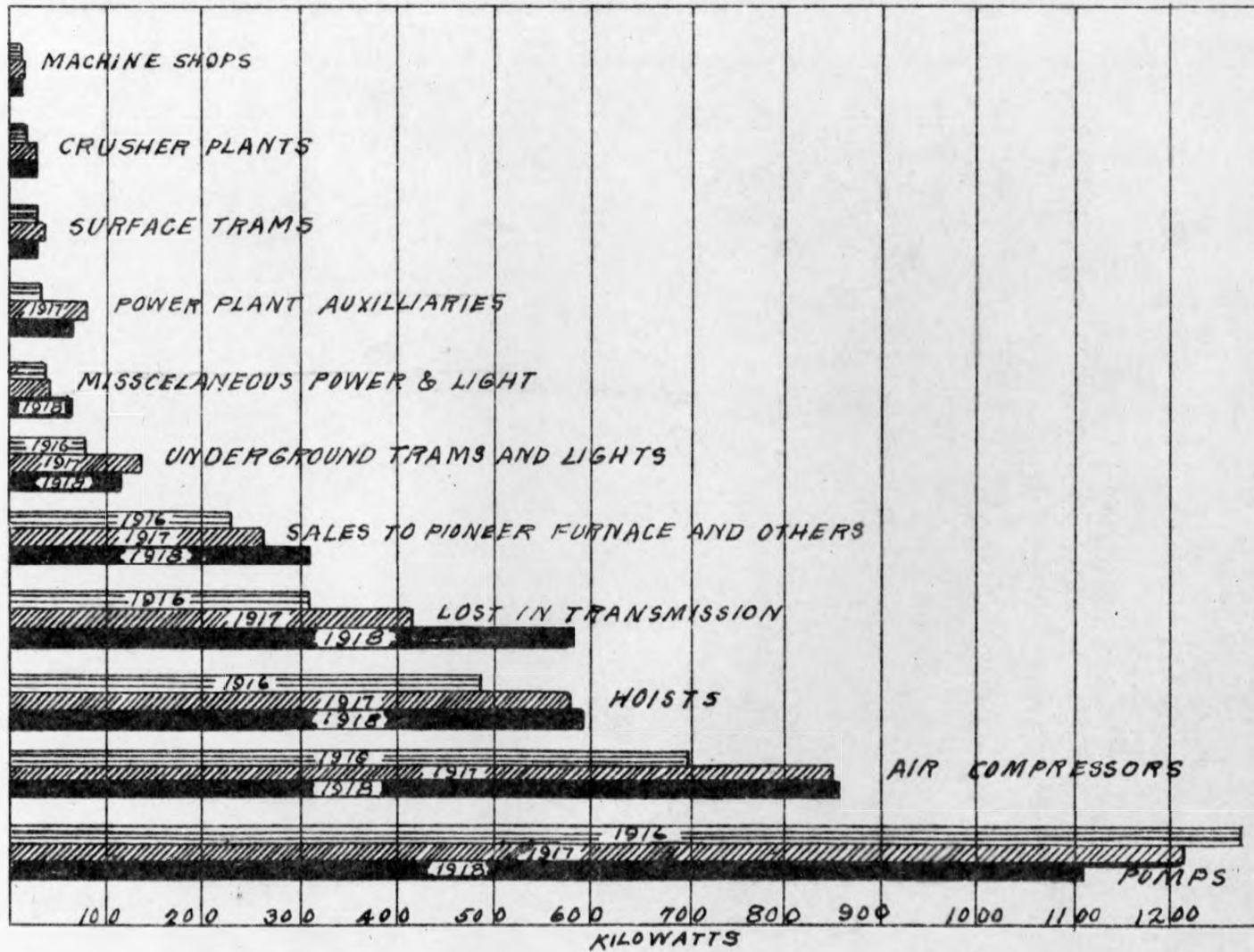
1918.



COST DIAGRAM



DISTRIBUTION OF ELECTRIC POWER 1916 1917 1918



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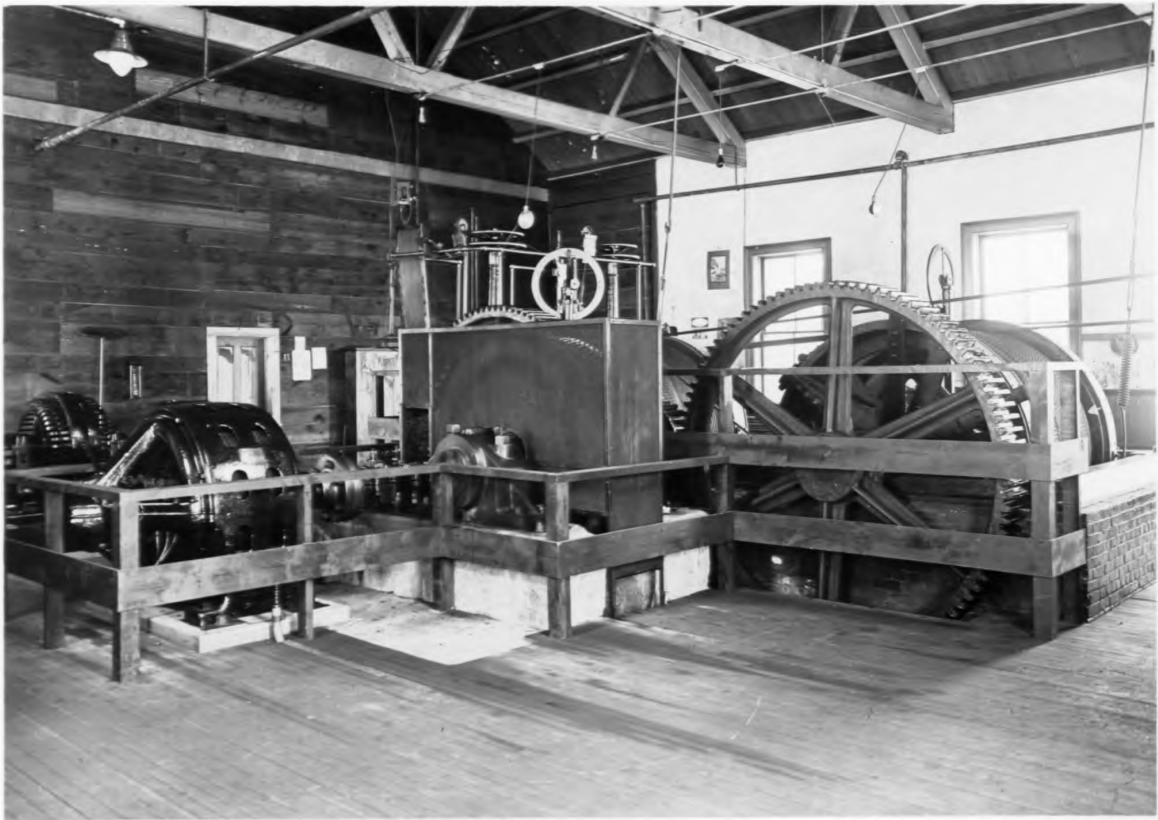


Plate No. 161

Hoist & Motor

Angeline Mine

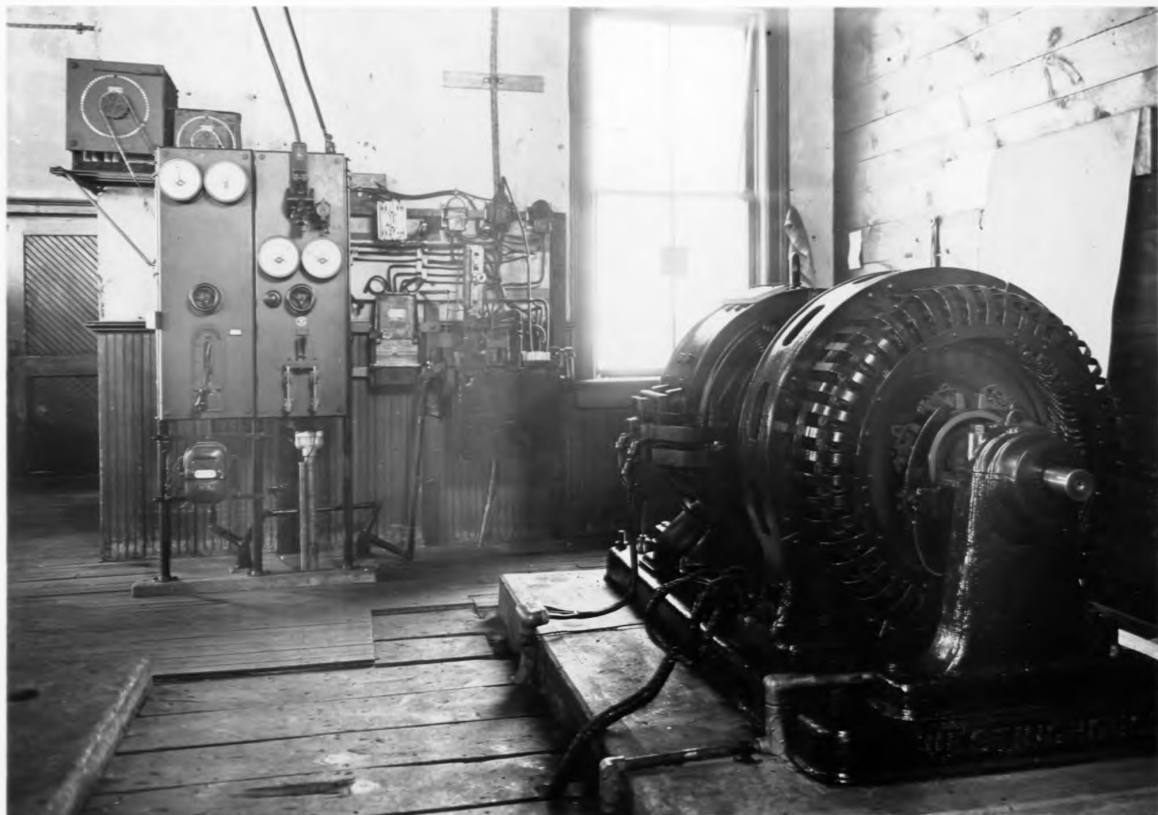


Plate No. 162

Haulage Set

Angeline Mine





Plate No. 163

Prescott Pump on 2400' Level

Athens Mine

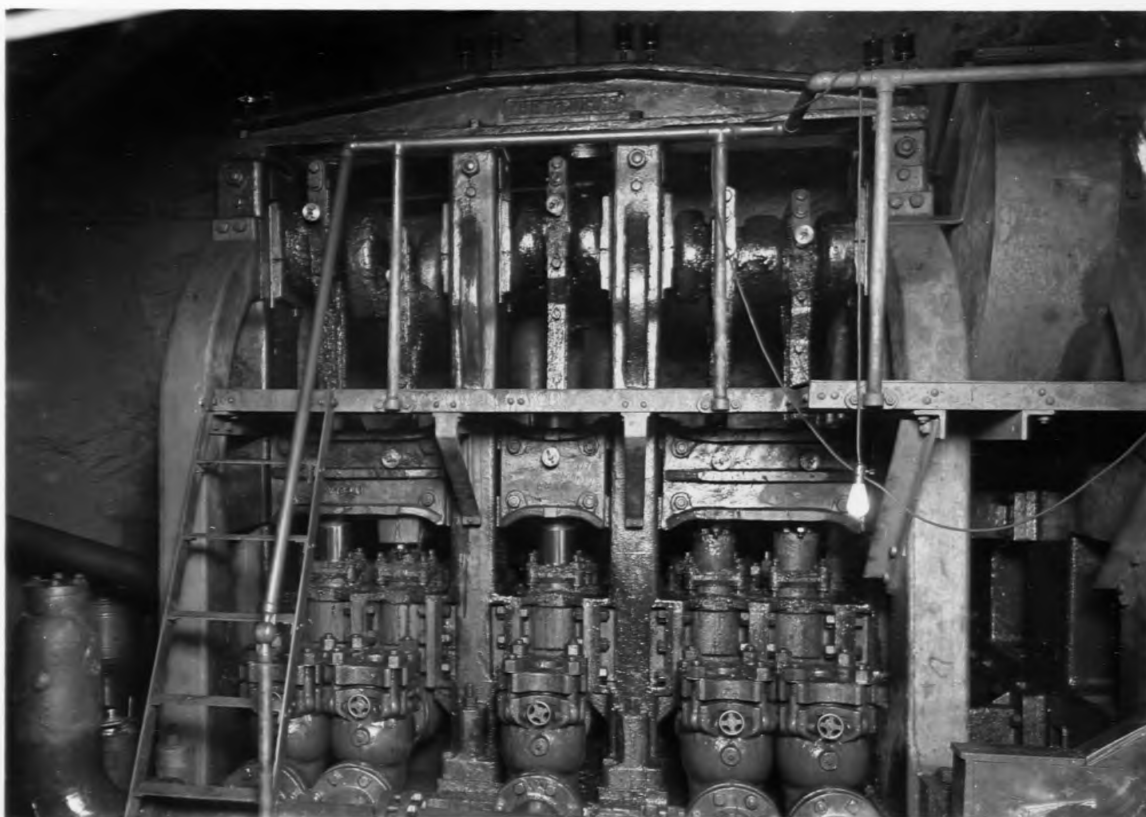


Plate No. 164

Aldrich 2nd Level Pump

Maas Mine



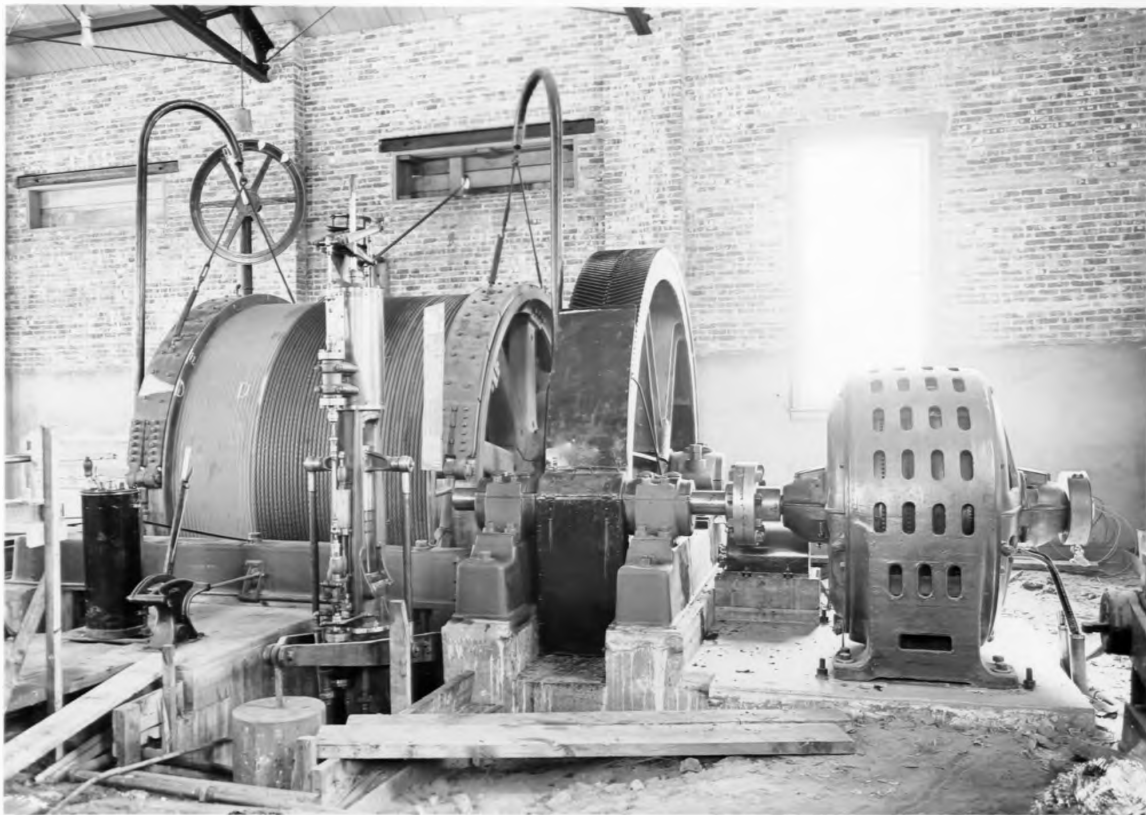


Plate No. 165

Cage Hoist & Motor

Barnes-Hecker Mine

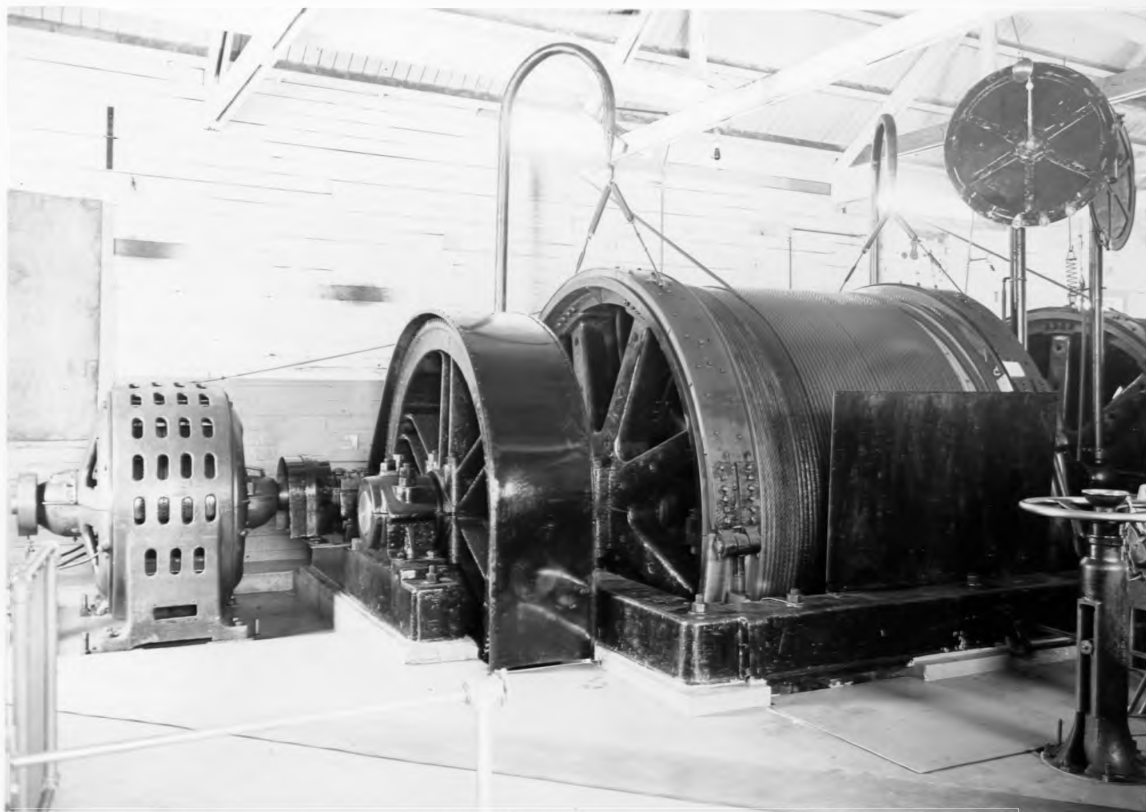


Plate No. 166

Cage Hoist & Motor

Francis Mine



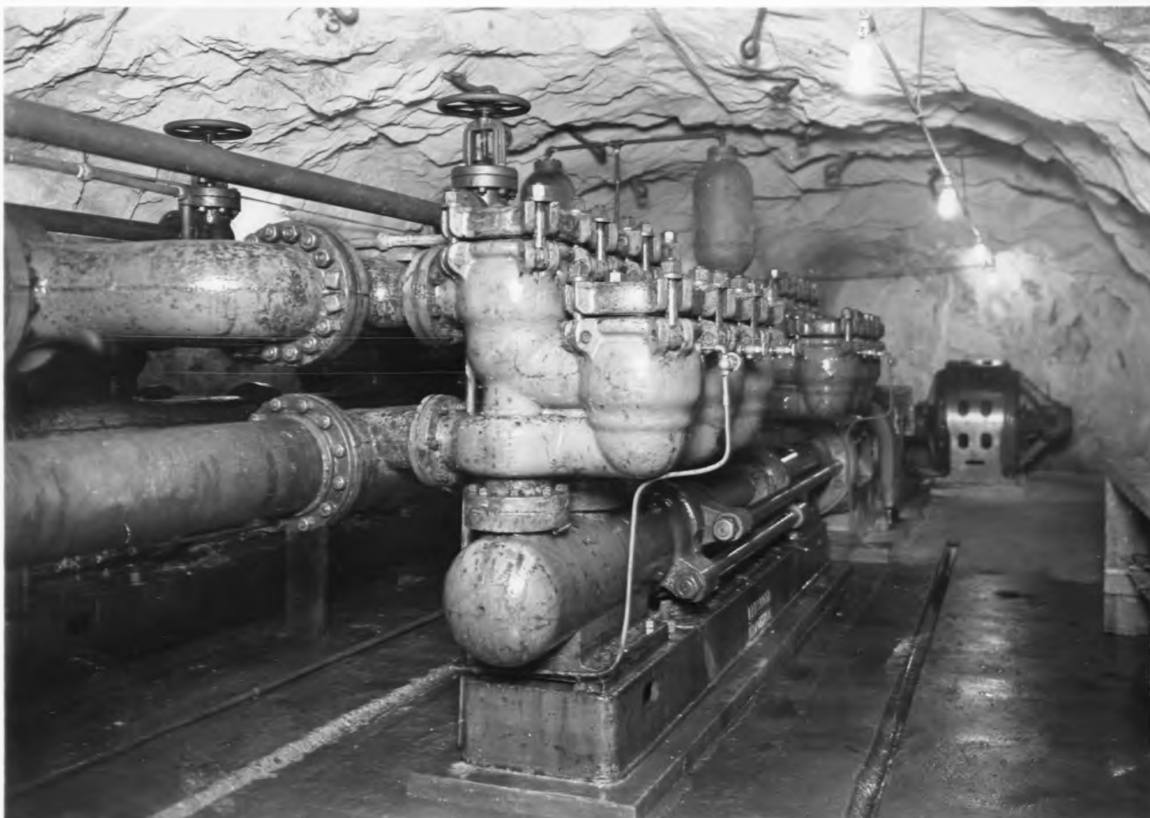


Plate No. 167

Prescott Pump - 1060' Level

Francis Mine



Plate No. 168

Centrifugal Pump - 1060' Level

Francis Mine

PHOTO BY
Childs
Art Gallery
Lansdown, Mich.

PHOTO BY
Childs
Art Gallery
Lansdown, Mich.



Plate No. 169

Dam

McClure Plant



Plate No. 170

Dam

McClure Plant



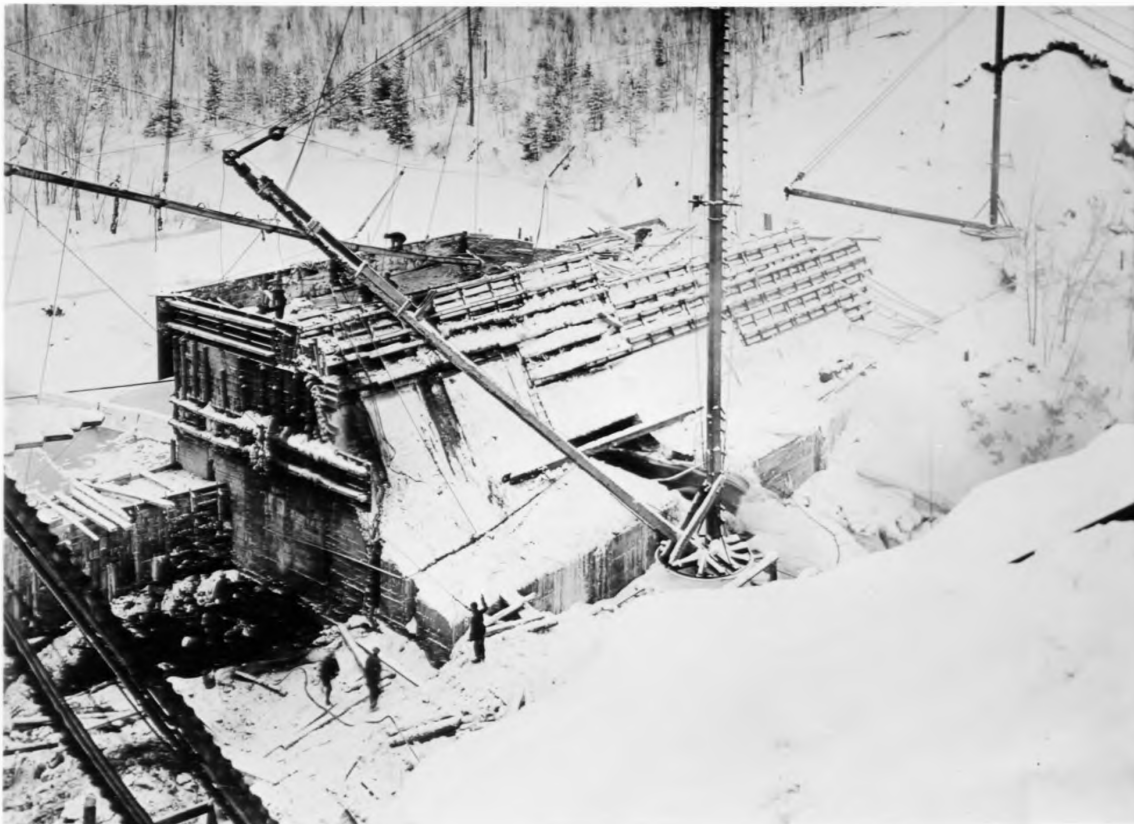


Plate No. 171

Dam

McClure Plant



Plate No. 172

Cut on Pipe Line

McClure Plant





Plate No. 173

Fill on Pipe Line

McClure Plant



Plate No. 174

Wood Pipe

McClure Plant



100



Plate No. 175

Wood Pipe & Surge Tank

McClure Plant



Plate No. 176

Wood Pipe & Surge Tank

McClure Plant





Plate No. 177

Wood Pipe

McClure Plant



Plate No. 178

Junction of Wood & Steel Pipe

McClure Plant





Plate No. 179

Steel Pipe

McClure Plant



Plate No, 180

Steel Pipe

McClure Plant





Plate No. 181

Power House Steel Work

McClure Plant



Plate No. 182

Power House

McClure Plant



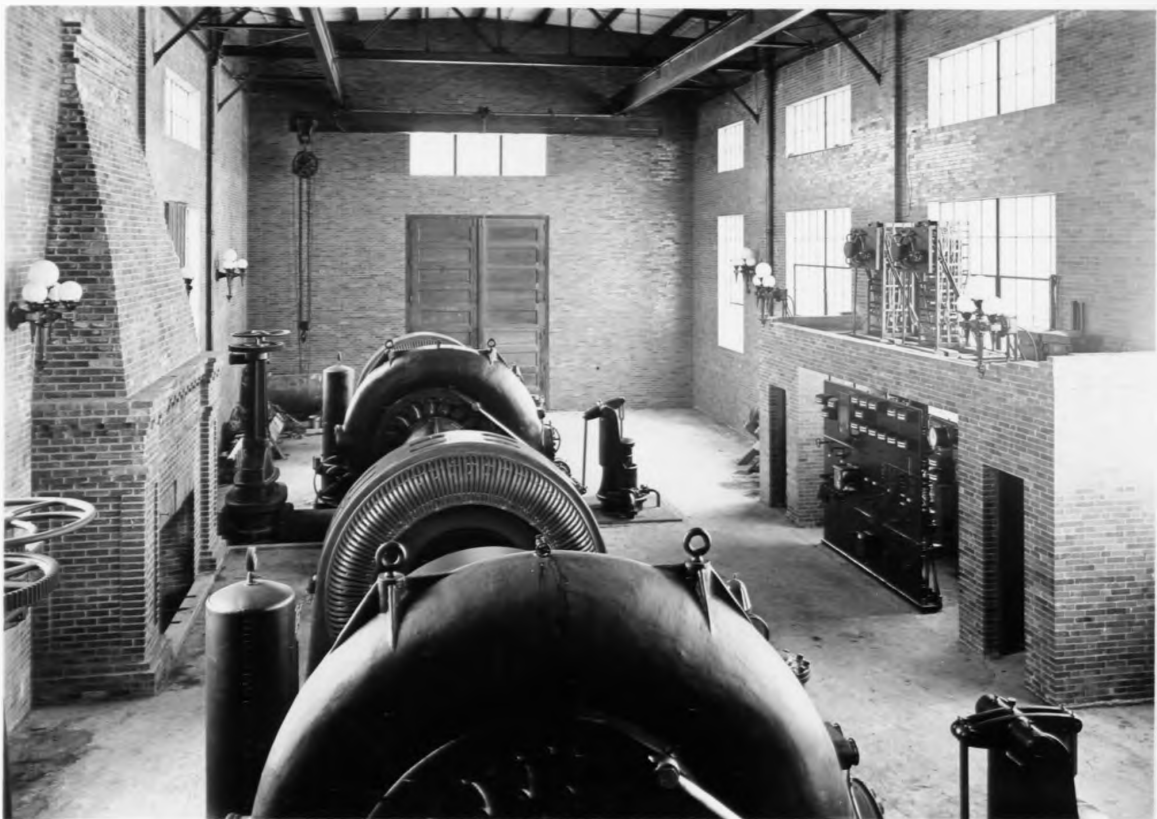


Plate No. 183

Interior of Power House

McClure Plant

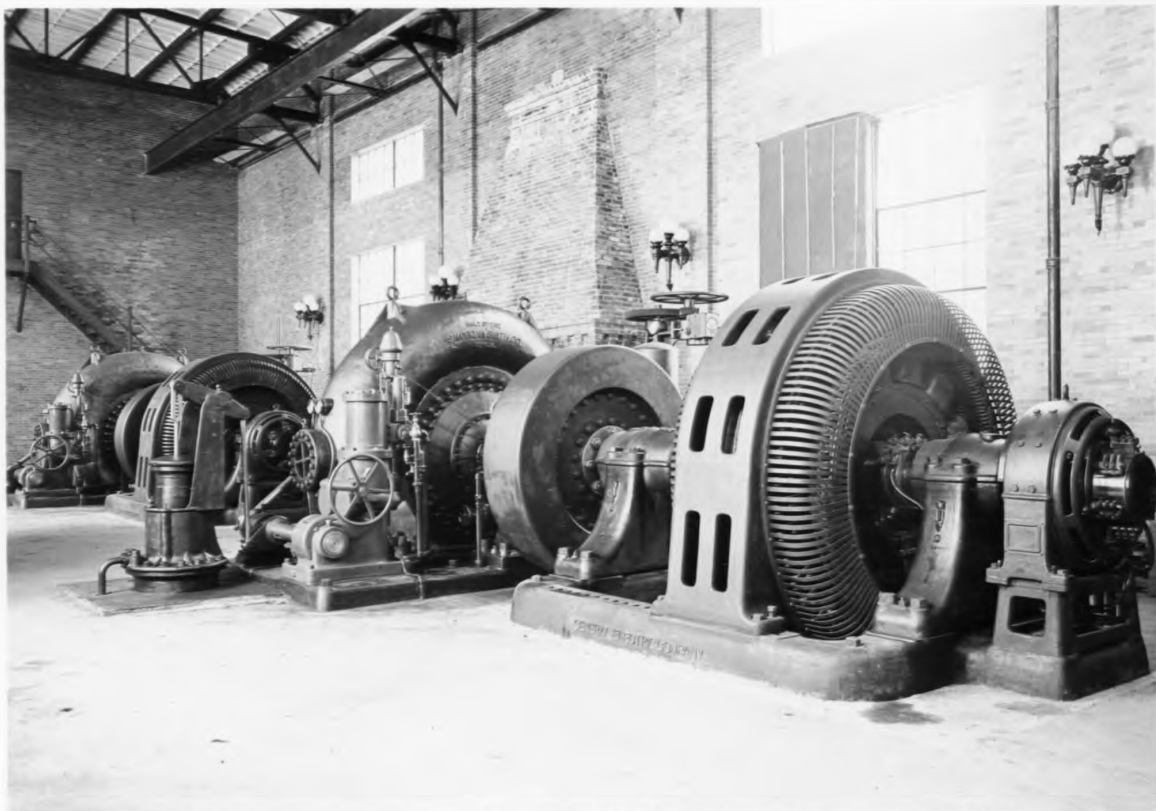


Plate No. 184

Water Wheels & Generators

McClure Plant





Plate No. 185

Switchboard

McClure Plant

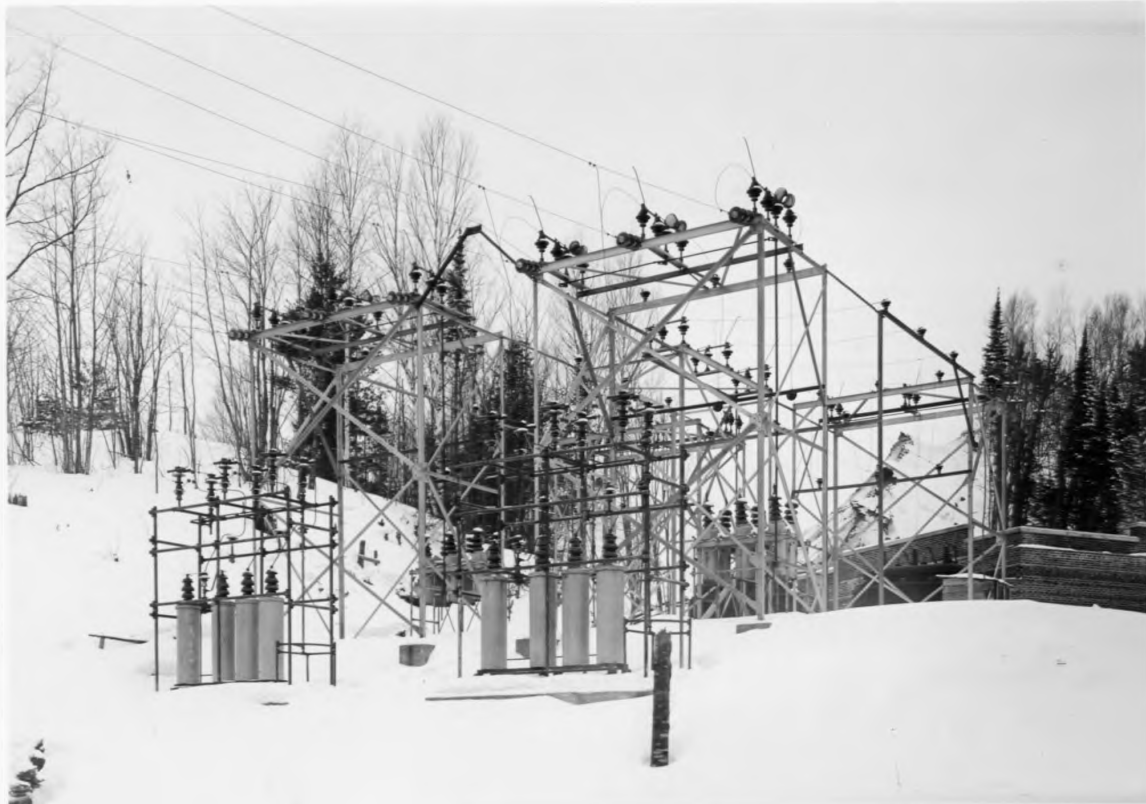


Plate No. 186

Outdoor Substation

McClure Plant



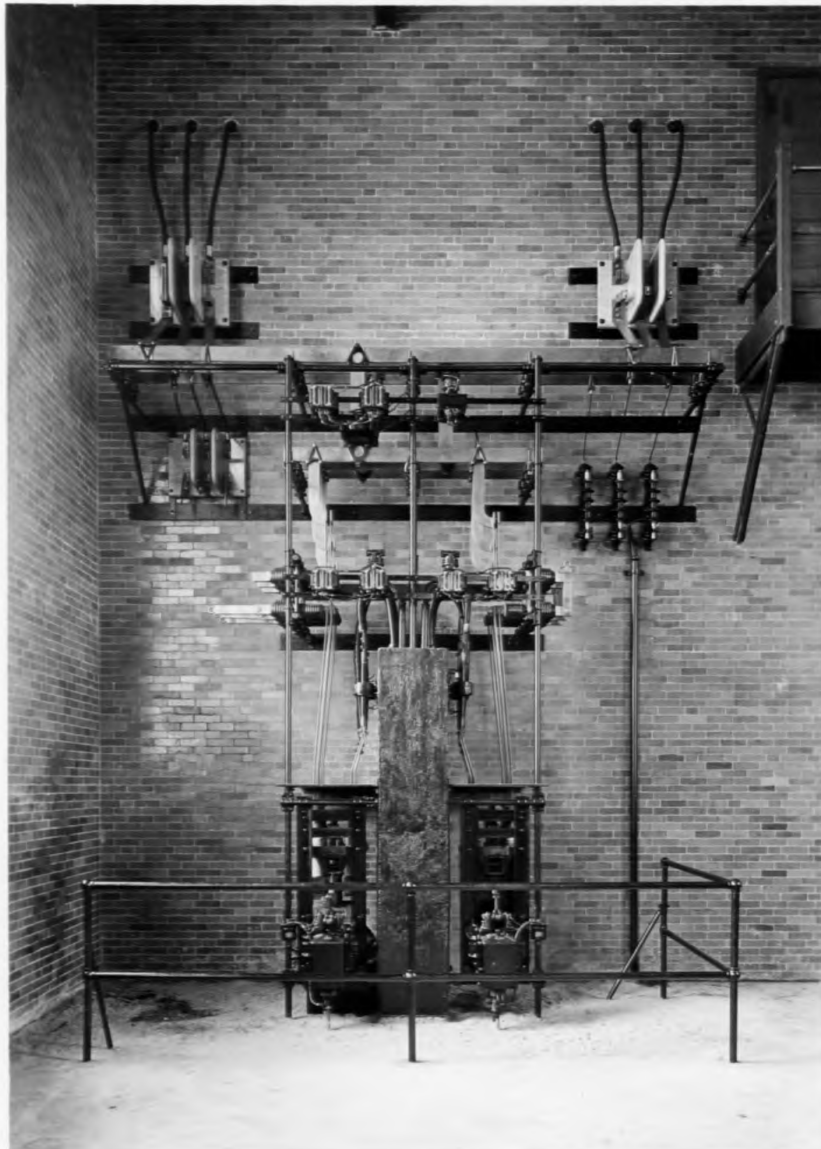


Plate No. 187

2300 Volt Bus Structure

McClure Plant