

Nicolson, and myself.

AUSTIN MINE.

The Austin Mine was finally unwatered the early part of the year and the drifts repaired. It is anticipated that mining will be resumed the coming season.

BARNES-HECKER MINE.

At the Barnes-Hecker Mine during the past year the shaft was bottomed at a depth of 1067' and three main levels started at depths of 600', 800' and 1000' from surface, respectively. Thus far all work has been in foot-wall Siamo slate and no detailed geological work has been done.

BUNKER HILL MINE.

No additional work was done here during the year. Drilling explorations started early in November 1918 and were discontinued in February 1919. This will be discussed later on in this report.

CLIFFS SHAFT MINE.

We have been able during the past year to bring the geological surveys of the accessible workings of the Cliffs Shaft Mine up to date. This work was done chiefly by Mr. Nicolson who was assisted by both Mr. Osborne of the Engineering Department and Engineer at this property, and by Mr. Allen of the Geological Department. Mr. Nicolson also made a new set of geological cross-sections of the entire property.

FRANCIS MINE.

Mr. Royce before leaving the Company, followed by Mr. Nicolson, kept the geology of this mine posted to date and all development work was particularly, closely and carefully recorded at all times. Mr. Allen has assisted in this work. The ore body as a whole has been quite a disappointment, due not only to its apparently unexpected limited character but also to the large amount of unreplaced slate rock mixed with it and its high sulphur content.

GWINN MINE.

Mr. Royce kept the geology of the new development work at the Gwinn Mine posted and, whenever able, the stopes as well. Mr. Sterling, Engineer at the property, supplied us with the latter information at times when we  
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could not visit all the stopes.

HOLMES MINE.

Mining was carried on in earnest at this property throughout the year. The shaft was sunk 200' and two new levels, 100' apart, the 3rd and 4th levels, were practically completed to the ore body. Mr. Nicolson kept the geological work posted to date and was assisted by Mr. Allen.

JOPLING MINE.

Work at the Jopling Mine for the year comprised several hundred feet of exploratory drilling. The drift being driven on the first of the year on the 540' elevation to the ore found at about this depth in surface hole No.37 was completed, as well as a crosscut across the iron formation in this vicinity. Although ore was encountered, it was very limited in quantity and mixed in quality. A small sub-level was also opened up in this ground about 24' above this elevation without encouraging results so that further work in this vicinity was abandoned. Mr. Smyth then recommended the main level be extended about 400' Southeasterly from which a more complete exploration of the iron formation could be conducted by drilling and, if nothing of importance is found, to surrender the lease on the property. This drift had just been completed at the end of the year.

LAKE MINE.

No geological surveys were necessary at this property during the year, the work having reduced itself to the mining of pillars in territory already surveyed. Diamond drilling, however, was continued for a part of the year from the bottom of the 5th level.

MAAS MINE.

Messrs. Cheneour and Moulton, engineers at the Maas, posted the geology as best they could and recorded their results on the mounted maps of the property. Mr. Afuhs transferred this information to the geological maps and cross-sections at the end of the year, preparatory to their being used for the annual ore estimate.

MACKINAW-GARDNER MINES.

Both mining and main level development work were carried on at these properties throughout the year. Detailed geological surveys have been made periodically and the work posted to date by Mr. Royce, followed by Mr. Nicolson.

MORRIS-LLOYD MINES.

The geological work at these properties was kept fairly well posted by Mr. Nicolson, assisted by Mr. Allen. The chief development work during the year was on the 6th level Morris Mine, which was extended both Southeasterly towards the Lloyd and Westerly towards the Barnes-Hecker.

NEGAUNEE MINE.

The main level developments at the Negaunee Mine were geologized by Mr. Royce before leaving the Company. Both Messrs. Chennecour and Moulton, engineers, in turn, have spent their available time on the detailed geology of the stope areas. These results were afterwards posted on our geological maps and cross-sections by Mr. Royce and, after he left, by Mr. Afuhs.

PRINCETON MINE.

Only a small amount of geological work was done at this property and consisted of posting up the work on the lower main levels from the points where it stopped before the mine was closed several years ago. Mr. Royce made these surveys.

REPUBLIC MINE.

Only one geological survey was made at the Republic Mine during the year. The workings remain accessible for a considerable time, consequently this work was purposely allowed to lapse in order to more quickly catch up with the back work at many of the soft ore mines.

SALISBURY, SPIES & STEPHENSON MINES.

No geological work was done at these properties during the year. Lack of assistance prevented work at the Salisbury, which is relatively unimportant geologically, whereas the Spies was shut down during the summer and the Stephenson was being recovered from the flood of December 1917.

EXPLORATIONS.

Drilling explorations were carried on during 1919 in the following districts and mines:

FROM SURFACE.

<u>DISTRICT.</u>	<u>RANGE.</u>
Ishpeming,	Marquette.
Negaunee,	"
Hibbing,	Mesabi.

FROM UNDERGROUND.

<u>MINES.</u>	<u>DISTRICT.</u>
Angeline,	Ishpeming.
Athens,	Negaunee.
Bunker-Hill,	"
Cliffs Shaft,	Ishpeming.
Francis,	Gwinn.
Gwinn,	"
Lake,	Ishpeming.
Maas,	Negaunee.
Morris-Lloyd,	North Lake.
Negaunee,	Negaunee.
Republic,	Republic.

During the year an option for exploring was taken on the Jemings property adjoining the Helmer Mine on the Mesabi Range. It includes the  $W\frac{1}{2}$  of the  $NE\frac{1}{4}$  and the  $NW\frac{1}{4}$  of the  $SE\frac{1}{4}$  of Section 14, 58-19. The option was relinquished January 1, 1920 but an agreement was entered into allowing this Company dumping rights on this property for its Wade and Helmer rock and wastage.

Option No.98 on the Spies Mineral Land Company's property, comprising 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 of Section 24, 43-35, was also relinquished in 1919.

The mining lease on the Imperial Mine at Michigamme was surrendered in 1919.

Mining leases were acquired on the Boeing, Bingham, Hill, North Star and Trumbull mines on the Mesabi Range. Explorations from surface were conducted during the early part of the year on the Boeing property.

Table No.IV, which follows, gives the footage drilled, the ore encountered and the cost per foot of drilling for both the surface and underground explorations. It will be noted that the average cost of surface drilling

was \$4.99 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 \$5.27 per foot. The average cost of underground drilling in the same way was \$3.60 per foot and \$3.68 per foot, respectively. The average cost on all the drilling was \$4.31 per foot and \$4.49 per foot, respectively. The increase of these costs over those of last year is entirely represented by the constant increase throughout the year of all supplies entering into the work.



SURFACE EXPLORATIONS.

MARQUETTE RANGE.

ISHPEMING DISTRICT.

SECTION 3, 47-27.

Hole No.18, which was started in October 1918 in the  $SE\frac{1}{4}$  of the  $NW\frac{1}{4}$  of Section 3, was still drilling on the first of the year. It was originally located to follow up the promising looking formation in the bottom of the old Union hole and to explore a territory which, from drilling in the Northeast part of Section 4 and also from shallow holes to the South of No.18 in Section 3, indicated a structure favorable for ore deposition. This hole had reached a depth of 792' on the first of the year without encountering ore. A very encouraging footage of good ore was cut, however, from 935' to 1070' and the hole was bottomed in slate at 1216', which it encountered at 1185'.

Two additional drills were immediately started and in the middle of July a fourth drill was added to hasten the development of this indicated ore body.

Holes Nos.19 and 22, 200' and 400' respectively East of No.18, encountered the ore but in somewhat smaller amounts than found in No.18. No.22, due to the mixed character of the ore here, is probably close to the Southeast edge of the ore body. Hole No.20, 200' North of No.18, also encountered ore, but No.21, 200' South of No.18, was blank. The latter hole, however, demonstrated the existence of a Northeasterly and Southwesterly trending normal fault with at least a 600' down throw on the South side and possibly a great deal more than this. Nearly all the holes cut this fault but where ore was encountered it was found to be North of the fault. It is hoped that, since this ore is limited by the fault on its dip, it may be found in commercial quantities at relatively the same geological horizon South of the fault; in other words, that it has been merely faulted down.

Hole No.24, which is drilling from a point about 600' South of No.18, was located to test this latter possibility and was 980' deep on the last of the year.

Hole No.25 was drilled on the West boundary of the property, or about 200' West of holes 18 and 20 and half way between them. Ore which undoubtedly connects with the main ore body was encountered from 765' to 810' but it was disappointingly mixed in character, only the last 15' of it being first class ore. It is quite possible, however, that this hole encountered the edge of the body and that it will be found folded somewhat to the Southwest and thicker to the South as it approaches the main fault mentioned above. This possibility will be tested the coming year.

Hole No.23, located 200' East of No.21 and 200' South of No.19, and started before No.21 demonstrated the fault and found to be blank, encountered good ore from 935' to 1000'. Although this lies to the South of the fault and probably does not connect with the ore in No.19, or the body to the North of the fault, it is very encouraging and perhaps indicates that ore in commercial quantities exists South of the fault at this horizon, which is much higher geologically than the ore North of the fault.

Hole No.27, located 200' East and 100' North of No.22, was 540' deep on the last of the year. This hole should prove definitely whether No.22 is on the Eastern edge of the ore body.

#### SECTION 4, 47-27.

Two drills were operating on this section at the beginning of the year. Hole No.28 was 80' deep in soft ore jasper and had as an object a systematic exploring of the formation to the footwall slate which was being carried on at regular intervals to a moderate depth. It encountered lean ore from 575' to 625' but nothing of commercial grade. The drill was then moved to Section 3. Following the completion of No.27 the last of December 1918, No.29 was located about 400' Northeast of the old Isaac's Pit. Although it was carried to the footwall slate, no commercial ore was encountered and the drill was moved to Section 3.

This completed for the present exploring on Section 4.



SECTION 5, 47-27.

The systematic exploring of the iron formation on this section down to the slate at moderate depths and at regular intervals of approximately 400' along the strike starting from the East side of the section was being conducted with one drill on the first of the year. Hole No.2 was 563' deep and in soft ore jasper on the first of the year. Some very encouraging enrichment of the formation was encountered but no ore of commercial grade. Hole No.1, completed in 1918, had a similar experience, as did also Nos. 3 and 4, all drilled at 400' intervals along the strike from East to West.

I believe the possibilities of discovering commercial ore in this vicinity are exceptionally ~~good~~ good due to the general character of the ground drilled thus far, but this work was temporarily discontinued on the completion of No.4 and the outfit moved to Section 3.

NEGAUNEE DISTRICT.

JACKSON EXPLORATION, SECTION 1, 47-27.

Exploring for a continuation of the ore encountered in 1918 in hole No.107 was being carried on with two drills at the beginning of the year. No.119, located 400' Southwest of No.107, was cementing a vug at 1245' on the first of the year. This was finally completed and the hole carried down to a greenstone sheet which it encountered at 1647' and in which it was bottomed at 1744'. No commercial ore was found and the drill was laid off.

Hole No.131 was located the first of the year a little more than 400' North of No.107. Although it was carried down to a depth of 2216', no good ore was found and exploring in this locality discontinued for the present.

SOUTH JACKSON PIT, SECTIONS 1 & 12, 47-27.  
& SECTIONS 6 & 7, 47-26.

The only drilling done in connection with the South Jackson Pit during 1919 was the sinking of 13 shallow churn drill holes, three in Section 1, one in Section 12, five in Section 6 and four in Section 7. These holes were all drilled in connection with the actual breaking of ore for the steam shovel. They served to sample the ground and were then loaded with heavy  
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charges of powder and blasted, resulting in a very satisfactory and cheap method of preparing the ground for the shovel.

MESABI RANGE.

KINNEY DISTRICT.

JENNINGS OPTION, SECTION 14, 58-19, MINNESOTA.

As previously mentioned, a drilling option was taken on this property. This was done to satisfy the conditions of an agreement which called for at least two standpipes to be sunk, the ledge tested and no ore found before dumping rights could be obtained for the Wade-Helmer properties. Consequently ledge was tested at the two points in question and nothing but unenriched taconite encountered. This work was done on contract by the Duluth Diamond Drilling Company.

HIBBING DISTRICT.

BOEING MINE SURFACE, SECTION 6, 57-20, MINNESOTA.

The work of check drilling this property recently leased by the Company from the Hill interests in order to definitely determine the method of mining, that is, whether strictly underground or by means of an open pit in connection with underground operations, was commenced early in February 1919, on contract by the Duluth Diamond Drilling Company. A system of checker-boarding, on 300' squares in the majority of cases, was used in locating the holes but where necessary the holes were drilled somewhat closer together.

Twenty four holes were drilled and as a result the tonnage was considerably increased due to the discovery of a relatively deep trough extending lengthwise of the property in a Northwesterly-Southeasterly direction. This deep ore was encountered at only one point by the original drilling. This work was completed early in June and an open pit decided on.

## UNDERGROUND EXPLORATIONS.

### ANGELINE MINE.

One shallow hole was drilled in the Angeline Mine during the year and the first since the mine was taken over by this Company. It was drilled horizontally and Southeasterly from the 1318' sub-level in the so-called Middle Deposit for the purpose of exploring the iron formation as far as the South greenstone or footwall. The ground was badly broken and when the hole had reached a depth of 43' casing was resorted to. The progress from this point on was so slow and difficult that the hole was finally stopped at 59' and drilling discontinued for the present.

### ATHENS MINE.

Drilling for general exploratory purposes and to aid in the current development work was resumed early in February and was discontinued the middle of March after completing three holes, Nos. 4, 5 and 6. Holes 7 to 10 inclusive were drilled from the middle of October to the early part of December when the work was again discontinued for the time being. Small extensions of ore were discovered but the work was mainly to locate foot and hanging wall contacts to aid in the location of development drifts.

### BUNKER HILL MINE.

Drilling which was started in November 1918 continued to the early part of February when the outfit was moved in to the Athens Mine for the work described in the previous paragraph. Hole No. 2, the first of a series of three holes drilled from the North drift on the 10th level to determine the depth of ore below this elevation at this meridian but more particularly for the purpose of locating the allowable mining and caving limit at the West boundary of the Athens property, was just being bottomed in footwall dike on the first of the year. This was a vertical hole.

The next hole, also drilled from the same location, was inclined  $-46^{\circ}$  on a course of practically due East. It encountered 63' of ore followed by 8' of second class material and at 75' by footwall dike, in which the hole was bottomed at 94'.

Hole No.4, the last of the series, was inclined  $-30^{\circ}$  nearly due South and was also drilled from the same location. It encountered 67' of good ore, 33' of dike and another run of 70' of good ore, followed at 170' by footwall slate and greywacke, in which it was bottomed at 261'.

The dike in the bottom of the first two holes, Nos.2 and 3, was the main East-West fault dike that limits the main Athens ore body on the North, whereas the dike in No.4 is apparently a cross dike branching from the former and cutting through the ore body.

#### CLIFFS SHAFT MINE.

Drilling in this mine was continuous throughout the year. Hole No.293 was being drilled from the 4th level "A" shaft on the 1st of the year. This was finished in January and Nos.294 to 311 inclusive completed during the year. The holes were spread throughout the mine pretty generally and were located and drilled mainly so as to explore the ~~formation~~ contact between the slate hanging and the iron formation which is the chief ore horizon here. A number of holes, however, explored for ore in the several fault areas for continuations of the so-called fault or dropper veins.

A total of 193' of first class ore, 161' of second class ore and 104' of lean ore were encountered, which is somewhat less, proportionally, than encountered in 1918.

#### FRANCIS MINE.

A series of eight holes, Nos.6 to 13 inclusive, were drilled in this mine from August to October. The holes were all drilled from the West portion of the 5th level to outline the extension of ore below the level. Most of the holes were drilled from a specially driven hanging wall drift extending slightly North of West and over on to this Company's property, the NE $\frac{1}{4}$  of the SE $\frac{1}{4}$  of Section 28, 45-25.

The main Westerly pitching Francis trough which carries the ore body was found to be appreciably contracted at the boundary between the Francis lease and this Company's property and barren of ore at this meridian. Unless the trough is found to be productive again to the West or another ore-bearing feature found to extend to the Southwest from the main trough, the ore below the 5th level can hardly amount to more than 90,000 tons with a

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possibility of somewhat less than this.

#### GWINN MINE.

A series of eight holes, Nos.17 to 24 inclusive, were drilled in this mine from April to August. They were all located on the Southeast side of the 10th level and for the purpose of more definitely outlining the main ore body on its Southeasterly pitch below the level. This is important in order to plan the next or 11th level, both as to its general lay out and its elevation. Although enough for this purpose, the drilling was not sufficient to determine the ultimate limits of the ore in depth, nor its horizontal extent.

#### LAKE MINE.

Drilling from the 5th or bottom level at the Lake to explore the known iron formation below the main Lake Mine footwall greenstone sheet and lying against the main Lake fault on the South, which started in November 1918 with hole No.502, was completed the last of October 1919 and the drill moved from the mine.

Three holes were drilled, No.502 vertical, No.503 dipping  $-67^{\circ}$  to the North and No.504  $-80^{\circ}$  a little East of South. The horizon of the iron formation was found to be wholly unoxidized in all cases, the material being a magnetic, sideritic grunerite and quite rich in grunerite.

#### MAAS MINE.

Four holes were drilled in this mine between the middle of March and the middle of July. The first three, Nos.24, 25 and 26, were drilled North-east, North and Northwest respectively from the West side of the 2nd level to explore, ~~theto~~ the slate footwall, the iron formation which is intersected by several cross dikes, as well as to explore for a possible downward extension of the ore encountered in surface hole No.7. No commercial ore was discovered in any of this work.

The last hole No.27, was drilled South from the South end of the 185' sub-level to explore the ground on the South side of the dike in which the drift was breasted and also as far as the South side of the Maas-Negaunee basin. The drill cut through the dike at the very start and encountered good ore to 10' followed by 10' of second class ore and then 30' of good

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ore. Sixteen feet of good ore was encountered from 290' to 306' but the intervening ground and also the ground following was all lean ore with occasional seams of second class material. Footwall transition slate was cut at 340' and the hole bottomed in it at 404'. This hole, in reality, was all on the Negaunee Mine property.

MORRIS-LLOYD MINES.

Drilling in these properties continued throughout the year and holes Nos.47 to 60 inclusive, completed. Hole No.61, being drilled horizontally to the South from near the West end of the 6th level Morris Mine, was in soft ore jasper at 85' on the last of the year. Hole No.41, a deep vertical hole previously drilled from the 6th level Morris Mine, was deepened from 1513' to 1640' during the year and, because of its deviation to a position practically parallel with the dip of the iron formation, was finally bottomed in soft ore jasper at the latter point.

Hole No.47, drilled from the 6th level Morris with a dip of  $\approx -43^\circ$  and a course of N.  $66^\circ$  W., continued the exploration of the fault crotch in which below the 6th level ~~in~~ the ore lies that was encountered by surface hole no.4. No.47 encountered the ore from 275' to 330'. This ore apparently runs up to the level to the West as indicated by the ore encountered in No.58 from 70' to 95'. Nos.57 and 59 each encountered 15' of good ore of at least 150' lateral extent about 40' South of the slate-jasper contact on this level and a short distance West of where the above fault crotch cuts the level. This ore is independent of that in the fault crotch.

Two holes, Nos.49 and 50, were drilled on the 1st level East Lloyd to explore for possible ore risers or lenses in the main fault crotch or against the fault dike. No commercial ore was found in the first hole but No.50 encountered 40' of excellent ore about in the center of the crotch. This is an entirely new lens.

Five holes, Nos.51 to 55 inclusive, were then drilled in the Lloyd Mine, principally to explore the main Lloyd fault contact and also the supposed second fault crotch to the South. No.51 was drilled from the 1130' sub-level, No.52 from the 1st level, No.53 from the 1065' sub-level

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and Nos. 54 and 55 from the 3rd level. No extensions of known ore bodies nor new ones were found in this work.

The remainder of the drilling for the year was done from the 6th level Morris Mine. No. 56 was drilled horizontally and Southwest from the first ore drift Southwest of the shaft to explore for a possible continuation of ore South and West of the ore already developed on the level at this point which had been cut off by lean material; also to explore for a possible downward extension of the ore on the hanging side of the ~~the~~ 4th level, as well as to test the possibility of an upward extension to the West of the ore encountered in Nos. 29 and 34. The latter two holes were drilled from the 6th level and the ore encountered in them heretofore has not been connected<sup>up</sup> with any known ore bodies. The first 50' was good ore and was followed by lean and second class material until at 205' a run of 105' of good ore was cut. This in turn was also followed by lean and second class ore until the hole finally bottomed at 427' because of difficulty in keeping it open without casing. These results were very encouraging and a crosscut was started immediately to develop this ore and determine its connection, if any, with the known ore occurrences already mentioned.

No additional commercial ore was discovered in the remaining holes which have not been mentioned but which were drilled horizontally to systematically explore the iron formation to a moderate distance South of the slate footwall at the elevation of the 6th level.

#### NEGAUNEE MINE.

The drilling of two holes on the 11th level Negaunee Mine was started early in December. The first hole, No. 26, was drilled horizontally and N. 47°40' W. from the breast of the hanging wall drift at S. 1050.2 and 83.2 E. to explore the ground in this vicinity and to more definitely outline the irregular hanging wall contact as an aid in laying out the development drifts on this level. It was drilled to a depth of 316' and encountered 38' of good ore from 162' to 200' averaging 61.66% iron and .092% phosphorus, as well as several narrow seams of lean ore.

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The second hole, No.27, was then located at approximately the same point as No.26 and drilled horizontally but on a course of S. 30° W. to explore for the limits of the comparatively narrow tongue of ore along the South footwall which had been cut by the crosscut from which this drilling was being done. To develop the level economically it is important to know the extent of this ore in a Westerly direction. The hole started in soft ore jasper and was still in it at 36' on the last of the year.

REPUBLIC MINE.

Drilling was resumed in this mine about the middle of January and continued throughout the remainder of the year. Twenty five holes, Nos.414 to 438 inclusive, were completed and No.439 drilled to a depth of 36' during that time.

All the holes were drilled for general and systematic exploratory purposes from the current working levels. They were all drilled horizontally with the exception of No.422 which was inclined at an angle of +30°38' from the 1935' level No.9 shaft. The object here was to explore the ore making down from the one working stope remaining on the 1815' level, the floor of which was being mined on a sub-level. Previous drilling had proved that the ore did not come down as far as the 1935' level itself and to know its limits was important in order that development raises might be economically planned.

One hole was drilled from the 1335' level Pascoe shaft to more definitely determine the hanging contact as an aid in planning a drift into the hanging from which a campaign of drilling can be systematically conducted. Two holes were drilled from the 1780' level, three from the 1850' level, two from the 1950' level, four from the 2070' level, seven from the 2270' level and one from the 2370' level, all in the Pascoe shaft. One hole, which was mentioned above, was drilled from the 1935' level, one from the 2080' level, two from the 2170' level and two from the 2270' level No.9 shaft. The 2170' and 2270' levels are being opened from the so-called No.9 winze. The latter was sunk from near the Northwest end of the 2070' level, which in turn connects with No.9 shaft.



The plan of drilling at this mine, which was followed with all these holes, is divided into three parts. In the first place, an attempt is made on all new levels to locate the downward extension of known ore lenses above where they are not found by drifting along the quartzite hanging contact but have probably dropped back into the jasper footwall. Secondly, the hanging contact zone is explored for new ore bodies by drilling in cases where rock drifting is not warranted until a discovery of ore is previously made; and, lastly, a systematic exploration of the jasper formation is made back to a horizon 100' to 200' from the hanging contact.

By referring to Table II it will be seen that during the year 254' of first class ore, 94' of second class ore and 221' of lean ore were encountered. This is very encouraging as it is probably the largest footage discovered by drilling in the history of the mine during the same length of time.

#### 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 submitted special reports covering each visit, giving detailed information thus acquired. Very little drilling was done during the year by other companies in these districts. The only new work of interest is the drilling commenced the latter part of the summer by Escanaba interests in the name of the Escanaba Iron Range Exploration Company. One hole has been completed and the second started in the vicinity of Pine Ridge on Section 28, 39-23, about four miles West of the city of Escanaba. The first hole encountered soft ore jasper between 500' and 600' in depth, which is assumed to be the Easterly extension of the Menominee Iron Range at Iron Mountain, Norway and Vulcan. The formation was reported to be very lean.

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.

TABLE V.

DETAIL STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1919.

GEOLOGICAL DEPARTMENT.

<u>Salaries.</u>	<u>Travel.</u>	<u>Operating Auto.</u>	<u>Supplies.</u>	<u>Office Expense.</u>	<u>Total.</u>
\$18,890.02	\$839.03	\$1,000.09	\$1,309.03	\$5.61	\$22,043.78

DETAIL OF LARGER ITEMS GROUPED AS SUPPLIES AND OPERATING AUTO.

Driving horse for winter season	-	-	-	\$250.00	
Paper sample bags	-	-	-	78.84	
Rental of Maas Drill Hole Compass	-	-	-	50.00	
2 Goodyear cord tires and tubes	-	-	-	118.98	
Depreciation of auto for Geological Dept.	-	-	-	237.50	
" " " " Eng. & Geol. Depts.				45.18	(Geol. prop).
" " truck " " " " " "				28.51	" "

EXPENSES OF H. L. SMYTH.

Travel. Supplies. Misc. Total.

\$509.75	\$12.77	\$120.00	\$642.52
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EXPENSES ACCOUNT VISITING OUTSIDE EXPLORATIONS.

Salaries. Travel. Total.

\$37.46	\$34.95	\$72.41
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SUMMARY.

Expenses of Geological Dept.	-	\$22,043.78
" " H. L. Smyth	0	642.52
" a/c visiting outside ex- plorations	-	72.41
Grand total		\$22,758.71.

TABLE VI.

COMPARATIVE STATEMENT OF CHARGES TO THE GEOLOGICAL DEPARTMENT FOR

THE LAST THREE YEARS.

	<u>1919.</u>	<u>1918.</u>	<u>1917.</u>
Salaries - - - - -	\$18,890.02	\$16,694.85	\$13,130.41
Travel - - - - -	839.03	329.64	221.55
Operating auto - - - - -	1,000.09	796.56	286.49
Supplies - - - - -	1,309.03	1,409.31	1,043.59
Visiting outside explorations	72.41	254.22	105.49
Miscellaneous - - - - -	5.61	4.89	12.23
<b>Total</b>	<b>\$22,116.19</b>	<b>\$19,489.47</b>	<b>\$14,799.76</b>
Expenses of H. L. Smyth, i.e. travel, supplies and mis- cellaneous - - - - -	642.52	763.86	569.05
<b>Grand total</b>	<b>\$22,758.71</b>	<b>\$20,253.33</b>	<b>\$15,368.81</b>

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

1. The larger average number of men employed during the year, as seen from Table III.
2. Increases in certain individual salaries.

The remaining increases are due mainly to the increased cost of travel, supplies, etc, and to the larger volume of work handled by this Department in 1919.

ANGELINE MINE

There have been no changes or additions to the mechanical equipment at this mine during the year. All machinery operated in a satisfactory manner.

CLIFFS SHAFT MINE

On February 6th the work of dismantling the old Ingersoll-Rand steam driven air compressor and the De Laval steam turbine was started to make room for the installation of two electric driven air compressors. This work was slow as it was necessary to cut off about 3 ft. from the top of the old foundations, which were reinforced with old wire rope and steel rails. The foundation for #1 machine was completed on February 28th and the foundation for #2 machine was completed on April 19th. The erecting engineer started to install the compressors on April 19th. No. 1 compressor was put in operation on May 12th and No. 2 on May 19th. Both machines have been in almost continuous operation and have been very satisfactory. These two compressors are of the Ingersoll-Rogler PRE-2 type, with a capacity of 2,443 cu. ft. per minute, or a combined capacity of 4,886 cu. ft. per minute. They are driven by 2200 volt, 3 phase, 60 cycle, 438 H.P., 180 R.P.M., General Electric synchronous motors direct connected to crank shaft of compressor.

August 6th a 5" x 6" Deane triplex pump, which was transferred from the McClure Dam, was put in operation in the compressor room. It is supplying all necessary cooling water for the air compressors. It is driven by a belt from a 10 H.P., 865 R.P.M., 220 volt, General Electric motor. This water is taken from the lake and after passing through the water jackets of the compressors returns again to the lake. At present there is no city water used on these compressors.

There were no other changes or additions during the year and all of the mechanical equipment operated in a satisfactory manner.

CLIFFS SHAFT MINE (Cont'd)

A new rotor was installed in hoist motor for "A" Shaft, the old one having crystalized due to overload.

Improved signal system was installed in each shaft.

HARD ORE SHOPS

An armature machine was installed in the Machine Shop, providing facilities in the one machine for banding armatures, turning or grinding and slotting commutators. This is a very satisfactory outfit.

HOLMES MINE

On April 21st the 300 G.P.M., Type L.G., bilge pump, bought from the Chicago Pump Company, was put in operation. It was installed about 200 ft. from the boundary line and is used to pump the water to the main pump station near the shaft on the 2nd level. This pump is driven by a direct current motor, the current being taken from the trolley line.

On April 30th we put in operation in the main pump station on the 2nd level a 5" x 10" Aldrich vertical triplex pump, with capacity of 150 G.P.M. against 1,000 ft. head. This pump is belt driven from a 50 H.P., 860 R.P.M., 2200 volt Allis-Chalmers motor. This is a temporary installation and was put in to release the large centrifugal pump borrowed from the Mackinaw Mine and to take care of the water until the permanent pump station could be completed.

The permanent pump station on the 4th level was completed in September and the work of installing the pumps was started. The 800 G.P.M., 1250 ft. head, 8-stage Cameron centrifugal pump was put in operation November 3rd. It is direct connected through flexible couplings to a 400 H.P., 1800 R.P.M., 2200 volt General Electric motor. The installation of the 7" x 12" Aldrich vertical quintuplex pump, 600 G.P.M., 1200 ft. head, was completed on November 29th. This pump is belt driven from a General Electric 250 H.P., 600 R.P.M., 2200 volt motor. Both pumps are operating satisfactory.

Power cables in shaft were extended to provide for permanent pumps.

All of the mechanical equipment operated in a satisfactory manner.

### LAKE MINE

In February the Ideal steam engine, formerly used to drive the underground haulage generator, was dismantled to make room for the installation of an electric driven Ingersoll-Rogler type PRE-2 air compressor. This machine has a capacity of 2,443 cu. ft. per minute and is driven by a 438 H.P., 180 R.P.M., 2200 volt General Electric synchronous motor direct connected to the crankshaft. It replaces the steam compressor formerly used. This compressor was put in operation on May 29th and it has proved to be very satisfactory.

On December 6th we put in operation an Allis-Chalmers centrifugal pump, 150 G.P.M., 30 ft. head, 1140 R.P.M., direct driven through a flexible coupling by a 3 H.P., 1140 R.P.M., 220 volt Allis-Chalmers motor. This pump furnishes cooling water for the compressor, and replaced a steam pump formerly used for this work.

There were no other changes or additions at this mine and all of the mechanical equipment operated in a satisfactory manner.

### SALISBURY MINE

The mechanical equipment at this mine operated in a satisfactory manner. There were no changes or additions during the year.

### ATHENS MINE

At this mine we have had considerable trouble with the 500 G.P.M., 2400 ft. head, Prescott plunger pump which was installed in November 1918, due to defective castings. These castings are being replaced by the Prescott Company and we do not expect to have any further trouble with this pump.

On September 15th we completed the installation of the second 5½" x 24", 500 G.P.M., 2400 ft. head, Prescott plunger pump. It was put in operation on November 19th. This pump is driven by a 400 H.P., 514 R.P.M., 2300 volt Westinghouse motor direct connected to counter-shaft through flexible coupling and herringbone gears to pump. This pump is operating in a satisfactory manner.

ATHENS MINE (Cont'd)

On September 26th we had a serious overwind, the hoisting engineer pulling the skip into the head sheave. On making an investigation of this accident we found the sheave broken, which cut the hoisting rope and the skip dropped back and caught in the dump. The skip was not damaged, but there was some damage to the skip dump slide and one girder in the head frame. This was repaired and ready for operation on September 29th. Carelessness on the part of the hoisting engineer was the cause of this accident. The overwind device operated, but it is impossible to set the overwind on this type of hoist to operate satisfactorily with so little head room between the dump and the sheave. The engineer has been discharged as we think he was entirely to blame for the accident.

There were no other changes or additions to the mechanical equipment.

Trouble which had existed in commutator of generator on flywheel set was finally located and cleared and present operation is very good.

MAAS MINE

A new Allis-Chalmers bushing type flexible coupling was installed on the Prescott underground plunger pump. It has proved to be very satisfactory.

The installation of the Ingersoll-Rogler air compressor was completed on August 16th and it was put in operation on August 21st. This compressor is a duplicate of the machines installed at the Cliffs Shaft and Lake mines, and replaces the steam driven compressor formerly used. It is located in a temporary building close to the shaft, but will be moved into the power house as soon as the steam hoists, which are now being replaced by electric hoists, are dismantled.

We have had considerable trouble with the steam driven cage hoist now in use. It is being replaced by a Lake Shore Engine Works electric driven hoist, which is now being installed. This hoist should be in operation in a short time. The foundation for the new electric driven skip hoist is also completed.

MAAS MINE (Cont'd)

No other changes or additions were made to the mechanical equipment at this mine during the year.

A spare pump cable was installed in the shaft.

MAAS CRUSHING PLANT

No changes were made and the plant operated satisfactorily.

NEGAUNEE MINE

The installation of an electric driven Ingersoll-Rogler air compressor was completed on June 6th and the machine was put in operation on June 19th. This machine is a duplicate of the ones installed at the Cliffs Shaft, Lake and Maas mines and is operating in a satisfactory manner.

The installation of two Aldrich vertical triplex pumps was completed in September. These pumps are 12" x 12", 1000 G.P.M., 200 ft. head, and are driven by a belt through herringbone gears from 75 H.P., 900 R.P.M., 2200 volt General Electric motors. Both pumps are operating satisfactorily. They are located on the 11th level.

No other changes were made and the mechanical equipment operated in a satisfactory manner.

A spare pump cable was installed and extension made to the 11th level.

SOUTH JACKSON CRUSHER PLANT

The crusher was not used during the year. The compressor furnished air for the work in the pit. All mechanical equipment operated satisfactorily.

BARNES-HECKER MINE

In May we installed a temporary pump on the 800 ft. level to take care of the water until the shaft and pump station are completed. This pump is an Aldrich vertical triplex, 5" x 10", 150 G.P.M., 1000 ft. head, and is



BARNES-HECKER MINE

(Cont'd)

belt driven by a 50 H.P., 865 R.P.M., 2200 volt Allis-Chalmers motor. It is operating satisfactorily.

The permanent skip hoist was installed in July and put in operation September 17th. This is a Lake Shore Engine Works hoist with a 10' x 7' drum having a capacity of 2,000 ft. of 1 $\frac{1}{4}$ " rope. It is driven by a 400 H.P., 360 R.P.M., 2200 volt General Electric motor with single reduction herringbone gears. This hoist is operating in a satisfactory manner.

A Westinghouse 6 phase, 2300/275 volt rotary converter with transformers was installed for the underground haulage; also cable for connecting same.

The permanent pump cable was installed in the shaft.

LLOYD MINE

There were no changes at this mine and all the mechanical equipment operated in a satisfactory manner.

MORRIS MINE

New herringbone gear and pinion were installed on cage hoist in July.

There were no other changes and all machinery operated in a satisfactory manner.

SEC. 6 SHAFT

No changes or additions were made at this mine and all of the mechanical equipment operated in a satisfactory manner.

### AUSTIN MINE

The unwatering of this mine was completed in June and it was immediately cleaned up and made ready for operations. The pumps were removed from the shaft and the hoist and skip overhauled and made ready for hoisting ore, which started in August. The water from this mine is diverted to the Stephenson Mine.

### FRANCIS MINE

In February a second electric driven endless rope tram plant of the C. A. Lawton type, with 3'3" sheaves, was installed on the second stocking trestle.

In March the 1000 G.P.M., 800 ft. head, Allis-Chalmers centrifugal pump, which had been temporarily installed on the 600 ft. level, was transferred to its permanent position in the 800 ft. level pump station and put into operation. The transfer of this pump completed the installation and equipment of this permanent pump station.

In April the 8 ft. rope sheave on the old tram plant failed and was replaced with one from the Stephenson Mine.

In May one of the main bearings of the Ingersoll-Rand air compressor ran hot and caused a short delay.

With the exception of these two mishaps the mechanical equipment gave no trouble during the year.

### GARDNER MINE

In January a new tram plant of the gravity type for stocking ore was installed and started operating.

There were no other changes in the mechanical equipment of this mine, which operated very satisfactory through the year.

MACKINAW MINE

In February a new top tram plant of the gravity type was installed and started operating on the ore trestle.

In March an Aldrich vertical quintuplex electric driven pump, 1000 G.P.M., 1000 ft. head, was installed in the permanent pump station on the 1000 ft. level and placed in operation.

There were no other changes in the mechanical equipment during the year.

GWINN MINE

During the year the Gwinn shaft was sunk 100 ft. deeper, to a total depth of 1117 ft.

There were no changes in the mechanical equipment during the year, the operation of which has been satisfactory.

GWINN CRUSHING PLANT

During the shipping season this plant gave continuous service, with no delays of any importance.

It is likely that a new 36" conveyor belt will be needed on the Robbins conveyor as the old belt has become badly worn during the past three seasons.

PRINCETON MINE

In February a new secondary shaft was installed on the hoist at #2 Shaft. The end of the old shaft carrying the disk for connecting to the motor shaft having failed. In September the same trouble occurred again and the new shaft was turned end for end and the disk re-fitted. A new shaft has been ordered to avoid future delays.

The installation of the new pumps on the 476 ft. level in #2 Shaft was completed in December. One of these pumps is a 10" x 16" Aldrich vertical triplex, capacity 1000 G.P.M., 500 ft. head. It is driven by a

PRINCETON MINE (Cont'd)

Westinghouse 150 H.P. belted motor. The other unit is a 3" 5-stage Allis-Chalmers centrifugal pump, 500 G.P.M., 500 ft. head, driven by a 125 H.P. direct connected Allis-Chalmers motor. As soon as the sump is ready these pumps may start operating and the old pumps in #1 Shaft shut down and removed from the mine.

PRINCETON CENTRAL POWER PLANT

In March the inside shell of the boiler feed water heater failed and was replaced with a new one.

Previous to this time several tubes in the Sturtevant economizer failed and it is thought that this economizer has about reached its limit of usefulness due to the incrustation and pitting of the tubes and headers.

In April the Allis-Chalmers air compressor was cut over from steam to electric drive. The boiler plant was shut down with the exception of one boiler furnishing steam for heating the District Office, Shops and Laboratory.

In July a temporary boiler was installed to furnish steam for the Laboratory and the boiler room was shut down completely.

In October the boiler room was cleaned up, the boilers, pumps and piping all drained and re-packed preparatory for a quick start at any time should steam be needed, and the plant was laid up indefinitely.

In November readings were taken of the temperature of the coal in the Central Power Plant coal dock by lowering thermometers down 1" pipes to the bottom of the coal pile and leaving them there over night. No thermometer showed over 100° F., and as a temperature of 600° F. is necessary for spontaneous combustion no fires are expected in this dock the coming season.

HEATING PLANTS

After the Central Power Plant air compressor was cut over from steam to electric drive, and the warm weather permitted the steam for heating purposes to be shut off in the Shops and District Office, only the Laboratory was left requiring steam for drying ore samples. It was found to be too

HEATING PLANTS (Cont'd)

expensive to operate one of the large boilers in the Central Power Plant boilerroom for this purpose. For this reason it was decided to install three independent heating plants, one in the Laboratory, one in the District Office and one in the Central Shops, and close down the Central Power Plant boilers completely. These installations were completed in January and appear to be working out very satisfactory.

PRINCETON PUMP STATION

The operation of this plant has been continuous throughout the year.

STEPHENSON MINE

At the beginning of the year 1919 the water stood 159 ft. below the collar of the Stephenson shaft. Due to insufficient pumping capacity and trouble with the belt driven Layne & Bowler pump #1 it had been impossible to lower the water below this depth.

During the month of April a 250 H.P. vertical type motor was direct connected to the Layne & Bowler pump #1, after which it gave continuous service, pumping approximately 2300 G.P.M. at 159 ft. head. The water fell steadily until May 20th, when the second Layne & Bowler pump was installed. This pump had a capacity of 2,000 G.P.M. against a head of 300 ft. However, at the start against the lower head of 260 ft. it threw over 3,000 G.P.M.

During the month of June the water fell to a depth of 325 ft. below the collar of the Stephenson shaft. The #1 Layne & Bowler pump extended only to this depth, and pending the arrival of a 2,000 gal. centrifugal pump to throw up to the Layne & Bowler #1 no progress was made. On July 21st the centrifugal pump was received and was immediately put into operation, after which the water again began to lower steadily until the 5th level was reached in September.

No attempt was made to unwater below the 5th level until new motors

were installed on the two permanent pumps located in the 5th level pump house; a new electric transmission cable run in to furnish current for this station; and a third pump installed. This pump is an Aldrich triplex, 1600 G.P.M., 500 ft. head. The three pumps gave a total capacity of 4,300 G.P.M.

During October the 6th or bottom level was unwatered. A centrifugal pump with capacity of 1000 G.P.M. against 1000 ft. was also installed in the 5th level pump station, giving a total pumping capacity of over 5,300 G.P.M. from the 5th level.

The #1 Layne & Bowler pump was removed from the shaft, well cleaned and greased, crated and stored in a shed built for it on surface. During this time the other mechanical equipment on the 5th level and in the shaft and about the mine was being cleaned up and put in shape for a resumption of production.

During the first part of November the #2 Layne & Bowler pump was removed from the shaft and stored in the same manner as #1.

The permanent pump on the 6th level was put into operation, but the cable from the 5th to the 6th level blew out several times, necessitating the shutting down of this pump until a new cable is received. In the meantime an air pump keeps the 6th level unwatered.

The 8" water column from surface to the 4th level was extended to the 5th level and connected to the old discharge header of the 5th level pump station. This arrangement gives us two independent discharge columns to the surface.

In October the construction of concrete dams on the 5th and 6th levels was started. The purpose of these dams is to segregate the shaft from the rest of the mine in case of a run of water or sand.

Two surface tram plants which had been taken from the mine while it was shut down were replaced. All other mechanical equipment is in good shape and practically ready for operation.

## BOEING MINE

Work started at this mine in July when a 30 H.P. Lake Shore Engine Works electric driven hoist was received from the Negaunee Mine and installed for sinking.

The permanent compressor, consisting of a Class WNR Angle Compound machine with cylinders 22" & 13" x 14" stroke, was received and installed in a temporary building located in permanent engine house. This machine was built by the Sullivan Machinery Company and has a displacement of 1,385 cu. ft. of free air per minute. It is driven by a 225 H.P. General Electric synchronous motor running at 225 R.P.M.

Pumps for sinking were picked up at the other mines in the district and consist of No. 7, 8, 9 and 10 Cameron single acting machines driven by air. These gave some trouble at first as their condition was not as good as reported, but after a second overhauling no more trouble was experienced.

The permanent pumps consist of one 11" x 12" Aldrich vertical triplex, 850 G.P.M., 350 ft. head, belted to a 100 H.P., 600 R.P.M., General Electric motor. The other is a 2-stage Allis-Chalmers centrifugal pump, 800 G.P.M., 350 ft. head, and is driven by a 125 H.P., 1800 R.P.M., Allis-Chalmers motor.

The permanent skip hoist was purchased from the Lake Shore Engine Works and has a 5' x 5' drum driven through one reduction of herringbone gears by a 200 H.P., 450 R.P.M., General Electric motor with full magnetic control.

The underground haulage system consists of a 115 K.W. General Electric motor generator set and two standard six ton General Electric locomotives. Two rotary dumps were purchased from the Car Dumper & Equipment Co. and 15 tram cars were purchased from the Lake Shore Engine Works, but it has been decided to install only one rotary dump at the present time. Only the rotary dumps and cars were received.

Two top tram haulage systems were ordered with 6 ft. dia. rubber lined sheaves, driven by 50 H.P. motors. Only one will be needed here, while the other will be used at the Wade Mine.

BOEING MINE (Cont'd)

A steel head frame duplicating the one at the Chase Mine was purchased from the Worden-Allen Company and erected during November and December. Due to delay in shipment of pocket planks it could not be completed.

Most of the shop equipment was received and stored. This consists of a 24" raised to 30" Lodge and Shipley patent head lathe with 12 ft. bed, a 24" upright drill press, a No. 3 Williams pipe machine and a No. 1 $\frac{1}{2}$  Jarecki bolt threading machine. There is also an emery wheel and grindstone and all are driven through countershaft by a 10 H.P. General Electric motor. The shop will not be completed until the coming year.

CROSBY MINE

Very few changes or improvements were made during the year.

An electric driven sump pump, good for 100 G.P.M. against 50 ft. head, was installed in shaft to replace the steam pump so that the steam plant could be shut down. This pump was furnished by the Chicago Pump Co. and is driven by a 5 H.P. vertical motor.

The heating mains leading from the change house boiler to the shops, engine house, garage and oil house were placed in American District Steam Co. wood pipe with a 4" tile drain beneath.

A 32"x 32" x 8' planer and a small power hack saw were added to the Machine Shop equipment.

An overloaded bank of three 2 K.W. transformers was replaced with three 5 K.W. transformers. These are used for surface lights, shop motor and underground sump pump motor.

A concrete top dressing was added to engine house floor and the engine house appearance improved with floor paint and belt guards.



### HELMER MINE

After the drain drift was finished from the shaft to the pit the pumps were removed, the shaft piping taken out and the shaft abandoned as it was only needed for pumping. The boiler house and dry buildings were torn down and the lumber and corrugated sheet iron used for a locomotive round house at the Wade Mine. Both boilers were removed and shipped to the Boeing Mine, where the 60" x 16' was used as an air receiver and the 60" x 18' bricked in for the heating system boiler. Nothing now remains at the Helmer Shaft.

It was decided to electrify the Helmer incline hoist and equipment to make this change was purchased from the Lake Shore Engine Works. None of this equipment has been received yet.

After the shipping season closed one 50 H.P. locomotive boiler was shipped to the Hill-Trumbull Mine.

### HILL-TRUMBULL MINE

Work at this mine started in October, when an 85-C Bucyrus steam shovel and 12 - 12 yd. Western dump cars were received from Clapp, Norstrom & Riley. Two 17" x 24" cyl., 45 ton, 6 driver, switching type locomotives were purchased from Butler Brothers. All of this equipment is second hand machinery, but has been overhauled and is in fair shape.

A small second hand concrete mixer, driven by a gas engine, was received from Trebilcock Bros. for pouring washing plant foundations.

Contracts have been let for washing and crushing plant equipment and plans are formulating for shop buildings.

After the shipping season closed at the Crosby Mine the 36 ton revolving shovel, No. 2 locomotive and 7 yard dump cars were brought to this mine for the winter to assist on stripping and filling.

MEADOW MINE

The greatest trouble at this mine seemed to be with the gasoline locomotive ignition system. This was changed from a Westinghouse distributing to an Eisman magneto type and the ignition has given no trouble for the last two months.

Due to careless tightening of Grosby clips one skip fell from surface to the bottom of the shaft and it was necessary to replace it with a new skip.

The heating system was overhauled during the summer.

There were no other troubles, changes or improvements.

WADE MINE

Most of the permanent electric equipment was installed during the spring. Due to poor design and workmanship the electric hoist operation was delayed, but most of its troubles have been corrected and it is now working satisfactorily.

It was necessary to put a new belt on the compressor. A spray cooling pond and electric driven pump was put in to cool the jacket water for this machine.

A 75 H.P. boiler was installed in the change house, the heating mains run underground through wood conduit and the temporary boiler house shut down.

A 100 G.P.M., 350 ft. head, Aldrich vertical triplex pump was installed in the underground pump station to supply water to location tank.

As a great deal of lathe work was required on the locomotives and shovels which the old lathe could not handle, it was taken out and replaced with the 24" lathe purchased for the Boeing Mine. A punching and shearing machine, a 20" shaper and a power hacksaw were added to the Machine Shop equipment.

### REPUBLIC MINE

During the year an additional storage battery locomotive was put in service and is giving good results.

An electric hoist was installed at #9 Shaft, which permitted #5 Boiler Plant and Hoisting Plant to be closed down with very satisfactory results. This hoist was furnished by the Lake Shore Engine Works and has a drum 12' in diameter x 12' long, capable of serving to a depth of 3400 ft. It is driven by two General Electric 500 H.P., 450 R.P.M., 2200 volt, 3 phase, 60 cycle induction motors through single reduction herringbone gears, there being one motor on each end of the drum. This is the largest hoist we have driven by A.C. motors and has been quite satisfactory from the start.

The water power plant has operated almost constantly on the compressors and has not produced enough, the remainder being supplied from the steam machine in the Central Power Plant.

### SPIES MINE

On February 21st the hoist originally purchased for the Chase Mine, and afterwards used as a winze hoist in the Morris Mine, was shipped to the Spies Mine to replace the steam hoist. This hoist was built by the Wellman-Seaver-Morgan Company and has a drum 6 ft. in diameter x 5 ft. face. It is driven by an Allis-Chalmers 200 H.P., 2200 volt, 580 R.P.M., 3 phase, 60 cycle induction motor.

On June 30th the mine was shut down. The pumps were taken out and shipped to the Republic Mine shop and are being repaired. The mine can be easily unwatered and the pumps installed when desired.

The hoist motor is being overhauled and repaired in the Hard Ore Shop and will be sent back to the mine when repairs are completed. With these repairs the equipment of this mine will be adequate for usual production.

## ELECTRICAL DEPARTMENT

The electric system is now fairly complete with the cutting in of the new McClure Plant.

This plant consists of two 5000 K.V.A. generators controlled by a five-panel switchboard, exciters mounted on shaft and unit operating at 600 R.P.M. Oil circuit breakers on generators and high tension lines are electrically operated. The Substation is a steel structure with two 3 phase, 2300/30,000 volt, 5000 K.V.A., transformers and two electrolytic lightning arresters. All of the electric equipment was furnished by the General Electric Company.

The water wheels are 6,500 H.P. each, designed for 400 ft. head at 500 R.P.M., and are horizontal type single runner turbines. They were furnished by the S. Morgan Smith Co. Flywheels, relief valves, electrically operated gate valves and Woodward water wheel governors were all supplied by the S. Morgan Smith Co.

The pipe line from the dam to the power house is 84" in diameter. There is 3,600 ft. of steel pipe and 9,700 ft. of wood stave pipe.

This plant was put in service February 5th, 1919, and is operating satisfactorily.

The Hoist Plant water wheel case burst February 15th, causing considerable damage. The repairs on this were not completed until August 13th, when the plant was again put in service.

On June 24th a large valve in the Carp River pipe line gave way, causing some damage and putting the plant out of service for several days. This was repaired and plant started up again on January 29th.

Our service was extended to the L. S. & I. Shops and power is supplied for their use.

The Marquette Branch Prison built a pole line to our Carp River Power House and we are supplying power for their use.

The principal increase in load during the year was due to the addition of the Republic Mine and Township, five air compressors, the

ELECTRICAL DEPARTMENT (Cont'd)

L. S. & I. Shops, Munising Woodenware and Munising City load.

Considerable time was spent during the year in testing and calibrating meters and our apparent losses are now very consistent.

During the year the right-of-way along all steel tower lines was cleared.

Improved signal systems were perfected and installed at several mines during the year. This development consists of multi-conductor armored cables terminating in water tight junction boxes, with lead and armored conductors for the service taps. This is very reliable and satisfactory.

A system of 60 volt lighting, with use of auto-transformers, has been adopted and gradually introduced and extended at various mines. The best record of this which we have indicates a saving of about 50% in lamp breakage.

The placing of miscellaneous electric wires in conduit has been gradually extended and a large part of the wiring is now of this type. The saving in maintenance and reduction of fire hazard fully justify this expense.

Reserve power cables have been placed in all of the more important mines.

A series of illustrated lectures were given early in the year for the educational service.

The Electric Plant as a whole is functioning well and we think efficiently, all things considered.

Some additions to transmission lines should be made the coming year and part of the older pole lines will need overhauling. This will be covered by a special report at the proper time.

The usual tables and diagrams are attached and these indicate very clearly the increase in load and apparatus connected.

ELECTRICAL DEPARTMENT (Cont'd)

CARP RIVER HYDRO-ELECTRIC PLANT

SUMMARY OF OPERATING CONDITIONS - 1919.

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation	1.18	1.57	1.17	3.47	2.10	2.88	3.29	2.11	2.91	3.70	4.42	0.70
Total precipitation for 1919 (Ishpeming)	- 29.50 inches.											
Average " at Marquette	- 32.8 " (46 years record)											
Drainage area above Intake Dam,	66.66 sq. mi.											
Cubic feet Precipitation in 1919,	4,571,860,800											
K. W. Hrs. generated at Carp River Plant in 1919,	16,400,200											
Cubic feet water utilized (90 cu. ft. = 1 K.W.H.)	1,476,018,000											
" " " in Storage Basin Jan. 1, 1919,	266,608,000											
" " " " " " Dec. 31, "	229,725,000											
" " " stored in 1918 used in 1919,	36,883,000											
" " " wasted over Intake Dam in 1919,	308,700,000											
Total run-off for the year 1919,	1,821,599,000											
Run-off per sq. mile of drainage area,	26,220,000											

	<u>1913</u>	<u>1914</u>	<u>1915</u>	<u>1916</u>	<u>1917</u>	<u>1918</u>	<u>1919</u>
Total Precipitation	30.11	26.53	38.41	36.83	25.46	31.05	29.50
Second ft. per sq. mi.	1.03	.67	.93	1.29	.70	.79	.83

ELECTRICAL DEPARTMENT (Cont'd)

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

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
<b>CARP RIVER POWER HOUSE -</b>				
Auxiliaries - 2 - 15 HP pump motors	30 HP.			
Water Supply Pump	<u>1</u>			
				31 HP.
<b>ANGELINE MINE -</b>				
Hoist	250			
Underground Haulage Set	150			
Top Tram	10			
Underground Centrifugal Pump	100			
"Happy Hollow" Hoist (to Hard Ore #3)	<u>25</u>		25	
				510
<b>CLIFFS SHAFT MINE -</b>				
Shop	25			
No. 8 Crusher	125			
No. 5 Crushers - 2 - 25 HP. motors	50			
Screens	15			
Top Tram	50			
Lower Tram	35			
Underground Haulage Set	100			
Hoist "A" Shaft	500			
Underground Plunger Pump No. 1	180			
" Centrifugal Pump	250			
Compressor - Allis-Chalmers	175			
Hoist "B" Shaft	500			
Underground Plunger Pump No. 2	200			
Laboratory Crusher	5			
Coal Crushing Plant	15			
" " " Exhaust Fan	$\frac{1}{2}$			
Tram			50	
Cooling Water Pump (from McClure Plant)			10	
Ingersoll-Rand Compressor #1			400	
" " " #2			<u>400</u>	
				3,085 $\frac{1}{2}$
<b>HARD ORE -</b>				
Machine Shop	7 $\frac{1}{2}$			
Carpenter Shop	25			
Blacksmith Shop Punch	3			
Water Supply Pump			2	
Armature Binding Machine			2	
" " "			$\frac{1}{2}$	
" " "			1/8	
Lathe Grinder	1			
Portable Drill			$\frac{1}{4}$	
" " - Large			$\frac{1}{4}$	
Commutator Slotter			<u>1/8</u>	
				41 $\frac{3}{4}$
<b>BROWNSTONE SUBSTATION -</b>				
Test Set	$\frac{1}{2}$			
Oil Filter Press	<u><math>\frac{1}{4}</math></u>			
				$\frac{3}{4}$
	fwd. 2,828 $\frac{3}{4}$ HP.	865 $\frac{1}{4}$ HP.	25	3,669 HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
HARD ORE #3 SHAFT				
brt. fwd.	2,828 $\frac{3}{4}$ HP	865 $\frac{1}{4}$ HP	25 HP	3,669 HP.
Hoist for Sinking Pump (from Angeline)		25		
Sinking Pump ( " Austin)		<u>150</u>		175
HOLMES MINE				
Air Compressor	340			
" " Cooling Water Pump	3			
Skip Hoist	400			
Cage "	400			
Underground Haulage Converter	150			
Machine Shop	7 $\frac{1}{2}$			
Top Tram	25			
No. 8 Crusher	100			
No. 6 Crushers - 2 - 40 HP. motors	80			
Screens	20			
Laboratory Crusher	2			
Underground Centrifugal Pump (to Mackinaw)	400		400	
Temporary U.G. Plunger Pump		50		
Permanent " " "		250		
" " Centrifugal Pump		<u>400</u>		2,227 $\frac{1}{2}$
LAKE MINE				
Underground Haulage Set	215			
Surface Drainage Pumps - 2 - 30 HP motors	60			
" " Pump	50			
" " "	20			
" " "	5			
Underground Plunger Pump	75			
" Centrifugal Pump	125			
" Ventilating Fan	40			
Ore Crusher	25			
Coal Crushing Plant	15			
Air Compressor		400		
" " Cooling Water Pump		<u>3</u>		1,033
SALISBURY MINE				
Hoist	400			
Underground Centrifugal Pump	400			
" Plunger "	100			
Compressor (to H.O. Shop for repairs)	150		150	
Underground Ventilating Fan	7 $\frac{1}{2}$			
Compressor Cooling Water Pump	2			
Surface Drainage Pump	30			
Compressor (from Republic Mine)		<u>150</u>		1,089 $\frac{1}{2}$
ATHENS MINE				
Cage Hoist	400			
Compressor	325			
" Cooling Water Pump	3			
Auxiliary Compressor (for hoist brakes)	5			
Underground Ventilating Fan	15			
Sinking Pump (1080 ft. station)	35			
" " (2400 " " )	50			
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Converter	150			
fwd.	6,475 $\frac{3}{4}$ HP	2,293 $\frac{1}{4}$ HP	575 HP	8,194 HP.

MECHANICAL DEPARTMENT



ELECTRICAL DEPARTMENT

(Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
brt. fwd.	6,475 $\frac{3}{4}$ HP	2,293 $\frac{1}{4}$ HP	575 HP	8,194 HP.
<b>ATHENS MINE (Cont'd)</b>	1,844			
Skip Pit Pump	2			
Laboratory Crusher	5			
Underground Plunger Pump #1	400			
Top Tram - 2 - 50 HP. motors	100			
Carpenter Shop	20			
Underground Ventilating Fan	15			
" Plunger Pump #2		400		
				2,786
<b>MAAS MINE</b>				
(Circulating Pump	40			
Turbine Auxiliaries (Injection "	25			
(Exciter	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist	50			
" Plunger Pump #1	320			
Winze Pump (4th level)	15			
Cooling Water Pump	5			
Skip Pit Hoist	15			
Top Tram - 2 - 50 HP. motors	100			
Coal Crushing Plant	15			
" " " Exhaust Fan	$\frac{1}{2}$			
Underground Plunger Pump #2	250			
Ingersoll-Rand Air Compressor		400		
Small Air Compressor for U.G. Pumps	2			
				1,845 $\frac{1}{2}$
<b>MAAS CRUSHING PLANT</b>				
Crusher	100			
Pan Conveyor	50			
Belt "	50			
				200
<b>NEGAUNEE MINE</b>				
Underground Haulage Set	215			
"Ilgner" Hoist Set	450			
Top Tram - 2 - 50 HP. motors	100			
Laboratory Crusher	5			
Auxiliary Compressor (for hoist brakes)	3			
U.G. Plunger Pumps - 2 - 300 HP. motors	600			
" Centrifugal Pump	350			
" Suction Pumps - 2 - 15 HP. motors	30			
Compressor Cooling Water Pump	3			(previously reported 5 HP)
Nordberg Air Compressor	325			
Shop	15			
Skip Pit Pump	5			
Underground Hoist (sent to Boeing Mine)	35		35	
Ore Crusher	25			
Ingersoll-Rand Air Compressor		400		
Commutator Grinder	1			
12th Level Plunger Pump	15			
11th " " "		75		
Exciters for U.G. Pump Motors (2)	40			
fwd.	12,724 $\frac{1}{2}$ HP	3,568 $\frac{1}{2}$ HP	610 HP	2,657 15,682 $\frac{1}{2}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
brt. fwd.	12,724 $\frac{1}{2}$ HP	3,568 $\frac{1}{2}$ HP	610 HP	15,682 $\frac{1}{2}$ HP.
SOUTH JACKSON CRUSHER PLANT				
Hoist	75			
Compressor	50			
Crusher	<u>150</u>			
				275
BARNES-HECKER MINE				
Cage Hoist	400			
Skip "		400		
Water Supply Pump		10		
Rotary Converter for U.G.Haulage		<u>150</u>		
Temporary Underground Plunger Pump		50		
Underground Ventilating Fan		<u>15</u>		
				1,025
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			
Ingersoll-Rand Air Compressor	250			
U.G. Plunger Pumps - 2 - 350 HP motors	700			
Laboratory Crusher	5			
Carpenter Shop (formerly on Top Tram)	25			
Underground Haulage Set	150			
Nordberg Air Compressor	325			
Compressor Cooling Water Pump	5			
Underground Hoist (sent to Spies Mine)	200		200	
Winze Plunger Pump	50			
" Centrifugal Pump	50			
Triplex Pump	50			
Top Tram - 2 - 50 HP. motors		<u>100</u>		
				2,625
SECTION 6 SHAFT				
Hoist	200			
Water Supply Pump	<u>3</u>			
				203
AUSTIN MINE				
Hoist (Sent to Salisbury Mine)	150		150	
Top Tram ( " " Francis " )	25		25	
Laboratory Crusher	3			
Vertical Sinking Pump (sent to Hard Ore #3)	150		150	
Hoist		200		
Top Tram		<u>25</u>		
				228
fwd.	17,560 $\frac{1}{2}$ HP	4,518 $\frac{1}{2}$ HP	1,135 HP	20,943 $\frac{1}{2}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
brt. fwd.	17,560 $\frac{1}{2}$ HP	4,518 $\frac{1}{2}$ HP	1,135 HP	20,943 $\frac{1}{2}$ HP.
<b>FRANCIS MINE</b>				
Underground Ventilating Fan	7 $\frac{1}{2}$			
Air Compressor	403			
Underground Centrifugal Pump	400			
Skip Hoist	400			
Compressor Cooling Water Pump	3			
Shop	5			
Top Tram	50			
Underground Haulage Converter	150			
Cage Hoist	400			
Underground Plunger Pump	350			
Rock Crusher (from Austin tram)		25		
Ore Tram		37		
				2,230 $\frac{1}{2}$
<b>GWINN MINE</b>				
Skip Hoist	400			
Cage "	400			
Underground Centrifugal Pump	400			
" Plunger "	350			
Top Tram - Ore	37			
Underground Haulage Set	150			
Rock Tram	10			
Shop	5			
9th Level Pump	35			
Underground Ventilating Fan (sent to Barnes-Hecker)	15		15	
				1,787
<b>GWINN CRUSHING PLANT</b>				
No. 7 $\frac{1}{2}$ Crusher	85			
Pan Conveyor	50			
Belt "	40			
				175
<b>GARDNER MINE</b>				
Hoist	400			
Sinking Pump (stored on surface)	35		35	
Top Tram	25			
				425
<b>MACKINAW MINE</b>				
Hoist	400			
Sinking Pump (stored on surface)	35		35	
Compressor	325			
Shop	7 $\frac{1}{2}$			
Sinking Pump	7 $\frac{1}{2}$			
Top Tram	25			
Underground Haulage Converter	150			
" Triplex Pump	100			
" Plunger "		350		
" Triplex Pump (stored )	75		75	
				1,365
<b>PRINCETON MINE #1</b>				
Underground Plunger Pump	50			
" Centrifugal Pump	50			
Fwd.	23,390 $\frac{3}{4}$ HP	4,930 $\frac{1}{4}$ HP	1,295 HP	27,026 HP.
				100

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS	
PRINCETON MINE #2	brt. fwd.	23,390 $\frac{3}{4}$ HP	4,930 $\frac{1}{4}$ HP	1,295 HP	27,026 HP.
Hoist	200				
Top Tram - 2 - 50 HP motors	100				
Underground Plunger Pump			150		
" Centrifugal Pump			<u>125</u>		575
PRINCETON MINE #3					75
Hoist	<u>75</u>				
STEPHENSON MINE					75
Top Tram	50				
Aldrich 5th Level Pump		250			
Centrifugal Sinking Pump (stored)	125			125	
Layne & Bowler " " #1 (stored)	250			250	
" " " " #2 "	350			350	
Underground Plunger Pump			250		
" Centrifugal Pump			275		
" " " (from Mackinaw)			400		
" " " (6th Level)			<u>50</u>		1,275
PRINCETON CENTRAL POWER PLANT					
(Circulating Pump	50				
Turbine Auxiliaries (Injection "	25				
(Exciter	33				
Underground Haulage Set	215				
Compressor	625				
Boiler Room Fan	25				
Coal Crushing Plant	15				
" " " Exhaust Fan	$\frac{1}{2}$				
Compressor Cooling Water Pump	7 $\frac{1}{2}$				
" " " " (stored at Mackinaw Mine)	3			3	
					996
PRINCETON CENTRAL SHOP					
Shop Motor	25				25
McCLURE PLANT (Construction Work)					
Air Compressor (sent to Wade Mine)	150			150	
Pump ( " " Cliffs Shaft)	<u>10</u>			10	
					0
ISHPEMING HOSPITAL					
Passenger Elevator	7 $\frac{1}{2}$				
Dumb Waiter	3				
Large Washer	2				
Small "	1				
Extractor	2				
Vacuum Cleaner	3				
" Pump	<u>1</u>				19 $\frac{1}{2}$
HOIST PLANT					
Exciter Motor-Generator Set		<u>20</u>			20
fwd.	<u>25,744<math>\frac{1}{4}</math> HP</u>	<u>6,450<math>\frac{1}{4}</math> HP</u>	<u>2,183 HP</u>	<u>30,011<math>\frac{1}{2}</math> HP.</u>	

MECHANICAL DEPARTMENT

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	TAKEN OUT IN 1919	CONNECTED JAN. 1, 1920 TOTALS
brt. fwd.	25,744 $\frac{1}{4}$ HP	6,450 $\frac{1}{4}$ HP	2,183 HP	30,011 $\frac{1}{2}$ HP.
<b>REPUBLIC MINE</b>				
Crusher		25		
Auxiliary Air Compressor (from Gwinn Mine)		5		
Crusher		100		
Pump in Engine House		75		
Centrifugal Pump in Engine House		20		
Coal Tram		7 $\frac{1}{2}$		
Pump		20		
Pascoe Shaft Tram		30		
Machine Shop		5		
Pump - 4th Level		15		
" - 3rd "		50		
Pascoe Shaft U.G. Pump		50		
" " Top Tram		15		
Portable Hoist		7 $\frac{1}{2}$		
Laboratory Crusher		3		
Picking Belt		5		
Fan		7 $\frac{1}{2}$		
Screen		10		
Tram		15		
Carpenter Shop		20		
Hoist # 9 Shaft - 2 - 500 HP. motors		1,000		
Motor-Generator for Underground Haulage		30		
Underground Hoist		100		
9th Level Winze Hoist		50		
				<u>1,665<math>\frac{1}{2}</math></u>
TOTAL MINING DEPARTMENT	25,744 $\frac{1}{4}$ HP	8,115 $\frac{3}{4}$ HP	2,183 HP	31,677 HP.
<b>FURNACE DEPARTMENT</b>				
Motor-Generator Set at Furnace		750		
Sawmill (8 motors)		445		
				1,195
<b>L. S. &amp; I. RY.</b>				
Machine Shop )				
Ore Dock & Pumps )				
Sawmill )		800		800
<b>MARQUETTE BRANCH PRISON</b>				
3 Motors		180		180
<b>MUNISING WOODENWARE COMPANY</b>				
Veneer Mill (13 motors)		695		
Woodenware Mill		100		
				795
<b>MUNISING ELECTRIC LIGHT &amp; POWER CO.</b>				
City Pumping		125		125
<u>GRAND TOTAL CONNECTED LOAD</u>	26,939 $\frac{1}{4}$ HP	10,015 $\frac{3}{4}$ HP.	2,183 HP	34,772 HP.

ELECTRICAL DEPARTMENT (cont'd)

The following motors are not connected to our general power

system:

	INSTALLED TO JAN. 1, 1919	INSTALLED IN 1919	CONNECTED JAN. 1, 1920 TOTALS
<b>SPIES MINE</b>			
Hoist Motor (from Morris Mine)		200	
Triplex Pump	50		
Crusher	50		
Air Compressor	<u>200</u>		
			500 HP.
<b>MESABA RANGE</b>			
<b>BOEING MINE</b>			
Sinking Hoist (from Negaunee Mine)		35	
Air Compressor		200	
Underground Plunger Pump		100	
" Centrifugal Pump		<u>125</u>	
			460
<b>CROSBY MINE</b>			
Hoist	75		
Compressor	50		
Plunger Pump	50		
Centrifugal Pump	85		
Machine Shop	3		
Conveyor Belt	40		
Screen	20		
Picking Belt	3		
Log Washer	20		
Turbo	20		
Ghip Screen	3		
Tables	20		
Underground Haulage Set	<u>150</u>		
			539
<b>HELMER MINE</b>			
Pump	20		20
<b>WADE MINE</b>			
Hoist	125		
Air Compressor	150		
" " Cooling Water Pump	2		
Underground Haulage Set	150		
Machine Shop	20		
Pump	50		
Centrifugal Pump	100		
Sump Pump	5		
Ventilating Fan	<u>15</u>		
			617
TOTAL	<u>1,476 HP.</u>	<u>660 HP.</u>	<u>2,136 HP.</u>

ELECTRICAL DEPARTMENT (Cont'd)

The following motors are on hand (Dec. 31st, 1919), but are not installed:

<b>CLIFFS SHAFT MINE</b>		
Top Tram (stator only)		50 HP.
<b>GENERAL STOREHOUSE</b>		
Motor-Generator Set	15 HP	
From Athens	10	
" Republic concrete mixer	5	
Spare General Electric	50	
" Allis-Chalmers	30	
" " "	10	
" from McClure Plant	7½	
" Hoist Motor	400	
" Motor-Generator Set	150	
"	5	
"	25	
" from Stephenson	250	
" " "	275	
" " McClure Plant	50	
" " Salisbury Mine	150	
"	<u>40</u>	
		1,472½
<b>ATHENS MINE</b>		
Spare - Small Hoist		25
<b>NEGAUNEE MINE</b>		
Flywheel Hoist Set	350	
11th Level Plunger Pump	<u>75</u>	
		425
<b>BARNES-HECKER MINE</b>		
Top Tram	50	
U.G. Plunger Pump	350	
" Centrifugal Pump	<u>400</u>	
		800
<b>AUSTIN MINE</b>		
Laboratory Crusher Motor		3
<b>FRANCIS MINE</b>		
Rock Crusher		25
<b>GARDNER-MACKINAW MINES</b>		
Sinking Pumps - 2 - 35 HP motors	70	
Triplex Pump	75	
Cooling Water Pump	<u>3</u>	
		148
<b>STEPHENSON MINE</b>		
6th Level Plunger Pump	50	
U.G. Centri. Pump	125	
Layne & Bowler #1	250	
" " " #2	<u>350</u>	
		775
<b>REPUBLIC MINE</b>		
Spare	10	
"	<u>10</u>	
		20
<b>LOANED TO MUNISING WOODENWARE CO.</b>		
		<u>100</u>
Total on Hand 12/31/19,		3,843½ HP.

ELECTRICAL DEPARTMENT (Cont'd)

The following motors have been ordered, but not received:

BROWNSTONE SUBSTATION			
Storage Battery Set			3 HP.
MAAS MINE			
Rock Tram		50 HP	
Skip Hoist		700	
Cage "		<u>400</u>	
			1,150
STEPHENSON MINE			
Top Tram - 2 motors 50 HP. each			100
REPUBLIC MINE			
Top Tram - 2 - 50 HP. motors			<u>100</u>
	Total,		<u>1,353 HP.</u>
BOEING MINE			
Hoist		200	
Underground Haulage Set		150	
Top Tram - 2 - 50 HP. motors		<u>100</u>	
			450 HP.
CROSBY MINE			
Sump Pump			5
HELMER MINE			
Hoist			200
HILL-TRUMBULL MINE			
Washing Plant		223 $\frac{1}{2}$	
Motor-Generator Haulage Set		<u>75</u>	
	Total,		<u>298<math>\frac{1}{2}</math></u>
			953 $\frac{1}{2}$ HP.
Total C.C.I. Co. load connected to General Power System			31,677 H.P.
" Outside	" " " " " "		3,095 "
" Connected load at Spies Mine			500 "
" " " Mesaba Range			1,636 "
" Spare Motors			3,843 $\frac{1}{2}$ "
" ordered, but not received - Ishpeming District			1,353 "
" " " " " - Mesaba			953 $\frac{1}{2}$ "



ELECTRIC POWER SYSTEM

SUMMARY OF OPERATIONS - 1919.

	KILOWATT HOURS GENERATED							Used by		K. W. H. Sold	Losses	Cost Per K. W. H. (Incl. Depr.)
	McClure	Carp	Hoist	Au Train	Maas	Princeton	TOTAL	Auxiliaries	Delivered to Line			
Jan.		1,848,800	469,575	486,560	316,600	157,050	3,278,585	53,610	3,224,975	2,638,782	18.18%	\$.00844
Feb.	*247,900	1 566 400	*354 500	311 280	462 200	197 100	3 139 380	65 243	3 074 137	2 624 313	14.63	.00941
March	496 400	1 533 100	0	300 012	411 800	165 500	2 906 812	59 278	2 847 534	2 420 741	14.99	.01063
April	1,214 100	1 457 200	0	510 900	0	0	3 182 200	7 394	3 174 806	2 721 588	14.28	.00628
May	1 556 100	1 551 100	0	504 680	0	0	3 611 880	7 325	3 604 555	3 208 561	10.99	.00684
June	2 532 000	1 200 300	0	252 340	7 200	4 850	3 996 690	8 160	3 988 530	3 532 143	11.44	.00640
July	1 997 800	1 548 600	0	157 710	40 200	66 450	3 810 760	14 120	3 796 640	3 133 430	17.47	.00762
Aug.	2 706 100	1 284 300	219 000	85 040	0	0	4 294 440	7 232	4 287 208	3 616 293	15.65	.00583
Sept.	2 739 200	999 200	519 000	91 730	0	0	4 349 130	7 685	4 341 445	3 664 023	15.60	.00757
Oct.	2 533 700	1 077 800	418 000	152 390	30 200	0	4 212 090	11 020	4 201 070	3 518 340	16.25	.00606
Nov.	2 138 700	1 111 400	534 000	247 010	0	0	4 031 110	8 795	4 022 315	3 399 078	15.49	.00858
Dec.	2 372 900	1 222 000	405 000	246 060	0	0	4 245 960	9 608	4 236 352	3 627 572	14.37	.00883
TOTAL	20,534,900	16,400,200	2,919,075	3,345,712	1,268,200	590,950	45,059,037	259,470	44,799,567	38,104,864	14.94	\$.00760

\*Note:- McClure Plant started up 8:30 A.M., Feb. 5th.  
Hoist Plant wrecked February 15th. Started up again August 13th.

MECHANICAL DEPARTMENT

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>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	
1919	423	48 580	89 137 049	1 834	57,792,500
<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
1919	3 494	377 901	907 895 024	2 402	298 889 689
<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	----
1919	947	173 178	521 145 000	3 009	25 471 515 (8 months)

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
------	------------------------	-------------------------------	---------------------	--	-------------------------------

HARD ORE #3 HEATING PLANT

1913	729
1914	810
1915	883
1916	922
1917	1,038
1918	955
1919	970

LAKE MINE

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	559 877	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
1919	5 884	334 419	510 718 170	1 527	192 626 467

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>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
1919	617	115 764	228 578 500	1 974	144 138 375

<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	- - - -	- - - - -
1919	740	155 643	414 045 000	2 660	85 503 850

COMPARATIVE TABLES

<u>YEAR</u>	<u>TONS COAL BURNED</u>	<u>TONS ORE &amp; ROCK HOISTED</u>	<u>CU. FT. AIR USED</u>	<u>CUBIC FT. AIR PER TON HOISTED</u>	<u>GALLONS OF WATER PUMPED</u>
<u>NEGAUNEE MINE</u>					
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
1918	1 293	524 869	443 996 750	845	828 575 874
1919	1 320	525 894	591 104 600	1 185	603 198 543
<u>MAAS MINE</u>					
1906	4,170	--- ---	260,733,698	---	311,792,458
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
1919	9 639	343 810	644 597 449	1 874	573 373 848

MECHANICAL DEPARTMENT.

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>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 taken out)	---	---
1917	0	46 994	---	---	---
1918	0	15 879	13,203,000	931	---
1919	0	56 840	---	---	---
<u>BARNES-HECKER MINE</u>					
1918	646	16,330	221,420,000	---	---
1919	603	29 731	---	---	(8 months) 5,481,940
<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
1919	1,132	313 887	936 264 700	2 982	340 883 140
(Air used in 1919 at Barnes-Hecker & Morris Lloyd.)					

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	61,876	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			(Mine idle entire year)		
1916	-	23 697	---	---	---
1917	-	54 167	---	---	---
1918	-	759	(Mine flooded in January)		
1919	19,212	---	---	---	---
<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
1919	499	102 651	291 060 000	-	45 865 547
			(Air used in Francis and Gwinn Mines)		
<u>GARDNER &amp; MACKINAW MINES</u>					
1914	303	--	221,355,000	-	---
1915			(Mine idle entire year)		
1916			(Mine idle entire year)		
1917	443	29,235	323,595,000	-	---
1918	533	37 883	388 395 000	-	---
1919	412	93 501	325 845 000	3,485	26,941,948

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>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
1919	1 132	154 002	(Air supplied by Francis Mine.)		199 404 200
<u>PRINCETON MINE</u>					
1909	3,104	143, 620	161,915,352	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
1919	468	219 230	---	---	131 496 940



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>PRINCETON CENTRAL POWER PLANT</u>					
			(output)		
1909	4,630	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			
1919	3 614	1 236 341 627			

PRINCETON PUMPING STATION

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
1919	920			237 147 315

COMPARATIVE TABLES

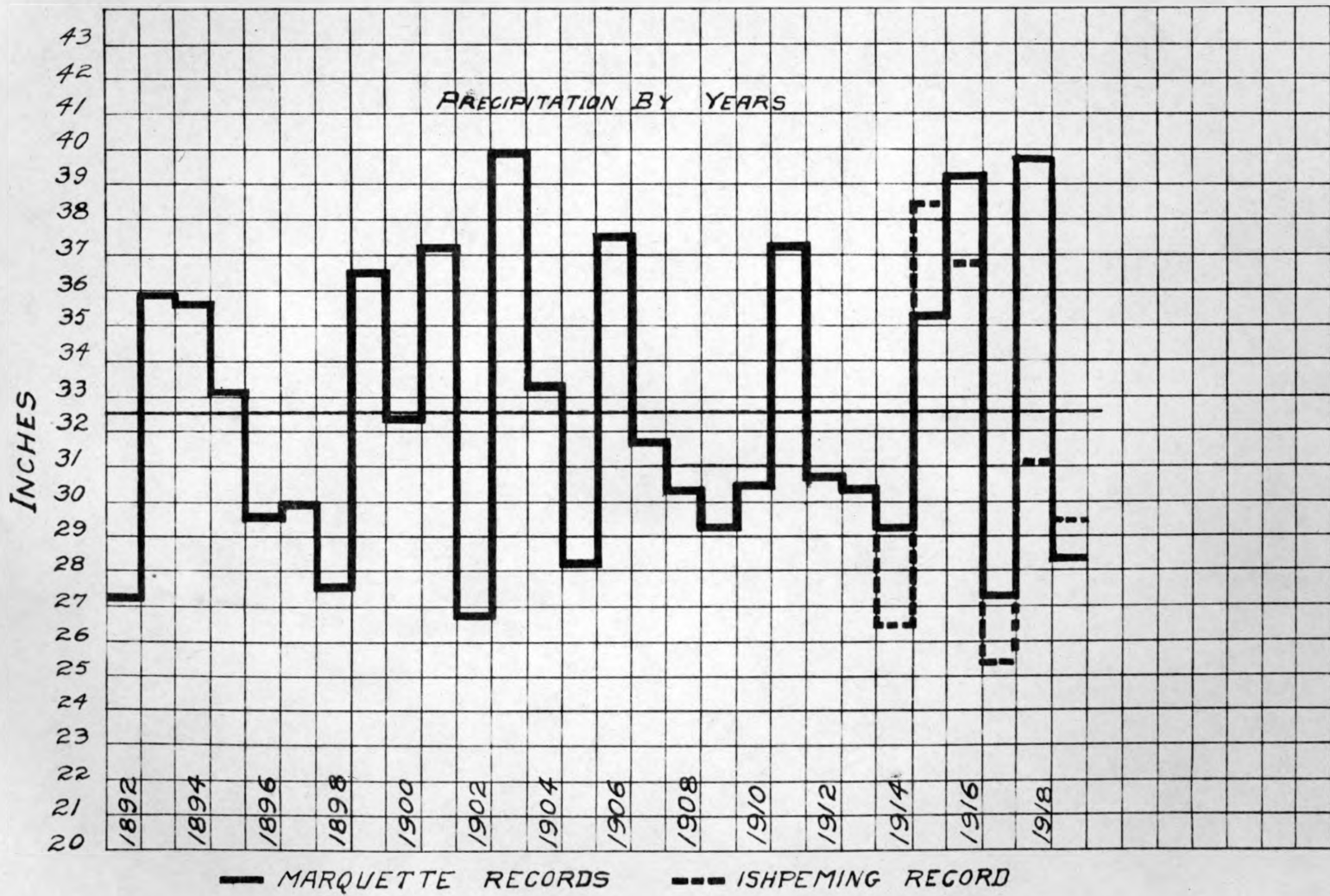
YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>STEPHENSON MINE</u>					
1909	2,396	140,683	181,915,347	1,313	191,342,376
1910	2 867	217 096	294 935 118	1 358	383 590 401
1911	4 182	239 991	384 041 898	1 600	625 253 183
1912	4 856	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)		
1919	724	1 662			122 32
<u>CROSBY 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	207 728	---	---	---
1914	(10 mo.) 2 151	(8 mo.) 23 221	---	---	---
1915	250	---	---	---	---
1916	2 069	127 373	---	---	---
1917	2 504	300 142	---	---	---
1918	3 097	255 787	---	---	---
1919	2 578	208 449	---	---	---
<u>HELMER MINE</u>					
1918	3,125	216,428	---	---	---
1919	1 274	71 867	---	---	---

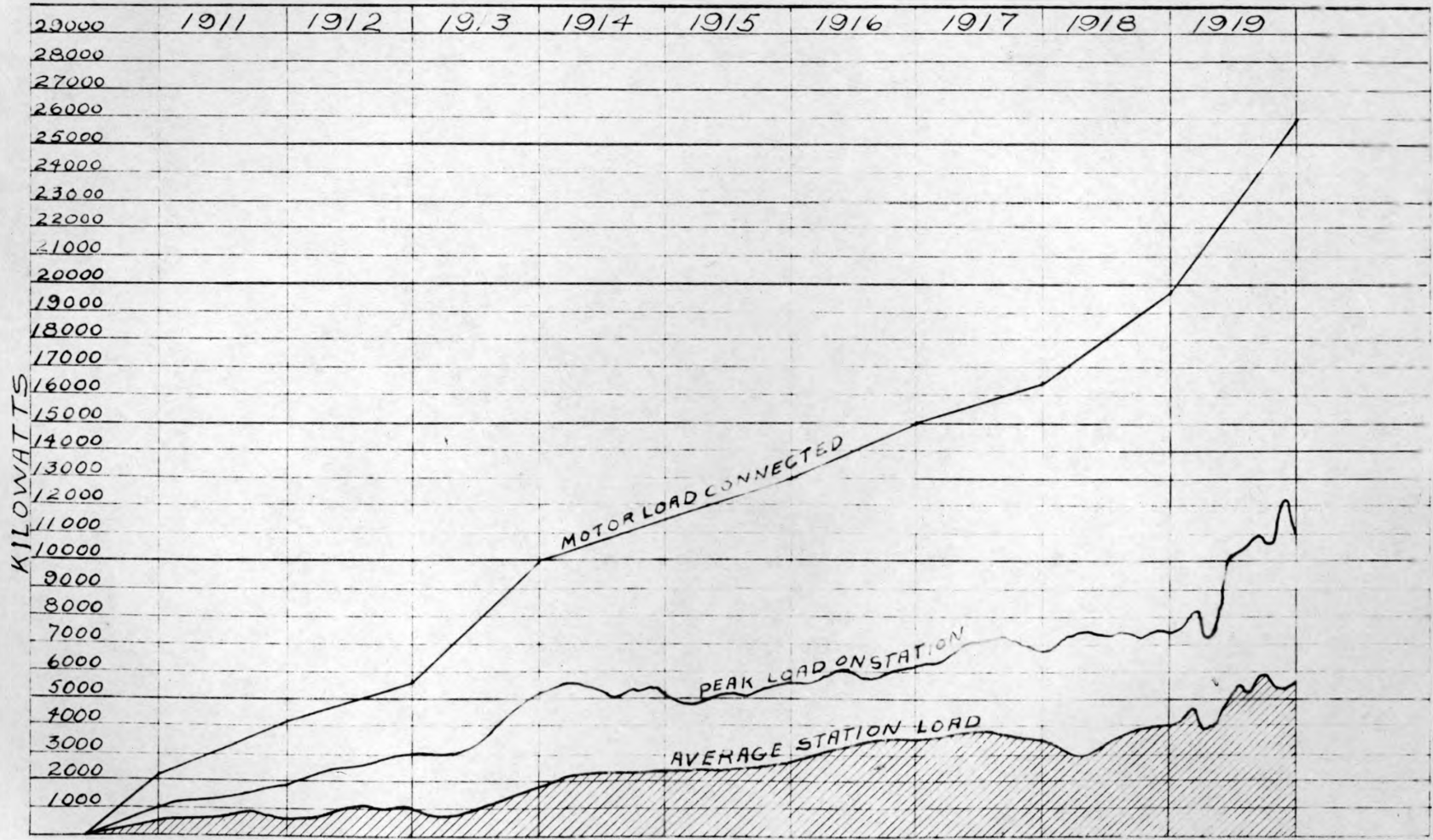
COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>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	---
1919	3 247	101 113	49 352 710	488	---
<u>WADE MINE</u>					
1918	3,820	72,305	---	---	---
1919	5 516	238 644	---	---	---
<u>REPUBLIC MINE</u>					
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	---
1919	5 709	185 383	1 228 202 000	6 625	34,770,380
<u>SPIES MINE</u>					
1916	1,644	20,308	---	---	---
1917	3 657	80 204	186,701,680	2,327	---
1918	2 154	124 477	---	---	---
1919	962	71 000	---	---	---
<u>BOURNE (BOBING) MINE</u>					
1919	---	2,048	---	---	---

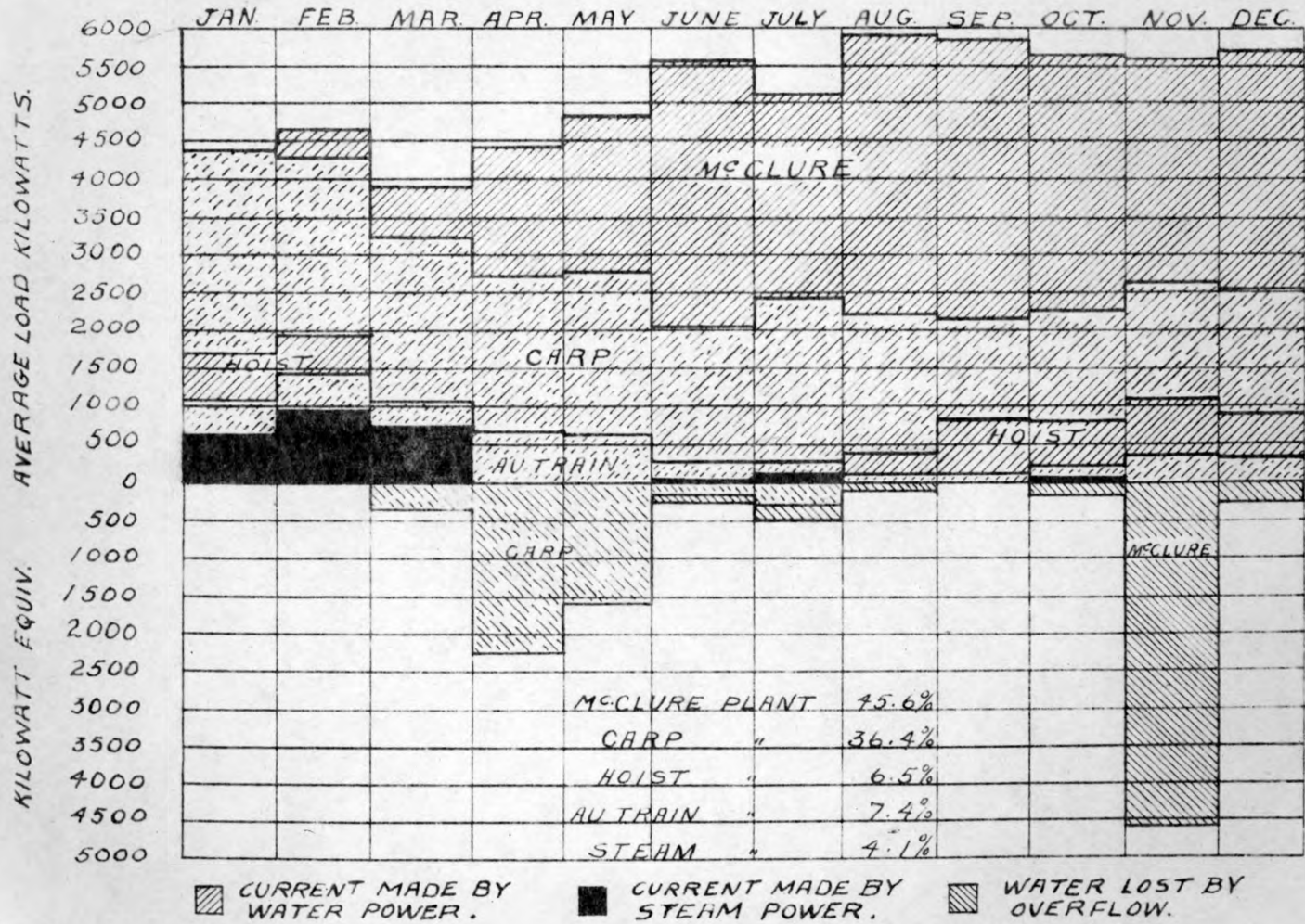
Note:-

- Lake Mine - Furnished air to Angeline Mine and Hard Ore Shops.
- Negaunee Mine - " " " Maas Mine.
- Maas Mine - " " " Negaunee Mine.
- Morris-Lloyd Mine - " " " Barnes-Hecker Mine.
- Austin Mine - Mine unwatered and hoisting started in August.
- Francis Mine - Furnished air to Gwinn Mine.
- P. C. P. Plant - Compressor changed to electric drive April 12th & 13th.
- Stephenson Mine - Mine unwatered in September. Hoisting started in Dec.
- Spies Mine - Shut down July 1st.

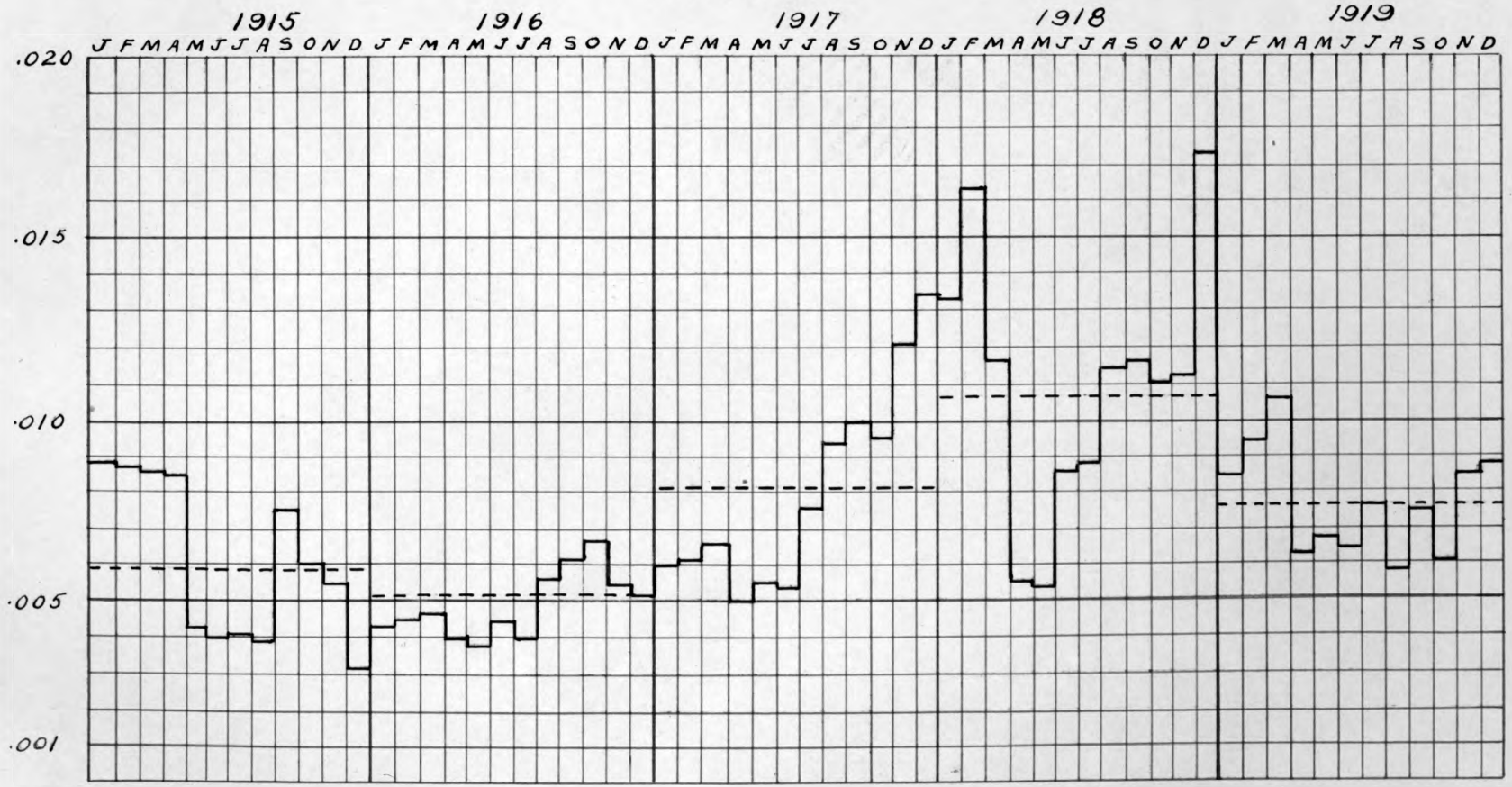




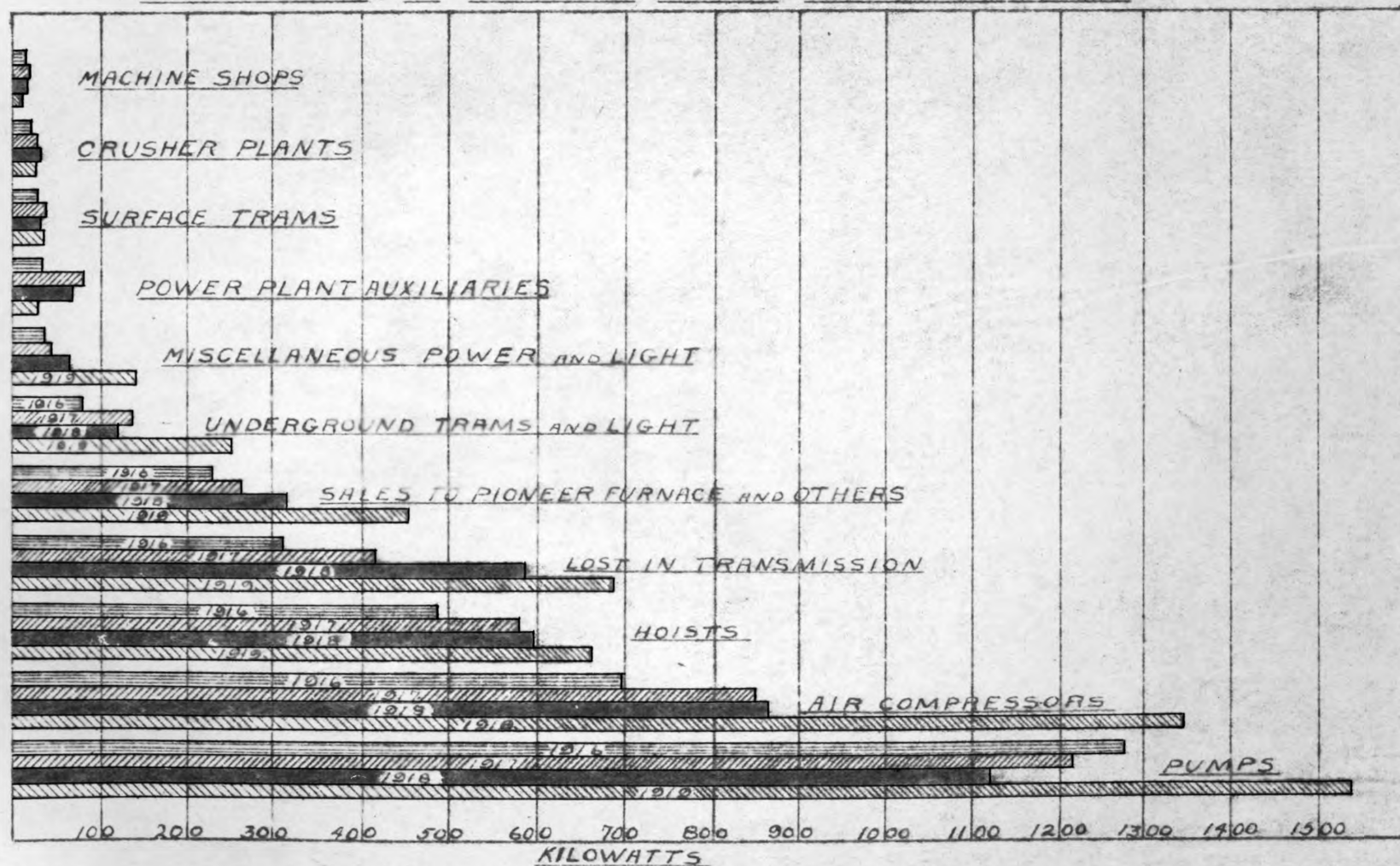
1919



# COST DIAGRAM



DISTRIBUTION OF ELECTRIC POWER 1916-1917-1918-1919.





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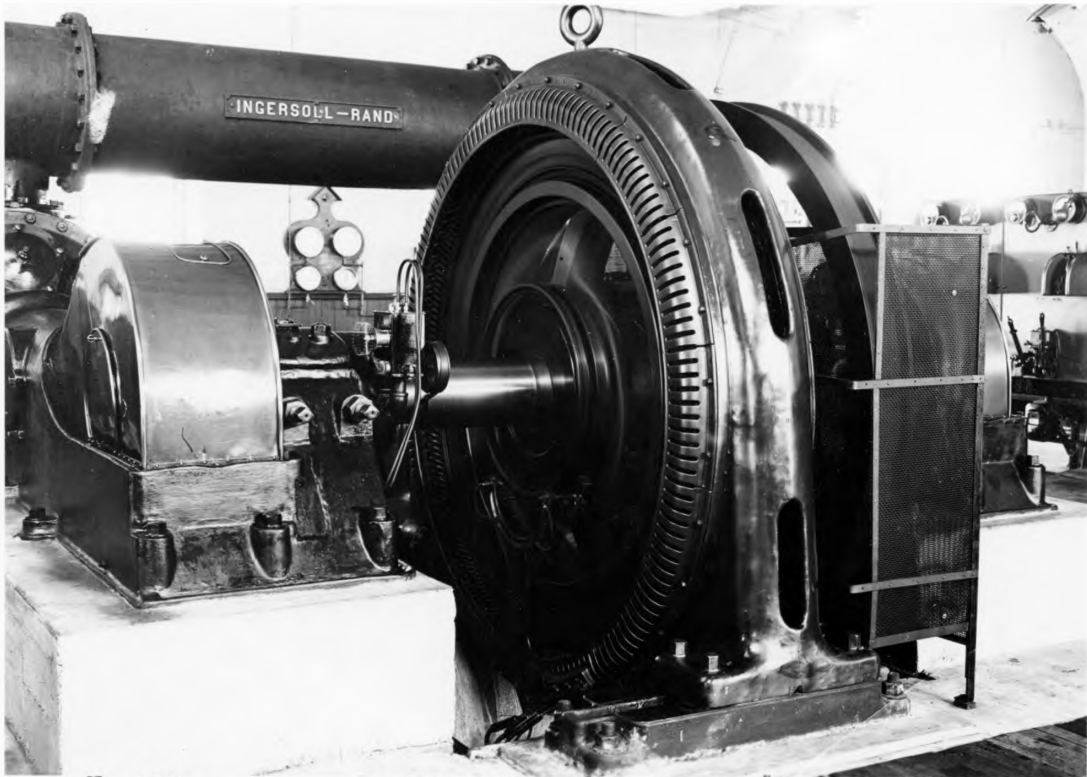


Plate No. 188

Ingersoll-Rand Compressor #1

Cliffs Shaft Mine

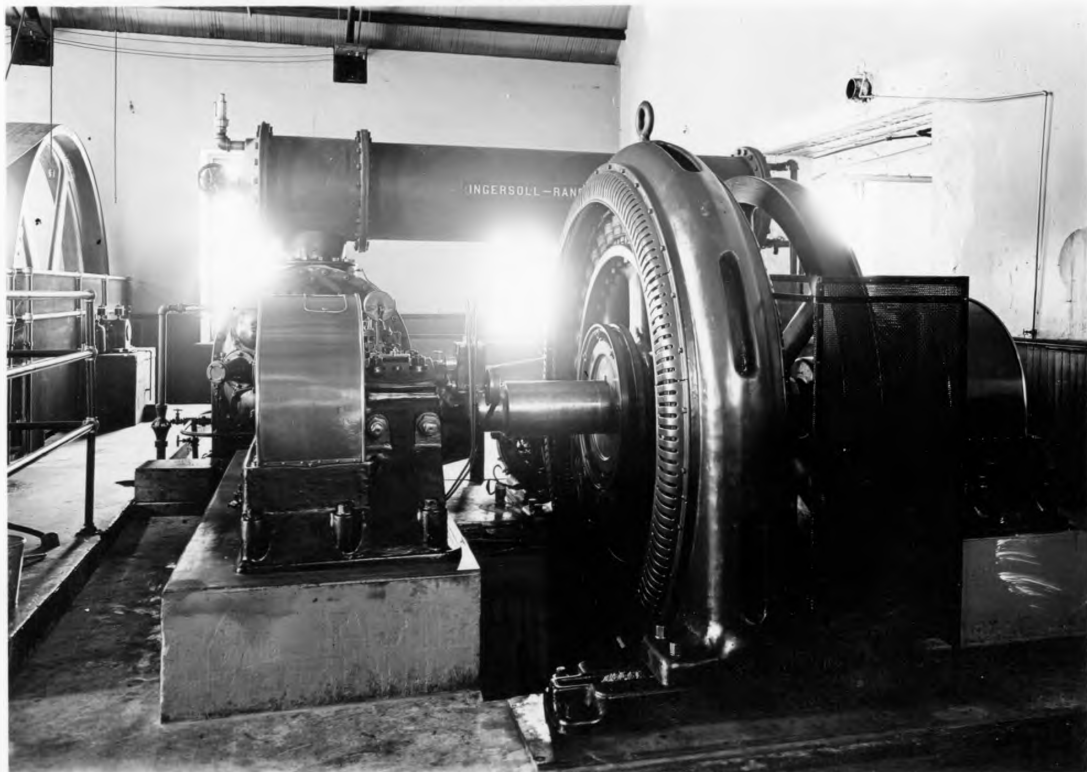


Plate No. 189

Ingersoll-Rand Compressor #2

Cliffs Shaft Mine



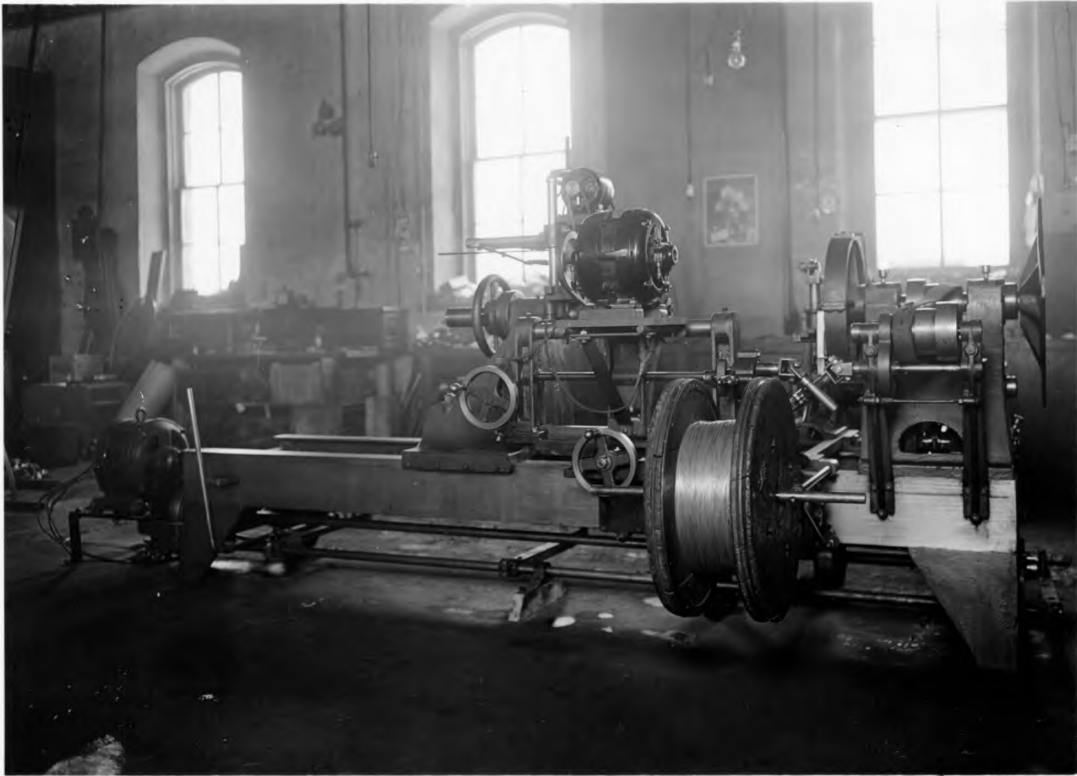


Plate No. 190

Armature Banding Machine

Hard Ore Shop



Plate No. 191

Armature Banding Machine

Hard Ore Shop



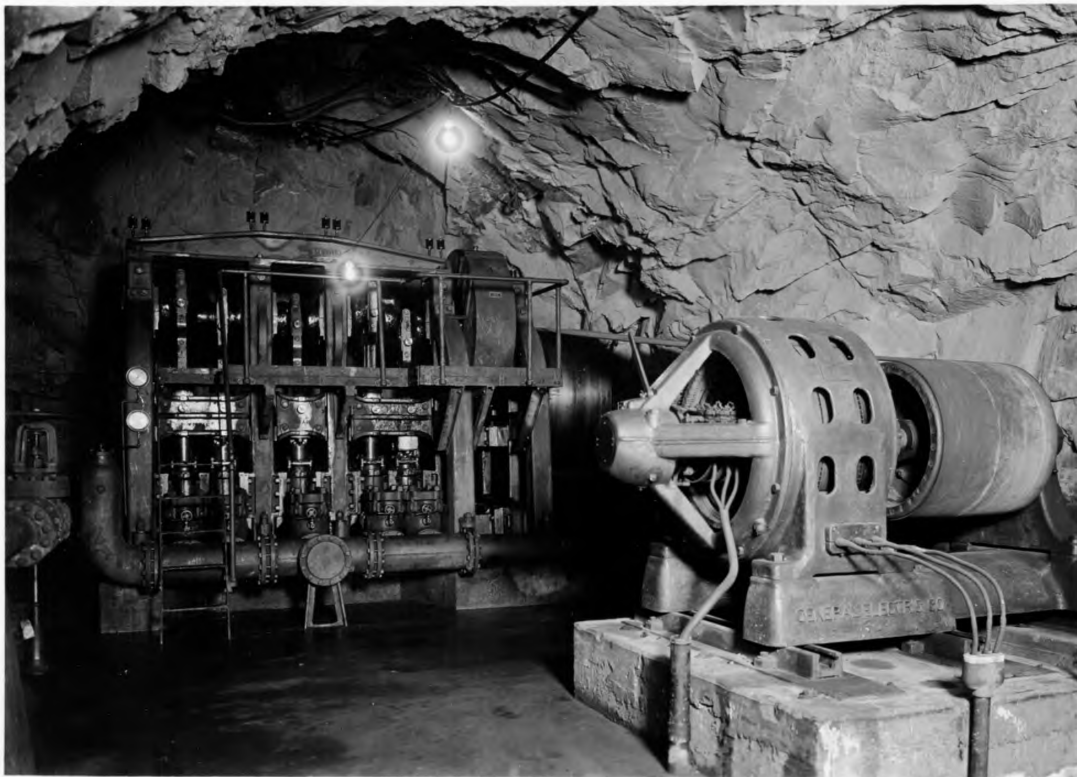


Plate No. 192

Aldrich Plunger Pump on 4th Level

Holmes Mine

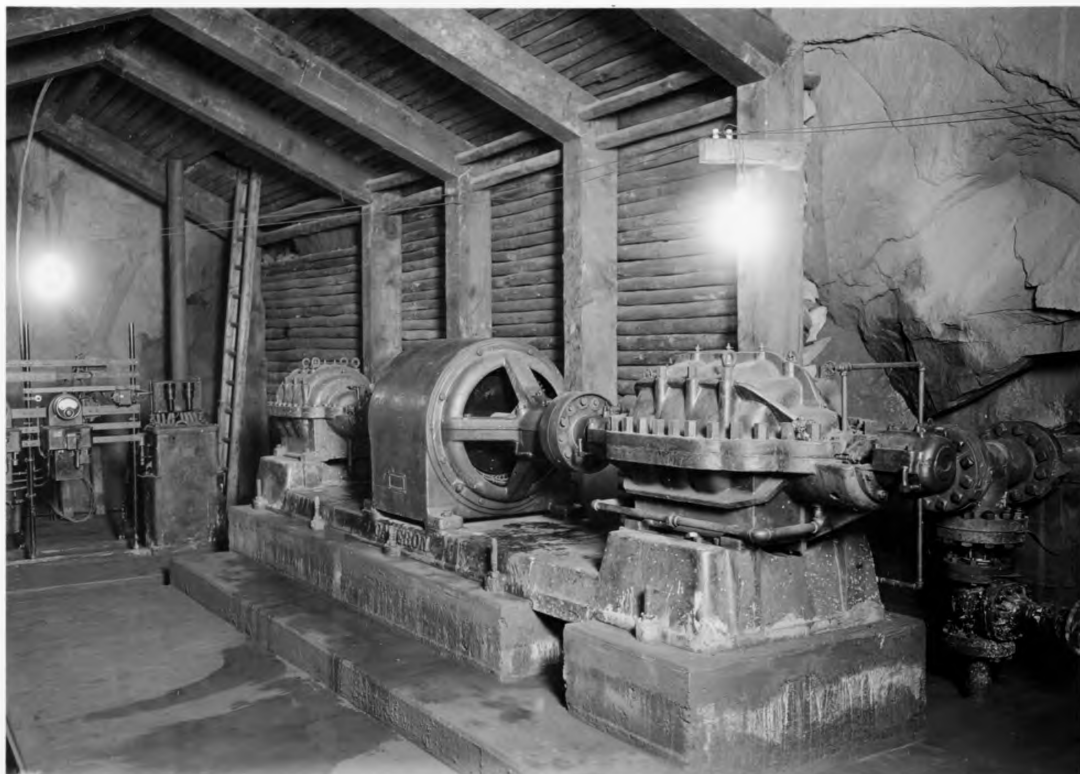


Plate No. 193

Cameron Centrifugal Pump on 4th Level

Holmes Mine.





Plate No. 194 Crescott Flunger Pump on 2400 ft. Level Athens Mine

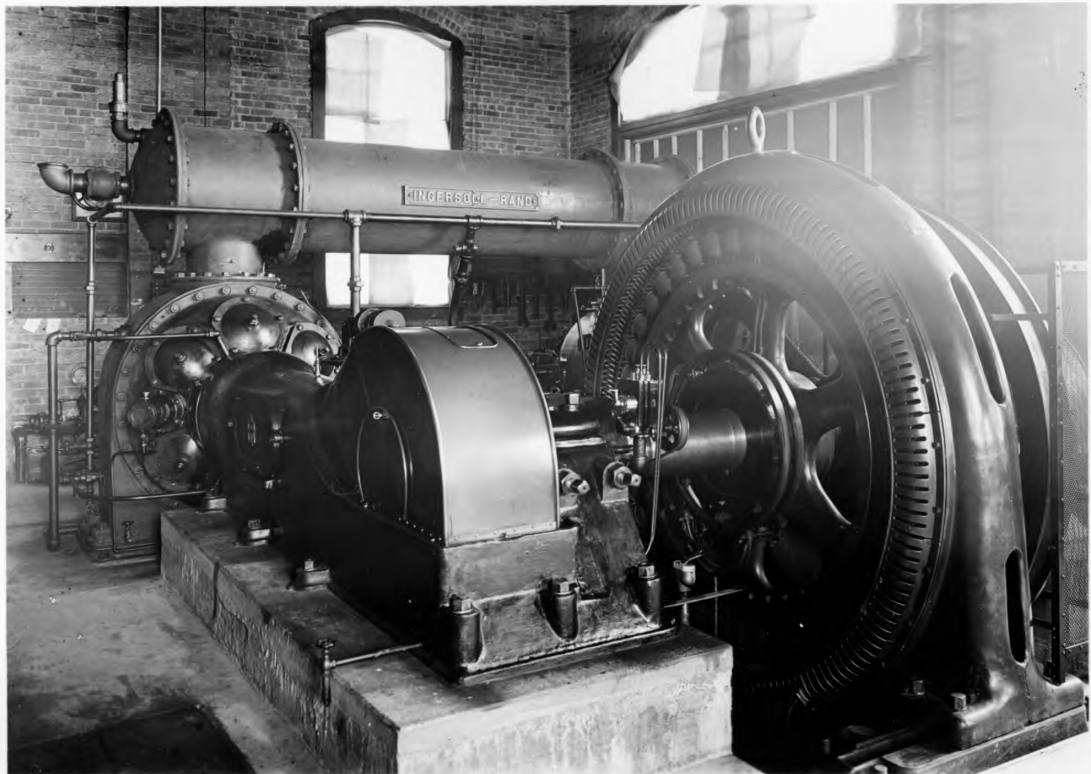


Plate No. 195 Ingersoll-Rand Compressor Lake Mine





July 1914

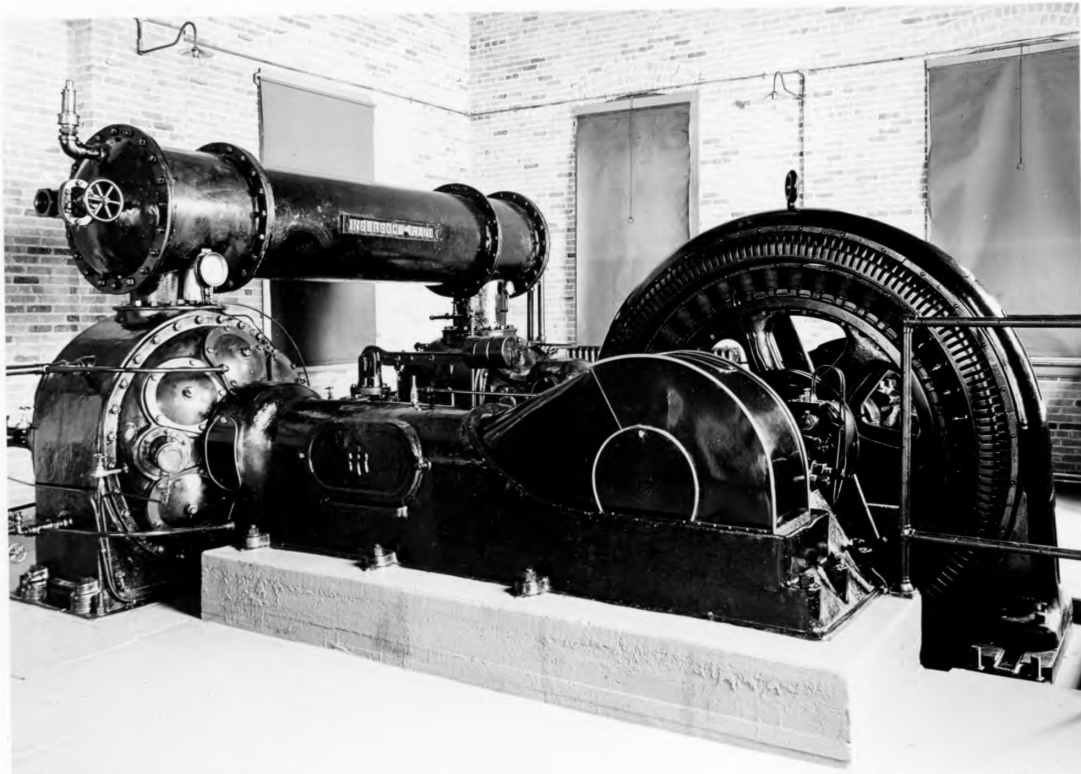


Plate No. 196

Ingersoll-Rand Compressor

Negaunee Mine

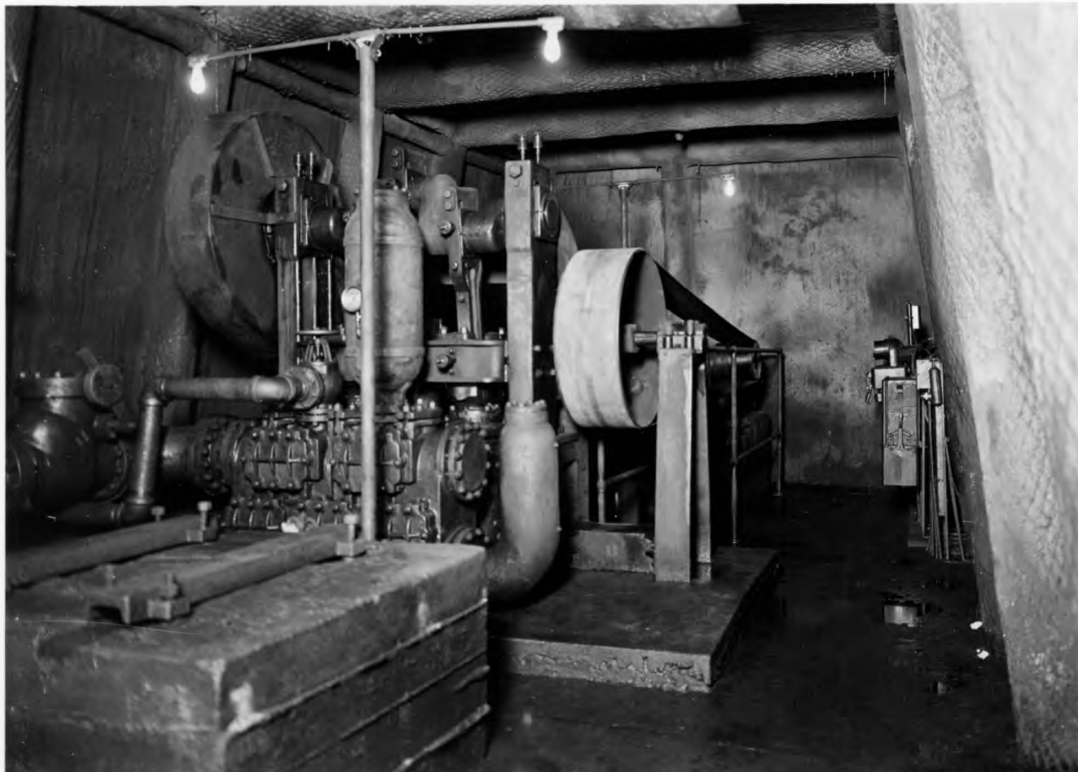


Plate No. 197

Aldrich Plunger Pump on 11th Level

Negaunee Mine



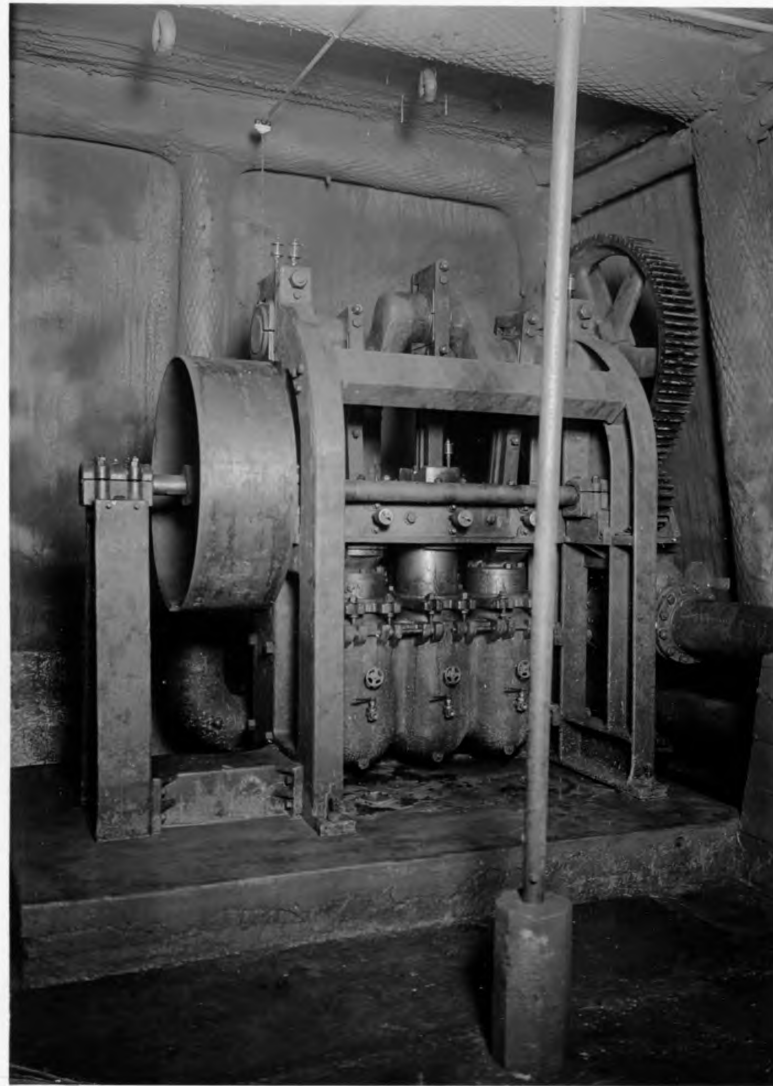


Plate No. 198      Aldrich Pump on 11th Level      Negaunee Mine



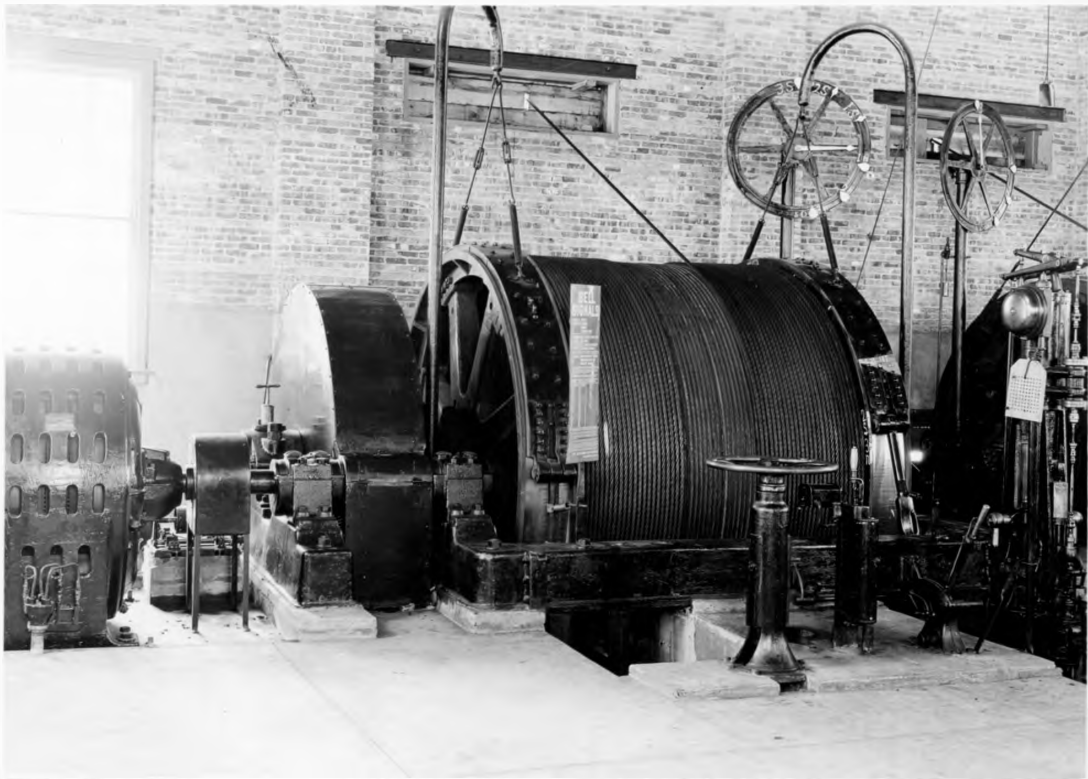


Plate No. 199

L. S. Eng. Wks. Skip Hoist

Barnes-Hecker Mine

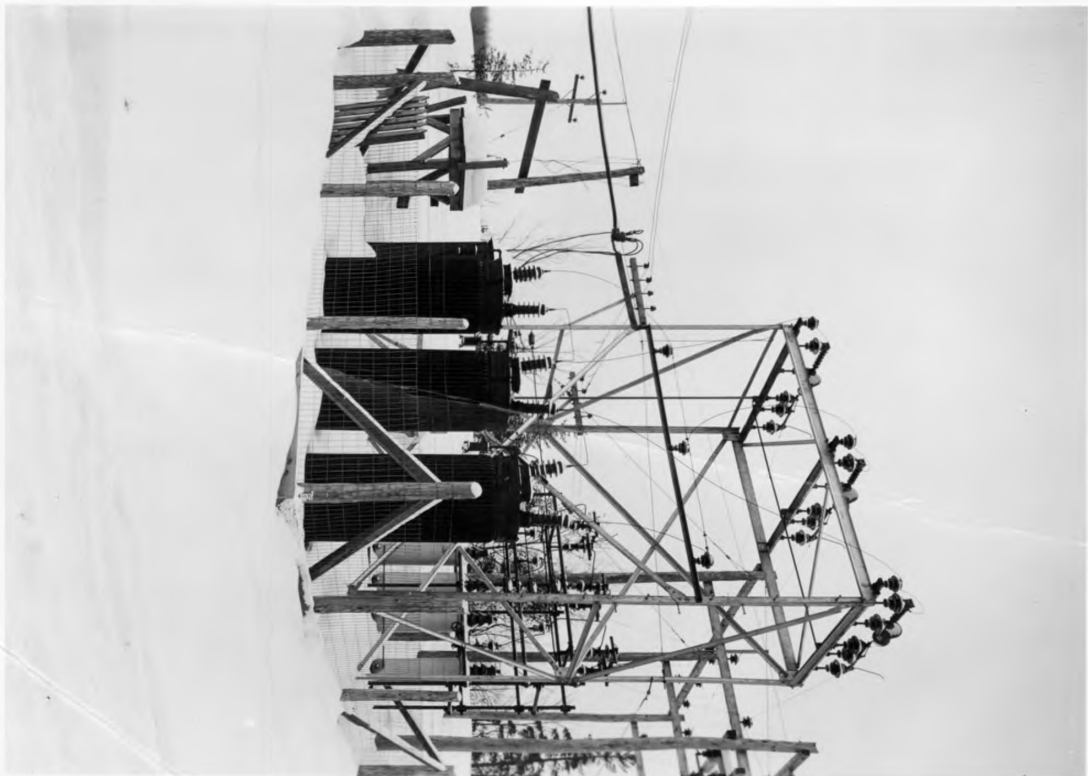


Plate No. 200

Outdoor Substation

Barnes-Hecker Mine



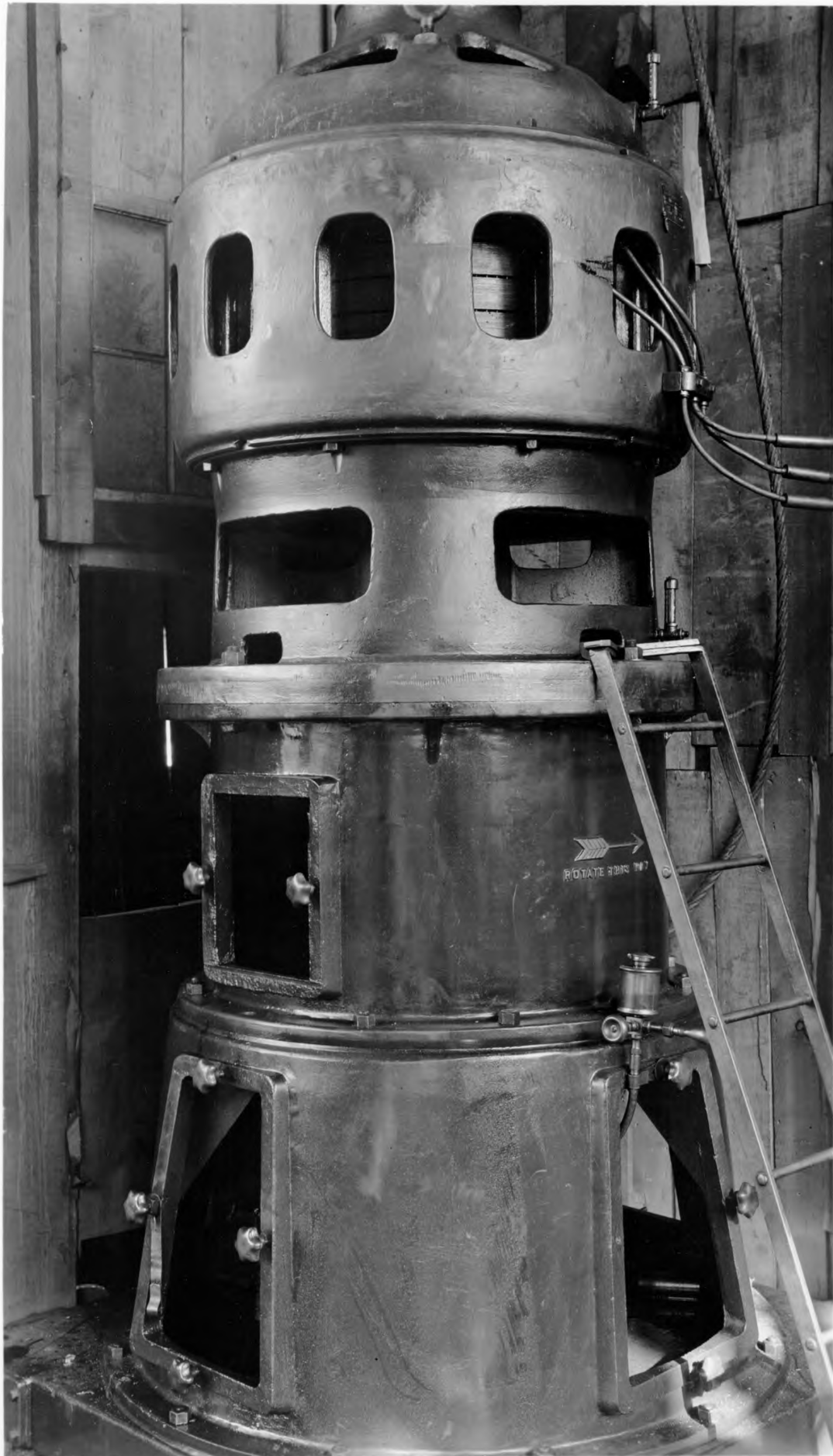


Plate No. 201

Layne & Bowler Pump

Stephenson Mine.





ANNUAL REPORT  
OF THE (1919)  
SAFETY DEPARTMENT

.....

The Annual Report of the Safety Department for 1919, as herewith outlined, is divided under the following heads: organization; mine fires, mine rescue equipment; mine rescue training; first aid treatment; first aid training; general safety precautions; safety conditions at mines; fatal, serious and slight accidents and statistical tables.

ORGANIZATION

All inspection of mines were made under the supervision of the Safety Inspector. Mine rescue and first aid training was conducted by J. H. Williams. Stenographic and clerical work for the first six months of the year was done by Miss Francis Bilkey and for the last six months by Miss Elsie Baker.

MINE FIRES

Three underground fires occurred during the year in the mines of the Lake Superior District which were so serious that the operators called upon the Bureau of Mine Car for help when fighting them. At this time of writing two fires have been reported since the first of 1920. Defective wiring is probably the greatest fire danger existing underground at the present time, though risks from carbide lamps and smoking by employees are ever present. There should be no curtailment by an operator in the maintenance of an adequate rescue equipment and in the training of employees in the use of them.

MINE RESCUE APPARATUS

In my last Annual Report I stated that there was not a unanimity of opinion among mining men relative to the value of the various types of mine rescue apparatus then in use in the country. When rescue apparatus was first introduced in this district local mining companies were influenced in the purchase of their equipment by the Bureau of Mines, who was then using the

Draeger type. This is true not only of the Cleveland-Cliffs Iron Co., but also of the Oliver Mining Co., Pickands-Mather & Co. and many other companies. While the Bureau had not placed itself on record as in favor of any particular type yet its employees by inference indicated that they favored the Draeger.

Since 1911 the Bureau of Mines has used several types of apparatus and has also developed a machine that would meet with the requirements of the work. It was allotted an appropriation of \$150,000.00 for this purpose. After a long period of experimentation it has issued a report which stipulates the general requirement of a breathing apparatus in order that it may be accepted as safe and efficient. These requirements are, the apparatus must yield an adequate supply of oxygen under easy and strenuous exertion; it must absorb the exhaled carbon dioxide corresponding approximately to the total oxygen supplied; it should be free from mechanical obstructions; the danger of the breathing bag or bellows being squeezed and emptied should be obviated; it should be absolutely tight against the smallest quantity of poisonous gases penetrating it; excessive high temperature should not be produced by the absorber; construction and arrangement of the apparatus should be simple and vital parts should be protected against breakage.

The Draeger apparatus supplies a limited amount of oxygen to the wearer which is delivered automatically by the reducing valve. In moderate activities this is sufficient; <sup>in</sup> in-action, too much; in strenuous exertion, insufficient. The reducing valve of this type of machine is liable to get out of order and there is a tendency of an injector to clog up.

There has recently been placed on the market two types of apparatus, The Paul and the Gibbs, each of which has a self-adjusting oxygen feed flow. As the oxygen leaves the cylinder the pressure is reduced by a bellows arrangement and is then fed into the breathing bag in exact accord with the wearer's requirement. In both types the period of time in which the apparatus can be used varies from two to ten hours, depending entirely on the activities of the wearer. The amount of oxygen carried in the cylinders is about the same as in the Draeger,

SAFETY DEPARTMENT.

SAFETY DEPARTMENT.

Fluess, and Westfalia.

The Gibbs apparatus was designed by W. E. Gibbs for the Bureau of Mines, which represents the result of the \$150,000.00 appropriation. The Paul, which is an improved Draeger, was designed by W. J. Paul, a mining engineer, who had charge of mine rescue and recovery work of rescue crews for the Bureau of Mines at Pittsburgh. From an extensive experience he had learned the capabilities and defects of the types of apparatus in use in the United States and he left the Bureau of Mines to perfect the apparatus which bears his name. After its completion he sold his patents to the American Atmos Corp., the successors to the Draeger Company.

The construction of the Paul apparatus has several of the features of the Draeger, such as the cylinders, the by-pass, types of connections, etc. The bellows or reducing valve is a similar design to that of the Gibbs. The apparatus however is mor compact and of greater stability than the Gibbs.

The Pickands-Mather & Co., Anaconda Copper Co. and M. A. Hanna Co. have recently installed the Paul apparatus. Our Company bought one machine in December month and since then it has been tried by many of our rescue employees. They all agree that the apparatus is more easy to work in than the Draeger.

I wrote to Mr C. E. Pettibone, Safety Inspector of Pickands-Mather & Co., and Mr D. J. Parker, Engineer with the Bureau of mines at Pittsburgh, asking if they would recommend any particular type of apparatus. Mr Pettibone replied that they had made a very thorough test of the different types of machines and had selected the Paul. Mr Parker replied that he could not recommend any particular type but gave, as his personal opinion, that we would make no mistake if we bought either the Gibbs or Paul apparatus. Mr F. F. Morris, president of the American Atmos Corp., recently informed us that the Bureau has approved the Paul apparatus, giving it a slighter higher rating than the Gibbs. I believe that our Company should discard the Draeger apparatus and buy the Paul. There will be a credit of \$50.00 given for each Draeger apparatus returned. This will represent a saving of \$1250.00 if we make the exchange within a reasonable length of time.

SAFETY DEPARTMENT.

### MINE RESCUE TRAINING

Training of employees in the use of rescue apparatus was continued throughout the year at all the operating mines. A total of 139 practices were held in which 113 men participated.

The number of men who received a complete or partial training at each mine vary from 5 to 23, the smaller number representing the Angeline mine and the larger the Negaunee mine. It is necessary from time to time to drop men who disqualified because of physical disability or advancing age. Since 1912 we have trained 246 employees and of this number 85 have disqualified. At the present time there are 161 trained men in the employment of the Company.

In October and November Rescue Car No. 10 of the Bureau of Mines visited Ishpeming, Negaunee and Gwinn, spending one week in each district. During this time a limited number of our first aid and mine rescue men visited the car and received supplementary training to that given by us. This was done in response to a request from the Bureau for men to train. All employees, who exhibited proficiency, are given certificates by the Bureau.

Apparatus repairs for the year cost \$278.54, an average cost of \$11.54 per machine. Supplies used in practise work, such as oxygen, caustic soda, etc. amounted to \$132.65, an average cost of 82¢ for material per individual practice.

### FIRST AID TREATMENT

The number of employees who were injured and failed to receive first aid treatment immediately when injured in proportion to the number who were promptly treated does not show any reduction when compared to the figures for the previous year. This is due to the fact that more slight accidents are being reported and because, as a rule, most employees are loath to leave their work to have iodine or dressing applied to a wound which they consider slight. It is necessary, however, to overcome this attitude on the part of our men in order to prevent infection cases, of which we suffered thirty-six during the year. From time to time placards are being posted on bulletin boards and special warnings are issued to shift bosses calling attention to this danger, and asking their

co-operation in preventing it. If an injury is considered serious, especially, if visible evidence of it is shown, there is no tardiness in having it reported. Many injuries are strains and sprains, so first aid is usually not sought, and the injury is not reported until the man has left the Company's property. There is a sufficient number of trained men and ample first aid equipment at all mines to take care of every emergency that may arise. It is hoped that better results shall be obtained and to this end a daily report is now being made by dry men in which they record the number of dressings they make.

FIRST AID TRAINING.

During part of the year first aid instruction was given to as many of our first aid men as could be obtained with the object of keeping the work fresh in their memory. About 200 men were given instructions, taking in men of all occupations from laborers to mining captains. After an opportunity had been given to all mines for all its employees to have a review of the work, new teams were organized at all the operative mines. These new teams received training during the last three months of the year.

The Company is doing considerable rock drifting, which entails more or less danger due to smoke and gas. A number of our employees have suffered partial or complete suffocation, but in every instance they were placed in the care of competent first aid men and under proper treatment were revived.

Cylinders of oxygen are supplied in each district to help in resuscitation.

The first aid supplies purchased during the year cost \$211.99. Distribution was made at all mines and surface plants of the Company.

Table I

Showing the number of First Aid and Helmet Practices and the number of men trained at mines during 1919.

Mine	First Aid Practices	No. of Men Trained	Helmet Practices.	No. of men Trained.
Cliffs-shaft	6	14	12	7
Lake	5	9	11	6
Holmes	10	16	12	7
SAFETY DEPARTMENT.				10

Salisbury-Angeline	9	11	11	10
Morris-Lloyd	6	16	11	8
Negaunee	10	23	12	13
Athens	12	10	12	7
Maas	9	15	11	8
Gwinn-Francis	11	19	10	10
Francis		9	9	7
Mackinaw-Gardner	8	12	4	4
Barnes-Hecker	9	8		
Republic	5	12	11	12
Princeton	11	17	11	12
Angeline		5	2	2
	<u>111</u>	<u>196</u>	<u>139</u>	<u>113</u>

Table II

Showing Occupation and Nationality of Mine Rescue  
and First Aid Men Trained 1919.

<u>Occupation</u>	<u>Helmet</u>	<u>First Aid</u>	<u>Nationality</u>	<u>Helmet</u>	<u>First Aid</u>
Mining Captain	0	1	American	1	26
Mine Foreman	0	1	English	50	72
Shift Bosses	28	29	Skandinavian	21	44
Miners	37	50	Finnish	16	16
Timberman	18	16	Italian	11	10
Pipeman	8	13	Austrian	1	2
Surface Laborer	0	3	German	13	3
Electrician	4	6	French		21
Engine House Man	0	3	Irish		2
Surface Foreman		6		<u>113</u>	<u>196</u>
Motorman	2	6			
Dryman	0	17			
Pumpmen	2	2			
Trackman	4	2			
Sampler	1	2			
Skiptender	2	1			
Diamond Drill Man	2	2			
Blacksmith	0	4			
Clerks	0	10			
Carpenter	0	3			
Cage Rider	2	3			
Top Lander	3	6			
Teamster	0	1			
Chemist	0	2			
Machinist	0	6			
Policeman	0	1			
	<u>113</u>	<u>196</u>			

.Table III

Showing Total Number of First Aid Men Trained

1912-1919.

Number trained - - - - -	374
" received certificates - - - - -	235
" left service of Company - - - - -	51
" deceased - - - - -	3
" now in employ of Company - - - - -	219

Table IV

Showing Total Number Of Mine Rescue Men Trained

1912-1919.

Number trained - - - - -	246
" left service of Company - - - - -	32
" disqualified - - - - -	50
" deceased - - - - -	3
" now employed - - - - -	161

Table V

Showing Number of Accidents Receiving First Aid Treatment, etc.

Mine	Received Treatment	Did not Report Injury	First Aid Not Needed.
Athens	16	11	2
Gwinn	21	7	3
Holmes	16	3	1
Lake	41	15	5
Morris-Lloyd	28	30	3
Maas	27	18	2
Gardner-Mackinaw	14	2	1
Negaunee	21	10	3
Princeton	20	21	5
Republic	36	25	3
Salisbury	14	3	
Spies	1	2	
Austin	1	2	
Stephenson	3	4	
Barnes-Hecker	6	3	
Angeline	3	1	1
Cliffs-Shaft	61	52	2
Francis	10	3	
Miscellaneous	10	9	1
Wade	10	21	
Meadow	1	5	
Crosby	1	15	
Hill-Trumbull	1	4	
	<u>361</u>	<u>266</u>	<u>32</u>



SAFETY INSPECTION

Safety Inspector

The Inspector made regularly monthly inspections of the mines in Marquette County except in the month<sup>s</sup> when inspections were made by Workmen and Foremen committees, when he directed the work of these committees. He made two inspections of the Spies mine and one of all the mines in Minnesota.

Workmen Committees.

Committees of workmen inspected all mines in the County in April, excepting the Athens mine, where many high raises and other development work was in progress. With one or two exceptions these committees rendered perfect reports.

Foremen Committee.

This Committee was composed of three shift bosses and its tour of inspection was made in October. The bosses were Wm. Mahoney, of the Athens Mine, A. J. Blomquist of the Gwinn mine and Jonas Johnson of the Holmes. The / committee found very little criticism to offer, merely calling attention to several minor omissions which may be found existing at one or another mine at any time when an inspection may be made.

Committee on Mechanical and Surface Equipment.

This committee was appointed by the Central Safety Committee, and Wilfred Tousignant, Mechanic, Gwinn District, John Bond, Electrician, Princeton mine, and Ernest Decaire, Surface Foreman, Salisbury mine, were chosen its members. An inspection of all mines in the County was made from September 8th to September 10th. It offered twenty-eight suggestions and recommendations.

Central Safety Committee.

This committee met monthly during the year, usually with Supt. G. R. Jackson presiding. All important subjects on which it took action are enumerated in this report under special safety precautions.

Committees on Fatal Accidents.

Supt. W. W. Graff was appointed to serve on the Fatal Accident Committee for the Company's Michigan mines, succeeding Gen'l. Supt. S. R. Ellicott. As the Company has acquired more mines in Minnesota, it was decided to have a local committee to investigate the fatal accidents occurring there. Supts. Meyers, Stevenson and Brewer were appointed to act on this committee.

RECOMMENDATIONS

The Company's present system of safety inspection, as now conducted, comprises monthly inspections of the mines in Michigan by the Safety Inspector and usually one annual inspection of the mines in Minnesota; an annual inspection of local mines by a foremen committee; an annual inspection of local mines by workmen committees and an annual inspection by a committee on mechanical and surface equipment.

I believe that it will be worth the time and effort involved to have the Minnesota mines inspected more regularly by the Safety Inspector, at least once in every three months, and also that an annual inspection of these mines be made by a local foremen committee, similar to our system in Marquette County.

A policy of the Company is best communicated to its employees through men who hold positions of responsibility and, the higher the positions are, the more effective will be the adoption of the policy. Very few recommendations have come from workmen committees. Foremen committees made valuable suggestions and recommendations during the first year of safety inspection. It is now more difficult to offer practical safety suggestions because the field has been covered many times by our most competent foremen. I believe that in order to obtain satisfactory results the Company must keep before its employees its policy for safety in its mining operations as effectively as possible and that this <sup>will</sup> be obtained by having a new committee inspect our mines, at least once a year. Such a committee could be composed of a superintendent, an office man and a mining captain, together with the Safety Inspector, acting as secretary. A number of the superintendents are probably too busy to serve in this capacity, but men like Supt. C. J. Stakel, Ass't. Supt. J. R. Reigart or Ass't. Supt. R. W. Meyers might be spared for this work.

Capt. J. H. Rough or Mr W. H. Moulton would be an ideal office man. Many of the mining captains have suggested that they would be pleased to serve the Company on a committee to inspect mines, and very valuable ideas would probably be given by captains like Mr Fred Ware and Mr Alfred Bone. If an inspection was made in the summer time it would not be necessary to inspect all mines in a continuous trip, but the mines could be visited when most convenient for men who served on the committees.

Under our present system of inspection no responsible officer of the Company corroborates the inspection of the Safety Inspector. A committee, as suggested, would be invaluable to an inspector as a source of information and guidance in the direction of the work which comes under his supervision. As the years pass it is evident that accident reduction is not so much a matter of safety devices as it is a question of spreading an influence among all employees for proper observance of our safety rules and regulations. An inspection by a new committee would bring these men in touch with all mining captains, shift bosses, surface foremen, timbermen and most of the miners and laborers. The personal element would be reached and influenced in a manner to a degree that bulletin notices, safety cigars, etc., do not compare.

Much of the success which has characterized the safety work of the Oliver Iron Mining Company, Pickands-Mather & Company and several other mining companies in the Lake Superior district has undoubtedly been the result of the employment of similar committees.

Table VI

The following table gives the number of foreman and workmen by mines, who have served on Safety Inspection Committees since the beginning of safety work.

<u>Mines</u>	<u>Foreman</u>	<u>Workmen</u>
Athens	2	0
Austin	1	12
Cliffs-Shaft	5	39
Gardner-Mackinaw	1	3
Gwinn	3	30
Holmes	1	6
Lake	6	39
Maas	6	27
Morris-Lloyd	5	39
Negaunee	7	39
Princeton	3	15
Republic	4	21
Salisbury	5	33
Stephenson	4	33
Miscellaneous	4	18
	<u>57</u>	<u>354</u>

GENERAL SAFETY PRECAUTIONS

Rules and Regulations.

Copies of our General Rules and Regulations in the English, Italian and Finnish Languages were distributed to all mines. A total of 1046 receipts were returned to the office of the Safety Department, divided as follows:- English 553, Finnish 296, Italian 197.

Copies of the Rules and Regulations for Foremen have been furnished to all new bosses,

Rules and Regulations for Operating Motors.

These special rules were printed with blank receipts attached and sent to all motormen. These rules are posted at each mine where motor trains are operated, but it was decided advisable to again remind motormen that they are individually held responsible for their enforcement.

Examination of Employees on Rules and Regulations.

We suffered a number of fatal accidents last year which clearly indicate that safety devices are not so important in the work of accident prevention as is the personal element. To obtain the best results possible, it is absolutely imperative that we continuously keep employees interested in their own safety. With this object in view the Safety Inspector recommended to

the Central Safety Committee that from henceforth, periodically but regularly, a limited number of employees should be examined on the Rules and Regulations. This recommendation was adopted by the Central Safety Committee and a committee, composed of Captain Rough, Mr Moulton and the Safety Inspector, were appointed to undertake this work.

On the first of November a notice to the effect that an examination would be held before the end of the year was prepared and signed by the General Manager. It was posted at all the mines and immediately there followed an increase in demand for copies of the Rules and Regulations. Examinations were held from December 8th to December 16th, when a total of seventy-seven men were questioned by the Committee. Of this number, sixteen were shift bosses and the rest were miners, cage riders, motormen, etc.

At each examination the Committee paid particular attention to the causes of preventable accidents, such as infection, projecting nails, trimming ore piles, etc. Special effort was made to impress upon the men their responsibility for the safety of their fellow workman as well as their own safety. The results of the examination were posted on the mine bulletin boards.

Since the examination was held it is very evident around the mines that it has a salutary effect. A second notice has already been posted announcing another examination.

#### Cross-Heads.

A cross-head was used in sinking the winze at the Republic mine. A Committee composed of Capt. Rough, Mr Eaton and Mr Bush were appointed to inspect it. This committee submitted two recommendations and after these recommendations were approved by the Central Safety Committee, Supt. Stakel was authorized to use it.

#### Automatic Couplers.

A fatal accident occurred at the Maas mine by the cars of a motor train becoming separated. Separation of motor cars may be due to worn couplers or to a poor track. In order to eliminate the danger of occurrences