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11. ACCIDENTS AND PERSONAL INJURY:

NAME: Tony Marich DATE: Jan. 31st, 1928.
CAUSE: Laying track to shovel #28 and was picking up a length of rail to place it in position when it slipped and crushed his left foot and ankle against another rail.
NATURE: Bruise medial surface left foot in region of lower 2 inch of tibia. Region of a bluish yellow discoloration.
TIME LOST: February 1st to March 5th, 1928.

NAME: E. H. Robinson DATE: Feb. 23rd, 1928.
CAUSE: Robinson was putting a steel plate liner in hopper under the big screen, when the liner slipped and fell on his left foot, bruising instep.
NATURE: Bruise - instep, left foot.
TIME LOST: 1/2 Shift Feb. 23rd to March 5th, 1928.

NAME: Victor Carlson DATE: Mar. 15th, 1928.
CAUSE: Bruised knee on small stone. Coyote holes are of such size that all work in them must be done on the knees. This particular hole was wet and while working in it his bruised knee became infected.
NATURE: Knee swollen (left) due to repeated trauma, due to position assumed while digging.
TIME LOST: March 15th to April 4th, 1928.

NAME: Harold Bischoff DATE: Mar. 17th, 1928.
CAUSE: Bischoff was unloading a car of ties, when one slipped and dropped on his left foot, bruising big toe.
NATURE: Bruise of toe (left foot)
TIME LOST: Five days.

NAME. John Carlson DATE: Apr. 28th, 1928.
CAUSE: A point of rock had been left last season. Powder had been loaded into two crevices in this rock for the purpose of breaking it down. In firing the shot, Carlson stationed himself, with his battery, at what he considered a safe distance (approximately 400 feet), but directly in line with the holes. Part of the charge blew out through the opening and a piece of rock hit Carlson.
NATURE: Wound (lacerated and contused) over right brow; fracture of ethmoidal portion of base of skull; contusion of right side of face and neck.
TIME LOST: April 28th to September 17th, 1928.

NAME: Loy Kolar DATE: May 21st, 1928.
CAUSE: During the day Locomotive #17 was moved, causing a pressure to form back of the "Johnson Bar". Kolar, not knowing that there was pressure back of bar, was releasing it when it sprang against him, striking him a glancing blow on the head.
NATURE: Laceration of scalp over frontal area. (Mid line).
TIME LOST: May 21st to May 28th, 1928.

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11. ACCIDENTS AND PERSONAL INJURY:

NAME: Lester Hodgson DATE: June 20th,1928.
CAUSE: Hodgson slipped on a sample mixing plate and struck his back on emery wheel stand.
NATURE: Wrenched back.
TIME LOST: June 20th to June 25th, 1928.

NAME: John Snarich DATE: Sept.11th, 1928.
CAUSE: He was in the act of carrying a length of 2" pipe of the water line, when his right foot became wedged between two rocks, wrenching right ankle.
NATURE: Sprain of right ankle.
TIME LOST: Sept. 11th to Sept. 15th, 1928.

NAME: Mike Skorich DATE: Sept. 27th,1928.
CAUSE: They were dismantling shovel #26 when one of the jack arms slipped and dropped on Skorich's right foot, crushing it.
NATURE: Redness and swelling of right instep. Bruise of bones, no fracture.
TIME LOST: 1/2 Shift Sept. 27th to October 16th, 1928.

NAME: Herman Polzin DATE: Oct. 31st,1928.
CAUSE: Polzin was entering the pit by way of the stairway. When he was on the third step from the bottom he tripped and fell to the ground, striking his left knee on a rock, bruising the knee.
NATURE: Bruise of left knee.
TIME LOST: Was laid off the next day.

NAME: Geo. Bobovich DATE: Dec. 4th, 1928.
CAUSE: They had just dumped a train of dirt and were righting the cars when the mechanism on one car refused to function. Bobovich caught hold of the chain lock to start the mechanism; this righted the car with such a quick movement that it caught his left hand under the chain lock and crushed the second finger.
NATURE: Crushing injury to second finger distal phalange, left hand.
TIME LOST: Did not return to work. Stripping job shut down Dec. 22nd.

12. NEW CONSTRUCTION AND PROPOSED NEW CONSTRUCTION:

A small pumphouse was constructed to the East of the approach tracks in the vicinity of the coal dock to cover the Layne and Bowler deep well pump.

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12. NEW CONSTRUCTION AND PROPOSED NEW CONSTRUCTION: (Continued)

A raft was constructed with empty steel barrels and cedar timber and placed in the Hill pit bottom. A centrifugal pump was placed on the raft to be used at times of heavy rains. We were unable to haul from the Hill pit bottom during the summer of 1928 on account of flood conditions and it was deemed advisable to put permanent pumping facilities here to avoid delays on account of flooding.

A small shelter house was constructed for the men working on the stripping dump. This structure is portable and we can pick it up with the locomotive crane, place it on a flat car and move it to any part of the operation that we desire.

It will be necessary to practically rebuild the railway track bridge over the township highway near the Washing Plant. This work will be done during the early spring of 1929.

13. EQUIPMENT AND PROPOSED EQUIPMENT:

A new dump plow was received early in October and used to very good advantage in connection with our fall stripping. This Jordan spreader, or plow, is of especially strong construction and was a great improvement over the old equipment, which we had rented from the Oliver Company, in previous stripping work.

The 1000 G.P.M. Layne & Bowler deep well pump was installed in the Trumbull pit during the fore part of December.

Due to flood conditions in the Hill pit it was necessary to install a centrifugal pump, mounted on a raft, to keep the water below the haulage tracks. The work of installing this pump was done during the month of September.

A feed water heater was placed on the 350-ton shovel for the fall operations. The heater was previously placed on the No. 101 locomotive for testing purposes.

14. MAINTENANCE & REPAIRS:

Following a two weeks lay-off, shop repair work was resumed on January 3rd, 1928.

The repairs to Locomotives Nos. 101, 102 and 103, which were started in January, were completed the fore part of March. The repairs on these locomotives were as follows:

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14. MAINTENANCE & REPAIRS (Continued)

The valves and pistons were fitted with new rings, worn pins and bushings in the link and valve motion were replaced where necessary; the drivers were removed and the boxes and hub liners repaired; badly worn tank wheels were replaced; the flues removed and new tips were lap-welded on them as required by the Minnesota law.

Locomotive No. 17 was thoroughly overhauled; the drivers removed, the boxes and hub liners repaired and cracks in the fire box welded. It was also necessary to lap-weld the flues on this machine.

The No. 19 locomotive had new tips welded on the flues. The revolving shovel No. 19 was taken into the shop on January 3rd for overhauling. The rollers were removed and repaired and the several engines were taken apart and worn parts replaced. This machine was taken into the shop again in December and was being cleaned and repaired at the close of the year. The No. 19 shovel was the one which over-turned on the track grade work in connection with the fall stripping.

The 60-ton Marion shovel, (#22), was taken into the shops and given a thorough overhauling during the month of March.

The dippers of shovels Nos. 22 and 27 were repaired during April.

Ten 20-yard cars were put through the shops from January 3rd to the middle of March. These cars were cleaned and greased, the brasses were repaired and new saddle plates were put in. The air valves and cylinders were also cleaned and repaired.

The 12-yard cars were given light repairs during April. The cost of putting this equipment in first-class shape is prohibitive, as they will not stand up under heavy service and we can only use them to advantage on light work.

The feed water pump was installed on Locomotive No. 101 during the latter part of April.

Repair work on the engines of the 350-ton shovel were finished during January, the work having been started in December, 1927. The 350-ton shovel was erected and put in shape for operations by February 23rd.

The Cyclone drill was given an overhauling during the month of February.

Shovels Nos. 19, 22, 26 and 27 were assembled during the latter part of April and made ready for ore operations by May 1st.

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14. MAINTENANCE & REPAIRS: (Continued)

The 8-ft. pan conveyor, which was practically rebuilt in the shops during the past year, will be considered under the subject of "Washing Plant Repairs".

Washing Plant Repairs:

During the months of January, February and March the repairs at the Washing Plant consisted of the following:

The paddle shafts of the logs and turbos were repaired.

The 8-ft. pan conveyor was taken apart and the pans taken to the shops. Wearing plates were welded on to the pans and new hinges were put on. This work was started in January and completed the latter part of March.

The head sprocket of the 8-ft. pan conveyor was sent to the shop and thoroughly repaired.

The head shafts of the logs and turbos were thoroughly repaired and the bearings re-babbitted.

New hopper and cushion boxes were placed under the trommel screen and this machine was given the necessary repairs.

19. WASHING PLANT OPERATIONS:

A new casting was put on the lower end of one of the turbos. The old one had cracked and could not be welded.

The rollers upon which the trommel screen revolves were removed and sent to the shop for re-tiring.

The settling tanks for the turbos were repaired.

The chutes, where the wearing is considerable, were lined with old pieces of scrap rail.

Hardwood blocks were put in the hinges of the 8-ft. pan conveyor to prevent their bending.

The washing plant crew was laid off from April 7th to April 23rd. The washing plant was prepared for operation during the latter part of April and the first week in May. After the ore season closed the mill was cleaned out and the pumps were disconnected.

During the first half of October the crew worked on the head sprocket of the 8-ft. pan conveyor, started repair work on the shafts and bearings of the logs and turbos and constructed a road around the end of the tail track trestle. The old trestle had to be filled or rebuilt and it was considered cheaper to fill it as we were handling a stripping job.

The last half of October and during all of November and December, the washing plant crew was engaged on the Holman-Cliffs drainage job and the Trumbull pit pump.

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18. NATIONALITY OF EMPLOYEES:

NATIONALITY	NO.OF MEN 1928	NO.OF MEN 1927
English,	11	12
Swedish,	14	13
Finnish,	8	9
French,	3	3
German,	10	5
Jugo-Slav,	17	20
Serbian,	4	3
Italian,	3	2
Croatian,	3	3
Irish,	14	13
Bulgarian,	2	1
Dane,	1	0
Norwegian,	5	2
Scotch,	6	3
Slovanian,	1	0
Austrian,	3	0
Welch,	1	1
Bohemian,	1	0
Polish,	1	1
TOTAL,	108	91

19. WASHING PLANT OPERATIONS:

The washing plant operations were started on May 7th and completed on September 26th.

General operating conditions were good throughout the season, no serious delays being experienced and no trouble was occasioned by frost chunks.

Some lean ore was handled and a large quantity of rocky material was put through the mill, which slowed down the operations at times.

The tailings were deposited in the North end of the basin, the capacity being more than sufficient for the season's operations.

The dragline raised the dyke around the South half of the basin during the summer. This work was started on May 26th and finished on August 14th. There is sufficient capacity on this side of the basin for our 1929 operations.

On August 15th, heavy rains washed out a section of the dyke along the edge of Penacie Lake. The dragline was standing near the wash-out and was carried down the bank and tipped over. No damage was done and the machine was picked up and finished it's work before the first of September. The dragline was then shipped to Hibbing for ditching work.

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19. WASHING PLANT OPERATIONS: (Continued)

In 1928 - 677,519 tons of wash ore were treated and in 1927 - 714,390 tons were put through the mill. The production of Concentrates in 1928 amounted to 449,346 tons, which compares with 443,000 tons for the previous year.

The rejects from the mill during 1928 amounted to 11,408 tons, running 28.35 Iron, as against 14,841 tons in 1927, averaging 25.66 Iron.

The gross recovery during the year 1928 was 66.32% and compares with 62.01% for the year 1927.

The iron unit recovery in 1928 was 87.77% as against 91.80% for the previous year.

The analyses of the product from the several machines for the years 1928 and 1927 were as follows:

	1928				1927		
	Iron	Phos.	Sil.		Iron	Phos.	Sil.
Screens	58.79	.052	7.93	Screens	58.38	.055	8.90
Logs	59,63	.050	7.28	Logs	59.71	.053	7.16
Turbos	55.63	.044	14.48	Turbos	55.85	.047	14.05
Tailings	15.18			Tailings	14.54		

The analyses of the plant rejects for the year 1928 were as follows:-

	Tons	Iron
Hill	9,080	30.60
Trumbull	2,328	19.59
Total 1928	11,408	28.35
Total 1927	14,841	25.66

The rock removed from the pit and placed on the dumps during 1928, together with the iron analyses, follows:-

	Tons	Iron
Hill	36,543	31.34
Trumbull	230	18.04
Total 1928	36,773	31.26
Total 1927	25,022	31.84

HOLMAN-CLIFFS MINE
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1. GENERAL:

The work on the pumping layout at the Holman-Cliffs Mine was started in October, and the pumphouse, which was built over the collar of the Oliver concrete shaft, was completed on November 3rd.

The electricians completed their work on the sub-station and the Hill-Trumbull washing plant crew finished installing the pumps on November 12th. The locomotive crane and Locomotive No.17 were sent over from the Hill-Trumbull Mine to aid in the work of installing the pumps. These machines were returned to Marble on November 11th.

The Layne & Bowler pump was started on the night shift of November 12th, but the ditch was found inadequate to take care of the volume of water and the banks overflowed and the water found it's way back to the pit. It was necessary to stop pumping operations until the ditch had been thoroughly cleaned and enlarged in places.

Locomotive No. 17, the locomotive crane and the dragline were sent over to Taconite from Marble on November 15th and were engaged from then until the 24th in connection with the ditch work. Besides the machines, with their crews, a force of twenty-eight men were engaged in cleaning out the pump discharge ditch, the work being finished on November 25th.

In order to insure the drainage of water across the flat to the East of the property, a force of four men was engaged to blast a ditch across a swamp. These men also blasted a ditch from the point where we contemplate discharging water from our raft pump, to the main ditch East of the mine yards. The raft pump layout will be installed during the month of January, and pumping started from this point.

The Layne & Bowler pump was started in the shaft on November 27th and the 5,500-gallons per minute which it handled was taken care of by the discharge ditch without any difficulty. The first nineteen hours of pumping lowered the pit water 3". When the Layne & Bowler pump started, the water elevation in the shaft dropped 14 feet and exposed the foot valve of the Worthington sinker and it was necessary to drop this pump another 5 feet. The present schedule calls for operation between 7:00 P.M., and 7:00 A.M., and twenty-four hours on all holidays. Our rate per K.W., on this schedule of pumping is $.0085, compared with the rate of $.015 on a 24-hour pumping basis. We were handling in excess of 6,500 G.P.M., from our shaft pumps at the end of the year.

The capacity of the raft pump, which will be installed in the Northeast corner of the pit, is estimated at 4,400 G.P.M. This will mean that we will be handling approximately 10,900 G.P.M., when all pumps are running. We will continue pumping nights and holidays at the cheaper rate, so long as weather conditions are favorable and ice does not form so as to block the drainage ditches.

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1. GENERAL:
(Continued)

The Hill-Trumbull carpenters started work on the pump raft December 15th and had it almost completed by the end of the year.

The washing plant crew started work on the discharge line for the raft pump on December 17th and completed their work by the end of the month.

The electrician and helpers were engaged in constructing a transmission line for the raft pump during the latter part of December.

No log of the pumping in the Holman-Cliffs shaft was kept for the few days that the Layne & Bowler pump operated in November. A log showing the depth of water lowered per day and the total drop for the month of December, is as follows:-

	Hours Pumping			
Day	Layne & Bowler	Worthington	Water Lowered	Total Drop:
1	24	-	5"	14"
2	12	-		
3	12	-		
4	12	-	1"	15"
5	12	-	2"	17"
6	12	-	1"	18"
7	12	-	1-3/4"	19-3/4"
8	12	-	1-1/4"	21"
10	12	12	5"	26"
11	12	12	2-1/4"	28¼"
12	12	12	2-1/4"	30½"
13	12	12	2-1/4"	32-3/4"
14	12	-	2-1/4"	35"
15	12	-	1-1/4"	36¼"
16	24	½	-	
17	12	-	4-1/4"	41½"
18	12	10	2-1/4"	43-3/4"
19	12	4½	2"	45-3/4"
20	12	1	2"	47-3/4"
21	12	-	1-1/2"	
22	12	1	1-1/2"	50-3/4"
23	24	-		
24	12	1	6-1/2"	57-1/4"
25	24	-		
26	12	-	5-1/2"	62-3/4"
27	12	-	1-1/2"	
28	12	-	1-1/2"	
29	12	-	1-1/2"	67"
30	24	19-3/4		
31	12	12	7"	74"

There apparently was a blockage in the drainage drift leading out from the bottom of the shaft to the pit. The Layne & Bowler pump would lower the water beyond the reach of the Worthington until December 30th, when the dam in the drift, interferring with the free flow of water, must have given away, as the Worthington pump has been able to

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1. GENERAL:
(Continued)

operate more or less steadily since that time.

22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1928.

A. STAFF.

The staff of the Geological Department for the year 1928 is shown in Table I below. The personnel has remained the same throughout the year:

TABLE I.

NAME.	OCCUPATION.	DURATION OF EMPLOYMENT IN 1928.	DAYS LOST. SICKNESS.	VACATION.	% OF WORKING DAYS WORKED.
E.L.Derby,Jr.,	Chief Geologist,	Entire year	0	16	94.1
A.H.Tillson,	Assistant Geologist,	" "	2	12	94.8
E. A. Allen,	Assistant, testing diamond drill holes, collecting & labeling samples, etc.	" "	0	10	96.3
Gustav Afuhs,	Draftsman,	" "	4	2½	97.6

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

TABLE II.

Total days of eight hours worked, - - -	272 days.
Sundays, - - - - - - - - - -	53 "
Full days resulting from Saturday afternoons,	26 "
Holidays, - - - - - - - - - -	14 "
Memorial to Mr. Duncan, - - - - - -	½ day.
Memorial to Mr. Mason, - - - - - -	½ "
Total,	366 days.

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

TABLE III.

YEAR.	AVERAGE NUMBER OF MEN.
1924	3.58
1925	4.00
1926	4.00
1927	4.00
1928	4.00

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

E. L. Derby, Jr. I continued to have charge of the Geological Department as Chief Geologist. A large part of my time, as in the past, was taken up with the general oversight and supervision of the work of the Department. This has included, besides the usual routine office work, surface drilling explorations on the Parks Option, North of the Mesabi Range in Minnesota; underground drilling in the Cliffs Shaft, Holmes and Virgil Mines; and geological surveys in the Athens, Cliffs Shaft, Gardner-Mackinaw, Holmes, Maas, Morris-Lloyd, Negaunee, Republic and Virgil Mines. I personally made frequent underground geological surveys of the new development work in the various mines, especially in the Virgil Mine.

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

During the first part of January and on my way home from attending the Fortieth Annual Conference of the Geological Society of America and the Society of Economic Geologists held at the Western Reserve University and Case School of Applied Science in Cleveland during the last of December, I went to Lansing and went over with Mr. F. G. Pardee, State Appraiser of Mines, all the recent geological information that the State Geological Survey has covering Iron County. This information,was obtained principally to assist me in the preparation of a geological report on the Michigan Mineral Land Company's property. On this trip, I also conferred with Mr. George P. McCallum, President of the D. M. & M. Land Company, Detroit, further in connection with the information for this report. On my way through Chicago, I attended a conference with Messrs. S. L. Mather, E. C. Congdon and Harvey A. Garver in connection with our Holman-Brown operation. Towards the last of January, I spent two days in Minneapolis, where in company with Mr. Barber and Mr. C. J. O'Connell, I conferred with the fee owners of the Joan No.3 property on the Cuyuna Range, which we completed exploring in December 1927. As a result of this conference, we later purchased the fee of a 23/24 interest in this property.

In February, I completed a detailed geological report of Iron County, with particular reference to the holdings of the Michigan Mineral Land Company. In this connection, I spent one day at Sidnaw in conference with Mr. Prickett. I also had a conference in my office with Messrs. Pardee and Osgood of the Michigan Geological Survey, going over the geology of several of our mines in connection with their valuation of these properties. In particular, I discussed in detail with Mr. Pardee the Virgil Mine and made a trip underground with him at this property. I might say right here that I believe his conception of the geology of this property is now quite different than before he paid this visit to us and in a way that will be an advantage to us. I also went over the drilling which we had done at the new Tilden siliceous ore property with Mr. Pardee.

In March, I spent two days in Chicago in conference with Messrs. S. L. Mather, G. R. Jackson, F. H. Berg and W. S. Prickett, principally on Michigan Mineral Land Company matters. I also called on Mr. Randall, of the Inland Steel Company, with the object of interesting his company in the purchase of all or a part of the Michigan Mineral Land Company's holdings. This finally resulted in the purchase by the Inland Steel Company of Mr. Prickett's half interest in this property. I also prepared several chapters on the geology and various phases of the Michigan Mineral Land Company's property at the request of Mr. Prickett, which he used in his prospectus to attract possible purchasers of the property.

In April, Messrs. Pinger, Paul and Maloit of the New Jersey Zinc Company, came here to study the various types of caving methods being used in our mines and also scraper operations. Mr. Pinger was formerly Assistant Geologist in this Department but is now Geologist for the New Jersey Zinc Company. Mr. Paul has charge of all the mines of the New Jersey Zinc Company with offices in New York and Mr. Maloit is Superintendent of the Eagle Mine in Colorado, where the problem of mining method is pertinent at this time. I conferred with them and provided them with the information they desired. I made up some depletion figures for the valuation of the Ogden Mine for Mr. Geffine and prepared a report on the Kloman Mine at Republic in connection with the Republic Mine itself. I wrote a special report on Canadian land offer No.1699, which came to us from our Cleveland office, covering the Von Hille Estate situated about forty miles Northwest of Port Arthur. This was represented to contain a very large tonnage of concentratable magnetite ore.

In May, I spent about two weeks during the middle of the month in Minnesota. In passing through Duluth, I conferred with Dr. William Palmer relative to his offer of 500 acres of mineral in Sections 7, 8 and 18, 52-14, St. Louis County, Minnesota. This is about fifteen miles North of Duluth, in the Gabbro District, where ore was reported to have been discovered in the bottom of a well some years ago. I spent one day at the Experimental Station of the University of Minnesota in Minneapolis. The rest of my time was spent on the Mesabi Range with headquarters at our Hibbing office. I directed the sampling of the ore banks in the Brown No.1 pit; also the sinking of fifteen test pits from which samples were taken. These samples were tested for their washability, and particularly to determine the advantage, if any, of secondary or fine crushing.

In June, I spent one day in the field in the vicinity of Sand Point on the East shore of Munising Bay, directly across from Grand Island, examining the sandstone cliffs that occur there. This work was done at the request of Mr. Bush, Land Agent, and I incorporated it in a special report. Mr. C. J. Muller, Geologist for the Oliver Iron Mining Company with headquarters in Duluth, conferred with me at my office on geological matters pertaining to the Section 16 Mine and their relation to the Holmes Mine. He later went underground at the latter property in company with Mr. Miller, of our Engineering Department. I spent about two weeks in Hibbing and Marble, Minnesota, completing the tests which were started during May on ore samples taken from the banks of the Brown No.1 pit. These tests consisted of hand washing and secondary crushing in order to guide us in designing the new washing plant to treat the Holman-Brown ores. I worked up these results and embodied them in a special report, which I prepared at Hibbing. In addition to this, I spent several days with Mr. Bolthouse, Superintendent of our Hill-Trumbull Mine, laying out plans for the first year's operation of the Holman-Brown pit. This involved a very careful study since previous to this operation enough stripping must be done to provide over 700,000 cu. yds. of surface material for a fill to carry the tracks into the washing plant; also considerable taconite must be removed from the so-called Taconite Island in the pit to make available enough high grade washing ore to sweeten the leaner wash ore as it is mined.

In July, I assisted Mr. Eaton in preparing figures for his report of July 9th on the valuation of the Holmes Mine. I held a conference in my office on July 7th with Messrs. Randall, of the Inland Steel Company, and Prickett, of the Michigan Mineral Land Company, relative to interesting the Inland Company in the purchase of Mr. Prickett's half interest in the Michigan Mineral Land Company. This resulted in Mr. Randall giving Mr. Prickett a check for $100.00 for a 30 day option to purchase his holdings. As previously mentioned in this report, this purchase was made by the Inland Company. I also prepared some figures for Mr. Geffine on the valuation of the Cliffs Shaft Mine for depletion purposes. These were later submitted to the Income Tax Unit of the Treasury Department at Washington in our attempt to have them revalue this property.

In August, I compiled a quantity of information used by Mr. Belden in the prosecution of the court proceedings relative to the vacation of the streets and alleys in the Race Course property and Maas, Lonstorf & Mitchell Addition, both at Negaunee. I spent ten days on a trip to Duluth and Port Arthur, Canada. At Duluth, I interviewed the Republic Iron & Steel Company officials relative to a proposed joint operation of the Virgil and Sherwood properties at Iron River. While at Port Arthur, I spent three days examining iron lands on the Matawin Iron Range located from 25 to 50 miles Northwest of the city. Mr. J. E. Marks, an old time prospector residing in Port Arthur and at one time employed by this Company, accompanied me on this examination. The territory covered included the so-called Von Hille Estate, mentioned as having been offered to us in April. I prepared a special report covering all of these examinations.

In September, I spent most of the time on a vacation in New England but on my return I spent one day at our Cleveland office going over with Mr. Geffine a number of matters pertaining to the Geological Department, and particularly the figures I had been preparing on the revaluation of the Cliffs Shaft Mine for depletion purposes.

In October, I spent two weeks in Minnesota with headquarters at our Hibbing office. I went into the field on the Parks Option, about 12 miles Northwest of Nashwauk, and laid out the first drilling which we did on this land. I went to Minneapolis in company with Mr. Parks and had Mr. Washburn, owner of the mineral in most of the land to be explored on this option, place in escrow in the Minneapolis National Bank the deeds from himself to Mr. Parks covered by the option contract. While in Minneapolis, I interview Professor Lambert and his assistant, Mr. Heilig, Engineers for the Minnesota State Tax Commission, in regard to the new estimate which they had made on the Hill Mine, more than doubling the tonnage we reported to them. This resulted later in a field examination of the Hill pit by these two men and a reestimate of the property. I also went to Duluth while on this trip and went over the drilling and much other data pertaining to the Sherwood, Aronson and Minckler properties with Mr. E. W. R. Butcher, Chief Engineer for the Republic Iron & Steel Company, and also got all his figures of tonnage and advance expenditures on these properties. This was done in connection with a proposition entertained by Mr. S. L. Mather that we might be able to ~~cooperate~~ operate one or more of these properties in conjunction with our Virgil Mine. Mr. Muller, Geologist for the Oliver Iron Mining Company, again came to my office and discussed with me the geology of the Section 16 and Holmes Mines and the relation of one to the other. He advised me that he had recommended a campaign of underground drilling in the former property from the bottom level. One or two of the holes, at least, will be drilled just South and close to our Holmes Mine boundary. He has promised to give me this information in return for the assistance that I have given him in correlating the geology of that locality. This information will likely be quite useful to us in rounding out our knowledge of the structure of the bottom level at the Holmes Mine. I also spent one day at Iron River witnessing the demonstration by the Radiore Company of their radio apparatus for determining the geological structure in rock formations. It acts on the principal of induction in electrical conductors, which in the case of the Iron River District, are the graphite pyritic seams in the black slate footwall. I believe this is the most practical of the new so-called geophysical methods in exploring the iron district of Lake Superior; in fact, this field is not adapted to any of these new methods except in very limited areas.

In November, and in conjunction with Mr. Meyers, I prepared a report on the feasibility of the joint operation of our Virgil Mine and the Sherwood lease held by the Republic Iron & Steel Company. This involved, among other things, the preparation of a new estimate of ore on the Virgil property, which I made.

I went to Minnesota and visited the drilling which we were doing on the Parks Option. I also went over the figures of a new estimate which was being prepared of the Hill Mine to be submitted to the Tax Commission in our petition for a revaluation of this property. At Ishpeming, I spent some time preparing figures for depletion purposes on the Athens, Cliffs Shaft, Maas, Morris-Lloyd and Negaunee Mines in anticipation of a trip to Washington with Mr. Geffine in December to go over the subject of revaluation of these properties with the Government Engineers.

In December, I spent three days at our Cleveland office in conference with Mr. Geffine and continuing the preparation of our estimates for the revaluation of the properties mentioned above with the Government Engineers at Washington. Messrs. Sadler, Jaynes, Geffine and I then went to Washington where Mr. Geffine and I conferred with the Government Engineers and started proceedings which we trust will result in the revaluation of at least the Cliffs Shaft Mine, and possibly the others mentioned, to our advantage. On my return from Washington, I spent one day in Minneapolis attending a meeting of the Minnesota Section of the American Institute of Mining & Metallurgical Engineers at the Experimental Station of the University of Minnesota and then went to Hibbing and visited the Parks exploration. I stopped all drilling at this property and advised giving up the option on account of the negative results obtained. I prepared a report on the Michigan Mineral Land Company's holdings, setting forth the lands which appeared to have no possible value for iron ore. This in particular is in connection with the payment of taxes on these lands. Late in the month, I spent a day at Ironwood, Michigan, gathering information relative to the physical conditions of the various Gogebic Range mines and prepared a special report covering this subject.

A. H. Tillson. Mr. Tillson continued as Assistant Geologist throughout the year. He made regular underground geological surveys in the Cliffs Shaft, Holmes and Morris-Lloyd Mines and in the Republic Mine before it was abandoned. He also made occasional geological surveys in the Gardner-Mackinaw, Maas and Negaunee Mines. He posted all of these surveys on the geological maps and cross-sections of the various properties and periodically posted the current extensions on the geological maps and cross-sections of the Athens and Virgil Mines. During the last of his work for the Company as District Engineer in the Gwinn District, he commenced the engineering work for the development of the water power at the Cataract on the Escanaba River. Because of this, he spent some time the early part of the year continuing this work at the Cataract until it was finally taken over by the Engineering Department. He also assisted the engineers in taking over the engineering work at the Gardner-Mackinaw Mine when this property was reopened early in the year and made an estimate of the ore in stock at the Francis Mine for the Engineering Department. He spent considerable time checking over the large number of descriptions of the Michigan Mineral Land Company's holdings which were shown on the geological map of Iron County that I prepared to accompany my report on this area. He also checked over the numerous outside exploration drill sections that were prepared in the Department. The rest of his time was taken up with the routine work of the office.

E. A. Allen. Mr. Allen continued as an Assistant in the Department during the year. At times, however, he also assisted several of the engineers with their surveys and particularly in making the estimates of ore in stock at all of the mines. He drove the Engineering Department Dodge truck at various times. The major part of his time, however, was spent in collecting, sampling and filing the diamond drill samples from the current explorations. Frequently he classified and reported on the core and sludge samples from the various explorations during my absences. He made all of the thin sections of rocks which were examined under the microscope. He also made the regular monthly carbon reports, assisted Mr. Tillson in a number of his geological surveys and helped Mr. Cooney on the annual inventory of diamond drill equipment.

Gustaf Afuhs. Mr. Afuhs continued as our Draftsman throughout the year. His work, as formerly, Has in part, consisted in preparing cross-sections of all current drilling and of the drill results which have been submitted to this office in the form of land offers or outside explorations. During the first part of January, most of his time was taken up in painting the annual report exploration sheets and legends. The greater part of his time immediately following this and extending into May was spent in preparing several mounted white print maps of Iron County on which he posted all the geological information that I had compiled for him and covered in my report of this area and also the parcels of land in which the Michigan Mineral Land Company had any interest. These maps were prepared in connection with both my geological report and the prospectus on the Michigan Mineral Land Company's property, prepared by Mr. Prickett and myself for the purpose of interesting prospective purchasers of these lands. It was a big job on account of the larhe amount of detail involved. He posted the geological longitudinal sections through the Morris-Lloyd and Spies-Virgil Mines. He made a number of tracings for Mr. Adams of curves showing the increase and decrease in the valuations placed by the Michigan State Tax Commission on our mining properties in Ishpeming and Negaunee compared with the valuation of all other property in the two cities and in Marquette. He made a new set of geological cross-section tracings of the Joan No.3 drilling to be used in our ore estimate for the Minnesota State Tax Commission, and prepared colored white prints of these sections. He made a tracing and colored several blue prints for Mr. Jackson of a part of the City of Negaunee in connection with the proposed new Cleveland-Cliffs Iron Company Addition. He prepared a map of a part of the Matawin Iron Range, Northwest of Port Arthur, to accompany my report on this district. He also prepared a new 200' to the inch tracing of the Republic Mine surface, including the entire Section 7, 46-29. Our other surface tracings of this area had confidential information on them so that it was impossible to use the prints to send out of the office. He made a tracing of the locality around Lake Michigamme and Three Lakes showing the lands owned by the old Michigamme Company and the American Iron Mining Company. This map will be used in connection with a geological report of these properties which I contemplate making. He also colored a number of white prints for Mr. Jackson of the Race Course and vicinity at Negaunee which were used in connection with our efforts to have the streets and alleys in that locality vacated. He made a tracing and colored several white prints of a map of the Virgil, Sherwood, Aronson and Minckler properties which accompanied a report by Mr. Meyers and myself to Mr. Elliott in connection with the possible joint operation of the Virgil Mine and one or more of these other properties. He spent most of December posting the past year's extensions on the special sets of geologic cross-sections of the Athens, Cliffs Shaft, Morris-Lloyd and Negaunee Mines which we photograph each year to accompany the annual ore estimates submitted to the Michigan State Tax Commission. He also assisted Mr. Tillson at times in posting the current extensions on the geological maps and cross-sections of our several mines. The rest of his time was spent on the routine work of the office.

C. SURFACE GEOLOGICAL SURVEYS.

No detailed surface geological surveys were made during the year. The field notes of the survey of the NW¼ of Section 25, 47-27, which was completed in August 1927, were plotted during the early months of 1928. As noted above, I made field examinations of several localities during the year, notably Sand Point near Munising and the Matawin Iron Range located from 25 to 50 miles North and West of Port Arthur, Ontario.

D. UNDERGROUND GEOLOGICAL SURVEYS.

D-1. ATHENS MINE.

The geological surveys at the Athens Mine were made periodically by Mr. Allen, Engineer at the property. We have kept this information posted on both the geological maps and cross-sections. The only development during the year, not consistent with expectations, was the discovery of a horse of jasper in the ore body on the sub-levels between the 6th and 8th main levels and along the contact of the main East-West dike. It is not serious.

D-2. CLIFFS SHAFT MINE.

We have kept the Cliffs Shaft geology up to date by making surveys each month coincident with surveys of the advance in mining made by the engineer. Both the geological maps and cross-sections have been posted regularly.

The development of new ore on the Bancroft lease, Lot 2 Section 3, continued very encouraging. Work is going on here on the 1st, 2nd, 3rd, 7th and 8th levels. New ore has also been found by drilling on the 4th and 6th levels. These developments now extend over a length of 1000' East and West. Development of the extension of ore from the old No.3 Mine continued good on the 5th and 6th levels. A drift 400' along the hanging contact failed to disclose any extension of ore from the old Incline Mine. Developments in the main Southeast Deposit also continued during the year with most of the work being done on the 4th, 5th, 6th and 8th levels.

In "B" Shaft, new ore was developed in the South lens and also in the main vein, both Southeast of the shaft. The latter ore connectedw with a deposit stoped out some time ago. On the 8th level, new ore was found in the North vein, Northeast of the shaft. It occurs in a fault zone and is narrow and irregular but below any ore stoped. This may connect with ore on the 5th level "A" Shaft. New ore was also found in a sub-level just below the 12th level at the West end of the mine and has been developed quite extensively the past year. The ore extending upward from the West end of the 15th level pinched out during the year.

D-3. GARDNER-MACKINAW MINE.

The Gardner-Mackinaw Mine was reopened early in the year and the first ore hoisted April 5th. Operations have been continuous since then but confined entirely to the Gardner lease. Most of the ore has come from extensions of the old stopes above the 1st and 2nd levels. Some new ore, however, has been developed on the Northwest end of the 1st level and on the Southeast end of the 2nd level. Raising into this latter ore from the 3rd level is going on at present. Plans are now being made to sink the Mackinaw shaft another 100' and open up a new main level, which will be the 5th. Mr. Tillson has made one geological survey at the Gardner since it was reopened.

D-4. HOLMES MINE.

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

A new main level, the 5th, was opened during the year. The development of the ore body at this elevation continues at the present time. The ore contact was encountered at the point anticipated. The other operations at the Holmes have consisted wholly of stoping in previously developed ore areas.

D-5. MAAS MINE.

Mining is still being pushed in the area along the North footwall above the 2nd level. This section of the mine must be exhausted before mining can be concentrated

in the large area below the 3rd level. The former area is being developed between the 2nd and 3rd levels from raises put up from a new footwall drift on the latter level. The other mining is being done in areas under the relatively flat hanging wall area above the 4th level.

The 4th level itself is being extended into the Race Course area. I made a geological survey of the new development work on this level and the subs above. Mr. Moulton, Engineer at the property, collected geological data periodically from the rest of the mine. All this information has been posted on the geological maps and cross-sections.

D-6. MORRIS-LLOYD MINE.

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

A drift on the 7th level Morris Mine extending roughly East and West and about 500' in length South of No.9 lease on Cleveland-Cliffs Iron Company fee land disclosed that the South side of No.33 deposit probably does not extend above this elevation. We anticipate, however, a large tonnage in this vicinity below the 7th level. Developments during the year in No.21 deposit in this same vicinity proved that this ore is a chimney or chute from the main deposit. The new 8th level at the Morris, 200' below the 7th level, was started during the year and development will be pushed at this elevation. The other developments at the Morris-Lloyd Mine were confined principally to mining in areas previously determined.

D-7. NEGAUNEE MINE.

Mr. Moulton, Engineer at the Negaunee, has collected the essential geological data at this property regularly and we have kept the geological maps and cross-sections posted to date. Work continued during the year opening up the new 12th level. No other notably changes have occurred at this property.

D-8. OGDEN MINE.

The Ogden pit, a producer of siliceous ore, was abandoned at the end of 1928 shipping season. There are perhaps 50,000 tons of ore in place above the level of Lake Ogden and some broken ore remaining in the pit but both are badly mixed with dike rock and will not pay to remove in view of the anticipated opening of the Tilden pit the coming spring.

D-9. REPUBLIC MINE.

The Republic Mine was abandoned during 1928. The last ore was hoisted on May 21st. For some time this operation showed a loss but it was hoped tnat new ore could be developed in sufficient quantity tow warrant continuing. This failed to materialize so that from a practical standpoint the property is exhausted. We estimate there is about 345,000 tons of ore remaining in the mine, mostly in shaft pillars which cannot be mined with safety, even though it could otherwise be removed economically, which it cannot.

D-10. TILDEN MINE.

The development of the Tilden as a siliceous ore open pit, to take the place of the Ogden, commenced early in the spring of 1928. A large area was stripped, most of it hydraulically, during the summer and fall. Construction work on the crushing plant, loading pockets, etc, continues and the property will be ready to produce ore with the opening of the 1929 shipping season.

D-11. VIRGIL MINE.

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

Development of the main ore body on its extension above the 4th level was under way at the beginning of the year. All of this area proved to be high in sulphur and after stoping several thousand tons of it and mixing it with low sulphur ore from the main stope above the 6th level, it was decided to discontinue mining this high sulphur product, at least for the present.

A narrow finger of new ore a short distance East of the Northeast limb of the main ore body on the 6th level was developed during the year. This ore connects with the main deposit on its upward extension somewhere between the 145' and 165' sub-levels. The balance, which in reality constituted most of the tonnage produced, came from stoping in the main ore body.

E. OPTIONS AND LEASES.

An option for exploring and purchase of fee was acquired from Mr. Charles Parks of Chisholm, Minnesota, the latter part of the year. This covered twenty six forty acre descriptions in Sections 14, 23, 24, 25 and 26, 58-24, in the Crooked Lake District of Minnesota, about twelve miles Northwest of Nashwauk. This option was relinquished later after drilling failed to prove any mineral value.

A 23/24 interest in the fee of the property covered by the Joan No.3 lease was purchased during the first part of 1928. Negotiations have been conducted to acquire the remaining interest but without success thus far. This property consists of the $S\frac{1}{2}$ of the $NE\frac{1}{4}$ of Section 34, 47-29, Cuyuna Range, Minnesota, and is a part of ~~the~~ our Pontiac Mine,

F. EXPLORATIONS AND COSTS.

Drilling explorations were carried on during 1928 in the following districts and mines:

F-1. FROM SURFACE.

DISTRICT.	RANGE.
Crooked Lake,	North of Mesaba Range.

F-2. FROM UNDERGROUND.

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

Table IV, which follws, gives the footage drilled, the ore encountered and the cost per foot of drilling for both the surface and underground explorations.

It will be noted that the average cost of surface drilling was $3.76 per foot, excluding certain items which are not actual drilling expense but which are charged to explorations. By including these items, the average cost was $4.19 per foot. The average cost of underground drilling in the same way was $2.46 per foot and $2.82 per foot, respectively.

Table V, also shown below, gives a comparative cost per foot of total drilling for the past five years. It will be noted that the costs for 1928 are perceptibly lower than any others recorded in this table. This is quite remarkable considering the small amount of drilling done, although we have tried to cut our overhead as much as possible.

I want to call particular attention to cost of drilling in the Cliffs Shaft Mine. A year ago it was noted that the costs for 1927 were the lowest of which we had any record. These were $3.10 per foot of total cost and $2.76 per foot for the cost of drilling alone. This year we have realized a cost of $2.86 per foot of total and $2.50 per foot of actual drilling expenses, a decided reduction from our former best year, 1927. I think this is really remarkable considering the hardness of the ground drilled at the Cliffs Shaft and reflects credit on the drill crew who are doing the work. They are the pick of our former large drill organization and we have been fortunate in retaining them.

TABLE IV.

SUMMARY OF DRILLING FOR 1928.

EXPLORATION.	DESCRIPTION. SEC.	T.	R.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A".	COST PER FOOT "A".	TOTAL COST "B".	COST PER FOOT "B".
SURFACE DRILLING.														
Parks Option,	25,	58-24,	Minn.	455	121	33	609	0	0	0	$2548.89	$4.19	$2291.76	$3.76
Total Surface Drilling,				455	121	33	609	0	0	0	$2548.89	$4.19	$2291.76	$3.76
UNDERGROUND DRILLING.														
Cliffs Shaft Mine,	3,9 & 10,	47-27,				3174	3174	516	277	103	$9066.20	$2.86	$7930.11	$2.50
Holmes Mine,	9,	47-27,				424	424	0	0	0	884.18	2.09	820.50	1.94
Virgil Mine,	24,	43-35,			309	254	563	25	43	33	1801.65	3.20	1496.35	2.66
Total Underground Drilling,					309	3852	4161	541	320	136	$11752.03	$2.82	$10246.96	$2.46
Grand Total Drilling,				455	430	3885	4770	541	320	136	$14300.92	$3.00	$12538.72	$2.63

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

The drilling on the Parks Option was done under contract by the S. E. Atkins Company, of Duluth.

TABLE V.

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

YEAR.	TOTAL FEET DRILLED.	COST PER FOOT "A".	COST PER FOOT "B".
1924	11,007	$4.10	$3.54
1925	11,708	3.22	2.84
1926	19,299	3.21	2.86
1927	20,169	3.88	3.30
1928	4,770	3.00	2.63

F-3. DIAMOND DRILL CARBON.

We had on hand January 1, 1928, a total of 407.31 karats of diamond drill carbon which inventoried at $44363.18. No new carbon was purchased during the year. We consumed in 1928 a total of 18.51 karats at a cost of $2049.25, leaving a balance of carbon on hand December 31, 1928, of 388.80 karats inventoried at $42313.93.

In addition to the above carbon, we sold during the year 17.83 karats of carbon fragments, too small to be of further use in drilling and not included in the above inventory. This carbon brought a total price of $100.00, which we consider very good.

F-4. DRILL SECTIONS.

Cross-sections showing a detailed report of the drilling in the Cliffs Shaft, Holmes and Virgil Mines will be found in the annual report book labeled; "The Cleveland-Cliffs Iron Company - Ishpeming, Republic & Iron River Districts, December 31, 1928". Cross-sections showing a detailed report of the drilling on the Parks Option will be found in the annual report book labeled: "The Cleveland-Cliffs Iron Company - Mesaba District, December 31, 1928". These books are submitted as a part of the annual reports of the Engineering and Geological Departments.

G. SURFACE EXPLORATIONS.

G-1. NORTH OF MESABA RANGE - CROOKED LAKE DISTRICT.

SECTION 25, 58-24, MINNESOTA - PARKS OPTION.

This description lies between the Mesaba Range on the South and the Western extension of the Vermillion Range on the North. Attention was first attracted to this locality by the discovery of several places along the banks of Balsam Creek and the Prairie River, both of which cross the parcels covered by the Parks Option, where hydrated iron oxide, or limonite, was being brought out of the soil by ground water feeding these streams. This action caused fan-shaped bodies of limonite to be deposited in these localities. This phenomenon has evidently gone on for many years as some of the deposits are of considerable size. Several crude samples taken from them averaged from 38% to 40% in iron.

It is impossible to predict with any assured accuracy, either the source of this iron or its original composition where it is in place. It might originate from the oxidation and decomposition of a vein of pyrite in the neighboring granite or other igneous rocks, or it might come from a sedimentary deposit of iron ore similar to that of the known iron ranges.

We acquired an option to purchase the fee of twenty six forty acre descriptions surrounding the more prominent of these seepages and were alloted $2500 to make a preliminary test of the ledge by standpiping, to be followed by a campaign of drilling should the disclosures warrant.

A total of three vertical holes were put down, each in the vicinity of one of the larger seepages. In all cases, the holes ledged in decomposed granite and were drilled into it from 40' to 60'. We encountered no evidence of migrating iron hydrate in the surface material passed through, which varied in depths from 141' to 159'. We were unable to continue further drilling with the funds allowed

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and since we encountered basal granite at ledge, and because the surface was so deep, we decided additional expenditure unwarranted at the present time. Accordingly, we have relinquished this option.

H. UNDERGROUND EXPLORATIONS.

H-1. CLIFFS SHAFT MINE.

One diamond drill was operated continuously in the Cliffs Shaft Mine throughout the year. One hole was finished and nineteen others were drilled, all in "A" Shaft. All of them were horizontal holes and had an aggregated footage of 3174'. Thirteen holes encountered ore in quantity sufficient to mine, an average of 37' in each hole.

Hole No.379 was being drilled N. 23° E. from the North side of the 7th level at the beginning of the year to cut across a synclinal fold in the hanging slate on the Bancroft lease and explore for ore at the hanging contact on the North limb of this fold. The hole deviated somewhat from its initial course and the fold proved to be wider at this point than anticipated so that the drill machine being used could not push the hole across and it was finally bottomed in hanging quartzite at a depth of 567'.

Hole No.380 was drilled due North from near the West end of the East-West drift on the North side of the 8th level to explore the hanging wall contact below the ground tested by No.379. It cut 23' of ore before encountering hanging slate. The results of this hole, when correlated with the developments on the 7th level above, clearly demonstrate a new structural feature on this meridian. The slate hanging apparently has been faulted down on the North side. The fault is of the reverse or thrust type and opens up new possibilities for ore in this locality.

Holes Nos.381, 385, 386 and 396 were also drilled due North from the same locality on the 8th level to explore for an Easterly extension of the ore discovered in No.380. The first three of these holes and commencing with No.380 were spaced about 175' apart, progressively East, and No.396 was located about 350' East of No.386. All encountered good ore. No.381 had 45'; No.385 had 20'; No.386 had 38', also two 5' seams; and No.396 had 10'.

Hole No.382 was drilled due North from the North side of the 6th level to determine the thickness of an ore pillar in which it was started and to locate the hanging contact. It cut 43' of ore.

Hole No.383 was drilled due North from a stope just below the 6th level and on the 1600 East meridian to determine the thickness of the dike on which the ore of this stope rested, also to test for the possible existence of ore beyond this dike. No ore was encountered and the hole went from dike into the faulted hanging slate.

Hole No.384 was drilled due North from the North side of the 7th level to explore for a possible downward continuation of the ore encountered in No.382. It succeeded in cutting good ore from 15' to 25' and from 102' to 145', a total of 53'. The material between these two runs of ore averaged better than 50% in iron and some of it may be mixed in with the good ore when mining actually takes place in this locality.

Holes Nos.387, 388, 394 and 395 were drilled due North from the North side of the 6th level into Bancroft territory to explore the fault zone previously referred to as being demonstrated by No.380 for possible ore bodies at this horizon. No.387 cut 93' of good ore and No.395 had 23' but in both cases the ore was a part of the main lens in which the holes were started. None of these holes encountered ore that can be attributed to the fault vein.

Hole No.389 was drilled S. 10° E. from the Northeast side of the 6th level to test the hanging wall contact where it folds over to the South and forms the main Cliffs Shaft basin. No good ore was found.

A series of four holes, Nos.390, 391, 392 and 393, were drilled from the Southeast end of the 5th level. One of these, No.391, was drilled due North and encountered the hanging slate almost immediately. The other three were drilled into the footwall, two due South and the other, No.393, S. 50° E. No.390 encountered 17' of good ore. No.392 was drilled through an anticline in the footwall into the Moro Mine syncline and encountered three runs of good ore aggregating 63' before encountering the hanging of the second fold. Hole No.393 failed to cut ore of mineable width.

Hole No.397 was drilled due North from the North side of the 4th level to explore for a downward extension on the pitch of the ore encountered in No.374. It cut a total of 55' of good ore before encountering the hanging contact. No.398 was drilled on a course of N. 70° E. from the North side of the 7th level to explore for the downward extension of the ore being stoped in this vicinity above the 6th level. This hole was completed at the end of the year and encountered 10' of good ore.

H-2. HOLMES MINE.

One hole, No.29, was drilled vertically from the tail drift at the shaft plat on the new 5th level at the Holmes Mine in order to test the iron formation immediately below the large greenstone sheet which forms the footwall of the Holmes Mine ore body. The formation was found to be a magnetite siderite practically unoxodized similar to that on other parts of the Range at this horizon and therefore unlikely to containa concentration of good ore.

We had anticipated this condition but decided one hole was warranted in order to prove beyond a doubt that we were not overlooking a possible ore occurrence at this horizon. This constituted the drilling done at the Holmes during 1928.

H-3. VIRGIL MINE.

One hole, No.94, was finished and seven additional holes, Nos.95 to 101, inclusive, were drilled at the Virgil during the early part of 1928. The last hole was completed and all drill work stopped on April 14, 1928.

Holes Nos.94 to 99, inclusive, were drilled with the Denver deep hole reciprocating air drill and all had an initial inclination of +15° in order to facilitate recovery of the cuttings. Nos.100 and 101 were diamond drilled and both horizontal. The churn drilling aggregated 309' and the diamond drilling 254'. Only 25' of good ore was encountered.

Four of these holes, Nos.94, 97, 99 and 100, were drilled from the 4th level and to the North of the main East-West drift, near its West end, to determine if and where the central ore finger cut the 4th level on its extension up the pitch. The main Virgil body, in rising above the 6th level, divides above the 120' sublevel into three more or less separate fingers. Another hole, No.98, was also drilled from this same drift but on a Southwesterly course. Its object was to test the footwall of the main ore finger and find out if the ore already partly developed near the collar of the hole, but on a sub-level just above it, had any considerable extent. None of these holes encountered ore in mineable quantity.

One hole, No.95, was finished and another, No.96, was drilled at the Northeast end of the 145' sub-level to more completely determine the limits of the central ore finger at this elevation. No.95 encountered 40' of good ore just at the end of 1927. It was finished at the beginning of 1928 in footwall slate. No.96 encountered 10' of good ore.

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Hole No.101 was drilled N. 45° E. from the North crosscut on the 6th level to explore for a Southeasterly continuation of the 10' seam of ore encountered in No.95. Mr. Meyers was very eager to prove this extension in order to plan a main level drift on the 6th level, and have it in ore, from which raises could be put up to mine a part of the main ore body which had been proved to flatten out above the 145' sub-level. This flattening from a normal steep pitch below made it impossible to mine this part of the ore body through the main stope. No ore was encountered in the hole, but even so, the information aided appreciably in planning and driving the crosscut in question.

I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES.

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

I-1. MARQUETTE RANGE.

The Inland Steel Company has acquired an option on the N½ of the NE¼; the SE¼ of the NE¼ and the NE¼ of the NW¼, all in Section 23, 47-28, about five miles Southwest of Ishpeming and a mile West of the old Fitch Mine. They started drilling here early in the spring, first with one drill, then added the second after getting a little magnetite ore in the first hole. The Jones & Laughlin Ore Company put down eight holes on this property in 1913. They encountered 37' of high grade magnetite ore in the first hole but could prove up no extension to this in the rest of the drilling.

The Inland people have completed five holes and are drilling the sixth and seventh. I am told no ore of importance has been discovered thus far, also that their results do not harmonize with the earlier drilling due most likely to the difference of classification of the material encountered.

I-2. MENOMINEE RANGE.

The Oglebay, Norton Company completed their drilling in Sections 33 and 34, 43-35, West of the Cortland Mine, which was begun in 1927. I understand they have leased seven forties in Section 34, including the old Cortland, and three forties in Section 33; that they have proved up approximately a million tons of ore with much promising territory untested and have started sinking a shaft on Section 33. The property is to be called the Brule. The descriptions as given to me are the NE¼ of the SW¼ and the N½ of the SE¼ of Section 33 and the SE¼ of the NE¼; the N½ of the SW¼ and the SE¼ of Section 34. They may also have the SE¼ of the SE¼ of Section 33. The descriptions in Section 33 are leased from D. H. Campbell of Iron River and associates and the descriptions in Section 34 from the Palms Book Land Company of Detroit. The ore body being opened is reported to be on the line between the NE¼ of the SE¼ and the NW¼ of the SE¼ of Section 33 with the major portion in the former forty.

I understand the Hanna Company is doing some drilling on two forties just Southwest of the above property and just Northeast of Stanley Lake, to-wit:- the SW¼ of the SW¼ of Section 33, 43-35 and the NW¼ of the NW¼ of Section 4, 42-35. The Hanna Company have acquired the old Chatham property and also are drilling the so-called Carlson property, adjoining the Baker Mine. The Carlson, I understand, consists of the NE¼ of the SW¼ and the W½ of the SE¼ of Section 31, 43-34. I am also told that the Hanna Company have the rest of Section 31, except the Baker and possibly the NW¼ of the NW¼.

On the old Menominee Range, the Inland Steel Company had an option on the Indiana Mine, the NE¼ of the NE¼ of Section 27, 40-30, which has produced about 245,000 tons but has been idle since the war. The Thomas Furnace Company were the last operators. The Inland Company did some drilling here and found some good ore in the first hole but nothing of importance after that. There is a considerable tonnage of siliceous ore on the property. I understand the option has been relinquished.

The fee owners of the Chapin Mine have spent about $20,000 drilling from the bottom levels of this property to explore for ore in depth. I am told that while ore has been encountered, it is not in mineable quantity. They are sufficiently encouraged, however, to continue during the present year with an equal amount of drilling if necessary.

I-3. GOGEBIC RANGE.

The exploration work being done by the M. A. Hanna Company East of Wakefield on the Eastern end of the Gogebic Range was shut down for a part of 1928 but was resumed the latter part of the year. I don't believe they have made any important discoveries but have been unable to get any details concerning this work.

J. EXAMINATION OF MINERAL LAND OFFERS.

Fifteen mineral land offers were received and reported on during the year as follows:

No.1693 covers the SE¼ of Section 27, 43-35 at Iron River, Michigan. The Buckholtz Mine occupies the NE¼ of this description. There is claimed to be 60,000 tons of ore in stockpile averaging 56.57% iron which was taken out during exploratory work. The offer was declined.

No.1694 covers a half interest in the SE¼ of Section 35, 57-23, Itasca County, Minnesota, about half way between Nashwauk and Marble and just North of the Patrick Mine of Butler Brothers on the Mesaba Range. The offer was declined.

No.1698 covers the E½ of the NE¼; the NW¼ of the NE¼ and the S½ of the NW¼, all in Section 20, 47-28, Marquette County. These descriptions lie about threex miles West of the property now being drilled by the Inland Steel Company on the South limb of the Marquette Range. The offer was declined.

No.1699 covers 14,000 acres comprising the Von Hille Estate located on the Matawin Iron Range of Ontario and about forty miles Northwest of Port Arthur. I visited this district in August, 1928, and, while I did not have time to cover all the Von Hills property, found the reports of the places I did visit, which were selected with care, grossly exaggerated. The offer was declined.

No.1700 covers an iron property on tide water in Newfoundland reputed to contain a large tonnage of available ore. The offer, due to the remoteness of the property, was not considered.

No.1701 covers nine forty acre descriptions in Sections 7, 8 and 18, 52-14, and two forty acre descriptions in Section 13, 52-15, both in St. Louis County, Minnesota. The locations are in the so-called Gabbro District and more particularly about fifteen miles due North of Duluth. Samples of limonite ore analysizing 62% were found in the bottom of a well but there is no assurance that they represented solid ledge. The offer was declined.

No.1702 covers Section 2, 45-28, Crow Wing County, Minnesota. Forty nine drill holes and standpipes have developed a small tonnage of high phosphorus iron ore on the Eastern end of the South Cuyuna Range. This property was previously offered to us three times. The offer was declined.

No.1704 covers four forties in Section 13, 44-35, Iron County, Michigan, and located about eight miles North of Iron River. Large pieces of float copper were claimed to have been found. The offer was declined.

No.1707 covers the Brainerd-Cuyuna Mine in Section 36, 45-31 and Section 1, 44-31, Crow Wing County, Minnesota, on the Cuyuna Range. It is estimated to contain 792,457 tons of developed ore and 517,754 tons of probably ore, all high phosphorus iron ore. The offer was declined.

No.1708 covers the Rowe Mine in Sections 17 and 18, 46-29, Crow Wing County, Minnesota, on the Cuyuna Range. It is estimated to contain 25,098,291 tons of iron and manganiferous ore. Much of it is low grade and must be concentrated. The offer was declined.

No.1709 covers eight forties in Section 31, 59-18, St. Louis County, Minnesota. It had also been offered to us in 1922. It is claimed that a sample from an outcrop analyzed 57.99% iron and about 25% silica. There are no explorations. The offer was declined.

No.1710 covers the NE¼ of the NW¼ and the W½ of the SE¼ of Section 36, 47-31, Baraga County, Michigan, located about seven miles West and a little North of Republic. There are no explorations. The offer was declined.

No.1725 covers the mineral rights in the N½ of the NE¼ of Section 1, 47-28, Marquette County. This description lies a half mile North of the Morris Mine at North Lake and is presumably underlain by footwall rocks. The offer was declined.

No.1727 covers the S½ of the SW¼ of Section 24, 43-35, Iron County, Michigan. This description lies a quarter mile South of the Virgil Mine. No exploring has been done but it is favorably located with respect to adjacent properties which have promise and I recommended that it be acquired if we could get it on reasonable terms. I also recommended that, if possible, we acquire the NW¼ of the SW¼ of the same section.

No.1729 covers 1940 acres located on Pond Ridge, a spur at the Southern extremity of Linville Mountain in Burke and McDonald Counties, North Carolina. There is reported to be a large deposit of hard brown hematite ore analyzing from 56% to 62% iron, very low in silica, only a trace to ½% sulphur, less than 1% phosphorus and 1½% to 2½% manganese. There has been only a small amount of prospecting done. The offer was declined.

E. L. Derby, Jr.
Geologist.

GEOLOGICAL DEPARTMENT.

K. EXPENSE STATEMENTS.

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

TABLE VI.

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1928.

Salaries, - - - -	$12,696.77
Travel, - - - - -	393.93
(1) Operating automobiles, -	873.95
(2) Supplies, - - - -	694.26
Office expense, - - -	5.27
Total,	$14,664.18

(1). DETAIL OF COST OF OPERATING AUTOMOBILES.

ITEMS.	COST.
Gasoline, oil & grease,	$174.99
Tools, - - - -	13.79
Repairs, - - - -	103.33
Depreciation, - -	400.78
License, - - - -	46.80
Tires, chains & tubes,	46.16
Miscellaneous, - -	4.23
Insurance, - - -	25.32
Total on Studebaker,	$815.40
¼ proportion Dodge truck,	58.55
Total,	$873.95

(2). THE MORE IMPORTANT CHARGES TO SUPPLIES.

Childs Art Gallery (Annual Report),	$204.82	(1/3 prop.)
Iron Ore, - - - " "	19.33	" "
Blue print paper, - - - -	141.78	" "
Tracing Cloth, - - - - -	73.84	" "
Drawing paper, - - - - -	16.10	" "
Repairs to transits, - - -	96.22	" "
Maas Compass rental, - - -	50.00	

TABLE VII.

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

	1928.	1927.	1926.
Salaries, - - - - -	$12,696.77	$12,976.88	$18,982.40
Travel, - - - - -	393.93	336.34	329.57
Operating automobiles, -	873.95	761.07	833.58
Supplies, - - - -	694.26	856.49	878.79
Office expense, - - -	5.27	0	3.42
Total,	$14,664.18	$14,930.78	$21,027.76

E. L. Derby, Jr.
Geologist.

GEOLOGICAL DEPARTMENT.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents:

Accidents resulted in the loss of four lives in 1928. This is the same number as occurred in 1927, but there were less men employed this year and the rate per thousand men employed therefore is slightly higher.

The fatality rate from 1911 to 1928, exclusive of the loss of life by the Barnes-Hecker accident in 1926, was 1.83 per thousand men; including the fatalities by that accident the rate was 3.12. The average annual rate for the years prior to 1911 was 4.96. Complete figures for these years appear in Table III of this report.

DESCRIPTION OF FATAL ACCIDENTS.

Accident No. 1.

Harry Spencer was injured at the Maas Mine, January 25, 1928, by being struck and knocked down by a locomotive train. He was taken to the Ishpeming Hospital immediately, and for a time it was thought that he would recover. Pneumonia developed, however, and caused his death two days later.

At the time of the accident Spencer was cleaning the 4th level ditch, at a point about 225 feet from the shaft station. There were two locomotive trains at the shaft and Spencer knew they were there and that they would be passing by where he was working. As the first train came along he stepped to one side of the drift and watched it pass. The other train was following at a distance of 200 feet, the runner looking ahead and ringing his bell. As the train approached within 20 feet of Spencer he stepped directly in front of the cars. The runner applied the brake and reversed the motor but before the train could be stopped the accident had occurred. If the distance had been five feet farther it probably would have been avoided.

Spencer was an Englishman, 67 years old, and is survived by a widow. The County Coroner decided not to hold an investigation. This fatality was classified as III-A-3, violation of rules by injured workman.

Accident No. 2.

Oscar Anderson, an electrician, was severely burned by current from a 30,000 volt high tension wire at Princeton, June 14, 1928. After he was injured he was able to walk with assistance and he was taken to his home in Gwinn by the local physician. Later in the day he was removed to the Ishpeming Hospital, where he died June 21st.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents - (Continued)

It was necessary to do some repair work on the south circuit of the transmission line from Ishpeming to Gwinn. Wm. Martin, foreman electrician of the Gwinn district, telephoned to Leo Voelker, foreman of the Ishpeming district, to have the switch pulled at the Ishpeming end, while he would pull the one at the Gwinn end and kill the line. After the telephone conversation Martin sent his crew to take off an insulator on the south circuit, under the impression that the line was dead. While engaged in this work Anderson was fataly injured.

The act of clearing the line was more complicated than pulling the switch on each end. It was also necessary to switch the sub-station in the Palmer district from one circuit to the other. When Martin had asked Voelker to kill the line Voelker immediately sent a man to the Palmer sub-station to disconnect the south circuit at that point. This man was to telephone to Voelker as soon as the switch was thrown and Voelker would have then pulled the switch at his end and the line would have been cleared. A misunderstanding over the method of operation resulted in the fatality.

Anderson was an American, 46 years old and is survived by a widow and three children. The County Coroner did not hold an inquest.

The Central Safety Committee classified this accident II-4, improper act or selection of work by the foremen.

Accident No. 3.

Waino Tarkka was instantly killed at the Cliffs-Shaft Mine, Nov. 24, 1928, by falling from the 10th level to the 15th level, "A" Shaft, a distance of 280 feet.

Tarkka was acting as cage rider when killed. With a shift-boss and a trammer he was riding from the 15th level to the 10th level, where the cage was to be stopped to pick up the men who were there, waiting to go to surface. As the cage reached the level and before it was correctly spotted Tarkka opened the door of the cage and started to step off. The hoisting engineer pulled the cage for a distance of five or six feet and Tarkka was thrown forward by the rapid upward move of the cage and his body plunged down the shaft.

Two safety standards were broken or neglected in the occurrence of this fatality, namely the keeping closed of the doors of a cage until it has been stopped at the proper designation and the given of a one bell stop signal to signify that fact.

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents - (Continued)

Tarkka was a single man, 27 years of age and was American born of Finnish parents. The Coroner's Jury rendered this verdict:"Accidental and no blame attached to any one".

The classification of this accident was II-5 and II-3, failure to instruct men as to the method of doing work and hazards incident thereto and a violation of rules.

Accident No. 4.

Gust Koski, a miner, was instantly killed at the Negaunee Mine by a fall of ground, December 18th, 1928.

When this accident occurred Koski and his partner, Frank Johnson, were drilling in the back, over the cap of the last set of timber against the breast of the slice they were advancing. Johnson heard some ore dribbling down over the timber and stopped the machine. He stepped back and Koski started back also. Before they had time to reach safety a large piece of ore, about six tons, settled from the back above the timber, knocked off three caps from the last sets of timber. Koski was caught by the fall but Johnson escaped unharmed.

Koski was a Finn, 36 years old, and is survived by a widow and three children. The verdict at the Coroner's inquest was "We find that Koski lost his life by an unavoidable accident and exonerate any one for any blame in connection with the accident".

TABLE I

Classification of Fatal Accidents 1911 to 1928, inclusive.
By the Central Safety Committee

I	Trade Risks		103
II	Negligence of the Company		
	Violation of Rules	4	
	Failure to Provide Safety Devices	4	
	Improper Method of Doing Work	4	
	Failure to Provide Tools or Safe Place to Work	2	
	Failure to Instruct Men	2	16
III	Negligence of Workmen:		
A	Injured Men		
	Improper Method of Work	8	
	Violation of Rules	7	
	Carelessness	6	
	Failure to use Tools or Appliances Provided	4	
	Failure to use Safety Device	1	26
B	Other Workmen:		
	Improper Method of Work	9	
	Violation of Rules	3	
	Carelessness	3	

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11. ACCIDENTS AND PERSONAL INJURY

Classification of Fatal Accidents 1911 to 1928, inclusive.
By the Central Safety Committee - (Continued)

	Failure to Use Tools or Applicances Provided	1	16
	Total		161

Classification of Causes of Fatal Accidents
from December 1st, 1898 to December 31st, 1928

A	Fall of Ground or Timber	86	
	Run of Mud or Sand	60	
	Fall of Chunk or Ore from Chute	2	
	Stray Chunk or Stick down Raise or Stope	2	150
B	Shaft Accidents:		
	Falling down Shaft	14	
	Rock or Timber falling down Shaft	2	
	Being struck or caught by Cage, Skip, Bucket or Tool	8	
	Falling from Cage, Skip or Bucket	11	
	Falling from Ladder in Shaft	5	
	Being carried or pushed into Shaft by Car	3	
	Attempting to Jump on or off Cage, Skip or Bucket	3	
	Being struck by Crosshead	5	51
C	Use of Explosives:		
	Explosion of Powder	14	
	Premature Blast	3	
	Fall of Ground or Timber due to a Blast	4	
	Being overcome by Gas	3	
	Miscellaneous Causes	1	25
D	Mine and Railroad Cars:		
	Being caught by Haulage Cars	12	
	Riding or attepting to ride Cars	6	
	Falling with Car from Trestle	4	
	By being run over by Railroad Car	6	
	By Miscellaneous Causes	1	29
E	Miscellaneous Causes:		
	Falling in Raise or Pocket	7	
	Contact with Electric Wire	7	
	Falling from Ladder, Trestle or Stage	4	
	Falling with machine or Tripod	2	
	Being caught under Pump Rod	2	
	Asphyxiation from Mine Fires	3	
	Being pulled into Moving Machinery	2	27
	Total		282

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11. ACCIDENT AND PERSONAL INJURY

a.

TABLE III.

Showing number of fatalities and rates per 1000 employees for thirteen years prior to Safety work and for 18 years of Safety work.

Year	Fatalities	Rate	Year	Fatalities	Rate
1898	6	5.63	1911	5	1.89
1899	4	3.41	1912	4	1.71
1900	4	2.80	1913	11	4.19
1901	9	6.83	1914	10	4.10
1902	8	5.38	1915	5	2.17
1903	8	5.15	1916	8	2.61
1904	4	2.97	1917	6	1.73
1905	12	5.88	1918	13	3.45
1906	10	4.13	1919	11	2.79
1907	17	6.33	1920	5	1.21
1908	6	2.57	1921	6	2.60
1909	13	5.15	1922	1	.45
1910	20	6.52	1923	6	2.19
			1924	5	1.88
			1925	2	.81
			1926	55	23.90
			1927	4	1.82
			1928	4	2.00*
	121	Avg. 4.96		161	Avg. 3.12

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

Year	U. S. Coal Mines	U. S. Metal Mines	Minn. Metal Mines	Mich. Metal Mines	C. C. I. Company
1911	4.97	4.45	5.46	4.28	1.89
1912	4.46	4.09	3.15	3.22	1.71
1913	4.70	3.72	3.16	3.12	4.19
1914	4.66	3.92	2.93	3.97	4.10
1915	4.44	3.89	2.71	3.74	2.17
1916	3.94	3.62	2.59	3.76	2.61
1917	4.25	4.44	3.04	3.40	1.76
1918	3.94	3.57	3.25	3.31	3.45
1919	4.27	3.43	3.09	2.99	2.79
1920	3.62	3.16	2.61	3.25	1.21
1921	4.11	3.09	2.51	3.63	2.60
1922	4.89	3.54	3.03	2.17	.45
1923	4.39	3.01	2.08	2.03	2.19
1924	4.80	3.51	5.61	2.30	1.88
1925	4.65	2.99	2.16	2.33	.81
1926		3.47	1.67	5.79	23.90
1927		3.10	2.55	2.02	1.82
1928					2.00*
	4.40	3.56	3.03	3.28	3.12

* Estimated figure.

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents:

There were 119 lost time accidents in 1928, the lowest number in the history of the Company, on the basis of the number of men employed. The number in 1927 was 207, and the reduction for 1928 was 43 per cent. As the Austin, Boeing and Stephenson mines were abandoned late in 1927, comparison should be calculated on the records of the mines that were operated both years. These figures are 119 accidents in 1928 and 164 in 1927, which give a reduction of 27 per cent for the former year. The Central Safety Committee classified 62 per cent of the 1928 accidents preventable, which is the highest proportion since the Committee has functioned. Two injuries were of so serious a nature that there is doubt when the men will return to work, although they are not expected to cause permanent disability.

The number of accidents which were of so serious a nature that they demanded compensation, including fatalities, total 86 for the year. This number was 70 per cent of all the accidents. In 1927, there were 144 compensable accidents and the proportion was also 70 per cent of the total.

The number of accidents by the usual chief causes, such as falls of ground, chunks rolling down piles, haulage operations, etc., was reduced by almost one-half, which duplicates the record of 1927 over the previous year. All causes show a reduction in the number of accidents.

Credit for the improved accident record for the past two years is due primarily to the Manager and General Superintendent, who have not been sparing in giving of their time and supervision to all the various activities related to accident prevention work.

The longest period and most shifts worked recorded were established by the Morris-Lloyd Mine. No accident occurred at this property from June 2nd to the end of the year, during which time 41,340 shifts were worked.

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11. ACCIDENTS AND PERSONAL INJURY

TABLE V

B Classification of all accidents by causes - 1928

By falls of ground in stopes, drifts and raises	15
By Pinching finger or foot between objects	15
By falling objects other than falls of ground	11
By chunks of ore or rock bounding from chutes	10
By haulage	10
By slipping or stumbling	9
By objects glancing or bounding	8
By chunks rolling down piles	7
By infection resulting from slight injuries	7
By falling from stage, ladder, etc.	6
By moving cable or rope	6
By moving machinery	5
By handling timber	4
By hand tools	2
By explosives	3
By electricity	2
By miscellaneous causes	3
	123

TABLE VI

Number of Compensable and Non-Compensable Accidents

Mine	Received Compensation	No Compensation	Total
Athens	9	3	12
Cliffs-Shaft	20	9	29
Holmes	5	2	7
Maas	15	3	18
Morris-Lloyd	6	3	9
Negaunee	14	3	17
Gardner-Mackinaw	2	1	3
Stephenson	-	1	1
Republic	4	1	5
Spies-Virgil	1	3	4
C. P. & L. Co.	2	3	5
Moving Maas Houses	-	1	1
Tilden	1	-	1
Hill-Trumbull	7	4	11
	86	37	123

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11. ACCIDENTS AND PERSONAL INJURY

TABLE VII

B Number of Accidents, number per 1000 Men employed and Percentage Classified Preventable - 1912 to 1928.

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

TABLE VIII

Injuries per 1000 Workers:

	1916 to 1920	1921	1922	1923	1924	1925	1926	1927	1928
C. C. I. Co.	175	170	168	166	152	152	185	90	77
Mich. Metal Mines	235	251	225	191	208	229	215	197	
All U.S.Metal Mines	241	249	268	275	278	283	245	221	

TABLE IX

Classification of All Accidents 1928 By the Central Safety Committee

1.	Trade Risk. (Incidental and Non-Preventable		46
II	Negligence of Company:		
	1. Failure to Use Safety Devices Provided	0	
	2. Failure to Use Proper Tools or Appliances Provided	0	
	3. Violation of Rules	1	
	4. Improper Act or Selection of Improper Method of Doing Work (By Foreman)	2	
	5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto	4	
	6. Failure to Provide Safety Devices	0	
	7. Failure to Provide Proper Tools, Appliances or Place to Work	3	10

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11. ACCIDENTS AND PERSONAL INJURY

B Classification of All Accidents 1928
By the Central Safety Committee - (Continued)

III Negligence of Workmen:

1. Failed to Use Safety Device Provided	2	
2. Failed to Use Proper Appliances or Tools Provided	1	
3. Violation of Rules	3	
4. Improper Act or Selection of Improper Method of Doing Work ..(By Workmen)	34	
5. Carelessness .. (By Workmen)	23	63
Other Workmen:		
1. Failed to Use Safety Devices Provided	0	
2. Failed to Use Proper Appliances or Tools Provided	0	
3. Violation of Rules	0	
4. Improper Act or Selection of Improper Method of Doing Work... (By Workmen(.....	3	
5. Carelessness... (By Workmen)	1	4
Total		123

TABLE X

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

Mine	Accident Frequency Rates Number of Accidents per 1000 Days Worked 1926	1927	1928	Accident Severity Rates Number of Days Lost per 1000 Days Worked 1926	1927	1928
Athens	.695	.332	.286	18.750	6.146	9.475
Cliffs-Shaft	.784	.353	.332	16.858	8.880	9.213
Gardner-Mackinaw		1.355	.141		5.079	2.378
Hill-Trumbull	.125	.137	.275	2.290	3.035	5.859
Holmes	.654	.400	.168	13.456	7.774	2.995
Maas	.429	.209	.360	20.695	6.146	16.318
Morris-Lloyd	.666	.366	.152	8.817	13.890	5.717
Negaunee	.428	.293	.238	13.094	8.189	7.563
Spies-Virgil	.457	.351	.154	19.418	5.713	.983
Republic	.693	.349	.310	14.348	2.706	7.103
Average All Properties	.665	.354	.232	18.332	9.566	7.073

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection:

Monthly inspection of our mines in this County were made by the Safety Inspector and reports submitted of the same. Special reports were made to the Manager upon hazards that should be called to his attention without unnecessary delay. A committee of three underground bosses from the Athens, Cliffs-Shaft and Morris-Lloyd mines, inspected the local mines in September, and the surface and mechanical equipment was inspected in October by a mechanic from the Maas Mine, a surface foreman from the Holmes Mine and an electrician from the Mechanical and Electrical Department. The Safety Inspector inspected the Spies-Virgil four times.

TABLE XI

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

Mine	Foremen	Workmen
Athens	8	21
Cliffs-Shaft	12	57
Holmes	9	27
Maas	11	45
Morris-Lloyd	11	60
Negaunee	15	60
Republic	8	42
Idle & Miscellaneous	43	252
	117	564

TABLE XII

List and number of all reports for prevention of Accidents made in 1928

Cage Riders	Daily	3175
Hoisting Ropes	"	2843
Ladderways	Weekly	386
Skip and Cage Roads	"	405
Cage Safety Catches	Monthly	115
Hoists	"	177
Mine Rescue and First Aid	"	195
Safety Inspection	"	83
Fire Hose Equipment	Quarterly	42
Electrical Equipment	"	25
Fire Extinguishers	Semi-Annual	27
		7473

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d. Special Safety Activities.

The Central Safety Committee.

The personnel of this Committee was the same as in 1927 with the addition of one new member, in the personage of Mr. Carl Brewer, Assistant Superintendent of the Negaunee District. A regular meeting was held each month, excepting in November. The classification of accidents, as reported in Tables one and nine of this report, was made by this Committee and all safety subjects of importance were referred to it for discussion.

Foremen Safety Conferences.

The Company's Fourth Safety Conference for all of its foremen was held at the Central Office, October 27th, with 100 men in attendance. The special features of this meeting were an address by Mr. Elliott, a paper entitled "Efficiency and Safety" by Mr. C. J. Stakel, Superintendent of the North Lake District, and a comparison of this year's accident record with that of prior years by Mr. Moulton, Secretary of the Pension Department.

District foremen conferences were held early in the year at Ishpeming, Negaunee and North Lake, for the formulation of safe standards in the operation of underground haulage. Similar conferences were held later at the same places, for the adoption of standards for the handling and use of explosives. It is the expectation that these new standards will be of valuable aid in stopping accidents by these causes. If they do not succeed, we at least can trace the responsibility for the failure to do so.

The Lake Superior Annual Safety Conference.

The Lake Superior Section of the National Safety Conference held its annual meeting at Duluth, June 25th and 26th. Our Company had four delegates from the Marquette District and eight from the Minnesota mines there. Mr. Elliott presented a paper on the subject"Safety- A Major Objective in Mining " and the Safety Inspector gave a description of two unusual mine accidents.

Michigan Safety Congress.

This Congress was held under the supervision of the Michigan Department of Labor and Industry, at Lansing, April 11th to the 13th. The Company's Inspector was one of the two delegates present who represented the Lake Superior Mining Companies. He submitted a report of this conference to the General Superintendent.

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d. Monthly Safety Bulletin.

This bulletin was sent to all foremen to keep them informed upon the most important facts relative to our safety work. In its publication an attempt is being made to impart to our foremen what other organizations are doing in safety work, and the writings and speeches of authorities in accident prevention work are freely quoted.

Joseph A. Holmes Association Safety Award.

A Certificate of Honor was given the Negaunee Mine by this organization for an outstanding non-fatal accident record in metal ore mining. The presentation was made at the mine June 22nd by Mr. F. C. Gregory, District Engineer for the Bureau of Mines. All the employees of the mine and many Company officials were present on this occasion. Mr. Elliott expressed his appreciation for the honor conferred upon the men and Captain Fred Ware stated that without their active cooperation it would have been impossible to have made the record. The mine had operated from January 23rd, 1919, to this date without sustaining a fatality. The record was broken December 14th, 1928, when a miner was accidently killed by a fall of ground.

Safety Flags.

The National Safety Flag flies at each mine provided it is exempted from an accident that incapacitates an injured employee from work over two weeks. When such an accident occurs, at the expiration of two weeks, the flag is lowered for a period of one week.

Two Banner Flags are provided, one for the mine that has operated the longest period without a lost time accident and another for the mine that has the most shifts worked without such an accident, but in no instance can the honor be granted for less than a month's record. Thus a small mine has an opportunity to compete with a large mine for the honor of flying one of these flags. As the Morris-Lloyd Mine was operated the last seven months of the year and suffered no lost time accident, no other mine was entitled to a Banner Flag during this period.

Distribution of Cigars.

As a indication to our employees that a satisfactory record in preventing accidents was recognized, it was decided that whenever a mine had operated three continuous months without sustaining a lost time accident all the men working at that mine would be given a cigar. All of our mines in Michigan, excepting the Cliffs-Shaft, established this record, and cigars were distributed accordingly.

Haulage Standards.

Standards for the installation and operation of underground haulage were adopted and printed in two codes, one for foremen and another for workmen. All employees engaged in this work were given copies of these new rules.

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d. Explosive Standards.

Standards for the handling and use of explosives were agreed upon at the December meeting of the Central Safety Committee. They will reach all foremen in printed form in January, 1929, and a new code for workmen will be posted at all mines the same time.

Haulage and explosive hazards cause many severe accidents and it is our desire to eliminate accidents by these causes.

Fuse Cutter and Cap Crimper Machine.

To eliminate the hazard involved in crimping caps by miners a machine at each mine is being installed by which one man, using this device, can cut the fuse and attach the caps and be in no danger of injury. This change will reduce the number of misfires at a mine, as dry fuse will always be used, and it also stops the careless storage of caps in a mine. Metal containers are provided for the transportation and storage of capped fuses.

Safety Zones and Haulage Drifts.

Where a passageway along a locomotive track does not provide ample safety to avoid a moving train safety zones are being cut and their location is indicated by a green light. It has been necessary to provide these places in the drifts of several mines but more especially at the Cliffs-Shaft Mine, where larger haulage cars are replacing the type formerly used.

Underground Illumination.

All shaft stations of the mines, with the exception of the Cliffs-Shaft and Mackinaw-Gardner mines, were white washed during the year. To maintain a tidy appearance as long as possible the walls are painted to a height of about six feet with hematite, and beyond this elevation white coating is applied.

Underground Storage of Timber.

A standard was adopted that requires the placing of skids for holding timber in haulage drifts, constructed at least 18 inches from the track and with a guard to prevent movement of timber toward the track. Greater care is being observed in stacking timber supplies in the passageways of the sub-levels.

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d. Ventilation.

Natural ventilation gives good air in the Cliffs-Shaft, Morris-Lloyd, Gardner-Mackinaw and Spies-Virgil Mines. The mines of the Negaunee District have air supplied by the operation of large fans and in the restricted areas of the Holmes Mine small fans are used when it is necessary to improve poor ventilation.

Samples of the air in the Athens Mine were taken during the hot season and sent to the Bureau of Mines at Pittsburgh, Pa. They showed a moderate dilution of carbon dioxide. Improvements were then made in the circulation of the pure air and analysis made later gave very good results.

Abandoned Properties

The open pits, caves and shafts of all abandoned mines and explorations were given careful attention and fences and guards were repaired where necessary. A number of large danger signs were posted around the caves of the Salisbury Mine, which has filled with water.

e. Safety Rules and Standards.

A total of 162 Book of Rules and Regulations were given to workmen during the year. 127 were in English, 21 in Finnish and 14 in Italian.

Copies of the new safety standards for the operation of underground haulage were given to 285 employees,- 199 for workmen and 76 for foremen.

TABLE XIII

Distribution of Rule Books:

Cliffs-Shaft	33
Morris-Lloyd	31
Gardner-Mackinaw	29
Tilden	26
Athens	18
Maas	11
Negaunee	11
Holmes	2
Spies-Virgil	1
	162

TABLE XIV

Distribution of Haulage Standards

	Workmen	Foremen
Cliffs-Shaft	23	11
Morris-Lloyd	53	15
Gardner-Mackinaw	9	5
Athens	21	8
Maas	29	8
Negaunee.....	34	13
Holmes	13	7
Spies-Virgil	17	8
Miscellaneous	0	1
	199	76

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f. First Aid Work.

No new crews in first aid to the injured were trained last year but employees who have had the Company's training in former years were given review lessons. There were 173 men who participated in this work and a total of 72 instruction sessions were held.

Mercurochrome has been substituted in lieu of iodine for treatment to prevent infection of slight injuries. This change was adopted upon the recommendation of our physicians.

First aid supplies, costing $267.79, were purchased and charged to the operating units in proportion to the amounts used.

TABLE XV

Showing the number of men trained - 1912 to 1928

Number of men receiving training	668
" " " " First Aid Certificates	535
" " " deceased	20
" " " Pensioned	6
" " " now employed by Company	314

g. Mine Rescue Work.

On January 12th a shift-boss at the Cliffs-Shaft Mine encountered smoke as he started his tour of underground inspection. He traced the smoke to its origin but it was too dense to fight the fire. He came to surface and notified the Safety Department. A crew of five men, equipped in oxygen rescue apparatus, was organized in a very short time, and proceeded to the fire. Within two hours it was extinguished. Without this equipment it was very probable that a large portion of the mine would have filled with smoke and gasses, which would have suspended mining operations, at least temporarily.

Again fire was discovered in a mine on the morning of January 28th. Smoke was found ascending in the main shaft of the Negaunee Mine at the beginning of the shift and a shift-boss in company with several men were lowered into the mine to investigate. They found a small fire burning in the ventilation door on the 10th level, which was easily extinguished.

These two fires were started because of defective wiring, and were the means of attracting our attention to the possibility of other fires originating elsewhere by the same cause. Mr. Elliott, therefore, had our electrical engineers make a very careful inspection of all underground electrical equipment and wiring with instructions to correct any unsatisfactory condition that would be found.

During the year 77 training instructions in the use of oxygen apparatus were given at our Michigan properties. There were 67 men who participated in this important work. The equipment that was formerly stationed at the Gwinn Central Office is now kept at the Gardner-Mackinaw Mine. Each of our mining districts in Michigan has its fire-fighting equipment apparatus, which is of the latest type and is always maintained in perfect condition.

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g. Mine Rescue Work - (Continued).

The Safety Department receives the quarterly and semi-annual fire inspection reports that are made at the mines by mine employees, and if there is any delay or failure in the discharge of this work, the mine superintendent is notified.

The cost of mine rescue equipment and supplies charged to the mines was $494.73. First Aid and Mine Rescue Training was given by Mr. J. H. Williams, who also kept rescue apparatus in repair, inspected and recharged fire extinguishers at office buildings and checked and filed the various reports as listed in Tables twelve, fifteen and sixteen.

TABLE XVI

Showing the number of men trained in Mine Rescue Work - 1912 to 1928.

Number given training	411
" Deceased	17
" Pensioned	1
" Disqualified	108
" left Company's Employment	154
" now employed and qualified to wear the apparatus	131

TABLE XVII

h. Expenses and Salaries.

Supplies		
Distribution of Cigars	90.26	
Printing Safety Standards	80.00	
Advertising in Mining Journal	75.00	
Safety Conference Banquet	84.41	
Underground Pictures of Safety Devices	28.50	
Purchase of Safety Flags	27.44	
Metal Safety Signs for all Mines	23.55	
Publications of National Safety Council	19.62	
Danger Signs for Open Pits	14.00	
Safety Exhibit at Duluth	11.81	
Clothes for Committee	7.20	
Miscellaneous	2.18	
	463.97	
First Aid and Mine Rescue Supplies	12.34	476.31
Travelling		
Safety Inspector	366.93	
Mine Rescue and First Aid Foreman	226.46	
Members of Committees	68.68	662.07
Salaries		6660.00
GRAND TOTAL		$7798.38

Respectfully submitted,

William Coulthard

Safety Inspector

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CLIFFS SHAFT MINE:

On June the 4th the spider on the #8 McCully crusher broke. A spider was taken from the South Jackson crusher to replace the broken one, and the broken one shipped to the Lake Shore Engine Works and the necessary repairs made.

All the mechanical equipment at this mine is in very good condition. Operation has been satisfactory during the past year.

HOLMES MINE:

A Bean vertical duplex 6" x 6" pump was purchased for the 5th level of this mine. This was put in operation about November 1st and is entirely satisfactory.

The skip hoist gave us some trouble on September 28th, when the gear keyway on the drum shaft gave out. This keyway was repaired and at the present time the hoist is operating satisfactorily. If any further trouble develops in this keyway it will be necessary to replace the drum shaft.

All other mechanical equipment operated in a satisfactory manner.

OGDEN MINE:

Operations at this mine have been discontinued and the equipment moved to the Tilden Mine.

ATHENS MINE:

A little trouble developed in the brake engine on the skip hoist. Repairs were made and it is now in good condition.

All mechanical equipment at this mine is in good condition. It has operated satisfactorily during the past year.

MAAS MINE:

In April the flanged coupling loosened on the motor shaft of the skip hoist. It was necessary to put a new half coupling on this motor because the old one was worn so that it did not fit the shaft.

On April 9th a bearing on the pinion shaft of the third level Aldrich pump burned out. This bearing was repaired and the pump is again in good condition.

A new crank pin was put in the Prescott pump on the third level because the old one became loose. This pump is again operating satisfactorily.

The new pump station on the fourth level is completed and an Aldrich 11" x 12" vertical triplex pump, received from the Boeing Mine, will be installed as soon as possible.

The steam turbine was operated about seven hours on September the 10th on account of trouble with the water wheels at the Carp Plant.

All mechanical equipment is in good condition and operation was satisfactory during the year.

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MAAS CRUSHING PLANT:

This plant operated satisfactorily during the year.

The fine reduction part of this plant, which includes the 10" McCully crusher and motor, belt conveyor with motor and reduction gear complete, also steel structure used over the crusher, has been dismantled and shipped to the Tilden Mine. It will be installed during the winter so as to be ready for operation in the Spring.

NEGAUNEE MINE:

A new pump station is being made on the 12th level at this mine. As soon as it is completed the 11th level pumps will be moved down to take care of the water on the 11th and 12th levels.

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

SOUTH JACKSON CRUSHING PLANT:

This plant was idle the entire year.

LLOYD MINE:

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

MORRIS MINE:

All mechanical equipment at this mine operated satisfactorily during the year. No trouble or delays.

SECTION 6 SHAFT:

No changes or additions. All mechanical equipment operated in a satisfactory manner during the year.

GARDNER-MACKINAW MINE:

Bailing water was completed in March.

The valves were changed in the Nordberg air compressor from a semi-corliss to a feather type, which improved the operation of this machine considerable.

All mechanical equipment is in good condition and operated in a satisfactory manner during the year.

GWINN CRUSHING PLANT:

This plant operated from May to November 17th. Operation was satisfactory.

PRINCETON PUMP STATION:

The pumps in this plant operated in a satisfactory manner during the year. There were no changes or additions.

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REPUBLIC MINE:

This mine was shut down on May the 21st, the last ore being hoisted on that date. All the underground equipment was removed, some being shipped to other mines and the balance stored on surface.

SPIES-VIRGIL MINE:

Considerable trouble was experienced with broken crankshafts on the underground pumps. The crankshaft on one of the Prescott vertical triplex pumps broke in January. A new shaft was received and installed in March and this pump is now in good condition and operating satisfactorily. A spare crankshaft for the two Prescott pumps was purchased and stored at the mine.

On February 20th the crankshaft on the Deane vertical triplex pump broke. A new shaft was received on April 17th and put in service. This pump is now in good condition.

Two new top tram larry cars were purchased and received from the Republic Iron & Steel Co. at Gilbert, Minn., these being in first class condition as they had never been used. One was put in operation in January and the other in February.

BOEING MINE:

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

DATE	EQUIPMENT	SHIPPED TO
June	Pit hoist with 50 HP. motor.	General Storehouse, Ishpeming.
June	Aldrich triplex pump with 100 HP. motor.	Maas Mine, Negaunee.
June	#4 Cameron pump.	Hill-Trumbull washing plant.
August	5'x5' drum Skip Hoist and 200 HP. motor	Brule Mining Co., Stambaugh, Mich.
August	800 G.P.M. Allis-Chalmers pump, Shop #5479, C.C.I. motor #399	Wade Mine.
August	800 G.P.M. Allis-Chalmers pump, Shop #12544, Motor #439.	Hill-Trumbull Mine pit.

A 1,000 G.P.M. Layne & Bowler pump was installed in shaft skip compartment in November by the M. A. Hanna Company to relieve water conditions at the Susquehanna Mine, close by.

HILL-TRUMBULL MINE:

In the pit the erection of the 350-ton Marion shovel was completed in February, ready to start stripping March 1st, but this work was postponed until ore season was over in October. Stripping started on south bank just below coal dock and continued double shift until December 1st, when cold weather stopped the operation. A total of 321,755 yards was moved with only two short delays; 1st - the hoisting cable broke close to the bail, and - 2nd - a main rotating pinion had to be replaced. An equipment of pontoons to move shovel on was made up to replace the track ties and these could be shifted by the shovel instead of pit men.

The #27 shovel did most of the work during the shipping season. When the season closed on September 26th, this machine was moved to lean ore stripping

HILL-TRUMBULL MINE: (Cont'd)

in Trumbull pit and worked from October 1st to November 14th, stripping 102,033 tons waste ore and removing 3,000 tons lean ore. With the exception of cracking one jack-arm, no serious trouble was experienced.

Due to a slide of ground in October, the #19 shovel tipped over on its side while cutting a loading track grade for #28 shovel. This was recovered without much damage and is now in shop for repairs.

On August 15th very heavy rains stopped work in the Hill pit. After waiting two weeks the water did not recede, so a spare 800 G.P.M. Allis-Chalmers pump from the Boeing Mine was installed on a barrel scow and connected to 10" discharge over the south bank, lowering water so operation could start in 24 hours. This scow was left for future emergencies. To eliminate future water troubles in Trumbull pit it was decided to drill a 20" well and install a 1,000 G.P.M. Layne & Bowler pump. Drilling was started in October and pump was installed and started operating the middle of December. From soundings made in pit churn drill holes the water is receding rapidly while pumping on 24-hour schedule. It is hoped the pit can be kept drained by running pump only 12 hours per day during ore season, using dump and second-class current for its operation, thereby cutting pumping costs in half.

The Washing Plant was started on May the 7th. Tables and chip screens were run about one day a month. The table tops were so decayed it was decided to overhaul them. Nine tables were put in good operating condition and rubber tops were purchased for the other nine. Twenty-five new Sacon rollers were installed under 36" belt conveyor, which finishes a complete set of 75, one-third being added each year. The largest repair job was rebuilding the 8-ft. apron of pan conveyor. New hinges, pins and 3/8" wearing plate on top of 5/8" pans put apron in first class condition. The season's work showed that the wood filling blocks on hinge straps were not needed as long as head pulley was kept built up to proper gauge.

At the tailings pond the dragline built up #2 basin with a dyke six feet high at the rate of 60 feet per day. A bad storm washed out a section of #1 basin in August, but tailing discharge was diverted to #2 basin and no delay caused.

One improvement that eliminated a man was to spot concentrator railroad cars with air and not use hand brakes, as in the past.

Tests run on locomotive #101 proved that a Worthington feed water heater did not show any saving under present operating conditions, so the heater was moved back on #28 shovel. Other tests showed that table grates were an improvement over finger grates, but run-of-mine splint coal showed no economy over egg splint.

WADE MINE:

No changes were made until August, when an 800 G.P.M. Allis-Chalmers centrifugal pump from Boeing Mine was installed in underground pump station. This was due - first - to increased water flow from Helmer pit, causing pole pump to run 24 hours per day, and - second - the sump was half full of mud and it was cheaper to install the pump than to clean sump. As the Wade open pit ore will be cleaned up next summer it is hoped to finish the mine without further expense cleaning sump.

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WADE MINE: (Cont'd)

The Dohm Construction Company used one Lima locomotive and the Marion 36 shovel during the summer, while loading ore from Helmer pit. A blast finished the small #32 shovel in pit and it was scrapped.

HOLMAN-CLIFFS MINE:

Plans were made to unwater this pit during the summer, but equipment was not installed until November. The old Layne & Bowler pump from the Stephenson Mine was equipped with new 4500 G.P.M. pump bowl and 16" column and installed in west compartment of #2 shaft. A second-hand Worthington sinking pump of 1,000 G.P.M. capacity, received from General Storehouse, Ishpeming, was installed in second compartment. These two pumps, up to January 1st, had lowered the pit water 74", working 12 hours out of 24 on week days and 24 hours on holidays. A 4,400 G.P.M. Cameron centrifugal pump, driven by a 275 H.P. motor, is being installed in the pit and with the three pumps it is hoped to remove all water by June 1st.

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Electrical Department:

The Cliffs Power & Light Co. has shown a healthy growth in current sales during the past year, with practically the entire increase consumed by outside parties.

All the current generated was by water power, with the exception of 3,700 KWH. from the Maas steam plant.

At the end of the year both the Carp and Dead River storage basins were full. The highest record of water occurred in June.

In October we had the largest output for any one month since plants were started.

The development of rural service, both through The Cliffs Electric Co. and by the Wisconsin-Michigan Power Co., who purchase from The Cliffs Power & Light Co., has shown a very interesting development.

Sale of surplus power to Munising Paper Mill was started in July.

Two substations were discontinued, one at the Barnes-Hecker Mine and the other at the Ogden Mine.

The Blueberry Mine of the Ford Motor Company, who own their own substation, about replaces the Barnes-Hecker, and the Tilden Mine development, which is served from the Palmer Substation, will exceed the Ogden.

The Athens-Negaunee feeder lines were rebuilt on account of mining operations, and a new feeder built to the Tilden Mine.

Installation of additional equipment at the Republic Plant is under way and should be completed early in 1929. This work is covered by E. & A. #8 and consists of a new 500 KVA. Westinghouse generator, which will be connected to the existing water wheel, and installation of a suitable Woodward water wheel governor. The feeder line from the plant to the substation was rebuilt, with capacity sufficient for the new and future developments. This plant will be partly automatic and will probably operate on peak load only.

The water wheels at the Carp Plant, after 17 years operation, developed erosion and wear which necessitates replacing runners and other necessary parts. This material is now on hand and will be installed after the Escanaba River Plant is ready for service.

The Carp Plant wood pipe line developed some leaks and a sufficient amount of new material is on hand to rebuild the portion affected.

A new circuit breaker was installed at the Au Train Plant to protect against shutdown in case of line trouble.

The substation installed at the Munising Paper Mill, purchased by them after completion, consists of two 500 K.V.A. transformers with steel structure and oxide film arresters. It is anticipated that a third transformer will be installed.

A severe storm occurred in the month of August which caused some delay. With this exception, no delays of consequence occurred during the year.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

The service throughout the year at all points seems to have been uniformly good and adequate.

With completion of present plants we hope to care for all load possibly available as rapidly as it develops.

ESCANABA RIVER PLANT:

This plant is covered by E. & A. #7 of the Cliffs Power & Light Co. Work was started November 1st, 1927, and carried through 1928 to near completion. Nothing unusual was encountered except the final location survey developed that more tunnel would have to be used, which decreased the length of steel pipe an equal amount. It now seems that this Plant will be put in service about the middle of February, and that the final cost will not exceed the authorization.

Electrical Department: (Cont'd)

Summary of Operating Conditions - 1 9 2 8 .

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation -	1.01	0.87	1.59	3.58	1.72	7.15	3.36	4.60	5.01	5.00	1.68	0.49

Total Precipitation at Ishpeming during 1928 - 36.06 inches.
Average " " Marquette - 32.8 " (46 year record)

CARP RIVER HYDRO-ELECTRIC PLANT:

Drainage area above Intake Dam,		66.66 sq. miles
Cubic feet Precipitation in 1928,	5,584,414,300	
Kilowatt Hours generated in 1928,	10,578,400	
Cubic feet water utilized (90 cu. ft. = 1 KWH.)	952,056,000	
" " " in Carp Storage Basin Jan. 1, 1928,	390,904,840	
" " " " " " " Dec.31, "	434,774,200	
" " " in 1928, stored	43,869,360	
" " " wasted over Intake Dam in 1928,	1,470,960,000	
Total run-off for the year 1928,	2,466,885,360	cu. ft.
Run-off per square mile of drainage area,	37,006,000	" "

	1913	1914	1915	1916	1917	1918	1919	1920	1921
Total Precipitation,	30.11	26.53	38.40	36.83	25.46	31.05	29.50	27.40	30.38
Second ft. per sq.mile,	1.03	.67	.93	1.29	.70	.79	.83	.73	.68

	1922	1923	1924	1925	1926	1927	1928
Total Precipitation,	33.67	21.90	22.95	20.71	35.69	29.86	36.06
Second ft. per sq.mile run-off	1.06	.59	.50	.25	.85	.98	1.11

McCLURE HYDRO-ELECTRIC PLANT:

Drainage area above Intake Dam,		140.52 sq. miles.
Cu. ft. Precipitation in 1928, (Hoist Plant 43.80")	14,251,150,602	
Kilowatt Hours generated at McClure Plant in 1928,	33,104,800	
Cubic feet water utilized (125 cu. ft. = 1 KWH.)	4,138,100,000	
" " " wasted over Intake Dam in 1928,	5,233,248,000	
" " " in Hoist Storage Basin Jan. 1,1928,	1,601,178,288	
" " " " " " " Dec.31, "	2,001,203,303	
" " " stored during 1928,	400,025,015	
" " " in Silver Lake Jan. 1, 1928,	491,875,500	
" " " " " " Dec.31, "	588,181,300	
" " " stored in Silver Lake in 1928,	96,305,800	
Total run-off for the year 1928,	9,869,678,815	cu. ft.
Run-off per square mile of drainage area,	70,236,820	" "

	1920	1921	1922	1923	1924	1925	1926	1927	1928
Second ft. per sq. mile, run-off	1.22	1.02	1.54	0.85	0.92	0.52	1.52	1.8	2.22

THE CLIFFS POWER & LIGHT CO.

SUMMARY OF OPERATIONS - 1928.

	KILOWATT HOURS GENERATED								Used by Auxiliaries	Delivered to Line	KWH. Sold	Transmission Losses	
	McClure	Carp	Hoist	Au Train	Maas	Princeton	Republic	TOTAL				K.W.H.	%
Jan.	2,632,200	598,600	906,000	181,580	0	0	0	4,318,380	16,590	4,301,790	3,735,623	566,167	13.16
Feb.	2 616 700	571 300	1 038 000	92 860	0	0	0	4 318 860	15 780	4 303 080	3 742 703	560 377	13.02
March	2 973 900	528 000	1 048 000	98 380	0	0	0	4 648 280	15 210	4 633 070	4 046 013	587 057	12.67
April	2 507 500	708 600	872 000	289 380	0	0	0	4 377 480	14 340	4 363 140	3 801 489	561 651	12.87
May	2 689 700	774 100	834 000	253 530	0	0	0	4 551 330	13 710	4 537 620	3 977 127	560 493	12.35
June	2 768 400	970 800	456 000	243 520	0	0	27,300	4 466 020	10 740	4 455 280	3 829 566	625 714	14.04
July	2 762 800	959 900	391 000	207 660	0	0	85 100	4 406 460	10 340	4 396 120	3 756 816	639 304	14.56
Aug.	2 938 700	967 400	703 000	109 330	0	0	112 200	4 830 630	13 010	4 817 620	4 084 291	733 329	15.22
Sept.	2 719 300	778 500	703 000	204 960	3,700	0	122 100	4 531 560	14 850	4 516 710	3 884 059	632 651	14.00
Oct.	2 996 300	1 155 800	636 000	287 820	0	0	86 200	5 162 120	14 064	5 148 056	4 487 969	660 087	12.82
Nov.	2 773 800	1 353 500	564 000	288 390	0	0	52 600	5 032 290	13 920	5 018 370	4 347 960	670 410	13.35
Dec.	2 725 500	1 211 900	591 000	270 220	0	0	0	4 798 620	14 224	4 784 396	4 147 893	636 503	13.30
	33,104,800	10,578,400	8,742,000	2,527,630	3,700	0	485,500	55,442,030	166,778	55,275,252	47,841,509	7,433,743	13.44

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

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

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
ANGELINE MINE:				
Hoist	250 HP.			250 HP.
CLIFFS SHAFT MINE:				
Shop	25			
No. 8 Crusher	125			
Screens	15			
Lower Tram #1	30			
Top Tram	100			
Hoist for "A" Shaft	500			
Underground Plunger Pump #1	180			
" Centrifugal Pump	250			
Allis-Chalmers Compressor	175			
Hoist for "B" Shaft	500			
Underground Plunger Pump #2	200			
Laboratory Crusher	5			
Coal Crushing Plant (Sent to Tilden Mine)	15		15	
" " " Exhaust Fan	½			
Cooling Water Pump for Compressors	10			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Lower Tram #2	50			
Heating Plant Condensing Water Pump	2			
Underground Haulage Set #2	215			
Small Hoist in Crusher Building	15			
Conveyor Belts - New Crushing Plant, 2 motors	40			
Jaw Crusher - " " "	75			
Feeder Belt - " " "	5			
Magnetic Separator " " "	1½			
Underground Scrapers - 40 - 25 HP. motors	900	100		
Lower Tram #3	30			
Battery Charging Set - 2nd level "A" Shaft	7½			
Underground Haulage Set #1	100			
Grinder in Drill Sharpening Shop	7½			
Battery Charger (from Republic)		30		
Rotary Screen		10		
Boiler Water Pump at Central Office		¾		4,504¾
BROWNSTONE SUBSTATION:				
Test Set	1/2			
Oil Filter Press	1/4			
Battery Charging Motor-Generator Set	3			
Commutator Grinder	1			
Synchronous Condenser	80			
M.G. Set on Voltage Regulator Control	1/4			
Large Oil Filter Press		2		87
fwd.	4,714 HP.	142¾	15	4,841¼ HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	4,714 HP.	142¾ HP.	15 HP.	4,841¾ HP.
HARD ORE SHOPS:				
Machine Shop	10			
Carpenter "	25			
Blacksmith Shop Punch	3			
Armature Banding Machine	2			
" " "	1/2			
" " "	1/8			
Lathe Grinder	1			
Portable Drill	1/4			
" " - Large	1/4			
Commutator Slotter	1/8			
Air Compressor	10½			
Water Supply Pump	7½			
Blacksmith Shop Blower	1/4			
Hacksaw	1/2			
Small Grinder	1/4			
				61¼
HOLMES MINE:				
Air Compressor	340			
" " Cooling Water Pump	3			
Skip Hoist - 2 - 400 HP. motors	800			
Cage "	400			
Underground Haulage Converter	150			
Top Tram	25			
No. 6 Crushers - 2 - 40 HP. motors	80			
Screens	20			
Laboratory Crusher	2			
Underground Plunger Pump	250			
" Centrifugal Pump	400			
Boiler Feed Pump	5			
Machine Shop	25			
Auxiliary Compressor for Hoist Brakes		7½		
5th level Deane Pump - Aldrich sinker		35		
" " Dean "		10		
				2,552½
OGDEN MINE:				
Compressor (Sent to Tilden Mine)	150		150	
Compr. Cooling Water Pump (to Gen.Storehouse)	2		2	
Elec. Shovel Motor-Generator Set (to Tilden)	110		110	
" " Air Compressor	4½		4½	
" " Oil Pump	1/4		1/4	
" " Trip Motor	2		2	
" " Exciter Motor	10		10	
Scrapers (2) (to Cl.Shaft)	50		50	
Pump (to Gen. Storehouse)	100		100	
Cyclone Drills - 2 - 10 HP. (to Tilden)	20		20	
" Drill	15		15	
				0
fwd.	7,739 HP.	195¼ HP	478¾ HP	7,455½ HP.

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt@ fwd.	7,739 HP.	195¼ HP.	478¾ HP.	7,455½ HP.
TILDEN MINE:				
Compressor (from Ogden Mine)		150		
Centrifugal Pump (from Gwinn Storage Shed)		275		
Scraper (from Cliffs Shaft coal crusher)		15		
Elec. Shovel Motor-Generator Set (from Ogden)		110		
" " Air Compressor " "		4½		
" " Oil Pump " "		1/4		
" " Trip Motor " "		2		
" " Exciter Motor " "		10		
Cyclone Drills - 2 - 10 HP. " "		20		
" Drill " "		15		
				601¾
ISHPEMING HOSPITAL:				
Passenger Elevator	7½			
Dumb Waiter	3			
Large Washer	2			
Small "	1			
Extractor	2			
Vacuum Cleaner	3			
" Pump	1			
Water Supply Pump	2			
				21½
ATHENS MINE:				
Cage Hoist	400			
Compressor - Nordberg	325			
Compressor Cooling Water Pump	3			
Auxiliary Compressor for Hoist Brakes	5			
Underground Ventilating Fan #1	15			
Sinking Pump - 2400' station	50			
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Converter	150			
Skip Pit Pump	2			
Laboratory Crusher	5			
Underground Plunger Pumps - 2 - 400 HP.	800			
Ore Tram - 2 - 50 HP.	100			
Carpenter Shop	20			
Ore Crusher	25			
Battery Charging Motor-Generator Set	1/4			
Underground Ventilating Fan #2	40			
Ingersoll-Rand Compressor	450			
Rock Tram	50			
				3,301¼
MAAS CRUSHING PLANT:				
Jaw Crusher	100			
Belt Conveyor	50			
Secondary Belt Conveyor (to Tilden Mine)	50		50	
Screen (stored)	50		50	
Pan Conveyor Motor-Generator Set	50			
Secondary Crusher (to Tilden)	100		100	
				200
fwd.	11,461¾	797	678¾	11,580 HP.

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	11,461¾ HP.	797 HP.	678¾ HP.	11,580 HP.
MAAS MINE:				
Turbine Auxiliaries (Circulating Pump	40			
Turbine Auxiliaries (Injection "	25			
Turbine Auxiliaries (Exciter	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist	50			
" Plunger Pump #1 (correction)	320	5		
Compressor Cooling Water Pump	5			
Ore Tram - 2 - 50 HP. motors	100			
Coal Crushing Plant	15			
Underground Plunger Pump #2	250			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Rock Tram	50			
Skip Hoist	700			
Cage "	400			
Boiler Room Fan	1/2			
Skip Hoist Rheostat Pump	2			
Carpenter Shop Saw	15			
Auxiliary Compressor for Hoist Brakes	7½			
4th Level Pump	50			
Cooling Water Pump	5			
Triplex Pump, 4th Level	50			
Centrifugal Pump, 4th Level		40		
Saw Gumming Outfit in Carpenter Shop		2		
				3,540
NEGAUNEE MINE:				
Underground Haulage Set #1	215			
"Ilgner" Hoist Set	450			
Top Tram - 2 - 50 HP. motors	100			
Laboratory Crusher	5			
Auxiliary Compressor for Hoist Brakes	3			
U.G. Plunger Pumps - 2 - 300 HP motors	600			
" Centrifugal Pump	350			
" Suction Pumps - 2 - 15 HP motors	30			
Compressor Cooling Water Pump	3			
Nordberg Air Compressor	325			
Shop	15			
Skip Pit Pump (motor burned out)	5		5	
Ore Crusher	25			
Ingersoll-Rand Compressor	400			
13th Level Plunger Pump	15			
11th Level Plunger Pumps - 2 - 75 HP motors	150			
Exciters for 10th level Pump Motors (2)	40			
Signal System Motor-Generator Set	1/2			
Timber Hoist - #2 Shaft	25			
Ventilating Fan - #2 Shaft	150			
Gravel Hoist	15			
Saw in Carpenter Shop	15			
Skip Pit Pump		3		
Underground Haulage Set #2 (from Gen.Storehouse)		220		
				3,154½
fwd.	17,891¼	1,067	683¾	18,274½ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	18,891½ HP	1,067 HP	683¾ HP	18,274½ HP.
SOUTH JACKSON CRUSHING PLANT:				
Hoist	75			
Crusher	150			
				225
BARNES-HECKER MINE:				
Cage Hoist (sold to Pickands, Mather & Co.)	400		400	
Skip "	400			
Water Supply Pump (to Holmes Mine)	10		10	
Underground Haulage Converter	150			
Location Water Supply Pump	2		2	
				550
LLOYD MINE:				
Skip Hoist	400			
Cage "	400			
Top Tram (1 motor stored)	80		40	
Ore Crusher	25			
Water Supply Pump installed underground	50			
Auxiliary Compressor for Hoist Brakes		5		
Top Tram		50		
				970
MORRIS MINE:				
Skip Hoist	600			
Cage "	400			
Shop	25			
Ingersoll-Rand Compressor #1	250			
4th Level Plunger Pumps - 2 - 350 HP motors	700			
7th " " Pump	100			
" " Centrifugal Pump	175			
Laboratory Crusher	5			
Carpenter Shop	25			
Nordberg Air Compressor	325			
Compressor Cooling Water Pump	5			
Top Tram - 2 - 50 HP motors	100			
Underground Haulage Set #1	150			
Centrifugal Water Supply Pump	50			
Heating Plant Condensing Water Pump	2			
Ingersoll-Rand Compressor #2	500			
Planer in Carpenter Shop	15			
Crusher	25			
Underground Haulage Set #2	215			
Winze Hoist - 7th level (to Gen. Storehouse)	200		200	
				3,667
SECTION 6 SHAFT:				
Hoist	200			
Water Supply Pump	3			
				203
AUSTIN MINE:				
Laboratory Crusher (to Gardner)	3		3	
				0
GWINN CRUSHING PLANT:				
Crusher	85			
Pan Conveyor	50			
Belt "	40			
Compressor		15		
				190
fwd.	24,281¼ HP	1,137	1,338¾	24,079½ HP

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	24,281¼ HP.	1,137 HP	1,338¾ HP	24,079½ HP.
FRANCIS MINE STOCKPILE:				
Triplex Pump (from Mackinaw)		7½		7½
GARDNER MINE:				
Top Tram (stored in Shed)	25		25	
Hoist (from Stephenson)		400		
Top Tram		50		
Laboratory Crusher (from Austin)		3		453
MACKINAW MINE:				
Hoist	400			
Shop	7½			
Top Tram (from Stephenson)	50			
Fire Pump in Engine House		20		
Underground Haulage Set	150			
Air Compressor	325			
Compressor Cooling Water Pump (from C.P.P.)		7½		960
PRINCETON MINE #2:				
Hoist	200			
Top Tram - 2 - 50 HP. motors	100			
Stockpile Loader		25		325
PRINCETON MINE #3:				
Hoist	75			75
STEPHENSON MINE:				
Skip Hoist	400			
Cage " (to Gardner)	400		400	
Top Tram - Bessemer (to Mackinaw)	50		50	
" " - C. & N. W.	50			
" " - #2 Bell (stored in Shop)	50		50	
Rock Tram	25			
Ore Tram	50			525
PRINCETON CENTRAL POWER PLANT:				
Turbine Auxiliaries (Circulating Pump	50			
(Injection "	40			
(Exciter	33			
Air Compressor	625			
Compressor Cooling Water Pump (to Mackinaw)	7½		7½	
Boiler Room Fan	50			
Coal Handling Machinery	10			
" " "	5			813
PRINCETON CENTRAL SHOPS:				
Shop Motor	25			
Grinder (to Escanaba River job)	3		3	25
PRINCETON CENTRAL PUMP STATION:				
Centrifugal Pump	100			
Automatic "	30			130
fwd.	27,617¼ HP.	1,650	1,874¼	27,393 HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	27,617¼ HP.	1,650 HP.	1,874¼ HP.	27,393 HP.
REPUBLIC MINE:				
Screen at #9 Shaft (stored)	25		25	
Crusher	100		100	
Auxiliary Compressor for Hoist Brakes	5			
Pump in Engine House	7½		7½	
Centrifugal Pump in Engine House	20		20	
Coal Tram	7½		7½	
Pump, bottom level #9 Shaft	20		20	
Machine Shop	5			
Pump - 4th Level (to Gen. Storehouse)	15		15	
" - 3rd "	50		50	
Pascoe Shaft Underground Pump, cross-over	50		50	
#9 Shaft Rock Tram	15		15	
Portable Hoist (to Escanaba River job)	7½		7½	
Laboratory Crusher	3			
Picking Belt	5		5	
Screen at Crusher	10		10	
Carpenter Shop	20		20	
#9 Shaft Hoist - 2 - 500 HP. motors	1,000			
M.-G. Set for U.G.Haulage (to Cliffs Shaft)	30		30	
U.G. Hoist - 7th Level Pascoe Shaft	100		100	
#9 Shaft Ore Tram - 2 - 50 HP. motors	100			
Drill Hoist - 7th level Pascoe Shaft	7½		7½	
Booster Compressor	200			
				1,313
CARP PLANT:				
Auxiliaries - 2 - 15 HP. pump motors	30			
Water Supply Pump	1			
Air Compressor		5		
				36
HOIST PLANT:				
Exciter Motor-Generator Set	20			
Oil Pump	3			
Air Compressor		5		
				28
McCLURE PLANT:				
Water Supply Pump	2			
Exciter Motor-Generator Set		17½		
Air Compressor		5		
				24½
ESCANABA RIVER PLANT: (Construction work)				
Air Compressor (to Gen. Storehouse)	50		50	
" "	100			
Centrifugal Pump	125			
Compressor Cooling Water Pump	3			
Concrete Mixer		7½		
Portable Hoist (from Republic Mine)		7½		
Grinder (" Prin.Cent.Shops)		3		
				246
TOTAL MINING DEPARTMENT	29,754¼ HP.	1,700½	2,414¼	29,040½ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
TOTAL MINING DEPARTMENT	29,754¼ HP.	1,700½ HP.	2,414¼ HP.	29,040½ HP.
PIONEER FURNACE:				
Furnace & Sawmill	1,195			1,195
L. S. & I. RR. CO.				
Shops, Sawmill, Ore Dock & Pumps	800			800
LAND DEPARTMENT:				
Sawmill at Munising - 2 motors	125			
Grand Island	10½			135½
LUMBERING DEPARTMENT:				
Dixon Location Water Supply Pump	5			
Tie Mill Saw	75			
" " Conveyors	37			
" " Shop	10			127
MICHIGAN GAS & ELECTRIC CO.;				
Ishpeming	2,170			
Munising	250			
Munising City Pumping	125			2,545
REPUBLIC TOWNSHIP:				
Water Supply Pump	25			25
OLIVER IRON MINING COMPANY:				
Pumps at Angeline & Section 16 Mines	525			
Air Compressor at Section 16 Mine	700			1,225
CITY OF ISHPEMING:				
Booster Pump at Brownstone	15			15
CITY OF NEGAUNEE:	435			435
THE CLIFFS ELECTRIC CO., PRINCETON	100			100
PALMER MINING COMPANY:				
Volunteer Mine, Palmer	800			800
EMPIRE-QUINN MINING COMPANY:				
Empire Mine, Palmer	135			
Archibald Mine, Gwinn	1,952			2,087
MUNISING WOODENWARE COMPANY:	695			695
FORD MOTOR COMPANY:				
Blueberry Mine		1,165		1,165
TOTAL OUTSIDE LOAD	10,184½ HP.	1,165 HP.	0	11,349½ HP.
GRAND TOTAL CONNECTED LOAD	39,938¾ HP.	2,865½ HP.	2,414¼ HP.	40,390 HP.

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

The following motors are not connected to our Power System:

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
SPIES MINE:				
Underground Triplex Pump	50 HP.			
Crusher	50			
Air Compressor	403			
Grinder in Shop	3			
Compressor Cooling Water Pump	3			
Hoist	400			
Boiler Feed Pump	2			
Top Tram (now on Circular Saw in Carp.Shop)	25			
Shop	5			
Compressor Cooling Water Pump	3			
Underground Haulage Set	150			
" Plunger Pumps, 8th Level (2)	300			
				1,394 HP.
MESABA RANGE:				
BOEING MINE:				
Sinking Hoist	35			
Air Compressor	225			
Underground Haulage Set	150			
Hoist (sold to Bristol Mine)	200		200	
Top Tram	50			
Compressor Cooling Water Pump	2			
Shop	10			
Blacksmith Shop Fan	1/4			
Tool Post Grinder (to Hill-Trumbull)	1/4		1/4	
Circular Saw " " "	3		3	
				472 1/4
CROSBY MINE:				
Log Washer	40			
Screen	20			
Picking Belt	3			
Chip Screen	3			
Tables	20			
Stockpile	7 1/2			
Centrifugal Pump	85			
#2 Turbo		20		
Feeder		20		
				218 1/2
HELMER MINE:				
Hoist	200			
				200
HOLMAN-CLIFFS MINE:				
Layne & Bowler Pump		350		
Worthington Shaft Pump		150		
				500
fwd.	2,448 HP	540	203 1/4	2,784 3/4 HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1928

Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	CONNECTED JAN. 1,1929 TOTALS
brt. fwd.	2,448 HP.	540 HP.	203¼ HP.	2,784¾ HP.
HILL-TRUMBULL MINE:				
Log Washer	25			
" "	40			
Turbos - 4 - 5 HP. motors	20			
~~Chip Screens - 2 - 2 HP. motors~~				
Crusher	100			
Sand Pump	10			
Sample Crusher	10			
Prescott Plunger Pump	125			
Centrifugal Pump	150			
Tables	20			
Shops	30			
Punch & Shear Machine in Shop	5			
Band Saw in Carpenter Shop	5			
Compressor in Shop	50			
Screen	20			
Conveyor	100			
Planer in Shop	2			
Variety Saw in Shop	5			
Forge Fan	½			
Electric Drill	¼			
Motor-Generator Set	65			
Blacksmith Shop Fan	¼			
Drill	¼			
Keystone Drill	15			
Tailings Pump	50			
Blacksmith Shop Fan	3			
Picking Belt	5			
Car Puller	7½			
Portable Grinder	1			
North Pit Pump	30			
Air Compressor at Washing Plant	25			
Churn Drill	10			
Boiler Feed Pump	5			
Blacksmith Shop Fan	3		3	
Chip Screens - 2 - 2 HP. motors		4		
Layne & Bowler Pump		125		
Tool Post Grinder (from Boeing)		¼		1,064
WADE MINE:				
Hoist	125			
Air Compressor	150			
Compressor Cooling Water Pump	2			
Underground Haulage Set	150			
Machine Shop	10			
Underground Triplex Pump	50			
" Centrifugal Pump	100			
Sump Pump	3			
Top Tram	50			
Clear Water Pump	15			
Blacksmith Shop Fan (from Hill-Trumbull)		3		658
TOTAL	4,040¾ HP.	672¼ HP.	206¼ HP.	4,506¾ HP.

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Electrical Department (Cont'd)

The following A.C. motors are on hand (Dec. 31, 1928), but are not installed:

CLIFFS SHAFT MINE:		
Top Tram -(stator only)	50	
Spare Top Tram	50	
Top Tram	50	
Hoist Stator only	500	
Small Conveyor Motor	2	
Scraper Motor	25	
		677 HP.
GENERAL STOREHOUSE:		
Centrifugal Pump from D. R. Storage Dam	3	
Spare Motor-Generator Set	15	
" from Republic Concrete Mixer	5	
" General Electric pump	50	
" Westinghouse Motor-Generator Set (Angeline)	150	
" General Electric " " " (Morris-Lloyd)	150	
" from Stephenson Mine plunger pump	250	
" " Hard Ore #3 plunger pump	35	
" " Holmes Mine crusher	100	
" Top Tram	50	
Bag Cleaner from D. R. Storage Dam	1/2	
Spare for Centrifugal Pump used at North Lake	200	
" from " " " " " "	5	
" Centrifugal Pump	30	
" from Morris Mine cage hoist	400	
" Haulage Converter from Francis	150	
" Plunger Pump from "	35	
" motor	40	
" Pump motor from Republic	15	
" Top Tram from Austin	25	
" Pump from Lake Mine	20	
Winze Hoist from Morris Mine	200	
Compressor from Crosby Mine	50	
		1,978½
LAKE MINE CHANGE HOUSE:		
Ventilating Fan from Salisbury Mine	7½	
		7½
MAAS MINE:		
Winze Pump	15	
Pump (from Morris Mine)	50	
Pump (" Boeing Mine)	100	
		165
NEGAUNEE MINE:		
Flywheel Hoist Set motor	350	
		350
ATHENS MINE:		
Pump Motor	35	
		35
MORRIS-LLOYD MINE:		
Centrifugal Pump motor (from McClure Plant)	50	
Top Tram	40	
		90
ISHPEMING HOSPITAL:		
Spare for Dumb Waiter	3	
		3
PRINCETON MINE:		
Underground Pump	150	
		150
fwd.		3,456 HP.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	brt. fwd.		3,456 HP.
GWINN STORAGE SHED & STEPHENSON TRANSFER:			
Stephenson 5th level Plunger Pump		250	
" " " " "		250	
" 6th " Centrifugal Pump		50	
" 8th " Plunger "		50	
" 5th " Centrifugal "		400	
" 6th " " "		125	
" Underground Hoist		75	
" 6th level Automatic Pump		30	
Austin Hoist Motor		200	
" Top Tram		25	
			1,455
REPUBLIC MINE:			
Spare		10	
"		30	
" Pump Motor		10	
Screen from #9 Shaft		25	
Crusher		100	
Pump from Engine House		7½	
Centrifugal Pump from Engine House		20	
Coal Tram		7½	
Pump from bottom level #9 Shaft		20	
" " 3rd level		50	
" " Pascoe Shaft cross-over		50	
#9 Shaft Rock Tram		15	
Picking Belt		5	
Screen from Crusher		10	
Carpenter Shop		20	
Underground Hoist		100	
" "		50	
Pump from 11th level		7½	
			537½
	TOTAL		5,448½ HP.
Spare motors at Spies Mine:			
Aldrich Triplex Pump		50	
Prescott Centrifugal Pump		400	
	TOTAL		450 HP.
Spare motors on Mesaba Range:			
BOEING MINE:			
Sump Pump		7½	
Pump Motor		125	
" "		85	
			217½
HILL-TRUMBULL MINE:			
Conveyor		50	
Screen		20	
Pump		3	
Shop		5	
Sump Pump		5	
Spare		3	
Plunger Pump		50	
Picking Belt		2	
Ventilating Fan		15	
			153
	fwd.		370½ HP.

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Electrical Department (Cont'd)

brt. fwd.		370½ HP.
WADE MINE:		
Pump	5	
Skip Pit Pump	5	
Centrifugal Pump	20	
		30
HOLMAN-CLIFFS MINE:		
Pump motor	275	
		275
TOTAL		675½ HP.

Total C. C. I. Co. load connected to Power System - Dec. 31,1928 - 29,040½ HP.
" outside " " " " " " - " - 11,349½

TOTAL CONNECTED LOAD 40,390 HP.

Total connected load at Spies Mine - 1,394 HP.

" " " " " Mesaba Range mines - 3,112¾ HP.

Total spare motors on hand Dec. 31, 1928 - Ishpeming District - 5,448½ HP.

" " " " " " - Spies Mine - 450 HP.

" " " " " " - Mesaba Range - 675½ HP.

Electrical Department (Cont'd)

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

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	JAN. 1,1929 TOTALS
AU TRAIN WATER POWER PLANT:				
Exciters (2)	34 KW.			34 KW.
CARP RIVER WATER POWER PLANT:				
Exciters (2)	150			150
HOIST PLANT:				
Exciter	17½			
"	37			54½
McCLURE PLANT:				
Exciters (2)	110			
M.G. Exciter		12		122
MAAS PLANT:				
Motor Driven Exciter	22½			
Turbo "	22½			
Compressor Motor Exciters (2)	20			65
PRINCETON CENTRAL POWER PLANT:				
Motor Driven Exciter	22½			
Turbo " "	22½			
Compressor Motor Exciter	12			57
REPUBLIC MINE:				
Exciter in #5 Engine House	7½			
" " Water Power Plant	17			24½
CLIFFS SHAFT MINE:				
Compressor Motor Exciters (2)	20			20
BROWNSTONE SUBSTATION:				
Battery Charging Set	2			
Line Testing Set	1/2			
Voltage Regulator Control	1/2			
Condenser Exciter	15			18
HOLMES MINE:				
Compressor Motor Exciter	10			10
ATHENS MINE:				
Nordberg Compressor Motor Exciter	10			
Flywheel Set Exciter	15			
Skip Hoist Generator	700			
Battery Charging Motor-Generator Set	1/2			
Ingersoll-Rand Compressor Motor Exciter	10			735½
MAAS CRUSHING PLANT:				
Pan Conveyor Generator	35			
" " " Exciter	1¾			36¾
fwd.	1,315¼ KW.	12 KW.		1,327¼ KW.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	JAN. 1,1929 TOTALS
brt. fwd.	1,315¼ KW.	12 KW.	0	1,327¼ KW.
NEGAUNEE MINE:				
Skip Hoist Generator	400			
Cage " "	150			
Flywheel Set Exciter	25			
Exciters for Underground Pump Motors (2)	28			
Ingersoll-Rand Compressor Motor Exciter	10			
Nordberg " " "	10			
Bell Signal Set	1/2			
				623½
MORRIS MINE:				
Ingersoll-Rand Compressor Motor Exciter	12			
Nordberg " " "	10			
Ingersoll-Rand " " "	10			
				32
MACKINAW MINE:				
Compressor Motor Exciter	10			
				10
OGDEN MINE:				
Thrust Generator on Electric Shovel	15		15	
Hoist " " " "	75		75	
Swing " " " "	15		15	
Exciter " " "	5½		5½	
				0
TILDEN MINE:				
Thrust Generator on Electric Shovel		15		
Hoist " " " "		75		
Swing " " " "		15		
Exciter " " "		5½		
				110½
TOTAL	2,091¼ KW	122½ KW	110½	2,103¼ KW.
Underground Haulage Generators:				
CLIFFS SHAFT MINE:				
Motor-Generator Set #1	100 KW.			
" " " #2	100			
Motor-Generator Charging Set	5			
" " " "		20		
				225
HOLMES MINE:				
Rotary Converter	100			
				100
ATHENS MINE:				
Rotary Converter	100			
				100
MAAS MINE				
Motor-Generator Set	100			
				100
NEGAUNEE MINE:				
Motor-Generator Set #1	100			
" " " #2		150		
				250
fwd.	605	170		775 KW

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	JAN. 1,1929 TOTALS
brt. fwd.	605 KW.	170 KW.	0	775 KW.
BARNES-HECKER MINE:				
Rotary Converter	100			100
MORRIS-LLOYD MINE:				
Motor-Generator Set #1	100			
" " " #2	100			200
MACKINAW MINE:				
Rotary Converter	100			100
REPUBLIC MINE:				
Battery Charging Set for Storage Battery Locomotives (to Cliffs Shaft)	20		20	0
TOTAL	1,025	170	20	1,175 KW.
Direct Current Motors:				
AU TRAIN WATER POWER PLANT:				
Governor Control Motors (2)	¼ HP.			¼ HP.
CARP RIVER WATER POWER PLANT:				
Rheostat Control (2)	1/4			
Governor " (2)	1/4			½
McCLURE PLANT:				
Valve Control (2)	2			
Rheostat Control (2)	1/2			2½
CLIFFS SHAFT MINE:				
Portable Hoist	10			
Re-crushing Plant Conveyor (taken out)	2		2	
Car Puller	6½			16½
HOLMES MINE:				
Sturtevant Fan	1½			
Scrapers 7 - 15 HP. motors		105		106½
OGDEN MINE:				
Hoist motor on Electric Shovel	100		100	
Swing " " " "	20		20	
Thrust " " " "	20		20	
TILDEN MINE:				
Hoist motor on Electric Shovel		100		
Swing " " " "		20		
Thrust " " " "		20		140
fwd.	163¼	245	142	266¼ HP.

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Electric Department (Cont'd)

	INSTALLED TO JAN. 1, 1928	INSTALLED IN 1928	TAKEN OUT IN 1928	JAN. 1,1929 TOTALS
brt. fwd.	163¼ HP.	245 HP.	142 HP.	266¼ HP.
ATHENS MINE:				
Skip Hoist	900			
Ventilating Fan	5			
Sullivan Scrapers - 2 - 6½ HP.	13			
				918
MAAS MINE:				
Timber Hoist - 2nd level	10			
" " 4th "	10			
Bilge Pump	5			
Ventilating Fan	15			
Sullivan Scraper	15			
" Scrapers - 7 - 6½ HP.	32½	13		
Denver Scraper	7½			
				108
MAAS CRUSHING PLANT:				
Pan Conveyor	40			
				40
NEGAUNEE MINE:				
Skip Hoist	500			
Cage "	200			
Timber Hoist - tunnel	10			
" " - 10th level	10			
Ventilating Fan	7½			
" Fans 3 - 5 HP.	15		15	
Scrapers 10 - 7½ HP.	60	15		
Sullivan Scrapers 10 - 6½ HP.	65			
" " 3 - 25 HP.	25	50		
Ventilating Fan (from Gwinn)		5		
Denver Scrapers 5 - 10 HP.		30		
				977½
MORRIS MINE:				
Ventilating Fan - 6th level	15			
Sullivan Scrapers 10 - 6½ HP.	45½	19½		
Denver Rock Drill Scrapers 7 - 7½ HP.	52½			
Sullivan Scrapers 2 -10 HP.	10	10		
				152½
TOTAL	2,231¾	387½	157	2,462¼ HP.

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Electrical Department (Cont'd)

Spare Generators and Exciters on hand December 31st, 1928:

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

Spare Underground Haulage Generators on hand December 31st, 1928:

GENERAL STOREHOUSE:		
Motor-Generator Set (from Angeline)	100	
" " " (from Morris)	100	
Rotary Converter (from Francis)	100	
TOTAL		300 KW.

Spare Direct Current Motors on hand December 31st, 1928:

ATHENS MINE:		
Fan Motor	15 HP.	
Timber Hoist Motor	10	
Fan	15	
		40 HP.
MORRIS-LLOYD MINE:		
Crane Motor	10	
		10
GENERAL STOREHOUSE:		
Pump Motor	20	
Scraper Motor	20	
		40
HOLMES MINE:		
Fan Motors - 2 - 1½ HP.	3	
		3
MAAS MINE:		
Fan Motor	5	
		5
TOTAL		98 HP.

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

MESABA RANGE:

Exciters and Generators installed up to December 31st, 1928:

BOEING MINE:
Compressor Motor Exciter — 6 KW.

Underground Haulage Generators installed up to Dec. 31st, 1928:

BOEING MINE:
Motor-Generator Set — 115 KW.

HILL-TRUMBULL MINE:
Motor-Generator Set — 55

WADE MINE:
Rotary Converter — 100

TOTAL — 270 KW.

Direct Current Motors installed up to December 31st, 1928:

HILL-TRUMBULL MINE:
Feeder Motor — 60 HP.

Total Exciters and Generators installed to December 31st, 1928 - 6 KW.

" Underground Haulage Generators " " 2 " 625 " " - 270 KW.

" Direct Current Motors " " 3 " 66 " " - 60 HP.

SPIES MINE:

Exciters installed to December 31st, 1928:

Compressor Motor Exciter — 10 KW.

Underground Haulage Generators installed up to December 31st, 1928 - 150 KW.

Top Tram Larry Cars - 2 - 20 HP. — 40 HP.

ISHPEMING DISTRICT:

Total D.C. Generators and Exciters installed to Dec. 31st, 1928 - 2,103¼ KW.

" Underground Haulage Generators " " " " " - 1,175 KW.

" Direct Current Motors " " " " " - 2,462¼ HP.

Total Spare D.C. Generators and Exciters on hand " " " - 50 KW.

" " Underground Haulage Generators " " " " " - 300 KW.

" " Direct Current Motors " " " " " - 98 HP.

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

Substation Transformers installed up to December 31, 1928:

	Phase	No.	K.V.A.	Total K.V.A.	
33000/2300 Volts					
Brownstone Substation	1	3	400	1,200	
Cliffs Shaft- Holmes Substation	1	6	500	3,000	
Morris-Lloyd Substation	1	3	590	1,770	
Barnes-Hecker "	1	3	250	750	
Republic "	1	3	400	1,200	
Maas "	1	6	590	3,540	
Prineton "	1	3	590	1,770	
Gwinn "	1	3	625	1,875	
Munising "	1	3	200	600	
McClure Plant	3	2	5,000	10,000	
Carp Plant	1	3	1,900	5,700	
Au Train Plant	3	1	1,250	1,250	
Palmer Substation	1	2	625	1,250	
Hoist Plant	1	3	667	2,000	
			TOTAL		35,905 K.V.A.
Chatham Substation	1	2	15	30	
Carlshend "	1	2	15	15	
Little Lake "	1	1	15	15	
					60 "
30000/6600 Volts					
Champion Substation	1	2	25	50	
Eben "	1	1	25	25	
					75 "
6600/2300 Volts					
Carp Plant	1	6	185	1,110	
Gwinn Substation	1	3	350	1,050	
Mackinaw "	1	3	350	1,050	
			TOTAL		3,210 K.V.A.

Transformers used for Underground Haulage installed to 12/31/28:

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

MECHANICAL DEPARTMENT
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YEAR 1928

Electrical Department (Cont'd)

Distribution Transformers installed up to December 31,1928.

2300/220/110 Volts	Phase	No.	K.V.A.	TOTAL K.V.A.
Angeline Mine:				
Hoist Control	1	1	7½	7½
CLIFFS SHAFT MINE:				
Office Lights	1	1	(10) 10	
" "	1	1	15	
Laboratory	1	1	5	
"A" Shaft Hoist	1	1	7½	
"B" " "	1	1	10	
Coal Crusher	1	2	(7½) 15	
Pump Station Lights	1	1	1	
Crusher House Lights	1	2	(1) 2	
Crushers	1	3	(10) 30	
Gravel Scraper	1	2	(37) 75	
Underground Scrapers	1	4	(50) 200	
" " "	1	3	(25) 75	
Motor- Generator Set for Battery Charging and 1st Level A Scrapers	1	3	(15) 45	
Rectifiers	1	7	(5) 35	
Lights	1	11	(1½) 16½	542
HARD ORE & BROWNSTONE:				
Light & Power	1	1	15	
Light	1	1	¾	
Light & Power	1	1	7½	
Shop	1	1	30	53¼
HOLMES MINE:				
Shop Power	1	3	(10) 30	
Engine House Lights & Power	1	1	5	
Skip Hoist Control	1	1	10	
Cage " "	1	1	10	
4th level Pump Station Lights	1	1	2	
Cage Bell Circuit	1	1	3/4	
Skip " "	1	1	1/2	
Shaft House Lights	1	1	3/4	
Pump " "	1	1	3/4	
Change " "	1	1	3/4	
Shaft " "	1	1	1/2	
Engine " "	1	1	7½	
5th level Pumps	1	3	(15) 45	113½
LAKE MINE:				
Engine House Lights	1	1	5	
Shaft Lights	1	1	3/4	5¾
			fwd.	722

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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
brt.fwd.					722
TILDEN MINE:					
Lights & Power	1	1		10	
Lights & Power	1	2	(5)	10	
" "	1	2		2	
Drills	1	3	(10)	30	
Shovel	1	3	(5)	15	
					67
ATHENS MINE:					
Machine Shop	1	2	(10)	20	
Surface Lights & Lab. Hot Plates	1	3	(10)	30	
Pump Station Lights	1	1		5	
" " "	1	1		2	
100 G.P.M. Pump	3	1		40	
Signal System	1	1		1	
Engine House Lights	1	1		5	
" " "	1	1		4	
Top Tram	1	1		2	
Top Tram Control	1	1		1	
					110
MAAS MINE:					
Lights & Injection Pump	1	3	(10)	30	
Coal Crusher & Shop	1	2	(10)	20	
Signal System	1	1		1/2	
3rd level Pump Station	1	2	(5)	10	
Bell Signal at 55 Winze	1	1		1	
Cage Hoist Control	1	1		10	
Skip Hoist "	1	1		2	
" " "	1	1		3	
Rock Tram "	1	1		1	
Heaters in Engine House	1	1		7½	
Top Tram	1	1		2	
4th level Pump	1	3	(5)	15	
					102
Maas Crushing Plant:					
Lights	1	1		7½	
Screen	1	3	(10)	30	
					37½
NEGAUNEE MINE:					
Shop Light & Power	1	2	(10)	20	
Engine House Lights & Power	1	1		10	
" " " " "	1	1		5	
Signal System	1	1		1/2	
Pump Station Lights, etc.	1	3	(7½)	22½	
12th level Pump	1	3	(5)	15	
Barn	1	1		5	
Gravel Pit	1	1		7½	
Hoist & Lights-#2 Shaft	1	3	(10)	30	
Engine House Lights & Power	1	2	(15)	30	
					145½
South JACKSON CRUSHING PLANT:					
Hoist Brake	1	1		5	
Lights	1	1		2	
					7
				fwd.	1,191

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
brt. fwd.					1,191
BARNES-HECKER MINE:					
Lights Engine House	1	1		5	
" " "	1	1		7½	12½
LLOYD MINE:					
Cage Hoist Control	1	1		7½	
Skip " "	1	1		7½	
Water Supply Pump House Lights	1	1		2	
Engine House Lights & Bell Signal	1	1		5	
Shaft House Lights	1	1		5	27
MORRIS MINE:					
Skip Hoist Control & Lights	1	1		10	
Cage " " " "	1	1		7½	
Signal System Lights	1	1		1/2	
Shop & Lights	1	3	(10)	30	
7th level Pump Station Lights	1	1		2	
Location Lights	1	1		10	
Club House Lights	1	1		5	
					65
SECTION 6 SHAFT:					
Hoist Control	1	1		7½	
Lights	1	2	(2)	4	
					11½
REPUBLIC MINE:					
G.E. Tram	1	1	(15)	15	
Lighting	1	3	(2)	6	
" & Pump	1	1		10	
Engine House Lights	1	1		7½	
Hoist Control	1	1		25	
Top Tram Controls	1	2	(1)	2	
Office Lights	1	1		3	
Motor- Generator Set & Pumps	1	3	(7½)	22½	
Pascoe Shaft Hoist Control	1	1		7½	
Power & Lights on Surface	1	3	(10)	30	
Water Power Plant Lights	1	1		1½	
Screen Motor & Lights	1	3	(3)	9	
Portable Hoist	1	1		10	
					149
AUSTIN MINE:					
Lights	1	1		10	
Shop	1	1		10	
					20
GARDNER MINE:					
Cage Hoist Control	1	1		10	
					10
MACKINAW MINE:					
Machine Shop	1	2	(5)	10	
Hoist Control	1	1		7½	
Signal System	1	1		1	
					18½
				fwd.	1,504½

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

Distribution Transformers: (Cont'd)

	PHASE	NO.	K.V.A.	TOTAL K.V.A.
brt. fwd.				1,504½
PRINCETON MINE:				
Top Tram Lights	1	1	3	
Pump House Lights	1	1	2½	
				5½
PRINCETON CENTRAL POWER PLANT:				
Coal Crusher	1	3	(7½) 22½	
Power Plant Lights	1	1	10	
Injection Pump	1	2	(15) 30	
Boiler Room Fan	1	2	(10) 20	
				82½
PRINCETON CENTRAL SHOPS:				
Power & Light	1	2	(10) 20	
				20
PRINCETON DISTRICT LABORATORY:				
Hot Plates	1	3	(10) 30	
				30
STEPHENSON MINE:				
Rock Tram	1	3	(10) 30	
Skip Hoist Control	1	1	10	
				40
AU TRAIN WATER POWER PLANT:				
Power Plant Lights	1	1	1	
Operator's Dwelling Lights	1	1	2	
Control	1	1	2	
Power & Lights, Dixon Location	1	2	(5) 10	
" " " Grand Island	1	2	(5) 10	
				25
CARP RIVER WATER POWER PLANT:				
Power & Light	1	1	10	
" " "	1	1	20	
Pump	1	2	(1) 2	
				32
HOIST PLANT:				
Power & Light	1	1	7½	
" " "	1	2	(5) 10	
				17½
McCLURE PLANT:				
Power & Light	1	2	(10) 20	
				20
ESCANABA RIVER WATER POWER:				
Power & Lights	1	2	(1) 2	
" " "	1	2	(1) 2	
				4
		GRAND TOTAL		1,781 K.V.A.

MECHANICAL DEPARTMENT
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Electrical Department (Cont'd)

Spare Transformers on hand December 31, 1928:

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
ANGELINE MINE:					
General Electric	1	1		1	1
ATHENS MINE:					
Spare	1	1		3	
Spare	1	1		3	
Spare	1	1		7½	13½
REPUBLIC MINE:					
General Eletric	1	1	(10)	10	
" "	1	1		4	
Lights & Pump	1	1	(10)	10	24
General Storehouse:					
General Electric for 440 shaft pump	1	1		100	
From Francis Converter	1	2	(35)	70	
General Electric	1	1		10	
" "	1	1		7½	
" "	1	1		5	192½
		GRAND TOTAL			251 K.V.A.

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COMPARATIVE TABLES.

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
CLIFFS SHAFT MINE					
1919	3 494	277 901	907 895 024	2 402	298 889 689
1920	3 854	334 347	872 225 408	2 638	262 308 003
1921	2 094	67 454	273 648 228	4 057	274 901 402
1922	891	138 702	419 382 000	3 023	399 874 439
1923	2 359	305 727	734 645 710	2 403	377 383 675
1924	2 224	309 996	784 461 617	2 530	388 257 675
1925	2 900	322 928	824 005 547	2 551	327 655 585
1926	1 470	350 604	801 351 000	2 285	379 727 700
1927	957	426 830	766 647 000	1 796	440 517 425
1928	1 008	416 344	804 600 000	1 932	463 182 750
HOLMES MINE					
1919	947	173 178	521 145 000	3 009	*25 471 515
1920	682	260 118	448 965 000	1 726	26 099 690
1921	832	191 147	275 057 000	1 439	38 456 053
1922	911	231 306	346 466 000	1 497	73 009 389
1923	704	289 984	431 820 000	1 489	82 640 803
1924	879	170 228	296 460 000	1 741	75 235 295
1925	679	172 507	253 125 000	1 446	56 962 287
1926	768	178 296	267 795 000	1 502	83 223 451
1927	816	186 436	333 180 000	1 787	79 829 181
1928	716	207 754	484 785 000	2 333	82 552 319
ATHENS MINE					
1919	740	155 643	414 045 000	2 660	85 503 850
1920	593	214 601	505 035 000	2 353	82 794 824
1921	515	177 065	359 055 000	2 027	73 114 028
1922	683	193 711	456 615 000	2 357	86 235 708
1923	971	246 704	635 535 000	2 576	103 329 157
1924	685	246 352	581 130 000	2 359	116 161 813
1925	789	214 510	468 900 000	2 186	131 715 395
1926	869	226 229	547 650 000	2 421	140 788 044
1927	790	233 221	679 815 000	2 914	127 086 869
1928	827	241 977	710 640 000	2 936	120 178 303
MAAS MINE					
1919	9 639	343 810	644 597 449	1 874	573 373 848
1920	5 097	351 521	571 224 659	1 625	513 176 403
1921	735	211 616	373 275 000	1 764	517 238 661
1922	628	219 676	458 010 000	2 083	516 431 109
1923	548	228 528	472 220 000	2 066	509 330 141
1924	682	224 291	470 880 000	2 099	522 683 088
1925	670	144 408	372 735 000	2 581	480 918 511
1926	829	245 992	420 930 000	1 711	508 242 996
1927	767	274 586	521 730 000	1 900	534 129 791
1928	657	272 740	679 005 000	2 489	553 419 346

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COMPARATIVE TABLES:

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	Cubic FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
NEGAUNEE MINE					
1919	1 320	525 894	591 104 600	1 185	603 198 543
1920	1 095	569 895	729 139 000	1 279	610 132 854
1921	838	258 967	306 315 000	1 183	597 401 853
1922	1 075	300 041	414 765 000	1 392	613 603 672
1923	996	383 914	655 695 000	1 708	582 912 109
1924	1 156	322 705	558 980 000	1 732	502 525 354
1925	1 100	342 824	660 600 000	1 927	436 422 253
1926	1 229	374 004	602 010 000	1 609	440 271 619
1927	1 139	501 516	895 680 000	1 785	603 746 976
1928	1 278	472 458	1 047 240 000	2 216	629 675 383
OGDEN MINE					
1925	* ---	61 514	— — —	— —	— — —
1926	— —	146 501	— — —	— —	— — —
1927	— —	174 106	— — —	— —	— — —
1928	— —	116 415	— — —	— —	— — —
MORRIS- LLOYD MINE:					
1919	1 132	313 887	936 264 700	2 982	340 883 130
1920	971	283 400	802 952 000	2 832	311 061 125
1921	848	234 809	681 918 000	3 067	321 064 176
1922	931	241 065	596 225 500	2 473	276 149 791
1923	1 031	273 124	826 038 000	2 460	267 210 477
1924	894	229 968	381 573 000	1 659	221 874 604
1925	919	258 062	611 836 920	2 371	172 168 518
1926	1 190	291 852	469 265 000	1 608	203 411 761
1927	1 096	333 736	688 545 000	2 062	223 631 596
1928	1 295	364 123	693 360 000	1 904	227 752 992
Hill-Trumbull Mine					
1922	3 447	352 651	— — —	— —	— — —
1923	4 096	311 012	— — —	— —	— — —
1924	3 049	322 823	— — —	— —	— — —
1925	3 364	521 382	— — —	— —	— — —
1926	3 738	522 017	— — —	— —	— — —
1927	4 149	544 405	— — —	— —	— — —
1928		495 748	— — —	— —	— — —
REPUBLIC MINE					
1919	5 709	185 383	1 228 202 000	6 625	34 770 380
1920	3 972	181 058	1 347 129 000	7 440	35 559 650
1921	1 436	79 761	954 242 000	11 964	35 132 398
1922	1 302	113 108	1 112 788 000	9 838	41 620 635
1923	1 816	137 181	1 279 058 000	9 329	37 204 860
1924	2 668	87 668	1 158 600 000	13 215	33 955 020
1925	2 275	90 773	871 386 000	9 599	27 210 960
1926	2 218	76 867	1 053 268 000	13 702	31 117 828
1927	1 743	71 499	928 003 000	12 979	41 876 020
1928	1 023	23 269	— — —	— —	— — —

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COMPARATIVE TABLES:

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU.FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
SPIES - VIRGIL MINES:					
1919	962	71 000	— — —	— —	— — —
1920	377	93 519	— — —	— —	— — —
1921	350	46 878	87 360 300	— —	— — —
1922	192	5 432	— — —	— —	— — —
1923	495	19 732	— — —	— —	— — —
1924	272	55 953	— — —	— —	— — —
1925	313	72 542	— — —	— —	— — —
1926	392	92 407	— — —	— —	— — —
1927	424	163 911	— — —	— —	— — —
1928	366	184 141	— — —	— —	— — —
GARDNER - MACKINAW MINE:					
1928	336	91 293	214 020 000	2 344	52 760 063

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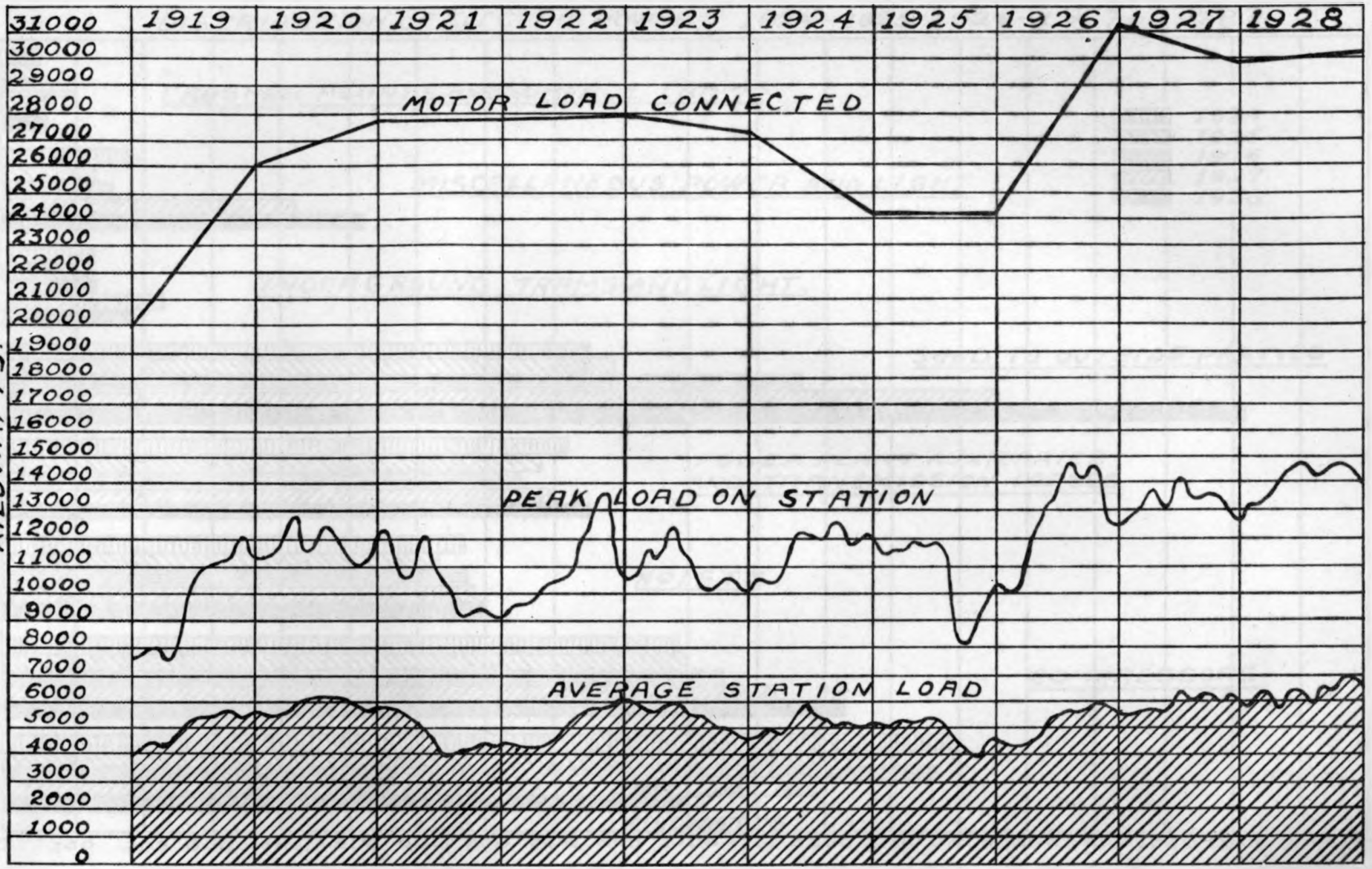

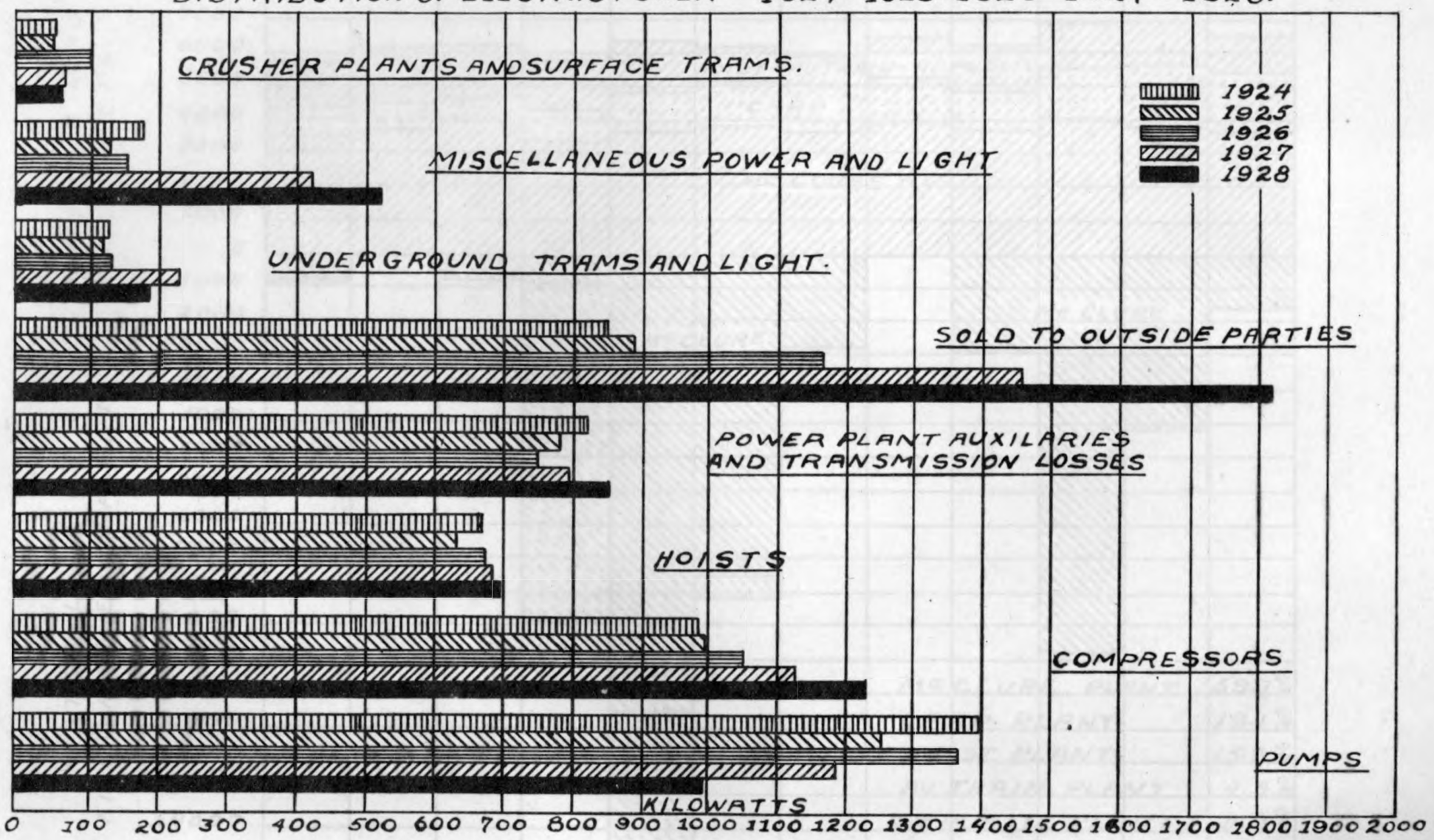
DISTRIBUTION OF ELECTRIC POWER 1924-1925-1926-1927-1928.
CRUSHER PLANTS AND SURFACE TRAMS.
MISCELLANEOUS POWER AND LIGHT
UNDERGROUND TRAMS AND LIGHT.
SOLD TO OUTSIDE PARTIES
POWER PLANT AUXILARIES AND TRANSMISSION LOSSES
HOISTS
COMPRESSORS
PUMPS
1924
1925
1926
1927
1928
KILOWATTS
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

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1928